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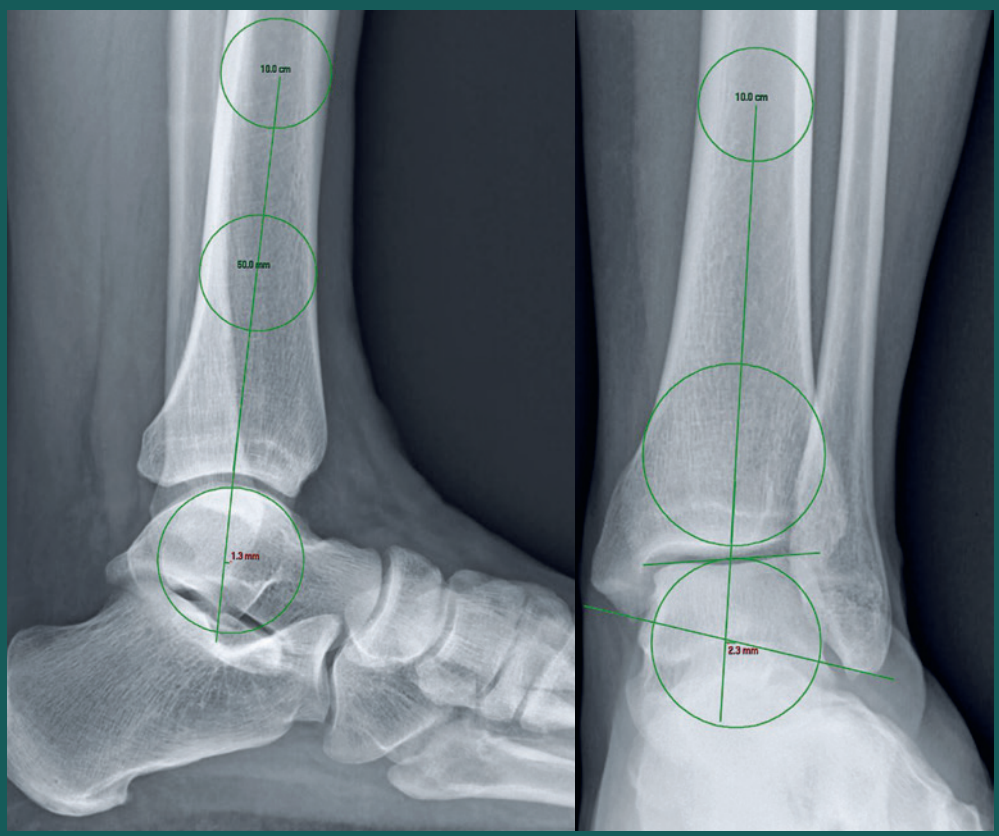

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JOURNAL OF THE Foot & Ankle JFA

A new path for the Journal of the Foot & Ankle - JFA

Hard work is the key to success. It may sound like a cliché, but the preparation and the release of this first edition of the new Journal of the Foot & Ankle (JFA) were based on this very concept, and we took it very seriously! For years many of us have dedicated time and efforts to bring this Journal to life. After countless meetings, discussions, phone calls, WhatsApp messages, and an infinite amount of writing, our collaborative hard work and friendship finally brought us here!

Now we need to stay focused and ahead of the game, looking forward to the future and the innovations. We should aim to publish high-quality, unbiased research, with emphasis on strong clinical evidence.

Our vision is to support researchers and research that can enable the Orthopaedic Foot and Ankle Surgery Community to understand better the complexity of the pathologies, guide treatment, and, most importantly, improve the treatment results and quality of life of our patients. Our thoughts are that keeping all these goals in mind will allow us to achieve the expected acceptance and respect of the research community, as well as the desired indexation. It is not an easy task! But we are confident we can get there with your help!

We're great believers in working as a team towards a common goal, and we are sure that with the help of our dedicated Foot and Ankle colleagues and researchers, we will soon make our vision become a reality! Let's do it together!

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Original Article

Minimally invasive technique with intramedullary nail for treatment of severe hallux valgus: clinical results and surgical technique

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Abstract

Objective: The purpose of the study was to evaluate early clinical and radiological results with a novel minimally invasive surgery (MIS) technique for Lapidus arthrodesis using intramedullary nail.

Methods: Retrospective review of patients with hallux valgus surgery during an 18-month period. Patients with a procedure other than MIS Lapidus nail fixation were excluded. We describe surgical technique with a percutaneous joint preparation and fixation with an intramedullary nail through a MIS approach. Demographic variables, early complications and radiographic parameters were measured.

Results: Ten feet in 8 patients with severe HV underwent a Lapidus procedure performed with a minimal invasive technique using intramedullary nail for fixation. No soft tissue complications and 1 patient required screw removal after bone healing. Mean HVA decreased from 31,4 degrees (range 17 to 47) SD (±9,3) to 10,3 degrees (range, -8,8 to 31,5) SD (±8,4), mean IMA decreased from 17,91 degrees (range, -17 to 20) SD (±0,9) to 5,46 degrees (range, –7,3 to 15.3) SD (±2,9) and mean DMAA decreased from 20,36 (range, 10-40) SD (±8,4) to 7,67 (range, -5 to 30) SD (±8,0).

Conclusion: Intramedullary nail for Lapidus arthrodesis with minimally invasive technique showed satisfactory radiographic correction and minimal complications, but further follow up is needed to analyze clinical-radiographic results.

Level of Evidence IV; Therapeutic Study; Case Series.

Keywords: Hallux valgus/surgery; Osteotomy/methods; Minimally invasive surgical procedures; Fracture fixation, intramedullary; Treatment outcome.

Introduction

Hallux valgus deformity is a triplanar deformity of the first ray which involves varying degrees of varus of the first metatarsal, valgus of the hallux, and pronation of the first ray. The Lapidus procedure was introduced in 1934 to correct hallux valgus in relation to hypermobility of the first ray[1]. The original technique consisted of an arthrodesis of the first cuneiform-metatarsal joint and the first intermetatarsal joint. The fixation was achieved by sewing the joint capsules with catgut. Later on, fixation was achieved by crossed screws performed by Hansen and colleagues[2] and led to a modified technique without intermetatarsal fusion. The Lapidus procedures has a strong ability to correct the pronated first metatarsal and reduce the subluxated sesamoids, due to most of the rotation, occurs at the tarsometatarsal Joint (TMT joint)[3]. It has a higher corrective power compared to other procedures for correction of hallux valgus deformity, therefore diminishing the rate of recurrence. Accepted indications for this procedure include: severe hallux valgus deformity being IMA >15, arthritis of the tarsometatarsal joint, metatarsus primus varus and hypermobility of the tarsometatarsal joint among others[1]. There are two main concerns regarding Lapidus procedure. The first is nonunion risk, with literature indicating a rate of approximately 2% to 10%[4-6]. The second concern is malunion, most commonly shortening and dorsiflexion of the first ray, leading to transfer metatarsalgia[6,7].

Study performed at the Department of Orthopaedic Surgery, Clínica Universidad de los Andes, Las Condes, Santiago, Chile.

Correspondence: Felipe Chaparro. 2501 La Plaza Av., Las Condes, Santiago, Chile, Zip Code: 7620001. **E-mail:** fchaparro@clinicauandes.cl. **Conflicts of interest:** none. **Source of funding:** none. **Date received:** April 07, 2020. **Date accepted:** April 07, 2020. **Online:** April 30, 2020.

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During the last few years, research and interest in hallux valgus surgery has grown, resulting in better outcomes and reduced complications. Fixation of Lapidus fusion has evolved in both its approach and method of fixation, looking for avoid soft tissue injury and better biomechanical resistance. It is recently that intramedullary nail has been introduced as a new method of first tarsometatarsal arthrodesis.

The intramedullary nail can resist superior forces across the fusion site and limits migration during healing to facilitate earlier weight-bearing. Being intramedullary, the nail is capable of accepting greater forces across the fusion site and limits migration during healing while providing even compression across the first TMT joint[8].

Minimally invasive surgery (MIS) for hallux valgus correction remains controversial. Literature regarding this topic is continuously growing, but at this time, there is scarce literature showing whether MIS for hallux valgus correction is effective compared to traditional approach or if correction remains stable over time. The most common complications following MIS were described by Oliva et al.[9], which are deformity recurrence, incorrect procedure selection or operative technique, and underestimation of osteotomy healing time. In contrast, the biggest advantage of MIS for hallux valgus is that correction can be done with a very small incision, limiting wound problems, maintaining local environment and a less visible scar.

Forefoot MIS is continuously growing based on third generation techniques, with promising results in terms of deformity correction, wound healing and patient satisfaction[10] Recently, 2 systematic reviews concluded that MIS is safe and reliable for hallux valgus surgery[11,12]. Theoretically, it would be of great interest to take advantage of benefits described for MIS surgery and nail fixation, but to our knowledge, there is no available literature regarding clinical results of MIS Lapidus procedure with this technique. Our objective is to describe Lapidus fusion consecutive case series, evaluating clinical and radiological results and description of MIS technique for the first tarsometatarsal arthrodesis using an intramedullary nail.

Methods

After obtaining IRB approval, a consecutive case series study was conducted. We retrospectively reviewed data from patients who underwent Lapidus MIS procedure for hallux valgus deformity correction with a Phantom® intramedullary nail (Paragon28, Colorado USA) from April 2018 to October 2019 in a single center with a minimum of 6 months follow-up. The indication for surgery was failure of conservative treatment including shoe modification and pads. Inclusion criteria were patients with severe hallux valgus deformity (defined as a deformity with IMA > 15) and hypermobility or arthritic changes at first TMT joint. Patients were excluded from our study if they have had previous first ray surgery, hallux valgus with indication for other technique, neuroarthropathic disease, incomplete imaging study or if they refused to participate. A patient chart and x-ray review were conducted to collect basic demographic data and deformity measurements: hallux valgus angle (HVA), intermetatarsal angle (IMA) and distal metatarsal articular angle (DMAA) pre and post-operatively

Clinical assessment

Patient demographic data which include aged, sex, body mass index (BMI) smoking status and relevant comorbidities (diabetes, hypothyroidism). Any complications of wound healing, infection, hardware removal, revision procedure of the first ray, or other complications requiring operative intervention were also recorded.

Radiological assessment

A single orthopedic surgeon reviewed all images. Weight-bearing x-rays of the operative foot were obtained at 2 weeks and 12 weeks, postoperatively for analyzing the radiographical parameters mentioned. Imaging included AP and lateral views. The HVA was defined as the angle between the longitudinal axis of the first metatarsal and proximal phalanx. IMA was defined as the angle between the longitudinal axis of the first and second metatarsals. The DMAA was defined as the angle between the distal first metatarsal articular surface and the longitudinal axis of the first metatarsal.

Results

Retrospectively 111 patients (185 feet) with hallux valgus deformity were analyzed during the study period in which 8 patients (10 feet) met the inclusion criteria, with a mean age of 59 years, all female. Median follow-up was 16 months (9-23) (Table 1). Radiographic measurements demonstrated significant improvements in IMA, HVA, and DMAA that were maintained at 2 weeks and 12 weeks postoperatively. At the final minimum follow-up of 6 months, significant improvements in IMA, HVA and DMMA were noted compared with preoperatively. The mean HVA decreased from 31,4 degrees (range 17 to 47) SD (±9,3) preoperatively to 10,3 degrees (range, -8,8 to 31,5) SD (±8,4). The mean IMA decreased from 17,91 degrees (range, -17 to 20) SD (±0,9) preoperatively to 5,46 degrees (range, –7,3 to 15.3) SD (±2,9) postoperative and the mean DMAA decreased from 20,36 (range, 10-40) SD (±8,4) preoperatively to 7,67 (range, -5 to 30) SD (±8,0) postoperative (Table 2). In regard to additional procedures performed in conjunction with the first TMT arthrodesis, all required lateral release, 6 feet required an Akin osteotomy and distal metatarsal osteotomy in 2 feet. At final follow-up there was no recurrence of hallux valgus defined as an HVA greater than 15 degrees or IMA >10. There were no wound complications. One patient needed an additional surgery due to symptomatic hardware in one foot. No cases of overcorrection were noticed.

Operative technique

The patient's operative extremity is marked, and consent confirmed. The patient is placed in a supine position on a

Table 1. Demographic parameters for the minimally invasive Lapidus procedure with intramedullary nail

Characteristic	Study Group
Age, mean±SD	59±6,3 years
Gender	All female
BMI kg/cm^2 mean ± SD	23,46±4,9
Smoking	
Non Smokers	(8/10)
Current	(2/10)
Comorbidities, N (%)	
Diabetes	(1/10)
Hypothyroidism	(3/10)
Without	(6/10)
Aditicional Procedures	
Akin Osteotomy	(7/10)
Arthroereisis	(1/10)
Average follow up (months)	16,4

BMI: body mass index; SD: standard deviation

Table 2. Radiographical measures preoperatively and after the minimally invasive intramedullary Lapidus procedure

	Preoperatively N (degrees)	Postoperatively N (degrees)	Percentage change (%)
HVA mean±SD	31,4 (±9,3)	10,3 (±8,4),	67,1
IMA mean±SD	17,91 (±0,9)	5,46 (±2,9)	69,5
DMAA mean±SD	20,36 (±8,4)	7,67 (±8,0)	62,3

radiolucent operating room table. For anesthesia, a regional extremity nerve block is performed. A tourniquet is applied to the operative limb in the proximal thigh to prevent bleeding and better procedure visualization. The procedure starts with a percutaneous lateral release using a Beaver blade. The medial eminence is resected via minimal invasive incision which is made just distal to the medial eminence. A specific driver system with high torque and low speed is required to be mounted to the 13mm length and 3.1mm conical Shannon burr. This offers a good ratio between cutting the bone and the risk of burning the skin. A speed of less than 10,000rpm is recommended. The 3.1mm wide conical shannon burr is used until it is in line with medial cortex of the metatarsal. A bone paste is generated which has to be squeezed out. If necessary, through the same incision a percutaneous Akin osteotomy is performed using a 20mm x 2.0mm Shannon burr and fixed with a 2,5mm screw, which normally is performed at the end of the procedure, as needed. The first tarsometatarsal joint (TMT) is located fluoroscopically on an anteroposterior (AP) image of the foot. A 5 mm incision is made in the medial side of the joint. The 3.1mm Shannon burr is introduced and sweeps up and down in order to debride the first TMT, constant fluoroscopic guidance is used to corroborate the complete debridement of the joint. The lateral margin is the base of the 2nd metatarsal. Once again, the bone paste formed is removed and abundant saline solution irrigation is introduced to clean the prepared joint. Bone graft is introduced if needed. In all of our cases, bone graft was not required. Reduction in 3 planes of 1st metatarsal is performed utilizing three 1.6mm kirschner wires. One of the pins will drive across the first to second metatarsal diaphysis while the other 2 will hold reduction across the first TMT in an area where it does not interfere with nail placement. Correction is corroborated radiographically in both planes of the foot. Nail's entry point of is located 23mm distally to first TMT joint in dorsal aspect of the foot. A 3cm incision is made lateral to the extensor hallucis longus centered on the entry point. Dissection of the soft tissue is done until the dorsal bone surface of the first metatarsal is identified. A target pin to aid the correct placement of the intramedullary nail is placed into the plantar and proximal aspect of the medial cuneiform. This is done under radiographically guidance to ensure the adequate position (Figure 1). Then place the radiolucent guide that will rest in the bottom of the medial side of the targeting pin. The radiolucent guide gives the correct angle of the initial starting pin of the nail. Then drill the guide pin being the starting point lateral to midline of the metatarsal and lateral to the extensor hallucis longus, measure the length and ream over the pin guide. Insert the nail with assembly of the proximal and distal part of the outrigger. Place two 3.5mm interlocking screws through nail´s proximal segment and remove the distal outrigger. Compression of the fusion site is made with the torque driver and then position is maintained with two distal 3.5mm interlocking screws. An additional screw from medial side of the first metatarsal to the lateral cortex of the second metatarsal might be needed if there is intercuneiform instability. The incisions are closed with a 3.0 non absorbable suture and soft dressings are applied (Figure 2). The postoperative protocol consists of compression dressing left in place with a rigid sole postoperative shoe. Weight bearing is allowed with crutches as tolerable. Sutures are removed at 3 weeks. Progression into full weight bearing with the aid of a rehabilitation program for 6 weeks. Patients had follow-up appointments at 2 weeks, 6 weeks, 12 weeks and 6 months postoperatively. In general, patients were allowed to return to normal athletic shoes at 6 weeks postoperatively and return to full activity after fusion was observed. All patients followed the same postoperative protocol.

DISCUSSION

Lapidus fusion for management of hallux valgus deformity is a popular yet challenging procedure. Nonunion is a major concern, having a frequency between 2-10%[2,5,13,16] and rising up to 33% after bilateral procedures[2]. From this cases, 50% become symptomatic[15]. Typical post-operative protocols include the need for prolonged non weightbearing to help obtaining primary bone healing and prevent secondary elevation of the first ray. Nonetheless recent studies have exposed low nonunion rates for the first TMT fusion, even with

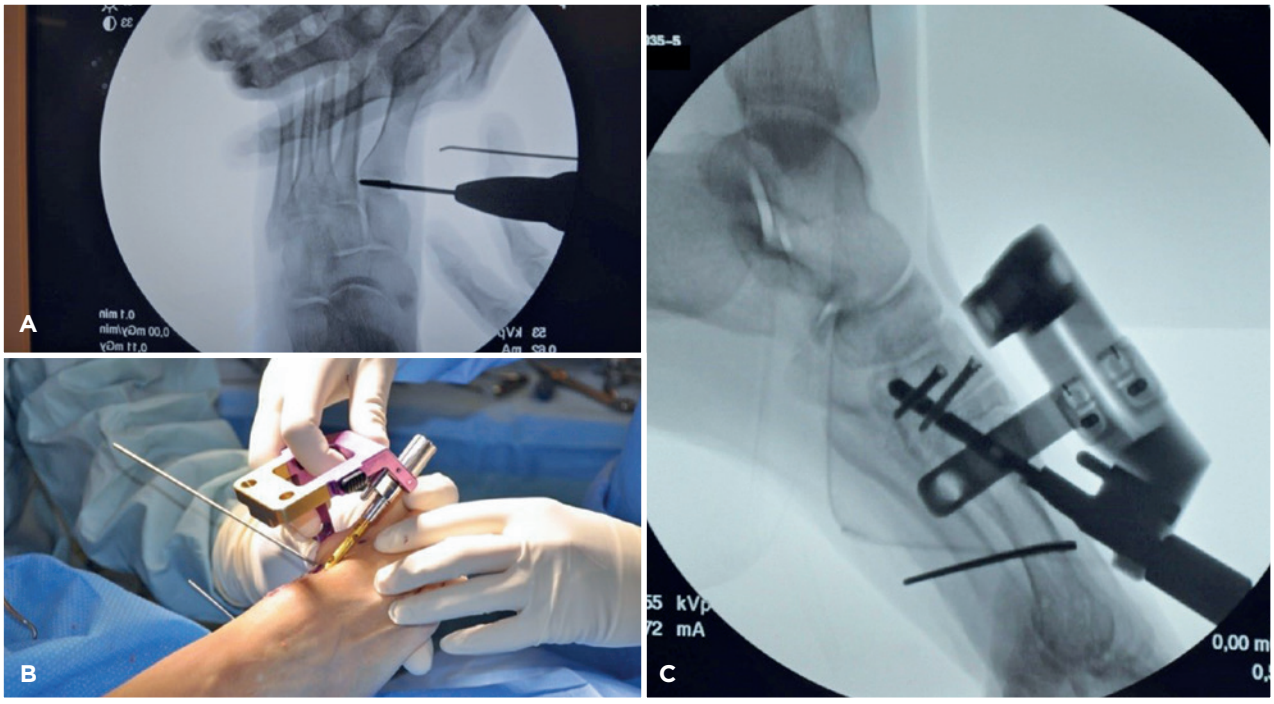

Figure 1. A. First TMT joint preparation through percutaneous approach with a Shannon burr. B. Clinical appearance during nail insertion. C. Sagittal radiographic appearance after nail insertion and proximal blocking screws.

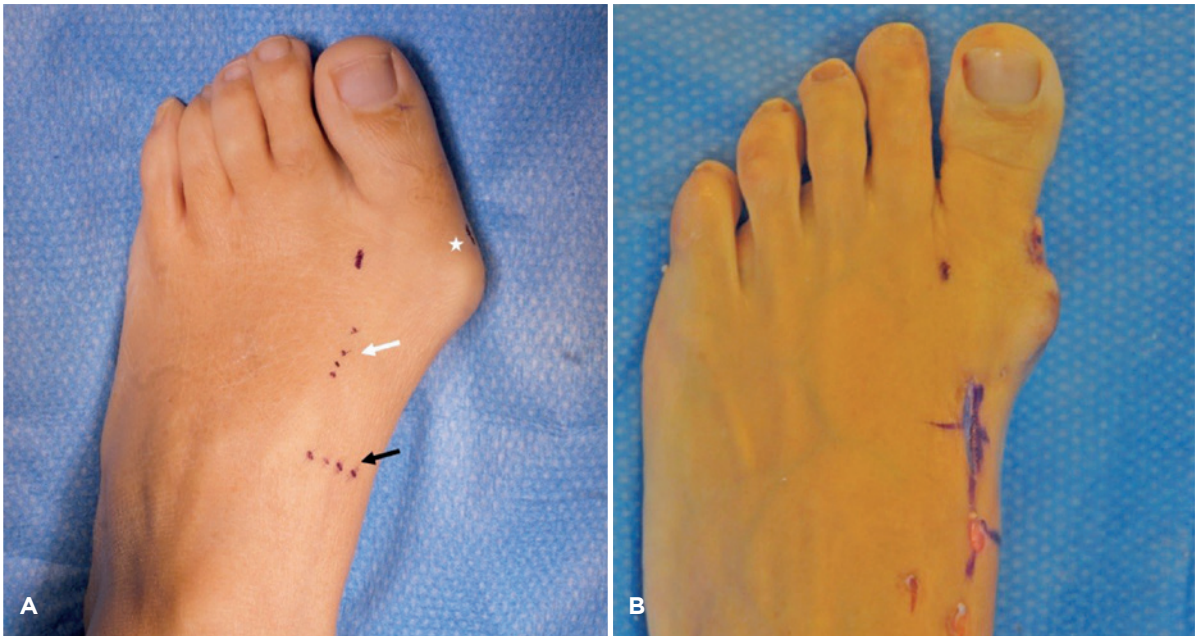

Figure 2. A. Severe hallux valgus deformity with markings in site of TMT joint (black arrow), nail insertion site (white arrow) and MTP joint (star). B. Postop result with correction of hallux deviation.

early weightbearing[16,17]. A multicenter study of 367 patients compared early weightbearing (<21 days) versus deferred weightbearing (>21 days) after Lapidus procedure and found no differences in union rates[17]. A more stable fixation would theoretically help reduce the nonunion rate and allow for early postoperative weight-bearing. The intramedullary nail

provides a stable fixation by resisting forces in 3 planes of direction. Comparison of fixation devices for Lapidus were previously studied. A cadaver study by Klos et al.[4] demonstrated that plates fixed in the plantar region are stiffer and have better load to failure than plates placed in the medial dorsal region. Another study compared first TMT fusion fixation in synthetic bones using a dorsal locking plate, a plantar locking plate, and fixation with an intramedullary device. The intramedullary device had the highest initial compression force[18]. The intramedullary nail contains a torque indicating driver which allows the surgeon to apply proper compression between 80-100N. This will allow compression and a stable fixation in the fusion site which could help obtain satisfactory fusion and allow for earlier weight bearing.

MIS surgery for hallux valgus correction is continuously gaining popularity among foot and ankle surgeons, but there is still a lack of good evidence to support it against traditional procedures. There are reports that state MIS for hallux valgus can obtain similar clinical and radiological reports to open procedures[19,20]. However, in order to obtain similar results, surgeons need to have previous MIS training. One of the advantages of minimal invasive surgery is diminishing soft tissue damage and maintaining local inflammatory environment that could promote healing. In our cohort of patients, there were no wound complication and swelling was managed by physiotherapy program contained in the postoperative protocol.

In terms of radiological parameters, our study showed a significant correction of all measured parameters, similar as expected with open fashion. The mean HVA decreased 21,1° (67,1% reduction), IMA 12,45° (69,5% reduction) and DMMA 12,69° (62,3% reduction). The rate of reduction of the HV angle and IMA has been described to 10°-22° and 6°-9°[13,21] after Lapidus procedure, which correlates with magnitude of improvement obtained with this technique (Figure 3). Malalignment typically results in shortening and dorsiflexion of the first metatarsal and may lead to transfer metatarsalgia of the second and/or third rays[21]. It can occur in up to 10% of the cases. None of our patients presented transfer metatarsalgia after 6 months follow up.

There were no major complications. Only one patient needed additional surgery due to symptomatic hardware, specifically a medial interlocking screw irritating the skin. In terms of fusion, at 12 weeks follow up, there was only one patient with no radiological signs of union albeit did not refer symptoms attributable to TMT joint non-union.

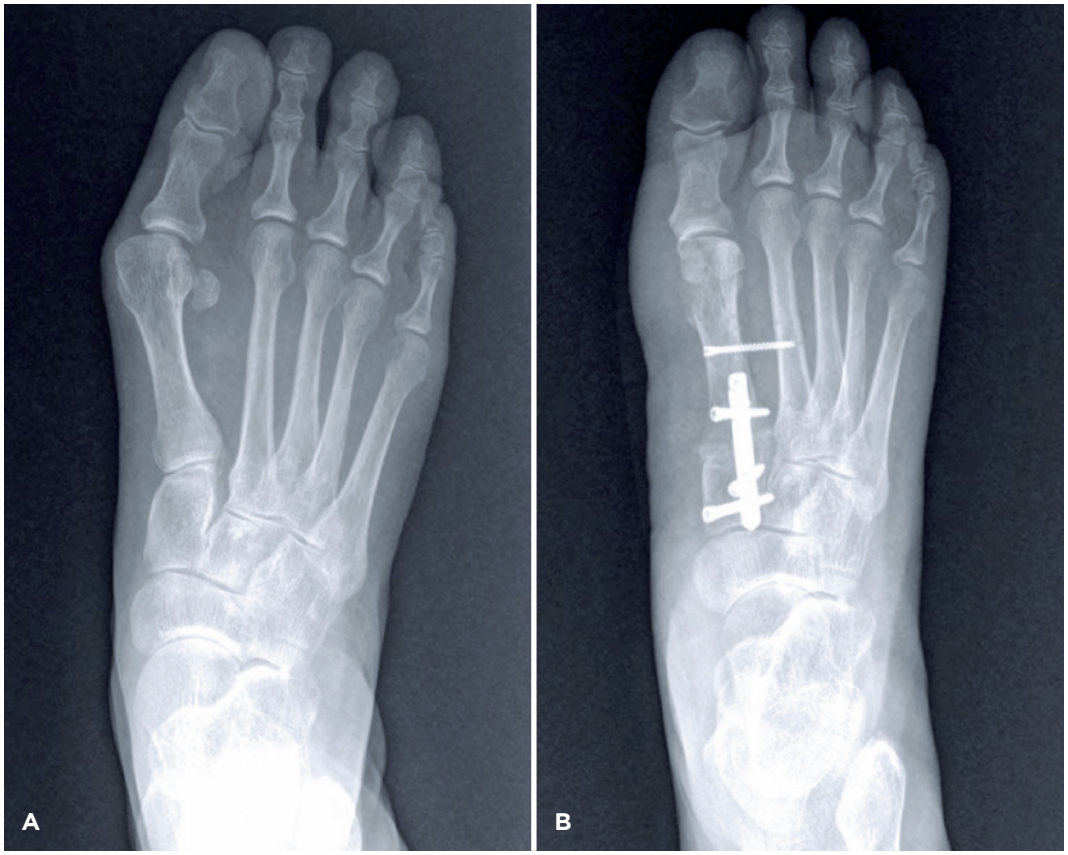

Figure 3. A. Preoperative and B. Postoperative anteroposterior (AP) radiographs demonstrating first tarsometatarsal arthrodesis with intramedullary nail.

The strengths of this study include reporting a novel technique for Lapidus fusion through MIS with an intramedullary implant that could have biomechanical advantages over traditional used implants (e.g. plates and screws) and is suitable for MIS usage. The main limitations of the study is short follow up of less than a year and small number of cases with no control group to compare clinical and radiological results. Radiographic evaluation in terms of fusion with CT-scan was incomplete so it was not possible to include it as an evaluation parameter. Further studies to investigate long-term outcomes, complications, and recurrence rates of MIS Lapidus procedure with intramedullary nail is needed.

Conclusion

The MIS Lapidus procedure with intramedullary nail is a safe and reliable procedure that allows early weight bearing, small incisions in order to minimize wound problems and adequate deformity correction. We believe this technique it's an attractive alternative in severe hallux valgus deformity management but larger population and long term clinical-radiological follow up studies are needed.

Authors' contributions: Each author contributed individually and significantly to the development of this article: FC *(https://orcid.org/0000-0001-6138-4384) conceived and planned the activities that led to the study, wrote the paper, participated in the review process, approved the final version; PC *(https://orcid.org/0000-0001-5304-0987) conceived and planned the activities that led to the study, wrote the paper, participated in the review process, approved the final version; AB *(https://orcid.org/0000-0003-4898-4259) wrote the paper, participated in the review process, approved the final version; MP *(https://orcid.org/0000-0002-2820-5337) wrote the paper, participated in the review process, approved the final version; GC *(https://orcid.org/0000-0002-1993-6250) wrote the paper, participated in the review process, approved the final version; CO *(https://orcid.org/0000-0003-2574-9010) conceived and planned the activities that led to the study, wrote the paper, participated in the reviewing process, approved the final version. *ORCID (Open Researcher and Contributor ID).

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Original Article

Tendoscopy in stage I posterior tibial tendon dysfunction: results after minimum follow-up of 8 years

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Abstract

Objective: To evaluate the progression of patients with this pathology treated by tendoscopy and with a minimum 8-year follow-up.

Methods: This is a retrospective study of patients operated on between 2008 and 2011. During that period, 11 patients with this pathology aged between 28 and 56 years (average 37 years) underwent surgery. The patients were assessed subjectively using the VAS scale and the AOFAS scale was used as the objective method.

Results: Nine of the 11 operated patients could be evaluated. Tendon injury was evident in three patients during the tendoscopy and open repair was indicated. Seven patients improved their symptoms according to the VAS and did not progress to stage II. Two patients progressed to stage II and underwent hindfoot reconstruction: one with tendon injury and the other without. The AOFAS scale improved on average from 64 to 96 in the patients who did not progress to stage II.

Conclusion: Tendoscopic synovectomy of the PTT is an effective surgical procedure to treat patients with stage I PTTD. It has the advantages of less pain and fewer complications of the soft tissues. If a tendon injury is encountered during the tendoscopy, it must be repaired through a 3 to 4cm incision above the injured area of the tendon.

Level of Evidence IV; Therapeutic Study; Case Series.

Keywords: Tendons/injuries; Tendons/surgery; Posterior tibial tendon dysfunction/therapy; Endoscopy/methods; Synovitis; Treatment outcome.

Introduction

Posterior tibial tendon dysfunction (PTTD) is a condition that involves progression from tenosynovitis to rupture and insufficiency of the posterior tibial tendon (PTT), causing adult acquired flatfoot deformity in its advanced stage[1-5]. Stage I was defined by Johnson and Strom[6] as tenosynovitis or tendinitis, in which the longitude of the tendon stays normal, there is no hindfoot deformity, and the diagnosis is basically clinical, characterized by swelling and pain in the posterior region of the medial malleolus due to swelling in the tendon path[7] that may radiate distally[8]. The tendon has a hypovascular zone of 14 mm in length, approximately 40 mm from its insertion into the scaphoid and normally this is the area where the patient's symptoms are generated.

In stage I of PTTD[6] the strength of the tendon may be normal, and the patient may be able to rise on their toes on the affected side, sometimes with much and others with little pain along the tendon. The condition is frequently incorrectly diagnosed as a sprained ankle[9] and regrettably delays a correct diagnosis and thereby proper treatment, which could help to improve the patient's symptoms and stop the progression of the condition, preventing it from progressing to the next stage and developing into adult acquired flatfoot[10,11].

Ultrasound (US) and nuclear magnetic resonance (MRI) can help to make the diagnosis more accurate. Comparing both methods[12], US proved to be less sensitive than MRI for this pathology. We routinely request an MRI for patients suspected of stage I PTTD to clarify and confirm the diagnosis.

Study performed at the Hospital de Clinicas Caracas, Caracas, DC, Venezuela.

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Myerson et al.[13] defined two different age groups with PTTD: a group of young adults with an average age of around 30 years with some form of systemic inflammatory disease (seronegative spondyloarthropathy) and a second group of older patients with an average age of around 55 years and a history of microtrauma and overuse that could be the cause of the condition.

Analyzing the different clinical and biomechanical factors[14] associated with stage I of this condition, a comparative study was conducted with healthy patients evaluating the differences in the height of the plantar arch, the muscle strength around the ankle, and biomechanical factors. In runners with PTTD, there was a significant difference when the plantar arch was lower, with a greater and longer eversion angle during gait, as compared to healthy runners. The hypothesis is that the greater pronation of the foot transmits a greater load to the posterior tibial muscle, which may explain the progressive nature of this condition.

Patients with stage I PTTD[15] are initially treated non-surgically with non-steroidal anti-inflammatory drugs, cryotherapy, local US[16], and a special ankle brace that supports the midfoot and hindfoot (preferably with the PTTD Airlift brace (Aircast)) for 3 to 6 months. Alvarez et al.[17] recommended a protocol with orthotics and a program of repetitive exercises with activities of aggressive plantar flexion, including lengthening of the gastrocnemius-soleus complex. After four months of treatment, 84% of the 47 patients studied had excellent subjective and functional results. Kulig et al.[18] described a protocol of working with progressive eccentric load on the tendon and lengthening of the gastrocnemius-soleus complex performed twice a day for ten weeks. This protocol was implemented in ten patients with early stage PTTD, resulting in improved symptoms and function without changes in the morphology or neovascularization of the tendon.

Patients with hindfoot valgus and forefoot pronation whose symptoms improve with conservative treatment may benefit from shoe modifications to protect any hindfoot valgus[19]. Adding scaphoid support and posteromedial elevation with an insole can take stress off the PTT.

If the symptoms persist following conservative treatment[3], surgical debridement and synovectomy of the PTT have been suggested. Mann[20] recommended tenosynovectomy for early stage I injuries because synovitis can invade the tendon and cause damage or rupture it. He suggested considering tenosynovectomy after three months of failed conservative treatment in patients with tenosynovitis caused by overuse or mechanical causes and tenosynovectomy earlier (at six weeks) in patients with seronegative disease.

Teasdall and Johnson[21] reported complete improvement of symptoms or mild pain in 17 out of 19 patients following open debridement through a curvilinear incision over the PTT path[3,22-27]. Debridement and synovectomy of the PTT can be performed endoscopically. Chow et al.[27] suggested endoscopic debridement in stage I PTTD to avoid problems in the soft tissues, infection, pain, adhesions, and prolonged hospitalization, demonstrating that it is a safe procedure that can achieve the same effectiveness as the traditional open procedure.

The objective of this study is to evaluate the results of patients diagnosed with stage I PTTD whose painful symptoms persisted after conservative treatment and underwent surgical treatment with endoscopic synovectomy with a minimum of eight years of follow-up.

Methods

This is a retrospective study of patients diagnosed with stage I PTTD with torpid progression under conservative treatment and who underwent endoscopic synovectomy with eight years of follow-up. Patients with autoimmune or seropositive rheumatological diseases were excluded from the study.

The patients were operated on at the Hospital de Clínicas Caracas from 2008 to 2011. During this period 11 patients with this pathology underwent surgery, nine females and two males ranging from 28 to 56 years of age, with an average age of 37 years. The average duration of painful symptoms in the region of the affected tendon prior to surgical treatment was analyzed.

The patients were subjectively assessed using the VAS scale, the results of which were classified as excellent, good, fair or poor according to the patient's responses. The AOFAS scale was used as the objective method.

Surgical technique

As we have described in previous studies of this pathology[28], we performed the two-portal technique described by Van Dijk et al.[29] The patient is placed in the supine position and we always perform the procedure under pneumatic ischemia. The operation can be performed under general or conductive anesthesia. The patient is examined, and the PTT path is marked on the skin using the medial malleolus and the scaphoid bone as references. The two portals are created over the tendon: the distal portal 2 cm proximal to the insertion into the scaphoid and the proximal portal 3 cm posterior and superior to the medial malleolus (Figure 1A).

An incision is made in the skin and the tendon sheath is opened with scalpel and mosquito forceps, respectively. The arthroscope of 2.7 mm and 30 degrees is introduced, and saline solution is injected into the tendon sheath (Figure 1B). The PTT is visualized from its insertion into the scaphoid up to 4 cm proximal to the proximal portal and examined with the probe. The synovectomy is performed with a small joint shaver (Figure 2). At the end of the procedure, the portals are sutured.

Following the procedure, the patient is placed in an airlift PTTD ankle brace (AIRCAST) for six weeks, the first two weeks with partial support and then full support. The patients then will remain with orthotic insoles in their regular shoes, protecting the hindfoot in a slight varus with a scaphoid support and posteromedial elevation to protect the tendon.

Posterior tibial tendon injury

If there is evidence of any injury of the PTT during the tendoscopy, the tendon sheath must be opened through a 3 or 4 cm long incision and the injury repaired by resecting the injured area and debriding the fissures. The defect is closed using non-absorbable 2-0 suture (ethibond) and the tendon sheath is left open to prevent fibrotic scarring (Figure 3).

After repair of the tendon injury, the patient is placed in an unsupported walking boot for three weeks and then partial support is authorized for an additional three weeks. At six weeks following surgery, the patient is transferred to the airlift PTTD ankle brace (AIRCAST) for six weeks.

Results

Endoscopic debridement was performed for stage I PTTD in 11 patients between 2008 and 2011. Nine (81%) of the 11 patients were able to be evaluated after a minimum of eight years of follow-up.

Functional results

Seven (78%) of the nine patients evaluated improved their symptoms according to the VAS and did not progress to stage II. In three (33%) patients a tendon injury was discovered during the tendoscopy and open repair surgery was indicated.

The average AOFAS scale score improved from 64 to 96 in the patients who did not progress to stage II.

Patients reported painful symptoms of an average of six months evolution prior to the surgical treatment, ranging from less than three to greater than 11 months.

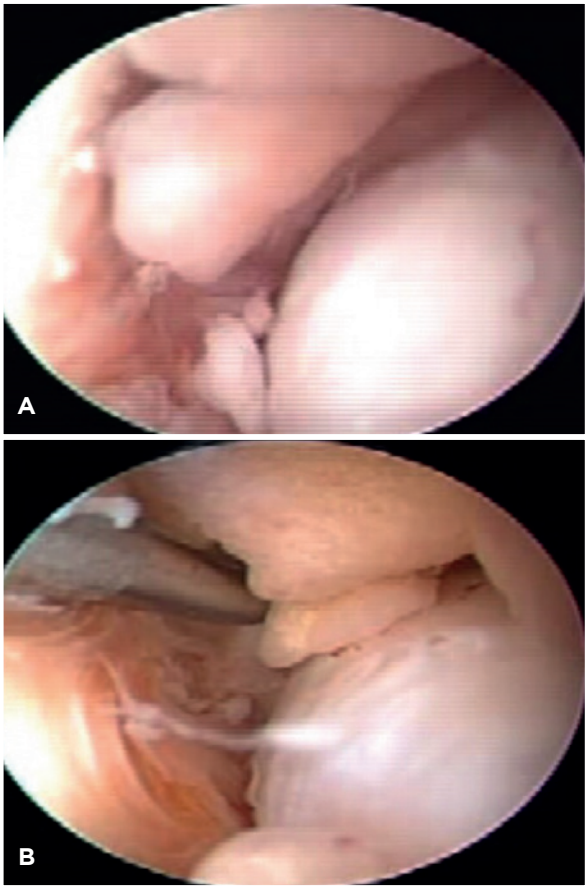

Figure 2. Tendoscopic image of the posterior tibial tendon, showing free bodies and synovitis around the tendon.

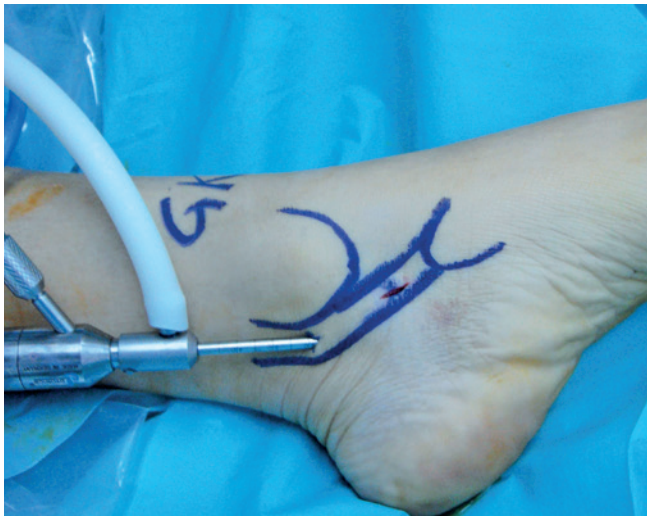

Figure 1. Surgical reference for tendoscopy of the PT. A. The path of the PTT is examined and marked on the skin using the medial malleolus and the scaphoid bones as the reference.

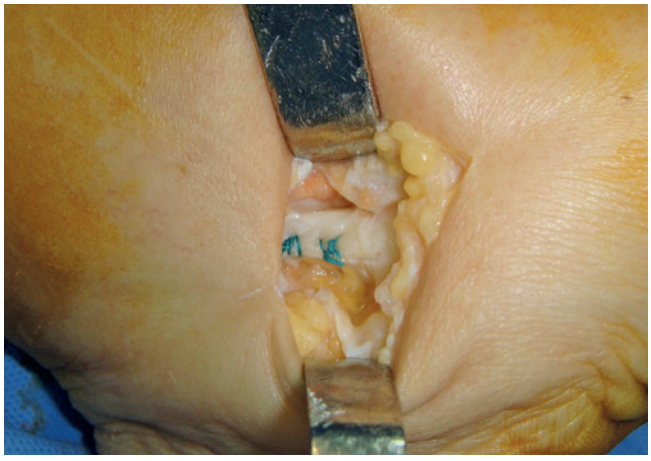

Figure 3. Repair of the tendon. The tendon sheath must be opened through a 3 to 4cm incision and the injury is repaired, resecting the injured section and debriding the fissures, The defect is closed using 2-0 non-absorbable sutures (ethibond), and the tendon sheath is left to prevent fibrotic scarring.

Two patients (22%) progressed to stage II and were indicated for hindfoot reconstruction with FDL tendon transfer, medializing calcaneal osteotomy and Cotton opening wedge osteotomy prior to completing two years following the tendoscopy. One of these patients, who reported ten months painful symptoms before surgery, had a tendon injury that required an open suture of the tendon and the other patient without a tendon injury, who reported five months painful symptoms symptoms before surgery, in the insertional region of the posterior tibial tendon, was treated with a simple tendoscopy.

No direct relationship between the onset of symptoms and progression to stage II posterior tibial tendon dysfunction could be established due to the small patient sample.

Complications

One patient with a tendon injury that required open repair, reported discomfort in the surgical wound that improved eight weeks after the surgery.

Return to work activities

The tendoscopic synovectomy patients returned to work between four and six weeks following surgery and the patients treated for tendon injuries returned on average after ten postoperative weeks.

Discussion

Stage I posterior tibial tendon dysfunction was defined by Johnson and Strom as tenosynovitis or tendinitis where the length of the tendon remains unchanged, there is no hindfoot deformity and the diagnosis is basically clinical, characterized by pain and swelling in the retromalleolar region. Unfortunately, the lack of knowledge about this pathology hinders early diagnosis and most patients who go to or are referred to a physician only do so in stage II or III, when there is hindfoot deformity, and instead of a simple, minimally invasive procedure, require complete hindfoot reconstruction. For this reason, it is important to disseminate to orthopedists the tools to diagnose and treat this pathology in an early stage to prevent its progression.

Patients who are diagnosed early with stage I PTTD are initially treated conservatively with NSAIDs, cryotherapy, ultrasound and are placed in a PTTD airlift brace (Aircast) for 3 to 6 months. If symptoms persist, surgical treatment to perform debridement and synovectomy should be indicated. At first, we waited even more than 6 months before indicating surgical treatment, but now we are a little more aggressive. If the patient's painful symptoms and functional weakness persist after 2 to 3 months of conservative treatment, we suggest surgical intervention with a tendoscopy at that time.

Chow et al.[27] did not report complications after tendoscopy for stage I PTTD. All their patients progressed without pain and with good tendon strength, being able to perform heel raises on the tips of the toes two months after surgery. Among the advantages of this procedure, in addition to a more cosmetically acceptable scar, the patients experienced less pain and fewer complication than patients who underwent open synovectomy. None of their patients progressed to stage II after a follow-up of 4 to 30 months (17 months average). The patients returned to work after 10 weeks and to participating in sports 6 months following surgery. All but two of the patients in our study reported subjective (pain scale) and objective (AOFAS scale) improvement and did not progress to stage II during an 8-year minimum follow-up.

One unsatisfied patient in our study did not have an injured or ruptured tendon. This patient progressed to stage II and required hindfoot reconstruction for this reason. Three patients had tendon injuries and needed open repair, only one of whom presented pain in the surgical wound, which improved in the eighth postoperative week. One of these patients, with a tendon injury that required an open suture, progressed to stage II and required hindfoot reconstruction with FDL tendon transfer, medializing calcaneal osteotomy and opening wedge osteotomy also known as Cotton osteotomy, less than two years following tendoscopy surgery.

Funk et al.[30] reviewed nine patients following synovectomy with and without tendon injury repair. All their patients presented objective and subjective clinical improvement. Pain was reported to be mild or absent in 8 of the 9 patients (89%). Eight patients could perform heel raises on the tips of the toes. In our study, 7 of the 9 patients progressed satisfactorily, pain free and able to perform the heel raise test with strength and without pain.

Conclusion

Endoscopic synovectomy of the PTT is an effective, minimally invasive surgical procedure for treating stage I PTTD patients. It has the advantage of less pain and fewer soft tissue complications. If a tendon injury is discovered during the tendoscopy, it should be repaired with non-absorbable sutures through a 3 to 4 cm incision over the injured region of the tendon.

This study has limitations as a single center study with a small patient sample in which all patients were treated and evaluated by the same authors.

Authors' contributions: Each author contributed individually and significantly to the development of this article: GK *(https://orcid.org/0000-0001-6050-3951) conceived and planned the activities that led to the study, interpreted the results of the study, performed the surgeries, data collection, statistical analysis, bibliographic review, survey of the medical records, formatting of the article, clinical examination, approved the final version; CK *(https://orcid.org/0000-0003-0787-7326) participated in the review process, data collection, statistical analysis, bibliographic review, survey of the medical records, formatting of the article, clinical examination, approved the final version.

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Original Article

Achilles tendon reconstruction combining a modified Dresden technique and endoscopic flexor hallucis longus transfer

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3. Universidad de los Andes, Las Condes, Region Metropolitana, Santiago, Chile.

Abstract

Objective: The purpose of this paper is to describe a minimally invasive chronic Achilles tendon rupture reconstruction combining a modified Dresden technique and endoscopic flexor hallucis longus (FHL) tendon transfer.

Methods: Our prospectively collected database was queried for patients presenting with chronic Achilles tendon rupture. Patients were included if they presented any of the following criteria: more than 65 years of age, history of previous DVT, active smoking habit and Diabetes. Pre and post-operative SF-36 and AOFAS hindfoot scores, complications, and patient satisfaction grades were recorded.

Results: Eight patients met the inclusion criteria; the median age was 49 years old (range 22 - 67 years). Two complications were registered (sural neuritis and minor wound dehiscence). Mean AOFAS score increased from 48 (range 40 - 63) to 91,6 (range 85 - 95). Regarding SF-36 score, the SFF-36 improved from 51,6 to 79,3 points and the SFM-36 enhance from 25 to 61,5 points. All patients evaluated their satisfaction regarding the performed procedure as satisfactory.

Conclusion: Chronic Achilles tendon rupture reconstruction combining a modified Dresden technique and endoscopic FHL transfer is an attractive option in high-risk patients, with favorable results at the short-term follow-up.

Level of Evidence IV; Therapeutic Study; Case Series.

Keywords: Achilles tendon/injuries; Achilles tendon/surgery; Tendon transfer; Reconstructive surgical procedures/methods; Endoscopy/methods.

Introduction

Chronic Achilles tendon ruptures (CATR) can produce elongation of the Gastrocnemius-Soleus complex, generating calf soreness, muscle cramping and/or functional disability[1]. Although several authors have tried to organize surgical treatment creating algorithms based on the tendon gap size, optimal surgical treatment remains to be elucidated[2].

Current treatment comprises some form of tendon reconstruction or tendons transfers in cases in which the muscular unit is scarred or presents severe fatty degeneration[1,2]. Although minimal invasive attempts to perform these operations have been advocated, most of these procedures are still performed through open surgery. In such a scenario, most case series report good functional outcomes after any of these procedures. Nevertheless, the patient faces a high risk of developing wound complications and infection, particularly those presenting risk factors such as old age, diabetes, smoking history and/or peripherical vascular disease.

Theoretically speaking, optimal surgical treatment must restore Gastrocnemius-Soleus complex length through a minimally invasive procedure, preserving muscular strength of the affected limb and diminishing complications risk.

The purpose of this study is to present our technique to address Chronic Achilles ruptures, combining a Dresden percutaneous technique, which is usually performed for acute ruptures, and an endoscopic FHL transfer.

Study performed at the Department of Orthopaedic Surgery, Hospital Clínico Universidad de Chile, Independencia, Región Metropolitana, Santiago, Chile.

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Silva F, Chaparro F, Escudero MI, Carcuro G, Ortiz C, Pellegrini MJ. Achilles tendon reconstruction combining a modified Dresden technique and endoscopic Flexor hallucis longus transfer. J Foot Ankle. 2020;14(1):14-8.

Methods

This study was approved by the Institutional Review Board.

Our prospectively collected database was queried for patients presenting with Achilles' tendon ruptures or re-ruptures with at least six weeks since the injury. Patients were included if they presented any of the following criteria: more than 65 years of age, history of previous DVT, active smoking habit, and diabetes. Patients with neurological disorders or not willing to participate were excluded from the study.

Pre and post-operative SF-36 and AOFAS hindfoot scores, complications, and patient satisfaction grades were recorded. Each patient assed their treatment satisfaction using a previously published scale as follows: Satisfied, satisfied with minor objections, satisfied with major objections, and unsatisfied[3].

Surgical technique

The procedure is performed under spinal anesthesia. The patient is placed prone in the operative table with a pneumatic thigh tourniquet at 250 The foot is placed at the edge of the table over a padded cushion that allows free movement of the ankle joint and to clear the contralateral limb from the operative area.

Traditional posteromedial and posterolateral arthroscopic portals are outlined and performed immediately adjacent to the Achilles' tendon. A 3.0 mm arthroscope and 4.0 shaver (Arthrex, Naples FL) are utilized to perform the posterior endoscopy. After identifying the FHL (Figure 1A), the tendon is freed for any surrounding tissue attachments, starting from the muscular belly to the posterior talar tubercles. This step will ensure that tendon retrieval will be safely performed. The deep fascia over the FHL muscular belly is opened with the shaver as well to enhance excursion.

In anticipation of FHL harvesting, the tendon is secured using a mini scorpion automatic suture passer (Arthrex, Naples FL) through the posteromedial portal. By folding the 2.0 Fiberwire suture (Arthrex, Naples FL) in half, a double suture is obtained. After piercing the FHL tendon with the automatic suture passer, sutures ends, and a loop are retrieved through the posteromedial portal. Both sutures end are introduced into the loop and pulled to deliver the loop into the posterior aspect of the ankle joint and grasp the tendon for manipulation. Thereafter, the ankle is positioned at maximum plantar flexion, and the FHL is pulled proximally through the sutures to harvest the tendon as distal as possible (Figure 1 C and C). After harvesting has been completed, the tendon is delivered through the posterolateral portal and prepared for transfer using 2-0 FiberLoop (Arthrex, Naples FL). This crucial step will prevent the tendon from being injured during tunnel preparation and prevent neurovascular damage at the medial side. FHL diameter is measured at this time to determine the size of the drilling guide, which will be of the same size of the harvested tendon (Figure 2A and B).

The dorsal aspect of the calcaneus needs to be debrided in anticipation of bone tunnel preparation and tendon transfer. Ideally speaking, the FHL needs to be transferred centered in the calcaneus and as closest as possible to the Achilles' tendon footprint, to emulate the vector pulling force of the native muscle.

Through the posteromedial portal, a guidewire is placed in the calcaneus under direct visualization and pulled out through the plantar skin in a dorsal-medial to a plantar-lateral direction (Figure 2C). It seems wise to confirm the guide position under fluoroscopy to achieve an optimal position (Figure 2D). A 20 mm depth tunnel is performed over the guidewire, and the tendon transferred to this tunnel. Sutures at the FHL tendon are recovered at the plantar skin and with the ankle held in maximal plantarflexion, these sutures are maximally pulled and clamped in the desired position using a hemostatic clamp. During this maneuver, the surgeon must visualize the tendon advancing through the bone tunnel under direct arthroscopic visualization.

Approximately at 2 to 6 cm from the Achilles tendon insertion, the tendon gap is identified through palpation. A transverse incision is made over the gap, and blunt dissection is carefully performed though the paratenon, taking care not to damage the sural nerve. Fibrous (scar) tissue is identified and resected to restore the muscular unit length (Figure 3A).

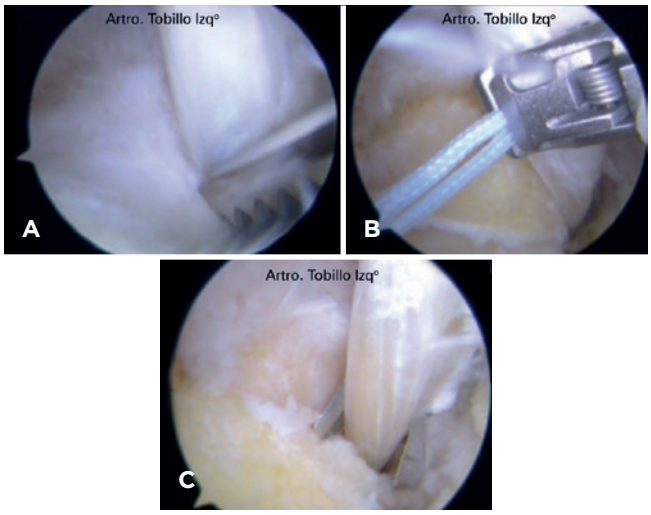

Figure 1. A. After FHL identification, the tendon is freed for any surrounding tissue attachments. B. The tendon is secured using a mini scorpion automatic suture passer (Arthrex, Naples FL) through the posteromedial portal. C. After positioning the ankle at maximum plantar flexion, and the FHL is pulled proximally through the sutures to harvest the tendon as distal as possible.

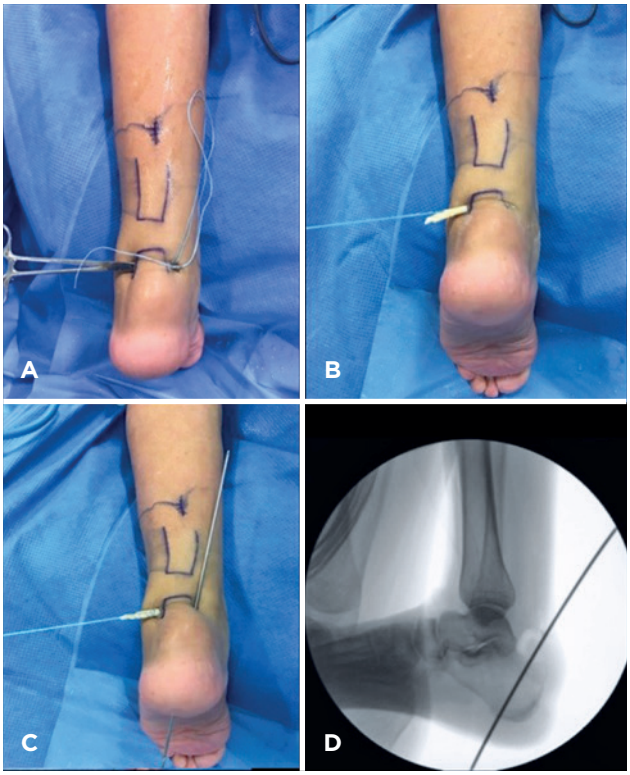

Figure 2. A. After harvesting has been completed, the tendon is delivered through the posterolateral portal. B. The tendon is prepared for transfer using 2-0 FiberLoop (Arthrex, Naples FL). C. A guidewire is placed in the calcaneus under direct visualization and pulled out through the plantar skin in a dorsal-medial to a plantar-lateral direction. D. Guide position confirmation under fluoroscopy.

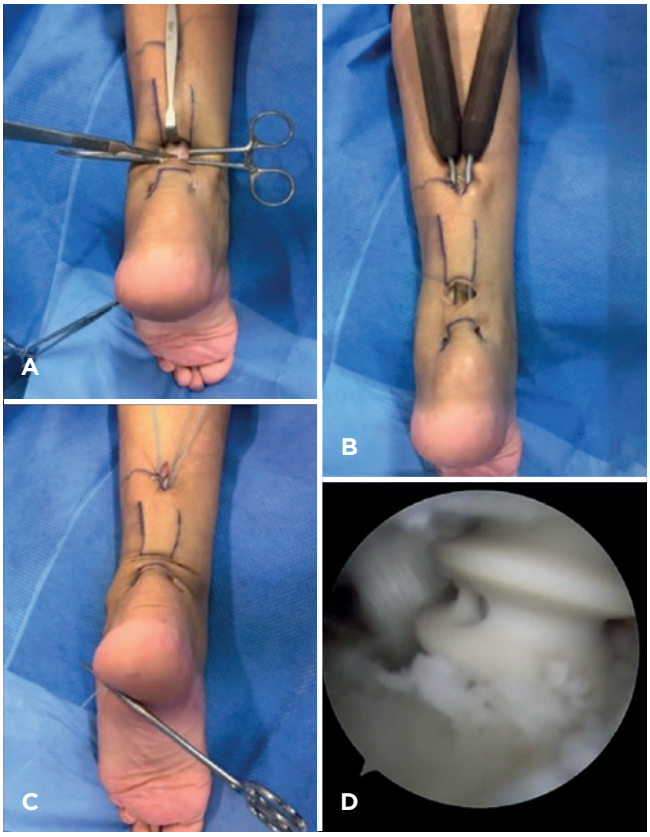

Figure 3. A. Fibrous (scar) tissue is identified and resected to restore the muscular unit length. B. Two Fiberwire N 2 (Arthrex, Naples FL) sutures are percutaneously passed at the distal stump and recovered through the instruments at the proximal incision. C. Both sutures are then knotted to the proximal stump. D. Final FHL fixation under arthroscopic visualization.

Using one Dresden instrument over the skin, a proximal incision is outlined and carried out to perform tenorrhaphy. Both Dresden instruments are delivered to the distal Achilles stump respecting the proximal paratenon, specifically between epiparatenon and subfascial plane, to avoid neurologic injuries. Two Fiberwire N 2 (Arthrex, Naples FL) sutures are percutaneously passed at the distal stump and recovered through the instruments at the proximal incision. Both sutures are then knotted to the proximal stump (Figure 3B and C). Once the Achilles tenorrhaphy has been performed, final FHL fixation is performed under arthroscopic visualization using a Biotenodesis screw one size under the diameter of the drilling guide (Arthrex, Naples FL) (Figure 3D).

FHL fixation reinforcement

In the last two cases, we have added tightrope fixation to the plantar side of the calcaneus to increase resistance for tendon pullout. In this situation, the tightrope button is loaded

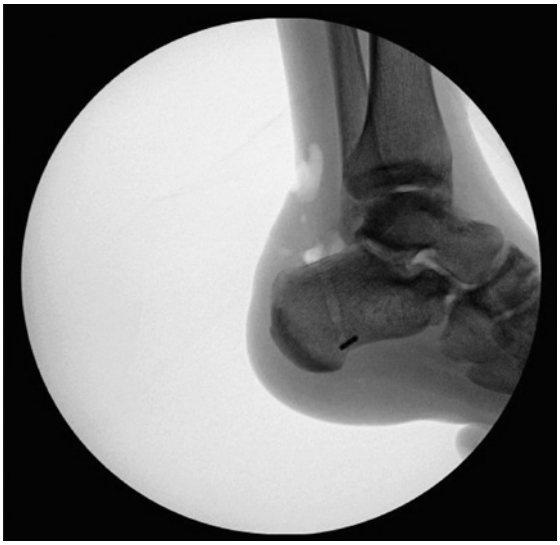

Figure 4. Checking tightrope fixation under fluoroscopy.

with the FHL tendon sutures end and delivered through the bone tunnel. After checking under fluoroscopy that the tightrope is perpendicular to the tunnel, both sutures are cinched to deliver the tendon into the tunnel before biotenodesis screw fixation (Figure 4).

Post-operative management

The operated limb is immobilized in a cam-walker boot in equinus for three weeks, weight-bearing as tolerated with two crutches. Sutures are removed at 3 weeks, and immobilization maintained for three more weeks in neutral position. Physiotherapy is initiated after suture removal with exercises only in plantarflexion to neutral until six weeks postoperatively, when immobilization is discontinued. At post-operative week six, dorsiflexion exercises are encouraged and progressed according to patient tolerance.

Results

Eight patients met the inclusion criteria. Gender distribution was 6 male patients and 2 females. Median age was 49 years old (range 22 - 67 years). Mean time to surgery was 126 days (range from 60 to 300 days). Mean follow up was 27 months (range from 6 to 37 months). Mean AOFAS score increased from 48 (range 40 - 63) to 91,6 (range 85 - 95). Regarding SF-36 score, the SFF-36 component improved from 51,6 to 79,3 points and the SFM-36 component enhance from 25 to 61,5 points (Figure 5 and 6). All the patients evaluated the performed procedure as satisfactory. At final evaluation, almost all patients were able to perform single heel rise test. The only patient that was unable to elevate his heel was six months out from his surgery.

In terms of complications, one patient presented transient sural neuritis, which resolved spontaneously five months after surgery. Another patient presented a minor dehiscence of the transverse wound, which healed uneventfully without major intervention.

Discussion

Chronic Achilles tendon rupture is a debilitating condition due to Gastronecmius-Soleus complex dysfunction; this leads to gait impairment and functional disability affecting the patient´s quality of life[4]. In this small case series, we demonstrate that our approach to chronic Achilles ruptures is a safe and effective procedure in the short term for patients over 65 years old, history of previous DVT, active smoking habit, and diabetes.

Several reconstruction techniques have been proposed[1]. In general, defects greater than 6 cms. are best suited for allograft/autograft reconstruction or tendons transfer. Although good functional outcomes have been obtained with both approaches, they are not without complications, specially wound breakdown and infection (7 to 17%)[5,6]. Unfortunately, we have seen the same problems in our practice, especially in high-risk patients. In this scope, the FHL transfer is widely used in these situations. Unfortunately, any tendon transfer is underpowered to restore the Gastronecmius-Soleus complex muscular power[7]. The latter is supported by the fact that no muscle in the leg is strong enough to compare with the native Gastronecmius-Soleus muscular complex. Besides, transferring a tendon resembles the anatomic axis of muscular pulling, but it's not the same. In order to perform its function, the Achilles tendon depends on the tension applied through the muscular belly. If the tendon is elongated, the muscle will have to contract to a greater degree to produce the same action, leading to power loss and decreased endurance. For these reasons, we associated FHL transferring with a shortening of the elongated Achilles tendon[8,9].

Alhaug et al.[10] reported on 21 patients with open FHL transfer technique, with good functional outcomes, a median AOFAS score of 87.1. However, a 52% complication rate, mostly by infection, makes this procedure less desirable. This rate of complications is similar with other manuscripts that have reported 17 to 25% wound complication rate with open tendon transfers[11].

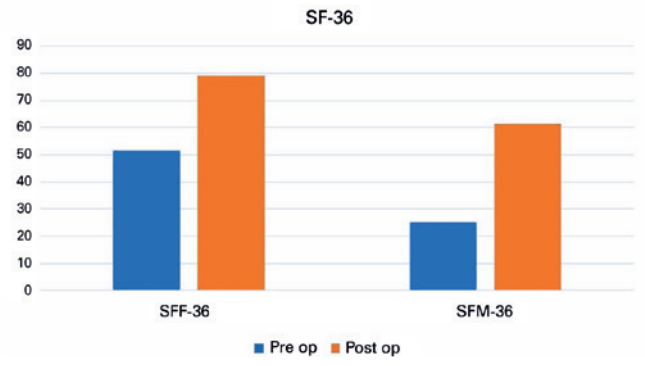

Figure 5. Pre and postoperative values for the physical (SFF-36) and mental (SFM-36) subscales of the SF 36 score.

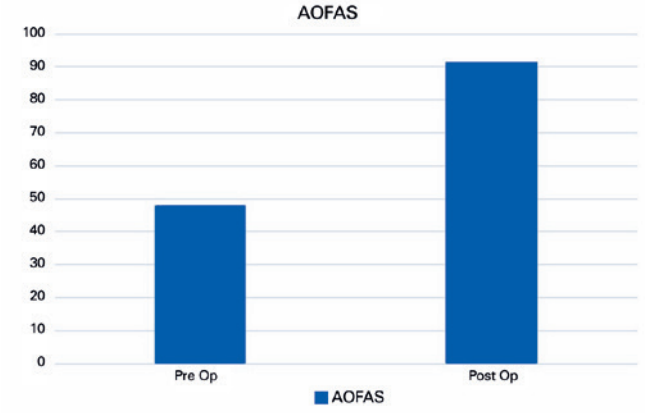

Figure 6. Pre and postoperative values for AOFAS Hindfoot and Ankle score.

Conversion to endoscopic procedures have been advocated to diminish these complications, especially in high-risk patients. Vega et al. published on 22 patients, with no wound complications and all patients returning to their daily activities and improving their AOFAS hindfoot score from 54 to 91. In a retrospective case series[12]. Husebye et al.[13] describe endoscopic FHL transfers on 6 patients, all patients were followed for at least 12 months. At final follow up all patients described better function and increased plantar flexion power.

Our results compare favorably with these previously published studies. However, none of them but ours attempted to restore Gastrocnemius-Soleus complex length, which we believe is a simple procedure that can be achieved minimally invasive with a low complication rate. In summary, the endoscopic technique provides good functional results with a high level of patient satisfaction and low wound complication rate. However, technical complications can occur in relation to tendon harvesting or tunnel drilling.

Lately, we have augmented our FHL tendon transfer fixation in two cases. In terms of tendon fixation, a myriad of techniques has been described with more or less popularity[14]. Interference screw is an increasingly used technique because it decreases donor site morbidity, and less tendon length is needed for transfer, reducing the need of auxiliary incisions[14,15]. To the authors´ knowledge, no clinical studies have described interference screw failure in FHL transfer. However, pull out cases of interference screws in biceps pathology have been reported[16]. Therefore, we believe some patients could benefit from adding a tightrope button in the plantar aspect of the calcaneus, particularly in those with a poor bone quality or athletes requiring early sports reintegration.

Conclusion

This study is not without any limitations. The lack of a control group to compare this surgical approach, a limited and specific sample size (high-risk patients), and the short-term follow-up hinders our ability to draw definitive conclusions. However, we believe this technique is simple, reproducible, and safe to restore the gastrocnemius-soleus complex length and transferring the FHL tendon endoscopically in patients with chronic Achilles tendon ruptures.

Authors' contributions: Each author contributed individually and significantly to the development of this article: FSV *(https://orcid.org/0000-0003-3969-2916) wrote the article, interpreted the results of the study, participated in the review process approved the final version; FCR *(https://orcid.org/0000-0001-6138-4384) wrote the article, participated in the review process, approved the final version; MEH *(https://orcid.org/0000-0002-8076-3360) wrote the article, participated in the review process, approved the final version; CC *(https://orcid.org/0000-0003-2574-9010) performed the surgeries and approved the final version; GC *(https://orcid.org/0000-0002-1993-6250) performed the surgeries and approved the final version; MJP *(https://orcid.org/0000-0002-2820-5337) performed the surgeries, wrote the article, approved the final version. *ORCID (Open Researcher and Contributor ID).

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Original Article

Lateral ankle stabilization with a polyester fiber construct implant as a revision for failed primary lateral ligament reconstruction

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Abstract

Objective: The aim of this study is to demonstrate an original technique in which a stable construct is made by fibular and calcaneal bone tunnels producing a figure of 8 with a Polyester implant as revision for failed primary ligament reconstruction.

Methods: This is a retrospective study of 19 patients with persistent lateral ankle instability diagnosis after a primary ligament repair treated between 2011 and 2019. The surgical technique is described in detail in which stabilization of the lateral ankle is performed. 11 men and 8 women with a mean age of 30.94 years (15-53). Follow up was 29.05 months (6-109). Pre and postoperative AOFAS ankle score were used as well as an AVS and a satisfaction questionnaire.

Results: There was a significant improvement in AOFAS score, 76.31 to 91.47 (<0.001). All the patients except one, stated to have a stable ankle and be Very satisfied (16) or satisfied (2) with the procedure. No infection was presented in any patient.

Conclusion: This technique is a reliable alternative in patients in which primary ankle ligaments have failed and no autograft or allograft are wanted to be used.

Level of Evidence V; Therapeutic Study; Expert Opinion.

Keywords: Lateral ligament, ankle/surgery; Lateral ligament, ankle/injuries; Ankle injuries/complications; Joint instability/surgery; Reoperation.

Introduction

Currently, most of the lateral ankle instabilities are treated with an anatomical Broström procedure described in 1966[1] and with all the modifications and augmentations developed since then either open or arthroscopic.

Good to excellent results have been published for this techniques as primary reconstruction of the ankle lateral ligaments[2,3] and no study has proved superiority in between open or arthroscopic conduct, both of them having excellent results[4].

Factors leading to failure of this primary repair include a brand-new trauma, hindfoot varus and also overuse associated with microtrauma and final failure. Also hyperlaxity is considered an important topic for this situation[5].

In this article, we will describe a Surgical Technique in which we produce bone tunnels on the fibula and calcaneus in order to do a construct to stabilize the lateral ankle of 19 patients with a Polyester implant.

Methods

This is a demonstration of the surgical technique and a retrospective study of 19 patients with history of ankle instability that previously had a lateral ankle ligament reconstruction and persisted with such instability that were operated with this technique from January 2011 to January 2019.

None of the patients on this study were professional athletes.

Study performed at the Centro Médico ABC, Campus Santa Fé, Santa Fe, Mexico City, Mexico.

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Exclusion criteria: patients with an advanced ankle arthrosis with limited ankle range of motion.

The failure of the primary surgery was determined as follows:

1. Patients claiming to have instability as or near as before the first surgery and not having a reliable ankle for everyday and recreational activities;
2. Physical exam with clinical instability sings (anterior drawer and talar tilt);
3. Evident Positive Ap X rays with stress.

Measurements tools:

1. All of the patients were asked to answer AOFAS Ankle score Pre and Postoperatively as well as Visual Analog Scale (VAS);
2. Satisfactory questionnaire (ranging from Very satisfied – Satisfied - Not so satisfied - Unsatisfied).

42.1% were female [8] and 57.8% were male [11], the age average was 30.9 years old [15-53] at the moment of the revision surgery.

The procedures that the patients had as first intervention were: classical Broström [15], Broström augmented with fiber tape [1], Evans procedure [2] and cadaveric graft [1].

Follow up was of 29.05 months (6-109) in which the AOFAS scale was filled and physical exam was made looking for clinical instability and stress X rays.

Surgical technique

With the patient in prone position, sedation and popliteal block on the affected limb are completed. Also, a thigh tourniquet was applied.

An incision is made starting 2cms above the tip of the fibula on the center of it down to the sinus tarsi until 1cm of the anterior calcaneus process is seen.

When there was a procedure different than classic Broström, the tissue or implant (native Peroneal brevis, tendon graft or fiber tape) was removed.

A bone tunnel with a 3.5mm drill is done 1.0 to 1.5cms above de tip of the fibula from anterior to posterior in a horizontal line (Figure 1), care is taken to protect peroneal tendons. Then, dissection is carried down passing the sinus tarsi to the anterior aspect of the subtalar joint and the calcaneus is exposed in a way we can see the dorsal anterior tuberosity without exposing the calcaneocuboid joint (CC joint).

The second tunnel is produced on the most posterior aspect of the anterior tuberosity just anterior to the subtalar joint which must be protected at all the time.

5 to 7mm below the upper border of the tuberosity perpendicular to the lateral wall and a second perforation is done with the drill in a vertical position from dorsal to plantar in line with the first tunnel, this begins 1 or 2mm medial to the upper border of the calcaneus (Figure 2).

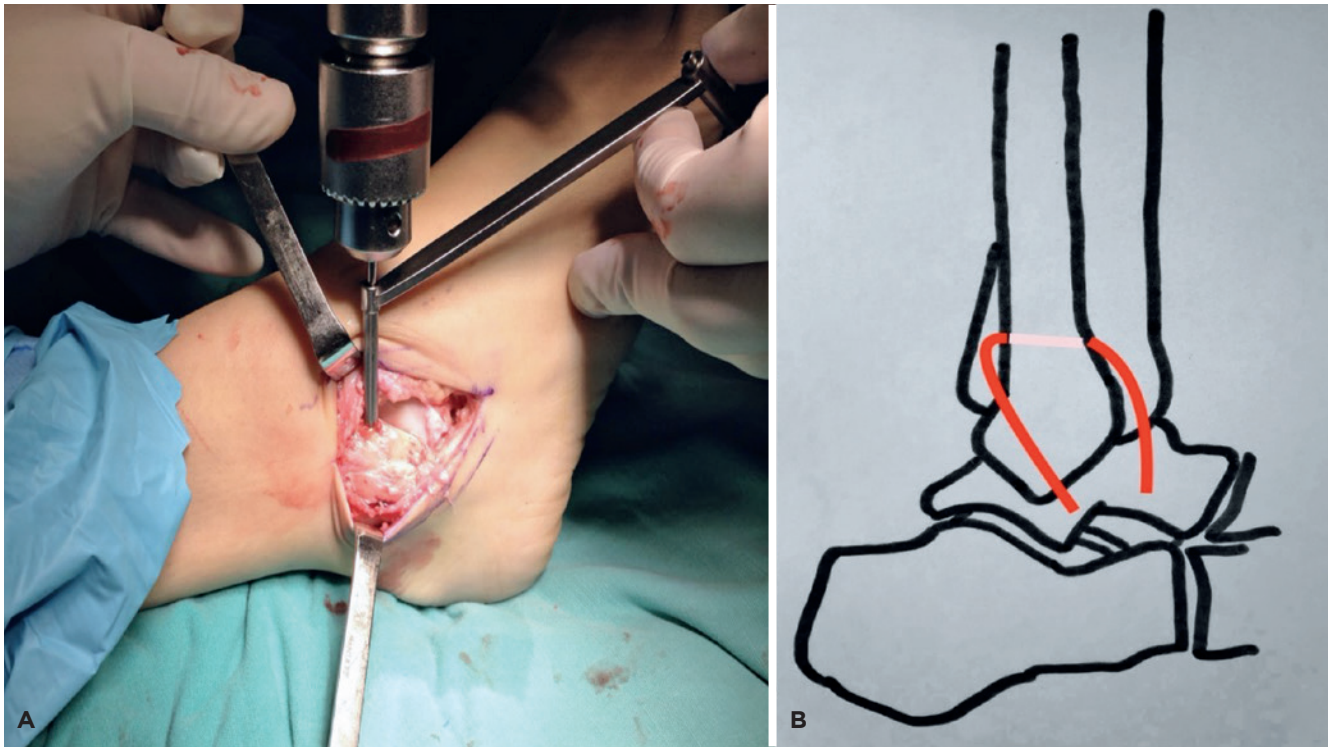

Figure 1. A. Fibular tunnel. B. The Implant is passed through fibular tunnel.

Then we use a ligament prosthesis manufactured out of polyester yarn in the form of bands with lateral edges rolled inside with a 3mm of width.

So, this "new ligament" is passed through the tunnels in a figure of 8 as show in Figure 3.

Just before tightening the knot, the ankle is placed in neutral position with no valgus or varus at all. Then we do 2 simple knots and use cyanoacrylate glue to fuse it.

Before closing the wound, remaining tissue around the anterior fibula is closed, we never used anchors at this stage. In most of the cases the Anterior talo-fibular ligament (ATFL) is not touched and just let it in place as it was.

We close the wound deep and superficial with absorbable suture and skin with non-absorbable.

A suropodalic splint is left for 2 weeks with non-weight bearing and then the patient can walk with a boot for 3 weeks

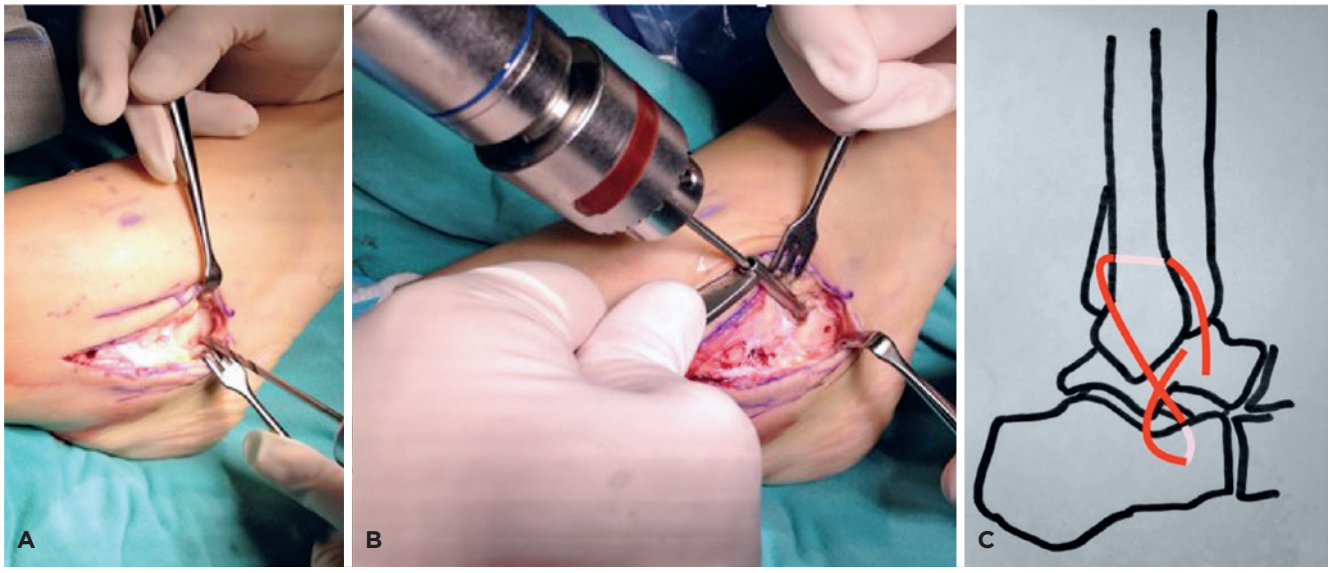

Figure 2. A and B. Calcaneal tunnel. C. Second tunnel passing.

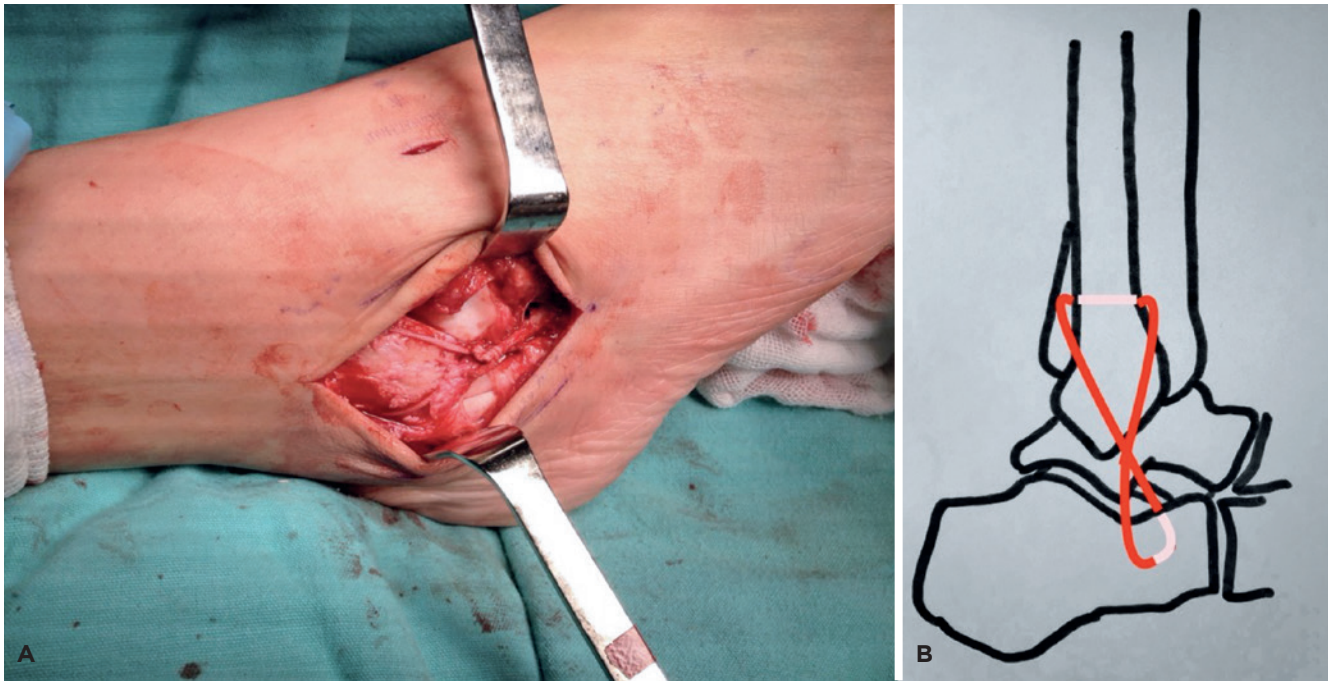

Figure 3. A. Figure of 8 with Polyester implant. B. Final result with a figure of 8 and a double knot.

so at 5 weeks postoperative he or she can walk with no orthopedic device.

Sutures are removed at 3 weeks postoperative and physical therapy is started at 6 weeks.

Results

AOFAS Ankle Score improved from pre-op 76.31 to 91.47 and this was statistically significant (<0.001) (Table 1, 2 and Figure 4).

Table 1. AOFAS pre and postoperative

Patient	AOFAS pre	AOFAS postoperative
1	82	100
2	63	87
3	82	100
4	79	90
5	79	100
6	79	90
7	79	95
8	79	100
9	63	100
10	63	95
11	82	95
12	82	95
13	82	90
14	82	90
15	82	90
16	72	90
17	61	64
18	64	82
19	62	85
TOTAL	**76.31**	**91.47**

Table 2. Change in AOFAS

Variable	Preoperative	Postoperative	Change	p*
AOFAS	79 (18.5, 61-82)	90 (7.5, 64-100)	11	<0.001

Values are: Median (IQR, min – max). *Wilcoxon signed rank test.

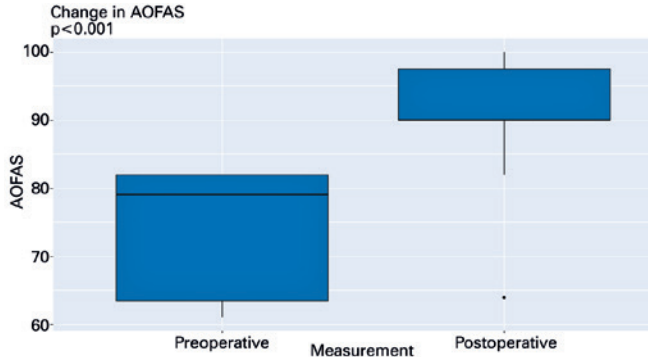

Figure 4. Change in AOFAS.

Patients were followed for an average of 60.15 months (96 to 12) and were asked to fill the AOFAS scale on the final follow up (January 2020).

AVS was 4.3 preop and 0.5 postoperative, this could be explained because pain was not the main symptom on this group of patients but was improved as well anyway.

Also, X rays with varus stress were taken postoperative to compare with the initial one, in all patients there was an evident difference on the talar tilt.

Clinically there was a very stable ankle on the physical exam and patients expressed security during uneven surfaces as well as stability during recreational sports and long-distance walking.

Regarding satisfaction questionnaire we had 16/19 very satisfied patients, 2/19 Satisfied and 1 unsatisfied.

Concomitant procedures were: 9 ankle arthroscopies of which 4 had microfractures done.

Complications included: wound delayed healing in 2 cases that finally healed in 8 weeks with no infection. Scar hypersensitivity was present for 3 months in 5 of the 19 patients that eventually disappeared.

1 patient had a rupture of the implant at 18 months of surgery that required a second revision where we could document the implant rupture at the level of the calcaneal tunnel. Her very first surgery was a Broström with Fiber tape, she also had poor bone quality due to intense smoking habit and severe peroneal brevis tendon weakness which we think it led to a more sever instability, an Evans Procedure was done in this case with a mediocre outcome.

Disscusion

The kind of construct used in this article is an original idea but is clearly influenced by the Chrisman Snook/Watson Jones fashion[6,7].

Non anatomic procedures like this tend to be discarded because of over tightening subtalar motion[5]. In none of our patients at the time for follow up, we had this kind of claim, in the other way they confirmed to have a very stable ankle and no ankle joint deterioration was seen in x rays.

Also, it is important to report that in 6 patients of this group, there was an intraoperative gross subtalar instability that could be the cause of the persistent instability sensation and this was clearly improved postoperative.

Regarding this topic, there are publications that believe that the sinus tarsi is a very important proprioceptive zone, due to sinus tarsi biopsy, Morsy and Filler[8] found that histological examination revealed the presence of large amount of neural elements (mechanoreceptors) together with abundant elastic fibers in all of the excised subtalar tissues.

Cho et al.[9] have done revision of failed Broström with a new augmented Broström with a fiber tape with very good results having only one failed case after this second surgery requiring a 3rd surgery where they used an allograft.

This numbers are very similar to the ones of this study in which we only had 1 patient failing due to implant rupture.

It is recommended to do non anatomic surgery (allograft or autograft) in a previously failed anatomic reconstruction because it is a poor prognosis to repeat it.

We think that not using patient´s healthy tissue like a peroneal, plantaris tendons, etc., or using cadaveric graft is an advantage because of the morbidity associated with it.

There was never a biological reaction to the implant or deep infection that required medical or surgical treatment.

The limitations of the study are a not very large patient population and despite the good results we don't really know what happens in a biological level with the implant and its bio-integration to bone.

Having a failed Broström procedure should always make us think about a new and more aggressive surgical act, allograft or autografts are very accepted conducts with very good results[5], but not free of donor site morbidity and possible immunological reaction or deep infection.

Conclusion

The present technique is an alternative for the revision surgery for lateral ankle stabilization due to strong construct, no biological reaction.

Authors' contributions: Each author contributed individually and significantly to the development of this article: LFHG *(https://orcid.org/0000-0001-9016-6167) conceived and planned the activities that led to the study, performed the surgeries, clinical examination, data collection, bibliographic review and approved the final version; EHO *(https://orcid.org/0000-0002-1637-8134) conceived the technique used in this study, clinical examination, interpreted the results of the study and approved the final version; ATG *(https://orcid.org/0000-0003-2441-0904) interpreted the results of the study, participated in the review process, statistical analysis and approved the final version. *ORCID (Open Researcher and Contributor ID).

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Original Article

Clinical and radiological outcomes of the first metatarsophalangeal arthrodesis with Kirschner wires for the treatment of severe hallux valgus

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Abstract

Objective: To present the clinical and radiographic outcomes of metatarsophalangeal arthrodesis of the hallux with crossed Kirschner wires and cerclage for the treatment of severe hallux valgus.

Methods: Twenty-nine feet of 21 consecutive patients who underwent metatarsophalangeal arthrodesis to correct severe hallux valgus between March 2011 and April 2018 were clinically and radiographically evaluated.

Results: After an average follow-up period of 42 months, 17 feet (58.6%) generated a response of total satisfaction with the procedure and 12 (41.4%) a response of satisfied with reservations; none of the patients were dissatisfied. Pain assessed using the visual analog scale improved from a mean of 8 before the procedure to 1.2 at follow-up. The American Orthopaedic Foot and Ankle Society score improved from a mean of 26.5 points before the procedure to 78 points at follow-up. The hallux valgus angle improved from a mean of 38.5° in the preoperative period to 13.1° at follow-up, i.e., an improvement of 25.4°. The intermetatarsal angle improved from a mean of 18.8° in the preoperative period to 15° at follow-up. Consolidation of arthrodesis occurred in all cases, but reintervention was required to remove the hardware in 17 operated feet (58.6%).

Conclusion: Metatarsophalangeal arthrodesis with crossed Kirschner wires and cerclage for the treatment of severe hallux valgus produced high rates of satisfaction, with substantial improvement in pain and functional parameters, consolidation in all cases and excellent radiological correction, but had the drawback high rate of reintervention for hardware removal.

Level of Evidence IV; Therapeutic Study; Case Series.

Keywords: Metatarsophalangeal joint; Arthrodesis; Hallux valgus.

Introduction

Hallux valgus is the most common deformity of the adult foot, affecting up to 30% of the urban population. It is also a frequent cause of painful symptoms, difficulty wearing closed in shoes, and aesthetic dissatisfaction. Factors associated with development of the deformity include genetic predisposition (family history) and use of closed in shoes, especially high heels and shoes with pointed toes, which alter the biomechanics of gait and areas of pressure on the foot, contributing to the onset and progression of the deformity[1-4].

Although many people live with the disorder without complaints or the need for treatment, a high percentage develops painful symptoms, functional and/or aesthetic complaints, which motivates the search for an orthopedist with the intention of correcting the deformity.

The most appropriate treatment remains controversial, especially when dealing with severe deformities. More than 100 surgical techniques are described for the correction of hallux valgus, each with its specific indications, limitations, advantages and disadvantages. First ray realignment osteotomies

Study performed at the Hospital Moinhos de Vento, Porto Alegre, RS, Brazil.

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are the most commonly used procedures at present, but the chances of recurrence or residual pain due to osteoarthritis secondary to deformity are disappointing and relatively frequent complications[5-7].

Osteotomies for hallux valgus correction are performed mainly at the level of the first metatarsal, in the distal, diaphyseal or proximal region, depending on the degree of deformity. Distal osteotomies are traditionally reserved for minor deformities due to their lower angle correction capacity. In major deformities, surgeons opt for a diaphyseal or proximal osteotomy, which are relatively major procedures that require a more robust internal fixation, often increasing morbidity and the cost involved in the surgery.

Metatarsophalangeal arthrodesis is a treatment that has the ability to correct severe deformities and produces high percentages of good results, besides eliminating any residual pain due to osteoarthritis secondary to deformity, a complication that, as already mentioned, occurs quite often after osteotomies[7-13]. Hallux valgus represents, in the vast majority of cases, a metatarsophalangeal subluxation with varying degrees of joint incongruity. In the long term, this biomechanical alteration causes asymmetric wear and tear of the metatarsophalangeal joint surface, which can become or remain symptomatic after a first ray osteotomy for realignment[13].

Successful arthrodesis eliminates the risk of secondary osteoarthrosis in the MTPJ (metatarsophalangeal joint), but has the drawback of eliminating mobility in this joint and limiting the use of some shoes, especially high heels. This postoperative limitation, however, does not usually represent a problem for patients who had been experiencing pain and having difficulty wearing dress shoes due to the deformity. Another disadvantage of arthrodesis is the cost of the procedure, since most techniques involve fixation methods that use sophisticated implants, such as locked plate and screws, with the main objective of increasing the stability of the fixation and reducing the chances of nonunion(14-20). Pre-molded implants are being developed with the objective of reducing surgical time, since they eliminate the need for intraoperative molding, reduce the occurrence of nonunion and the need for reintervention to remove them, as they adapt to the regional anatomy with much more precision. These implants, however, are available in few treatment centers and cost much more than traditional implants[17-20].

This study presents the clinical and radiological outcomes of metatarsophalangeal arthrodesis for the treatment of severe hallux valgus, using fixation with Kirschner wires, a simple technique with very inexpensive implants, available in the vast majority of hospitals.

Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate) number: 26187319.3.0000.5330.

The Informed Consent Form was waived as the data were collected through medical records, retrospectively and while maintaining the postoperative clinical routine.

Medical records of patients who had undergone correction of severe hallux valgus through metatarsophalangeal arthrodesis between March 2011 and April 2018 were evaluated. Preoperative clinical information and radiographs were evaluated and compared with postoperative radiographs and clinical data collected at least twelve months after surgery.

According to clinical routine, the AOFAS score is applied first. This system consists of a functional scale of the metatarsophalangeal joint that measures alignment, pain, functionality and mobility, graded from 0 to 100. The system is followed by the visual analog scale for pain, then the satisfaction questionnaire containing the following options: totally satisfied, satisfied with reservations, or not satisfied.

The radiographs evaluated were weight-bearing anteroposterior and lateral pre and postoperative views of the foot.

The review of medical records with AOFAS scores, visual analog scale of pain and satisfaction questionnaire allowed an objective analysis of the degrees of satisfaction, pain, and functionality of all patients. The degrees of deformity were also assessed using radiographic measurement of the intermetatarsal and metatarsophalangeal angles, comparing the results of the pre and postoperative radiographs. The evaluation of postoperative radiographs revealed consolidation of the arthrodesis and the degree of angular correction of the deformity.

Surgical technique

The procedure was performed under sedation and ankle block in all cases. Through a medial incision, made in the center of the metatarsophalangeal joint, measuring approximately 5 centimeters in length, the cartilage of the head of the first metatarsal and of the proximal phalanx was removed manually using an osteotome, rongeur and curette. The first ray was then realigned in the frontal and sagittal planes and fixed with 4 crossed Kirschner wires, 2 of which were from proximal to distal and 2 from distal to proximal, and with cerclage in a horizontal figure-of-eight format (Figures 1A and 1B). After radiological control of the positioning of the wires and of the correction achieved, the joint capsule and skin were closed with vicryl 3-0 and vicryl rapide 4-0 sutures, respectively.

Postoperative period

Weight-bearing with Barouk postoperative shoes was allowed the day after surgery and maintained until the eighth postoperative week. Radiographs are taken between 6 and 8 weeks and between 12 and 16 weeks from the date of surgery. The postoperative questionnaire with the AOFAS scale and visual analogue scale of pain is completed in the last review 12 months after surgery.

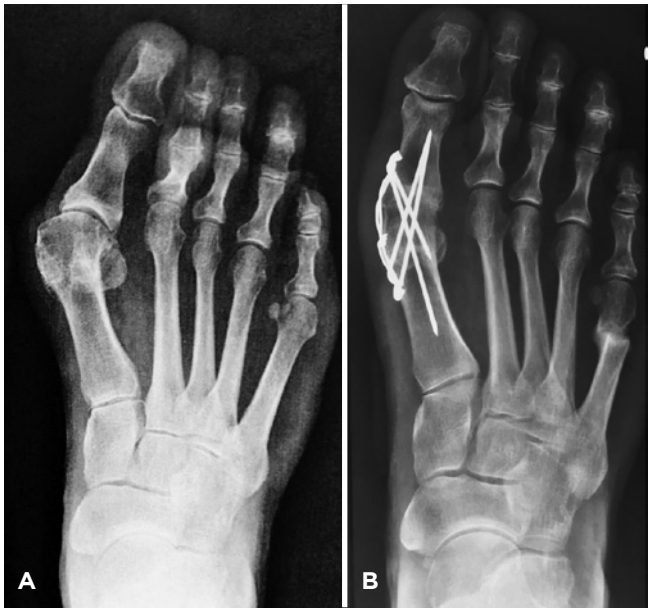

Figure 1. A. Pre and B. Postoperative radiographs.

Table 1. Pre and postoperative values

Variables	Pre	Post	p
AOFAS (n=29)	26.5 ±14.6	78.1±8.8	<0.001
VAS (n=29)	8 (7-9)	0 (0-1)	<0.001
MTPJ (n=19)	38.5±9.9	13.1±4.9	<0.001
IMMA (n=19)	18.8±10.7	8.9±2.7	0.001

AOFAS: American Orthopaedic Foot and Ankle Society score; VAS: Visual Analog Scale; MTPJ: metatarsophalangeal joint; IMM: intermetatarsal angle.
Implant removal was required in 17 of the 29 feet (58.6%) during follow-up.

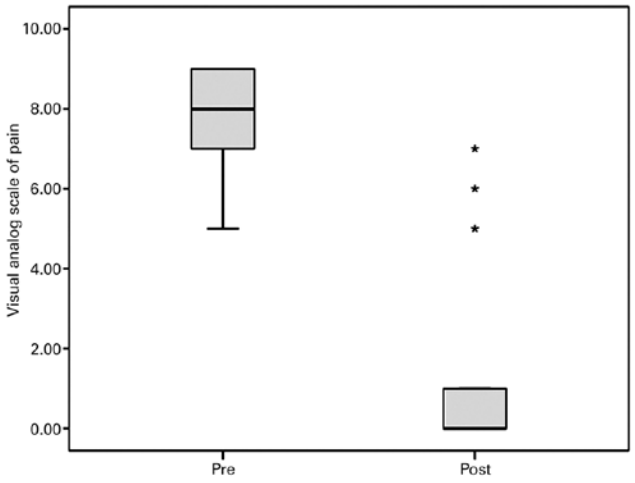

Figure 2. Comparison of the visual analog scale of pain before and after (Pre: median (P25-P75)=8 (7-9); Post: median (P25-P75)=0 (0-1); p<0.001).

Statistical analysis

Quantitative variables were described by mean and standard deviation or median and interquartile range. Categorical variables were described by absolute and relative frequencies.

To compare means before and after surgery, the paired sample t-test was applied.

The level of significance adopted was 5% (p<0.05) and the analyses were carried out using SPSS version 21.0.

Results

We evaluated 21 patients with a mean age of 69 years (+10), where the most frequently observed comorbidity was rheumatoid arthritis occurring in 5 patients (23.8%). Fourteen patients had no associated pathology (66.7%) while 2 had other conditions (9.6%) (spastic hemiplegia and Parkinson's disease).

Of the 21 patients evaluated, eight (38.1%) were operated bilaterally, totaling 29 feet, six feet operated on the right side (20.7%) and seven on the left (24.1%). The mean follow-up time was 41 months (+22.5).

After this follow-up period we applied the satisfaction questionnaire and observed that 17 feet generated a totally satisfied response (58.6%), while 12 feet generated a satisfied with reservations response (41.3%) and no patient was dissatisfied with the surgery.

Application of the AOFAS score revealed a significant improvement, with a preoperative score of 26.5 (+14.6) and a postoperative score of 78 points (+8.8) (Table 1). There was a significant reduction in pain levels, as shown in Figure 2.

The radiographic angle measurements revealed a mean improvement in the metatarsophalangeal angle of 25°, from a preoperative mean of 38.5° to a postoperative mean of 13.1°. The intermetatarsal angle improved on average 3.8°, from a preoperative mean of 18.8° to a postoperative mean of 15° (Table 1).

Complications

A bilaterally operated female patient developed deep vein thrombosis, which progressed favorably and without sequelae with drug treatment. Hardware removal was required in 17 of the 29 feet, entailing the need for a secondary procedure in 58.6% of cases. There were no cases of recurrence.

Discussion

Arthrodesis of the metatarsophalangeal joint is a procedure widely used in the treatment of hallux valgus, especially in complicated, recurrent, and/or severe cases. The degree of postoperative satisfaction and the rate of return to previous activities and sports after the procedure are high[2,3]. Although

Ripstein recommended the combined use of a proximal procedure, osteotomy or Lapidus arthrodesis for angular correction of the deformity, several studies have shown that isolated MTPJ arthrodesis has the ability to bring the hallux valgus and intermetatarsal angles back to values considered normal[21].

The most common complication is nonunion, with an estimated occurrence of around 7% in the presence of hallux valgus[22]. Increasingly robust fixations with increasingly sophisticated implants aim to reduce the incidence of this complication that usually requires reintervention, which did not occur in any case from our series. Another reason for reoperation in patients undergoing metatarsophalangeal arthrodesis of the hallux is the removal of synthesis material, which was very common in our series. As it is a joint subject to high demand, osteosynthesis for MTPJ arthrodesis is usually robust, but soft tissue coverage in the region is scarce and irritation of the synthesis material often occurs as soon as the initial procedural edema decreases. In our group of patients, the consolidation rate was 100%, eliminating the need for reintervention due to nonunion, and surpassing other studies. We credit this success to longitudinal fixation involving an extensive intramedullary area promoted by crossed Kirschner wires, combined with cerclage that promotes a tension band effect against the resilience of the deformity and produces compression at the arthrodesis focus.

On the other hand, our reintervention rate for the removal of hardware was 58.6%, much higher than other series, which we associated with the difficulty in adjusting the exact length of the Kirschner wires so that they are not protruded at the ends. The advantages of the procedure include technical simplicity, once no special instrumentation is needed, and the low cost, and availability of the hardware used.

Conclusion

MTPJ arthrodesis in the treatment of hallux valgus performed with crossed Kirchner wires and cerclage produced high levels of satisfaction, with substantial improvement in pain and functional parameters, and excellent correction of radiographic parameters with consolidation in all cases, but had the drawback of a high rate of reintervention to remove synthesis material.

Authors' contributions: Each author contributed individually and significantly to the development of this article: LHB *(https://orcid.org/0000-0002-2299-8452) interpreted the results of the study, participated in the review process, approved the final version; JAVS *(https://orcid.org/0000-0002-6321-9566) conceived and planned the activities that led to the study, wrote the article, participated in the review process, approved the final version. *ORCID (Open Researcher and Contributor ID).

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Original Article

Preliminary short-term results of ankle arthroplasty with the Taric® prosthesis

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ABSTRACT

Objective: Present the clinical and functional outcome of the first five ankle arthroplasties performed in our department.

Methods: Five patients (five feet) with secondary arthrosis of the ankle underwent ankle arthroplasty with the Taric® prosthesis. Average age at the time of surgery was 42 years. Follow-up time averaged 43 months. We recorded the immediate postoperative complications. For clinical evaluation we used the VAS pain scale, the AOFAS hindfoot and ankle scale, and the Foot Function Index. We measured the leg-foot range of motion. On the radiographs, we measured the alpha, beta, and gamma angles as well as sagittal balance. We sought to identify the presence of posterior osteophytes (bone spurs).

Results: We observed a case of medial malleolus fracture and a case of superficial suture dehiscence. In two cases, we considered the final outcome to be poor. The mean VAS of pain before surgery was 8.8 points while the postoperative score was 5.4 points. On the AOFAS scale, the average preoperative score was 52 points and the score at final evaluation, 70 points. We noticed a 10º increase in leg-foot range of motion.

Conclusion: The assessment of the first patients undergoing ankle arthroplasty with the Taric® prosthesis yielded outcomes considered poor in 40% of cases. However, in those with an outcome considered satisfactory, there was an improvement in pain and an increase in leg-foot range of motion. In all patients, we noticed the formation of a posterior osteophyte alongside the posterior cortex of the distal tibia.

Level of Evidence IV; Therapeutic Studies; Case Series.

Keywords: Ankle; Osteoarthritis; Surgery; Arthroplasty, Replacement, Ankle.

Introduction

Symptomatic ankle arthrosis causes a significant decline in the quality of life of patients[1]. The advent of ankle arthroplasty brought new expectations, but the real benefits and long-term outcomes are still being studied[1]. Although there is still uncertainty about which procedure leads to better outcomes, whether it is arthrodesis or arthroplasty, the latter has increased in popularity, with a large number of recent publications[1-6]. However, the risks and potential complications still persist[7-10], and adequate knowledge of the procedure may help us avoid them.

The aim of this work is to present the preliminary results of the first five ankle arthroplasties performed in our department and to identify the factors of good outcomes and the main complications to date.

Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate) number: 19234719.2.0000.5479.

Study performed at the Santa Casa de Misericórdia de São Paulo, São Paulo, SP, Brazil.

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This is a retrospective observational study that met the requirements in relation to human and animal rights.

Between May 2015 and April 2016, five patients (five extremities), all female, underwent surgical treatment of ankle osteoarthrosis with arthroplasty of this joint, performed by the Foot and Ankle Surgery Group of our hospital. Taric® prostheses (Implantcast) were used in all cases. The mean age at the time of surgery was 42 years (ranging from 35 to 49 years). The follow-up time ranged from 37 to 48 months, averaging 43 months. Body mass index (BMI) ranged from 28.1 to 34, indicating that patients were in the range between overweight and obesity. In all patients, ankle arthrosis was considered secondary: three patients had a diagnosis of rheumatoid arthritis, one patient a history of osteochondral lesion of the talus, and another, a history of ankle fracture. Patients diagnosed with rheumatoid arthritis were being regularly monitored by the rheumatologist, with the disease controlled and using immunosuppressive medication, which was suspended at the time of surgery[7].

For functional clinical assessment, in addition to the orthopedic physical examination, we also used clinical photographs, the visual analogue scale of pain (VAS)[11,12], and the American Orthopaedic Foot and Ankle Society (AOFAS) ankle and hindfoot scale[13], and compared data obtained in the preoperative period with data obtained in the last outpatient appointment. In addition, the Foot Function Index (FFI)[14] was used in the postoperative period (the FFI was not collected in the preoperative period). To assess joint range of motion, we chose to measure movement between the leg and the foot, knowing that this movement involves other hindfoot joints. We asked the patient to perform as much plantar flexion movement as possible, followed by maximum dorsiflexion, while maintaining the sole of their foot on the ground at all times. The positions obtained were documented with photography and lateral radiography of the ankle and foot (in the upright position). By measuring the longitudinal axis of the distal tibia with the position of the ground, we obtain the range of motion between the ankle and the ground (leg-foot movement) (Figure 1).

We measured radiographic data, both pre- and postoperatively. We used the alpha angle to assess valgus and varus deformity of the joint surface of the distal "tibia" on the anteroposterior radiograph with internal rotation of 20 degrees[15-18] (Figure 2). In the lateral radiograph, we evaluated tibial component inclination using the beta angle[15-18] (Figure 3). To evaluate the positioning of the talar component, also in the lateral radiograph, we measured the gamma angle[15-17]. The variation of these angles during outpatient follow-up was considered a sign of component movement and a high risk of loosening or sinking.

In addition to the abovementioned angles, we also evaluated sagittal balance, which reveals the offset of the ankle joint (anteroposterior position of the talus in relation to the long axis of the tibia). This enabled us to observe whether there were cases with ankle subluxation[19] (Figure 4). Sagittal balance is measured on the lateral radiograph of the ankle. In this radiograph, we also evaluated the coverage of the posterior cortex of the distal tibia by the tibial component. According to the manufacturer of this prosthesis model, this coverage (extension of the tibial component to the posterior cortical limit of the distal tibia) is not necessary. We also examined the radiographs for signs of periprosthetic

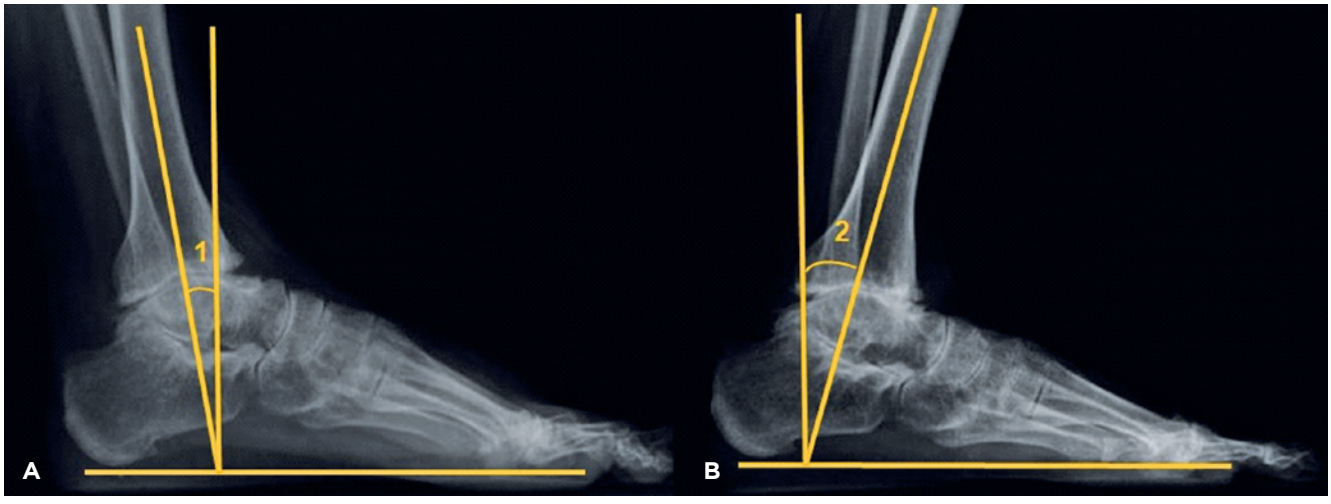

Figure 1. Method for radiographic measurement of ankle range of motion. In figure "A" we can see angle "1", which represents maximum plantar flexion, measured through the difference between the angle formed by the long axis of the tibia with the ground, and the right angle (neutral) of 90° with the ground. In figure "B" we can see angle "2", which represents maximum dorsiflexion, measured through the difference between the angle formed by the long axis of the tibia with the ground, and the right angle (neutral) of 90° with the ground. The sum of the two angles (1 + 2) represents the total range of motion of the ankle being assessed.

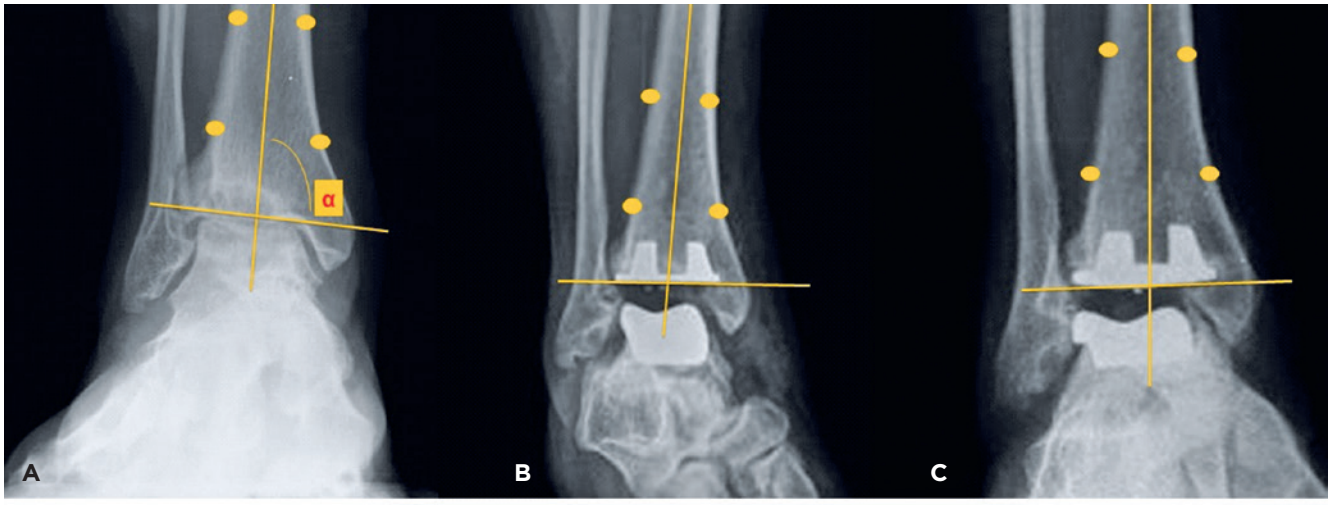

Figure 2. Measurement of the alpha angle "α". Measured on the radiograph in the frontal view with medial rotation of 20°, through the medial angle formed by the long axis of the tibia and the distal joint surface of the tibia/joint surface of the tibial component. The figure shows the values of one of the cases assessed in the preoperative (A), immediate postoperative (B), and late postoperative (C) periods.

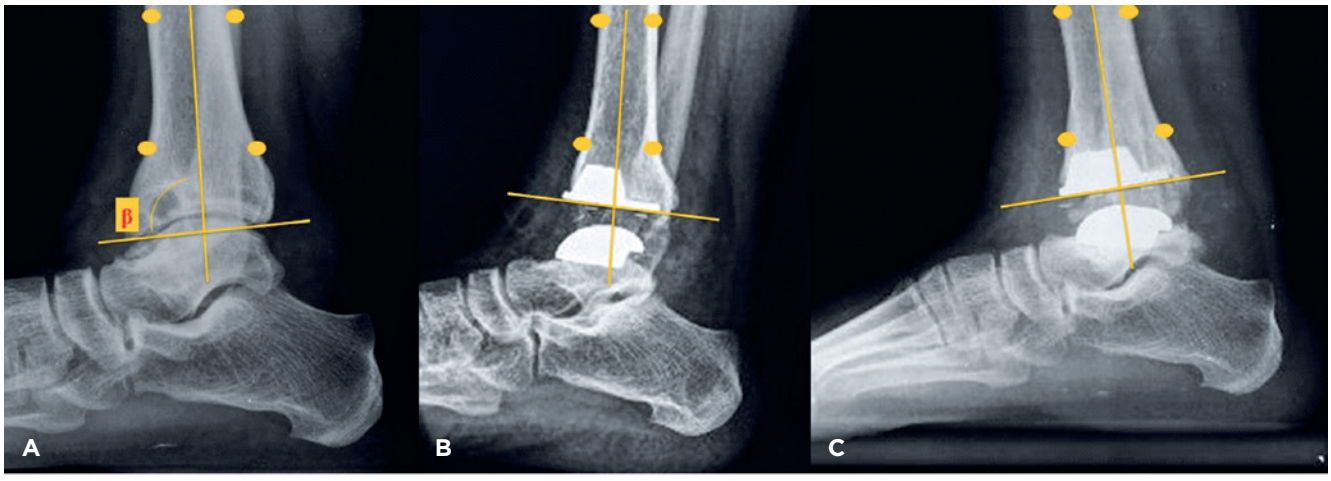

Figure 3. Measurement of the beta angle "β" on the lateral radiograph. Anterior angle formed by the long axis of the tibia and the distal joint surface of the tibia/joint surface of the tibial component. The figure shows the values of one of the cases assessed in the preoperative (A), immediate postoperative (B) and late postoperative (C) periods.

radiolucency, which indicates loosening of the component, presence of intraosseous cysts and formation of osteophytes in the distal tibia (Figure 5).

The access route used was the anterior approach, between the extensor hallucis longus and the tibialis anterior, described for this surgery. The joint surfaces of both the distal tibia and the talus were prepared according to the recommendations of the standard implant technique. Stability and range of motion were tested with the test prosthesis. If these were considered satisfactory, the final prosthesis was implanted. Special care was taken in distancing the soft tissues over the course of the surgery, in order to avoid wound healing issues. In a patient with rheumatoid arthritis, there was also arthrosis in the talocalcaneal joint, which was fixed, in the same procedure, with a 6.0 mm cannulated screw inserted from the dorsal to plantar direction (from the talus to the calcaneus), and without removing the talocalcaneal joint cartilage.

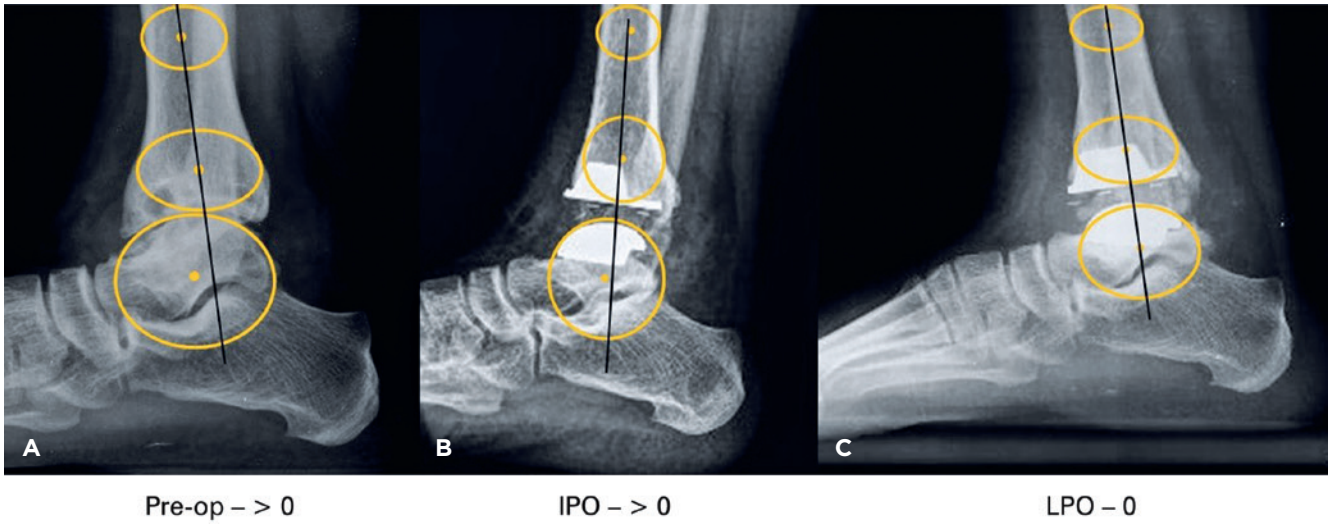

Figure 4. Evaluation of sagittal balance on the lateral radiograph of the ankle, where there must be alignment between the long axis of the tibia and the center of rotation of the talus. The figure shows the sagittal balance of one of the cases assessed in the preoperative (A), immediate postoperative (B) and late postoperative (C) periods.

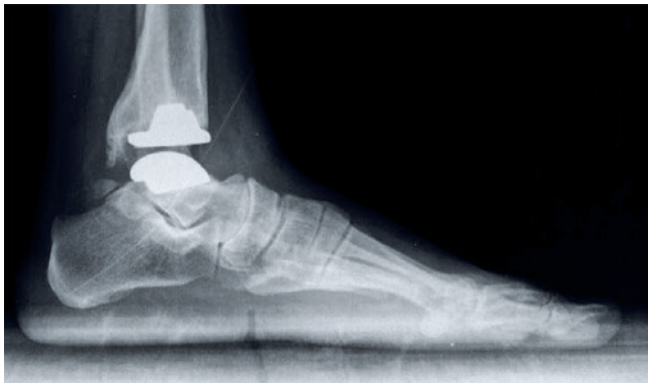

Figure 5. Posterior osteophyte – Lateral radiograph of the ankle of one of the cases assessed, 37 months after surgery, showing the formation of an osteophyte in the posterior region of the tibia. Despite the ectopic bone formation, the patient had a satisfactory functional outcome and 23° gain in the total range of motion of the ankle.

We also assessed the complications that can occur during surgery, such as malleolus fractures, and the immediate postoperative complications such as suture dehiscence, skin necrosis, exposure of the anterior tibial tendon, superficial and deep infection, and whether there was any relationship between these complications and the final outcome[7,8].

Results

During surgery, a medial malleolus fracture occurred in one case, treated immediately with fixation using cannulated screws. Fracture consolidation was achieved. This patient had arthrosis secondary to osteochondral lesion of the talus. We also observed, in one case, suture dehiscence in a patient diagnosed with rheumatoid arthritis who was taking corticosteroids. It was resolved with local dressings alone.

Of the five patients, we observed significant improvement in pain in three cases, in which the outcomes were considered satisfactory. Two patients still reported severe pain at their last return appointment. The average VAS score prior to surgery was 8.8 points (ranging from 8 to 9 points). After the procedure, this mean score was 5.4 points (ranging from 0 to 10), a reduction of 3.4 points. However, considering only the three cases with good outcomes, we noticed a significant improvement in pain. The three patients had a VAS score of nine points in the preoperative period and scores of zero, two and five points postoperatively.

On the AOFAS scale[13], the mean value before surgery was 52 points (ranging from 39 to 66). In the postoperative period, the mean score was 70 points (ranging from 38 to 90). Considering only the three cases with satisfactory outcome, the final result was 85, 85 and 90 points. As regards the Foot Function Index, we found a mean of 40%, ranging from 14% to 68%.

When evaluating the range of motion (ROM) between foot and ankle (leg-foot movement), prior to the surgical procedure, we found a mean value of 31° (ranging from 25° to 35°). In comparison, the mean ROM observed in the postoperative assessment was 41° (ranging from 27° to 58°), a 10° increase. In the cases with outcomes considered satisfactory, there was a gain in the range of this motion (11°, 12° and 23°), while in the cases with outcomes considered unsatisfactory, there was no increase in motion.

The results of the measurement of radiographic parameters are shown in tables 1 to 4. No particularities were observed between these parameters and the final result of the assessment. As regards the gamma angle, there are no values described as normal for this type of implant. Nevertheless, in case number four, we believe that the talar component was poorly positioned and that the 25º angle was high.

Table 1. Values obtained in the measurement of the alpha angle (α) (coronal inclination) on the preoperative, immediate postoperative, and last outpatient assessment postoperative radiographs.

	α – Preoperative	α – IPO	α – LPO
Case 1	89	85	83
Case 2	88	87	91
Case 3	89	91	92
Case 4	91	89	90
Case 5	85	90	94

Table 2. Values obtained in the measurement of the beta angle (β) (sagittal inclination) on the preoperative, immediate postoperative, and last outpatient assessment postoperative radiographs

	β – Preoperative	β – IPO	β – LPO
Case 1	90	94	91
Case 2	92	92	93
Case 3	95	91	93
Case 4	94	89	90
Case 5	89	85	83

Table 3. Values obtained in the measurement of the gamma angle (λ) (positioning of the talar component) on the preoperative, immediate postoperative, and last outpatient assessment postoperative radiographs.

	λ – IPO	λ – LPO
Case 1	18	12
Case 2	21	21
Case 3	9	10
Case 4	22	25
Case 5	21	19

Table 4. Values obtained in the measurement of sagittal balance on the preoperative, immediate postoperative, and last outpatient assessment postoperative radiographs

Sagittal Balance	Preoperative	IPO	LPO
Case 1	>0	>0	0
Case 2	0	>0	>0
Case 3	0	0	<0
Case 4	0	<0	<0
Case 5	>0	>0	>0

We observed the growth of a posterior osteophyte near the distal tibia, of varying sizes, in all cases; however, none of these were symptomatic.

Discussion

Despite the small number of cases and the average follow-up time of 43 months, which we consider short in this type of surgery, the publication of this case series is relevant. This is the first article with this prosthesis model published in our country (Brazil). The analysis of outcomes and complications at this time helps to minimize future negative outcomes and to draw a profile where this surgery may be the best choice, besides emphasizing the importance of adequate training before the surgeon undertakes an ankle arthroplasty[7,20].

Fracture of the medial malleolus is a complication described during surgery and in the postoperative period[6-9,20]. It can happen during the cutting of bone with the saw, or during the insertion of a particular prosthesis component[7]. It appears to decrease as the surgeon's experience with the surgical technique increases, and immediate treatment is advocated following its detection.[7] It occurred in one case, and was fixed during surgery using cannulated screws. Consolidation was achieved.

Surgical wound healing complications are also described[2,4,6,10,20]. Small suture dehiscences, small areas of skin necrosis and superficial infection are considered minor complications. Deep necrosis, with exposure of a tendon or one of the prosthesis components, and deep infections are major complications that can affect the treatment outcome[4,6,7]. We observed only one case of suture dehiscence, which was adequately treated with a series of dressings. This patient had arthrosis secondary to rheumatoid arthritis, a fact that may increase the incidence of this complication. For this reason, we recommend, as do other authors[4,9,18], greater care in manipulation and distancing of soft tissues during surgery on patients diagnosed with rheumatoid arthritis.

The major advantage of arthroplasty over ankle arthrodesis lies in maintaining joint mobility[18,20]. Range of motion after arthroplasty varies in the literature[10,17,20,21]. Accurate measurement of ankle range of motion is the subject of studies[22,23]. Coetzee and Castro[23] published a method that assesses isolated ankle movement following arthroplasty. Thornton et al.[22] believe that the movement between leg and foot is easier to measure and can be used in the assessment of both patients with arthrosis, and those undergoing arthroplasty or ankle arthrodesis. We chose to assess leg-foot movement, with the same parameters described by Thornton, yet using weight-bearing radiographs in the lateral view, with maximum plantar flexion and maximum ankle extension. We hope to thus obtain a measure that is reliable and reproducible both preoperatively and postoperatively. In the cases evaluated, there was a 10 degree gain in the range of motion, which we consider important.

We also observed pain relief, but wish to emphasize that it was not complete. Valderrabano et al.[17] observed total pain

relief in 54% of their patients. Gougoulias et al.[10] stressed that residual pain is common after ankle arthroplasty. In our small case series, there was an improvement in the VAS scale in cases considered satisfactory, and only one patient was completely pain free.

Although the indication for total ankle arthroplasty in patients diagnosed with rheumatoid arthritis is discussed, some[4] argue that in patients with good bone stock, whose disease is under control and who do not have major ankle and hindfoot deformity, arthroplasty can avoid accelerated articular degeneration of neighboring joints, which usually happens after ankle arthrodesis[2,9]. Adequate preoperative preparation must be observed[2,9,18]. In our study, the prosthesis was implanted in three patients diagnosed with rheumatoid arthritis. We considered one patient to have a good outcome, another an acceptable outcome, and one a poor outcome. In one case (good outcome), due to concomitant subtalar arthrosis, we performed the percutaneous fixation of this joint without removing joint cartilage. We believe that in these cases, due to rheumatoid arthritis, spontaneous joint fusion should occur. This enables us to avoid a new approach. The only case in which we observed delayed wound healing also occurred in a patient with rheumatoid arthritis. Although complete healing occurs after 4 weeks and we can use only local dressings changed weekly, we recommend greater care in the manipulation and distancing of soft tissues in these patients.

To measure the loosening of the prosthesis components, we used radiographic measurements. Supporting the tibial component in the posterior tibial cortex could prevent arthroplasty failure due to loosening and sinking of the tibial component[1]. However, in the surgical technique of the prosthesis adopted in this study, there is no such recommendation. We did not observe sinking and loosening. A minor accommodation of the components is to be expected. The angle described for assessing the talar component is the gamma angle. Valderrabano et al.[17] found a mean for this angle of 17.2 degrees in the STAR® prosthesis. Cadden found a mean of 20 degrees in the full prosthesis[5], while Le et al.[16] recorded values of 22 degrees when evaluating two types of implant. We did not find values described for the Taric® prosthesis in the literature. In this study, assessing the four cases in which we believe that the component was implanted correctly, we recorded a mean value of 17 degrees for the gamma angle.

Poor positioning of the implant can also have a detrimental effect on the final outcome[8,19]. If the implant was poorly positioned, the outcome was considered poor. This focuses on the need for adequate surgeon training before performing this surgical procedure.

Heterotopic ossification is a common finding after ankle arthroplasty (25% to 63%), and is more common in the posterior region of the distal tibia[17,21,24]. Valderrabano et al.[17] correlated heterotopic ossification to a reduced range of motion. Lee et al.[21] found less mobility and worse scores on the AOFAS hindfoot and ankle scale. The prophylaxis of this complication is still a matter of debate, and it appears to be more frequent in post-traumatic arthrosis. Other possible related factors are long surgical time, inadequate removal of bone debris after osteotomies, and the size of the small tibial component, leaving areas of spongy bone of the distal tibia exposed after the placement of the tibial component[21,24]. In the model evaluated in this study, there is no concern with covering the posterior cortex of the distal tibia with the tibial component. We observed heterotopic ossification of varying sizes in all cases. We were unable to relate this ossification to the range of motion or the AOFAS score, but its presence in the five cases drew our attention. Follow-up for a longer period of time, as well as a larger sample group, could help us respond to this issue.

This case series consisted of the first cases of arthroplasty undergoing surgery in our department. Despite the small sample and the short follow-up time, we observed some complications. At first glance, it appears to us that the ankle arthroplasty evaluated here did not produce the outcomes we initially expected. However, we must remember that there is a learning curve for this surgical technique, and the results tend to improve in the hands of surgeons who are more experienced with the procedure[7,20]. According to Haskell and Mann[8], complications tend to decrease substantially after the fifth prosthesis fitting.

Conclusion

The assessment of the first patients to undergo ankle arthroplasty with the Taric® prosthesis had outcomes considered poor in 40% of cases. However, in cases with an outcome considered satisfactory, there was improvement in pain and gain in leg-foot range of motion. In all patients, we noticed the formation of a posterior osteophyte alongside the posterior cortex of the distal tibia.

Authors' contributions: Each author contributed individually and significantly to the development of this article: WCLN *(https://orcid.org/0000-0001-7997-4868) wrote the article, participated in the review process; MTC *(https://orcid.org/0000-0001-9411-9376) conceived and planned the activities that led to the study, wrote the article, interpreted the results of the study, participated in the review process and approved the final version; RCF *(https://orcid.org/0000-0002-9886-5082) conceived and planned the activities that led to the study, participated in the review process and approved the final version. *ORCID (Open Researcher and Contributor ID).

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Original Article

Patients' perspective on the surgical treatment of hallux valgus

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Abstract

Objective: To evaluate patients' perspectives on the risk factors for hallux valgus, and their quality of life before and after surgery.

Methods: This is a cross-sectional, retrospective study, conducted in a tertiary hospital with 50 patients undergoing surgical treatment of hallux valgus. Data were tabulated using three methodological figures: central idea, key expressions and collective subject discourse.

Results: Regarding the risk factors, most of the patients demonstrated knowledge, expressed through central ideas such as: heredity, and wearing inappropriate shoes. In relation to quality of life before surgery, impairment was noted, inferred by central ideas such as: pain and discomfort, restriction in the use of shoes, functional limitation and aesthetic impairment; and regarding postoperative quality of life, most patients expressed satisfaction with the results.

Conclusion: Authentic discourses in the context of a prevalent pathology have expressed, for the first time, the conceptions of risk factors, quality of life before and after hallux valgus surgery.

Level of Evidence V; Therapeutic Study; Expert Opinion.

Keywords: Hallux valgus; Foot deformities; Qualitative research; Bioethics.

Introduction

Hallux valgus is one of the most common foot diseases requiring orthopedic surgical treatment. The prevalence of hallux valgus in the general population ranges from 21% to 70%; consequently, 2 million surgeries to correct this deformity are performed in the United States each year[1].

Hallux valgus has different levels of severity, and under certain conditions, it can be considered a serious problem, affecting quality of life. Patient complaints may include difficulty in selecting shoes, limitation in daily activities, toenail disorders, and the occurrence of callus[2,3].

In addition to the severity of the hallux deformity, other factors may affect quality of life of these patients. Hallux valgus treatment mainly aims to correct the deformity and reduce the pain. However, 26% to 30% of patients remain dissatisfied even after surgical correction. Thus, understanding other associated factors may provide information on treatment goals beyond the surgical approach alone[4,5].

For Minayo, qualitative research answers particular questions, considering as study subjects people belonging to a group and with a certain social condition, with a universe of meanings, values, beliefs and attitudes. Exploratory research is carried out in an area in which there is little accumulated and systematized knowledge, constituting the first stage of a broader investigation, and is developed when the subject is little explored. Due to its probing nature, it does not present hypotheses, although these may arise during or at the end of the research[6].

In practice, it is clear that not all patients with deformity are aware of the risk factors involved in the genesis of the pathology. Still, it is considered that surgical treatment brings

Study performed at the Universidade Federal de Minas Gerais, Belo Horizonte, MG, Brazil.

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great improvement in the quality of life of these patients. This study uses a qualitative approach to evaluate patients' perceptions regarding the risk factors for this prevalent disease and their quality of life before and after surgery.

Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate) number: 15861618.5.0000.5149.

This is a retrospective, exploratory-descriptive study, with a qualitative approach.

The inclusion criteria were patients submitted to hallux valgus surgery in the last seven years who agreed to participate in the study.

The study was conducted from April 1, 2019 to December 1, 2019. Its subjects were 50 patients submitted to surgical treatment for hallux valgus and followed up in a tertiary hospital.

To discover and describe the patients' views concerning the surgical treatment of hallux valgus, within the framework of Social Representations (RS), the method of Collective Subject Discourse (CSD) was used, as it enables a closer examination of the phenomenon under study. CSD is a set of discursive data tabulation procedures used to gain insight into a particular topic. The analytical process was operationalized in several steps: selecting key expressions from each discourse, analogous to the vital tone; identifying the central idea of each key expression in order to synthesize the content; identifying similar or complementary central ideas; and gathering key phrases for the central ideas[7].

Individual interviews were conducted, with three semi-structured questions that addressed: the causes of hallux valgus (bunion), quality of life before surgery, and quality of life after surgery. The interviews were recorded and later transcribed to obtain the results. Data on the patients' age, sex, and time (in years) since surgery were also gathered. Patients were asked to sign an Informed Consent Form (ICF) in advance, in compliance with Resolution 466/12 of the National Health Council, which deals with research involving human beings. Any ethical issues related to this work were guided by the above Resolution, and were brought to the attention of the research subjects prior to signing the ICF.

Based on CSD guidelines, three methodological figures were adopted in this work: Key Expression (KE), Central Idea (CI) and Collective Subject Discourse (CSD). For the data analysis, the order of the steps was strictly followed.

The first step involved carefully reading the transcribed narratives/discourses, to gain a general overview and a better understanding of discursive manifestations.

In the second step, each transcript was read separately from each of the guiding script questions.

In the third step, after reading the content of all the responses to each of the three questions, from each respondent, discourse analysis was used to identify Key Expressions (KE) that reveal the essence of the discourse. These KE were placed in italics. Next, the Central Ideas (CI) were identified, which accurately summarize the meaning of each of the discourses analyzed and each homogeneous set of KE, and will later form the CSD. In addition to the CI, the KE can also refer to a methodological figure. This same procedure was performed for all three questions.

The fourth step involved discourse analysis, which separately represented each CI with its respective similar or complementary KE.

In the fifth stage, the collective discourse was constructed for each grouping. It was necessary to sequence the KE of each group formed, outlining it with a beginning, middle and end. The KE was linked using grammatical connectors, to maintain cohesion of the discourse.

Results

In regard to the sample characterization, 96% of respondents were female and 4% male. The average age was 51.4 years. The average time since surgery was 4.3 years.

Table 1 shows the central ideas and prevalences found for the first question: what do you think were the causes of the bunion?

The central ideas (CI), key expressions, and collective subject discourse for the first question are listed below:

CI: Genetics and Heredity- 50%

CSD: "The causes were *genetic*. Both my *grandmother* and *mother* have deformed feet (...) I believe the deformities were *hereditary* in origin, I have many cases of this problem in the *family* (...) it is likely to be *hereditary* since my *maternal grandmother* also has bunions; it makes sense because I've had the deformities since I was *young* (...)"

CI: Type of footwear worn - 30%

CSD: "It is directly related to the *type of shoe* worn, in my case, frequent use of *high heels* (...) *Tight shoes* (...) Continuous use of *high heels* and *closed shoes* (...) the most important issue are very closed *shoes* (...)"

CI: Don't know -20%

CSD: "I *don't know* what the causes were, I always had it on my left foot (...) I have *no idea*"

Table 2 shows the central ideas and prevalences found for the second question: How would you describe your quality of life before surgical correction?

Table 1. What do you think were the causes of bunion?

Central idea	Prevalence
Genetics and heredity	50%
Type of footwear worn	30%
I don't know	20%

The central ideas (CI), key expressions, and collective subject discourse (CSD) for the second question are listed below:

CI: Pain and discomfort - 50%

CSD: ''Before the surgery I felt a lot of *pain* and *discomfort*; my feet used to be *swollen*, and the bunion was *red* and *painful* (...) *Pain* in every part of the foot: the bunion, the toes, the heel (...) I felt a lot of *pain*, both in the feet, and in the knees due to *walking the wrong way* (...) All my shoes used to *hurt* (...) Before the surgery I only remember the *terrible* and *continuous pain* (...)''

CI: Footwear restriction- 20%

CSD: My quality of life was not good because the *deformity* did not allow the use of certain *models* of more *delicate shoes* (...) I always *had to* select certain types of *shoes* (...) Before the surgery it was horrible, I could not wear *high heels, closed and narrow shoes* (...) I had *difficulty* finding *shoes* and they *got ruined* quickly because of *walking the wrong way* (...)''

CI: Functional Limitation - 15%

CSD: ''I had a lot of *difficulty* to practice physical activity (...) The quality of life was *very poor*, I couldn't walk *long distances* (...) After taking off my shoes I *couldn't put* my feet on the floor (...) I used to feel *insecure* when walking (...)''

CI: Aesthetic Prejudice - 15%

CSD: ''I was very *ashamed*, because the middle toe overlapped the great toe (...) *Unfavorable* aesthetics (...) *Median* quality of life due to discomfort because of *aesthetics*; I was *ashamed* of the *swollen* and *reddish* appearance of the bunions (...)''

Table 3 shows the central ideas and prevalences found for the third question: how would you describe your quality of life after surgical correction?

Table 2. How would you describe your quality of life before surgical correction?

Central idea	Prevalence
Pain and discomfort	50%
Restriction on the use of footwear	20%
Functional limitation	15%
Aesthetic damage	15%

Table 3. How would you describe your quality of life after surgical correction?

Central idea	Prevalence
Total improvement	75%
Partial improvement	25%

The central ideas (CI), key expressions, and collective subject discourse (CSD) for the third question are listed below:

CI: Total Improvement - 75%

CSD: ''After the surgery it was a great *relief*, I don't feel anything today; now, my foot has returned to *normal*, and I am able to wear *any type* of shoe (...) It has *improved* a lot, because now I can wear any shoe, I feel no pain, and besides, my feet have become more *beautiful* (...) it *changed* my life; now I can move all my toes *easily* and without pain (...) Now I wear high heels, I can practice sports *normally*, such as running, swimming, cycling, weight training (...) *Much better*; I can wear any kind of shoes, without discomfort, pain or embarrassment (...) It has *completely* changed my life.''

CI: Partial Improvement - 25%

CSD: ''Comparing before and after, there was an improvement; however, the foot has *poor mobility*; it *swells* after walking or standing for long periods, and it *hurts* most of the time (...) I still had to have *another surgery* to remove the screws (...) *Moderate improvement*, in the *cold* I have *pain* in my foot, something I did not have before the surgery, and it becomes *swollen* later in the day (...) It improved well, but it could be better if I had the *other foot* corrected also (...)''

Discussion

The association of hallux valgus with genetic and hereditary causes is frequently seen in the literature. Coughlin[8] reported a family history in 72% of patients in his retrospective study, with 94% of the participants reporting a family history of hallux valgus deformity, and 31 reporting that their mothers also had a bunion. Pique-Vidal et al.[9] and colleagues, in a report of 350 hallux valgus patients, constructed a three-generation pedigree in which 90% of the participants reported that some relative also has a bunion. In this study, heredity was also consolidated as a relevant central idea concerning the risk factors of hallux valgus. Of the total respondents, 50% mentioned heredity as a correlated factor in the development of the deformity. In a study by Coughlin and Jones[10] this proportion was even higher, with 86 out of 103 adult patients (84%) reporting a family history of hallux valgus deformities (parents and grandparents).

A study by Owoeye et al.[11] showed a low prevalence of hallux valgus in a typically barefoot Nigerian population. When the manufacture of fashionable leather shoes far exceeded the manufacture of traditional sandals in the 1970s, the incidence of hallux valgus deformity increased substantially[12]. In this study, 30% of the respondents considered the type of footwear worn to be directly related to the development of the deformity. This finding was consistent with the study by Coughlin and Jones[10] in which only 34% of patients undergoing surgical correction cited constricting footwear as a cause of their deformity.

The presence of hallux valgus is associated with reduced quality of life for those who suffer from this condition[13]. In this study, central ideas correlated with this loss of quality of life were well noted: pain and discomfort, restrictions in the wearing of shoes, functional limitation, and aesthetic impairment.

Pain is the most important and most commonly reported complaint related to hallux valgus. Thordarson et al.[14] found that body pain scores were consistently poorer for bunion patients compared to the general population. Pain was also the most prevalent central idea (50%) among the respondents in this study.

Tight, narrow-fitting shoes with a constrictive toe compartment can cause the foot to mold to the shape of the shoe, leading to the formation of hallux valgus, or exacerbating an existing deformity[15]. In this study, 20% of the respondents mentioned the use of tight-fitting shoes use as a central idea for the impaired quality of life. A study by Saro et al.[16] showed that unrestricted footwear selection seems to be an important factor for patients' perception of health-related quality of life. Regardless of the degree of correction, patients who were unable to wear their preferred choice of footwear were significantly worse in terms of pain and mental health.

A systematic review by Nix et al.[17] found that there were biomechanical gait changes in hallux valgus patients. These included reduced peak ankle dorsiflexion and foot supination during walking. Elderly patients with deformity described a less stable gait pattern, with reduced speed and decreased stride length when walking on uneven surfaces. This impairment was also highlighted by 15% of the participants of this study, inferring functional limitation as a central idea for the impaired quality of life.

Most research on hallux valgus patients has focused on the complications and reducing the deformity, but patients are also equally concerned about the repercussions of the surgery on their daily lives. However, measurements of general health and quality of life regarding foot and ankle surgery have been largely ignored so far[15]. This paper is the first in the Brazilian literature to consider the surgical treatment of hallux valgus in a qualitative, patient-centered approach, with original descriptions of the participants' perceptions of their pathology-related quality of life.

Thordarson et al.[18] found, at 12 months of follow-up, a significant improvement in physical and body function scores in patients who received surgical treatment for hallux valgus. Torkki et al.[19] reported a significant difference in pain levels between surgery and non-surgery groups, at 1 year of follow-up. In this study, the majority of patients expressed satisfaction with the surgical treatment. Thordarson et al.[20] report that the patients outcome was not influenced by the degree of deformity, the amount of correction, or the type of surgery performed.

Ferrari and colleagues assessed evidence from randomized trials involving surgery to correct hallux valgus. They found that the number of patients who remained dissatisfied at follow-up was around 25–33% of cases, although the hallux valgus angle and pain had improved[21] . In this study, dissatisfaction was also evidenced. This can be elucidated by the passage: *''Comparing before and after, there was an improvement; however, the foot has poor mobility; it swells after walking or long standing for long periods, and it hurts most of the time''.*

Conclusion

This qualitative approach evidenced, in an unprecedented way, that most patients have some knowledge of the main risk factors for the occurrence of hallux valgus. It was observed that the quality of life of patients with this disease is impaired, and postoperatively, satisfaction with the results was observed in the majority of the respondents.

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Original Article

Isolated subtalar arthrodesis causes loss of ankle mobility

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Abstract

Objective: To evaluate and quantify, through physical examination, loss of ankle mobility in patients undergoing subtalar fusion, in comparison to the contralateral side.

Methods: A total of 12 patients who underwent unilateral isolated subtalar arthrodesis for different conditions were selected. The assessment was performed with the aid of a goniometer, measurements of the bilateral range of motion of the tibiotarsal joint, in closed chain weight-bearing and open chain non-weight-bearing. The same foot and ankle surgeon performed all measurements.

Results: The operated side achieved significantly lower range of motion values in the closed chain weight-bearing test compared to the contralateral side, with a mean difference of 5.4° (p=0.029) for dorsiflexion and 7.6° (p=0.006) for plantar flexion. No statistically significant difference was found in the open chain test.

Conclusion: Isolated subtalar joint arthrodesis leads to reduced range of motion in the ipsilateral ankle.

Level of Evidence III; Therapeutic Study; Comparative Retrospective Study.

Keywords: Arthrodesis; Subtalar joint; Joint diseases.

Introduction

Subtalar joint arthrodesis (SJA) is a procedure used by foot and ankle surgeons to treat degenerative disorders of this joint[1], aiming at possible corrections of deformities and at relieving chronic pain. This surgical approach is usually the treatment of choice for primary and secondary arthrosis, and in some cases is also used to treat posterior tibial tendon insufficiency and tarsal coalitions (Figure 1). It is a viable surgical option when no other hindfoot joint is involved. Studies show that isolated subtalar fusion can affect neighboring joints, but not to a debilitating degree. At present there is no objective and accurate method to assess the effect of different hindfoot arthrodeses on the movement of unfused adjacent supra and inframalleolar joints[2].

Clinically, patients undergoing isolated SJA benefit from improved quality of life and pain relief[3], and these benefits are, in most cases, superior to the procedural limitations. This arthrodesis restricts eversion and inversion movements by 84% and 88%, respectively[4], reduces to some degree the movement of the talonavicular and calcaneocuboid joints, and produced an average decrease of 46% in the excursion of the posterior tibial tendon during active hindfoot inversion[5]. Patients commonly have difficulty accommodating their feet on uneven ground, and may progress with some degree of arthrosis in adjacent joints.

Physical examinations of patients with limitations in the sagittal plane of the ankle joint are not an uncommon occurrence in the immediate or late postoperative period.

Study performed at the Hospital Mater Dei, Belo Horizonte, MG, Brazil.

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Few studies have objectively quantified the value of this loss. Most of them are trials with cadaveric models of healthy feet, and do not take into account the subject's clinical evaluation.

The aim of this study is to assess and quantify, through physical examination, loss of ankle range of motion (ROM) in a patient undergoing isolated SJA compared to the healthy contralateral side.

Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate) number: 22254619.5.0000.5128.

This is a retrospective study to assess ankle ROM in patients undergoing isolated subtalar arthrodesis between 2017 and 2018 in a tertiary referral hospital. Patients with sequelae of calcaneal fractures, primary arthrosis, talocalcaneal bar, sequelae of pes cavus and sequelae of pes planovalgus in posterior tibial tendon insufficiency, in which the only procedure on the operated foot was subtalar arthrodesis, were enrolled in this study. Exclusion criteria were: bilateral involvement or any other surgical procedure on the contralateral side, presence of other arthrodeses on the foot or ankle, adjuvant soft tissue procedures and follow-up of less than 12 months.

To assess ankle movement, we performed the ROM measurement in the sagittal plane of the tibiotarsal joint in closed and open chain with weight-bearing, comparing the operated side with the contralateral side, which served as a control. To measure the range of motion of weight-bearing closed chain dorsiflexion (MDF), the patient was positioned standing with one foot on the floor and the foot to be examined on a bench about 30cm high, keeping the knee and hip flexed (Figure 2). The patient then leaned forward with most of their body weight on the examined foot. To measure weight-bearing plantar flexion (MFF), the patient was asked to lift the heel of the examined foot so that they would be standing with the limb on the bench supported by the toes alone, with the knee still flexed and with most of their weight body resting on the examined foot[6] (Figure 3). Measurement of range of motion in open chain of dorsiflexion (MDA) and plantar flexion (MFA) was performed with the patient in the supine position on a stretcher, and the ROM performed passively (Figure 4). The angle between the longitudinal axis of the tibia and the lateral margin of the foot was used as a parameter and measured using a goniometer. All patients were evaluated and had their ranges of motion measured by the same Foot and Ankle surgeon. The measurements were performed on the limb that had undergone surgical intervention and on the contralateral limb, which was considered the parameter of normal mobility for each subject.

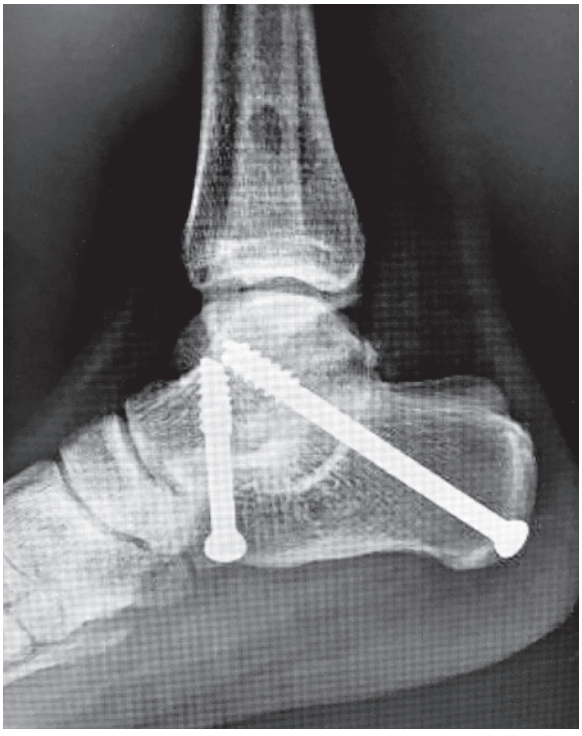

Figure 1. Lateral ankle radiograph showing subtalar joint arthrodesis.

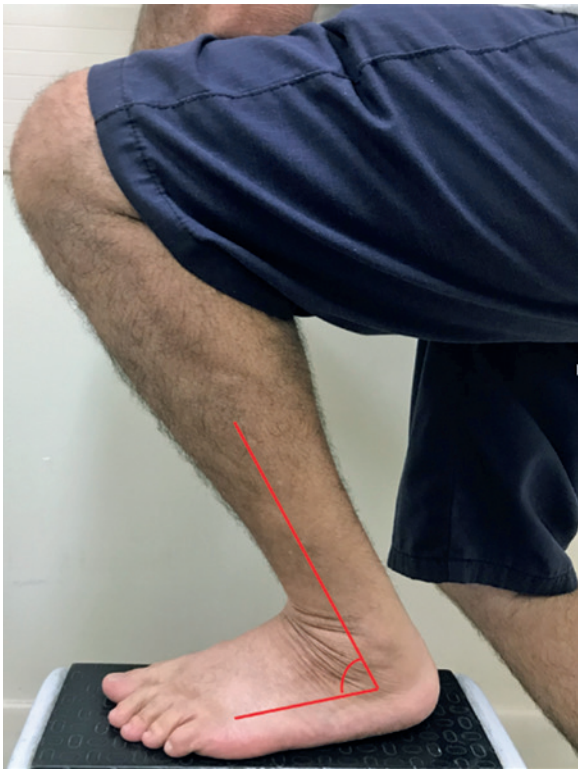

Figure 2. Evaluation of weight-bearing closed chain ankle dorsiflexion. Hip and knee flexed with body weight on the evaluated limb. The red line shows the angle used to measure the range of motion.

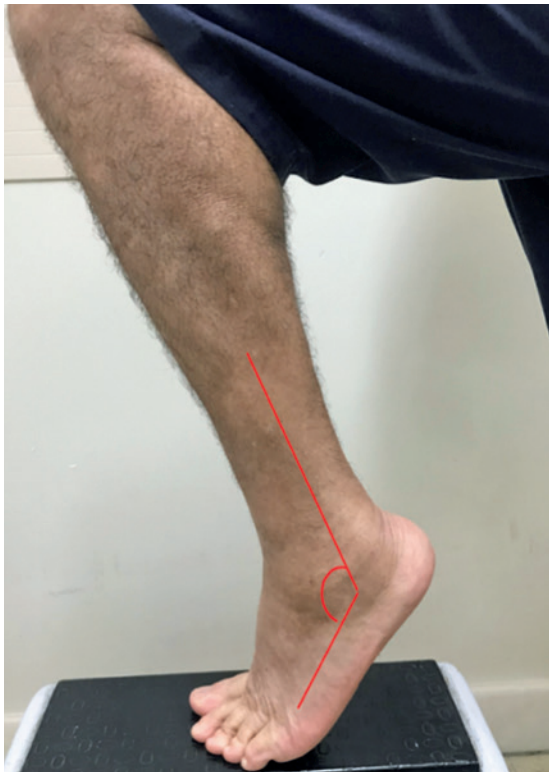

Figure 3. Evaluation of ankle plantar flexion in weight-bearing closed chain test. Hip and knee in flexion with body weight on the evaluated limb, with the patient on the tips of his toes. The red line shows the angle used to measure the range of motion.

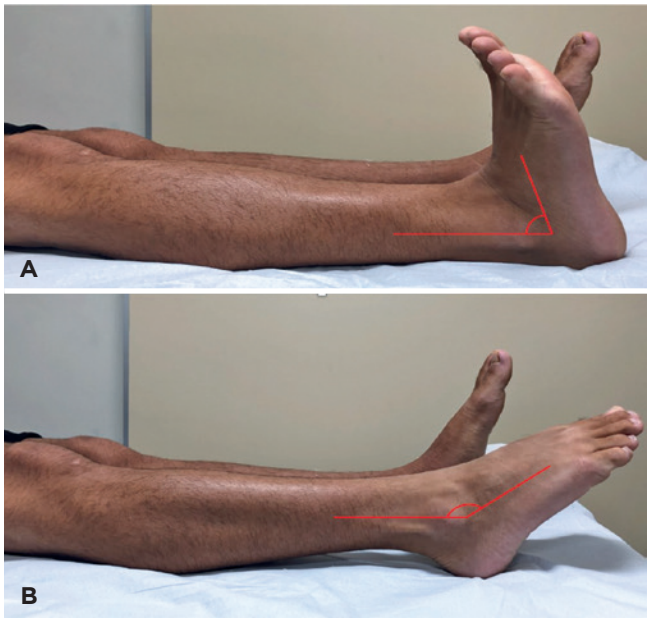

Figure 4. Evaluation of ankle dorsiflexion (A) and plantar flexion (B) in non-weight-bearing open chain test.

All patients answered a brief questionnaire covering the resumption of daily activities, the resumption of sports activities, and the visual analog scale (VAS) of pain.

To statistically verify if there is difference between the left and right sides of the MDF, MFF, MDA and MFA variables, the Mann-Whitney test was performed[7]. To assess the factors related to the differences between one side and the other, we conducted Spearman's correlation test between the quantitative variables, the Mann-Whitney test[7] for the categorical variables, and the linear regression model for the Pathology variable. The software used in the analyses was R Studio. The p-value of <0.05 was considered significant.

Results

A total of 12 patients were selected, aged between 24 and 73 years. Within this sample, four were female (33%) and six male (67%). Considering the affected side, the sample consists of an equal number of patients operated on the right or left side. The condition responsible for most of the isolated talocalcaneal arthrodesis procedures, with 42% of cases, was calcaneal fracture, which includes primary fusions or sequelae after previous osteosynthesis. The other causes were talocalcaneal coalition (25%), primary arthrosis (17%), pes planovalgus (8%), and pes cavus (8%) (Table 1).

Eight patients resumed the sport they engaged in before the fusion as normal. Only two patients had not yet resumed sports activities at the time of this analysis, and the remaining patients did not engage in any sports activities before the arthrodesis. All patients assessed resumed their daily activities, such as work, recreational activities and social life. The VAS answered by the patients averaged two on the scale of zero to ten.

Table 2 presents the comparison of categorical variables between the operated and nonoperated sides. Significant differences between the sides can be seen in the weight-bearing

Table 1. Descriptive analysis of categorical variables

	Variables	N	%
Sex	Female	8	67%
	Male	4	33%
Operated side	Right	6	50%
	Left	6	50%
Conditions	Calcaneal fracture	5	42%
	Talocalcaneal coalition	3	25%
	Primary arthrosis	2	17%
	Pes planus	1	8%
	Pes cavus	1	8%
Resumption of daily activities	Yes	12	100%
	No	0	0%
Resumption of sport	Yes	8	67%
	No	4	33%
Mechanical axis	Normal	12	100%

Table 2. Comparison of ankle mobility between the operated and nonoperated sides

Variable	Side	Mean	S.D	p-value
MFF	Operated	30.6°	1.8	p=0.006
	Not Operated	38.2°	1.0	
MDF	Operated	12.8°	1.8	p=0.029
	Not Operated	18.2°	1.1	
MFA	Operated	32.7°	2.4	p=0.081
	Not Operated	38.0°	1.4	
MDA	Operated	12.3°	1.7	p=0.208
	Not Operated	15.3°	1.1	

MDF and MFF range of motion tests. The mean difference in dorsiflexion was 5.4° (ranging from 0°-10°) as compared to the normal side (p=0.029), and the mean loss of plantar flexion was 7.6° (ranging from 2°-20°), also compared with the contralateral limb (p=0.006).

The difference in non-weight-bearing open chain ROM averaged 3° (ranging from 2° to 11°) for MDA (p=0.208) and 5.3° (ranging from 2° to 18°) for MFA (p=0.081), with no statistical significance.

Discussion

The result of this study showed a difference in ROM measurements between closed and open chain. The non-weight-bearing open chain test showed less loss of movement than the weight-bearing closed chain test. The result also revealed that in our sample, the loss of ankle ROM was probably due to fusion of the subtalar joint, not having any statistical significance when we compared loss of ankle movement with the variants sex, operated side, nature of the condition that led to arthrodesis, presence of residual pain and alteration of the mechanical axis.

It is widely accepted in the orthopedic community that the purpose of SJA is to relieve pain and improve function[8]. Some arthrodeses prevent certain functions, as they limit the patient's ability to perform movements considered crucial for activity[9]. After a clinically and radiologically fused subtalar joint, there is a high rate of patient satisfaction and more than 90% of patients are able to perform their daily activities[10]. In the case of this study, in which patients underwent isolated SJA, the movement of this locked joint can lead to alterations such as difficulty in walking on uneven terrain. Patients should be aware that fusion is a salvage procedure, which will cause persistent changes in gait, with the potential for deterioration due to the development of arthrosis in neighboring joints[10-12].

The best way to assess and quantify loss of ankle movement in patients who have undergone isolated subtalar arthrodesis is to measure and compare the amount of movement in the bilateral sagittal plane, giving consideration to the fact that the healthy contralateral limb is considered normal for each patient. Savva and Saxby reported that dorsiflexion and plantar flexion capacity was almost 20% lower compared to the healthy side when they assessed postoperative range of motion in the sagittal plane in patients with subtalar arthrodesis for calcaneal fracture sequelae[13]. Another study compared ankle range of motion after isolated SJA with the contralateral side, and the result was average movement in the sagittal plane of 9.8° of dorsiflexion (contralateral limb, 14.2°) and 47.2° of plantar flexion (contralateral limb, 52.4°). This represented a reduction of 30% (4.4°) and 9.2% (5.2°) in dorsiflexion and plantar flexion, respectively, when compared to the contralateral limb[14]. In the study in question, they performed the measurements under load, and distinguished between closed and open chains, which no study found in the literature had done. We found a 5.4 ° reduction in dorsiflexion and 7.6° in plantar flexion, both under load in closed chain. In open chain, the reduction was 3° and 5.3° for dorsiflexion and plantar flexion, respectively.

Several studies have used cadaver foot and ankle models to investigate ROM before and after arthrodesis[2,4,15,16]. Despite the relevance of these studies in defining the parameters to be evaluated when defining the type of arthrodesis to be performed and the joints to be involved in the case of a condition that requires some hindfoot fusion, these studies were carried out without considering the effect of the load applied on the lower limb, or the muscle strength vectors that interfere in ankle movement. Accurate clinical evaluation of foot and ankle ROM after a particular arthrodesis procedure is difficult, because several factors can interfere with the measurement, such as knee, hip or lower back conditions, which limit the ability to bear weight on the ankle to be assessed, thus interfering in the final result despite the fact that some forms of measurement are shown to be reliable in the literature[6,17-19].

The result of this study showed that even though subtalar arthrodesis leads to loss of ankle mobility, the non-weight-bearing open chain test specifically had a higher ROM in the study compared to the weight-bearing closed chain test. This greater mobility was due to the fact that the midfoot joints were not locked during the open chain test. Accordingly, we can attest that these joints contribute to hindfoot mobility in the sagittal plane after an isolated subtalar fusion. We must also remember that the patient undertaking the open chain test was supine with their knee extended, without counteracting gastrocnemius force, and that a possible shortening of this muscle could alter the plantar flexion movement.

The type of pathology that triggered the subtalar arthrosis does not seem to be related to the magnitude of loss of ankle ROM. One study demonstrated that there was no difference in ROM in the sagittal plane between patients with subtalar arthrosis secondary to calcaneal fracture and those with other etiological factors[1]. Our study showed no difference when we compared loss of ankle movement with the nature of the pathology that led to the arthrodesis. There are no studies comparing range of motion after subtalar arthrodesis in relation to other etiological factors.

This study has some limitations. It consists of a small sample, with only 12 feet. We measured only one simple movement in the sagittal plane alone. The joint complex of the ankle and foot are composed of a system of joints that act synergistically and normally no movement is performed alone.

Further studies comparing the impact of loss of ankle movement after isolated subtalar arthrodesis on the patient's activities of daily living, and biomechanical studies showing the value of the contribution of each hindfoot joint to ankle mobility will be needed in the future.

Conclusion

Isolated subtalar arthrodesis leads to significant loss of ankle movement in the sagittal plane, particularly in plantar flexion. Midfoot joints contribute to continued ankle mobility after a subtalar fusion, offsetting the loss of movement to some extent.

Authors' contributions: Each author contributed individually and significantly to the development of this article: CMPT *(https://orcid.org/0000-0002-2503-8721) conceived and planned the activities that led to the study, interpreted the results of the study, wrote the article and approved the final version; RZAP *(https://orcid.org/0000-0001-9692-5283) conceived and planned the activities that led to the study, performed the surgeries, participated in the review process and approved the final version; FASL *(https://orcid.org/0000-0001-5214-2420) conceived and planned the activities that led to the study, participated in the review process, approved the final version; RSC *(https://orcid.org/0000-0001-5388-475X) conceived and planned the activities that led to the study, interpreted the results of the study, participated in the review process, approved the final version; TAAS *(https://orcid.org/0000-0003-2333-2334) participated in the review process, approved the final version; DSB *(https://orcid.org/0000-0001-5404-2132) participated in the review process, approved the final version. *ORCID (Open Researcher and Contributor ID).

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Original Article

Evaluation of calcaneal enthesophytes in insertional Achilles tendinopathy by radiography and magnetic resonance imaging: intra- and inter-observer reliability

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Abstract

Objective: Evaluate intra- and inter-observer variation in the presence of enthesophytes in patients with insertional Achilles tendinopathy on radiographic (X-ray) and magnetic resonance imaging (MRI) images.

Methods: We selected X-ray and MRI images of 20 patients diagnosed with an injury. We sent a questionnaire to five foot and ankle surgeons and five radiologists. We obtained answers about diagnosis accuracy and the presence of insertional enthesophytes (bone spurs).

Results: Intra-observer agreement with regards to diagnosis accuracy in the MRI analysis was a K of 0.77 (0.62 to 1.00), while in the X-ray analysis, the K was 0.95 (0.77 to 1.00). Intra-observer agreement on the presence of enthesophytes in the MRI analysis had a K coefficient of 0.90 (0.68 to 1.00) and intra-observer agreement in the X-ray of 0.93 (0.86 to 1.00). The evaluation of inter-observer agreement on the diagnosis accuracy had a K coefficient between 0.09 and 0.20. Inter-observer agreement regarding the presence of enthesophytes was a K value between 0.59 and 0.63 for the MRI and a K between 0.81 and 0.82 for the X-ray results.

Conclusion: Intra-observer values for diagnosis accuracy of the MRI and X-ray tests indicated strong to almost perfect agreement, similar to the intra-observer values for evaluation of the presence of enthesophytes, but the X-ray had better agreement. In both tests, intra-observer agreement on the presence of osteophytes was weak in comparison to inter-observer agreement, yet in the inter-observer evaluation of the presence of enthesophytes, the X-ray agreement was greater than the MRI values.

Level of Evidence III; Diagnostic Study.

Keywords: Calcaneal tendon; Tendinopathy; Observer variation.

Introduction

Approximately 6% of the general population will develop insertional Achilles tendinopathy at some point in life[1]. The condition has a bimodal distribution, is more common in athletes, and represents 6-17% of all injuries in this group. However, it can also be present in middle-aged, overweight patients who are non-athletes and have no history of physical activity[2]. There is also a correlation between the condition and seronegative arthropathies[3]. Achilles tendinopathy is characterized by pain, functional limitation and swelling around the tendon. It can be classified as an insertional and non-insertional tendinopathy, two distinct pathologies with different pathophysiology and treatment options[4]. The middle and insertional portions of the tendon are morphologically, functionally and physiologically different in their normal state. At the onset of the pathology, changes in the cell matrix are indistinguishable and the pathophysiology appears to be

Study performed at the Hospital Madre Teresa, Belo Horizonte, MG, Brazil.

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the same. However, as the lesion develops, the characteristics and treatment options of each one appear different[5].

The essence of tendinopathy is an ineffective tendon repair response, with degeneration and random proliferation of tenocytes, rupture of collagen fibers and subsequent increase in the non-collagenous matrix. In diseased tendon samples, characteristics such as loosening of the fibers and the existence of more wavy fibers are present, with an increase in type III (reparative) collagen[6-8].

The diagnosis of insertional tendinopathy is based mainly on patient history and physical examination. Upon palpation, there is tenderness in the distal 2 cm of the Achilles tendon, with the presence of swelling and redness in the posterior region of the heel. Tests to assess the limitation of ankle range of motion and to rule out possible contractures and shortening supplement the clinical examination. Patients report pain, which is aggravated by physical activity, and stiffness, especially after prolonged periods of rest[1].

The presence of an enthesophyte in the posterior region of the calcaneus does not confirm the presence of insertional Achilles tendinopathy and is not exclusive to patients with this condition, as it may also be present in asymptomatic patients without foot and ankle diseases. However, the presence of symptoms is more common in patients with the presence of insertional enthesophyte[9]. After clinical suspicion, the use of imaging tests helps to confirm the pathology and provides characteristics of the lesion that may influence treatment. Lateral X-ray of the calcaneus is an inexpensive and accessible test, and the best radiographic view to assess the insertional region of the Achilles tendon. This test provides information about the bone characteristics of the lesion, such as the size and location of the enthesophyte, bone conformation of the hindfoot joints and associated diseases, such as Haglund's deformity. The availability of MRI has grown over the years, and it has become a routine test at most major centers. It provides three-dimensional information about the location of the insertional enthesophyte and also enables us to study the conditions of soft tissue surrounding the lesion.

We did not find any studies demonstrating the superiority of one method over another in the literature. The aim of this study was to assess intra- and inter-observer agreement for each type of test. Both the diagnosis and the presence of entesophytes were considered in this agreement analysis.

Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate) number: 24716719.1.0000.5127.

All patients received guidance regarding respect for human rights in relation to the research project and signed the Informed Consent Form.

X-ray and MRI images of 20 patients diagnosed with Achilles insertional tendinopathy who attended an appointment between the years 2018 and 2019 at 2 hospitals in Belo Horizonte and were treated by specialist foot and ankle surgeons were evaluated. The inclusion criterion consisted of obtaining all the medical records in addition to X-ray and MRI results.

These patients were assessed, and the tests used in the research project were those carried out before any treatment, whether conservative or surgical, had been established.

A digital questionnaire was sent to 5 foot and ankle surgeons and 5 radiologists specialized in the musculoskeletal system with varying lengths of experience in the area. They were blinded in relation to the patients and test results they evaluated. They analyzed insertional tendinopathy according to the presence or absence of calcaneal enthesophytes, based on the lateral X-ray of the calcaneus and on MRI images. For each MRI test, 2 coronal, 2 sagittal and 2 axial sections were selected in T1- and T2- weighted scans, with a 90° inclination of the sections in relation to the calcaneus, where we filmed short videos in which it was possible to see the entire thickness of the calcaneus. These videos provided a clearer view of its posterior tuberosity and the insertional portion of the Achilles tendon. The X-ray and MRI images were included in the questionnaire twice, in random order, to enable us to analyze the intra-observer variation and compare the inter-observer variation. In the questionnaire, it was not possible to return to any previous question and no previous training was offered to visualize the lesion. The questions were of the multiple-choice type, in which the respondent answered whether or not a posterior calcaneal enthesophyte was present in the test evaluated. In addition to the 2 options for each question, the respondent could check a third option, stating whether those images were inadequate to assess the lesion.

Statistical analysis

Ten raters and 20 patients participated in this study. Each of the raters evaluated each test (MRI and X-ray) of each patient at two different time points. We used the Fleiss' Kappa, which is a measure used to assess agreement between three or more raters for each of the tests performed (inter-observer variation). Cohen's Kappa, in turn, was used to assess agreement between the two evaluations performed by the same rater (intra-observer variation)[10,11].

Results

Imaging test results of 20 patients diagnosed with Achilles insertional tendinopathy and the presence of enthesophytes were evaluated. Eight of these patients (40%) were female and 12 (60%) were male. Age ranged from 29 to 77 years (mean age of 49.2 years and standard deviation of 12.5 years). The lesions presented with 11 cases on the left (55%) and 9 cases (45%) on the right.

Regarding the diagnosis of the lesion and the presence of enthesophytes, this finding was identified in 13 (65%) patients and was not identified in 7 (35%) patients.

Tables 1 to 4 show the assessment of intra-observer agreement for each of the tests used, considering the accuracy of the diagnosis of the lesion and the presence of enthesophytes.

Table 1. Assessment of intra-observer agreement in relation to the accuracy of the diagnosis of the lesion in the magnetic resonance imaging analysis

(1st assessment X 2nd assessment)					
Rater	1st assessment	2nd assessment		Kappa Coefficient	p
		Right	Wrong		
1	Right	**17 (85.0%)**	0 (0.0%)	1.00	**<0.001**
	Wrong	0 (0.0%)	**3 (15.0%)**		
2	Right	**17 (85.0%)**	0 (0.0%)	0.77	**<0.001**
	Wrong	1 (5.0%)	**2 (10.0%)**		
3	Right	**20 (100%)**	0 (0.0%)	--	--
	Wrong	0 (0.0%)	**0 (0.0%)**		
4	Right	**15 (75.0%)**	0 (0.0%)	1.00	**<0.001**
	Wrong	0 (0.0%)	**5 (25.0%)**		
5	Right	**16 (80.0%)**	2 (10.0%)	0.62	**<0.001**
	Wrong	0 (0.0%)	**2 (10.0%)**		
6	Right	**17 (85.0%)**	0 (0.0%)	0.77	**<0.001**
	Wrong	1 (5.0%)	**2 (10.0%)**		
7	Right	**19 (95.0%)**	0 (0.0%)	1.00	**<0.001**
	Wrong	0 (0.0%)	**1 (5.0%)**		
8	Right	**16 (80.0%)**	1 (5.0%)	0.83	**<0.001**
	Wrong	0 (0.0%)	**3 (15.0%)**		
9	Right	**17 (85.0%)**	1 (5.0%)	0.77	**<0.001**
	Wrong	0 (0.0%)	**2 (10.0%)**		
10	Right	**17 (85.0%)**	2 (10.0%)	≈ 0.00	0.730
	Wrong	1 (5.0%)	**0 (0.0%)**		

Note: the significance probability refers to Cohen's Kappa coefficient.

Table 2. Assessment of intra-observer agreement in relation to the accuracy of the diagnosis of the lesion in the X-ray analysis

(1st assessment X 2nd assessment)					
Rater	1st assessment	2nd assessment		Kappa Coefficient	p
		Right	Wrong		
1	Right	**19 (95.0%)**	0 (0.0%)	--	--
	Wrong	1 (5.0%)	**0 (0.0%)**		
2	Right	**17 (85.0%)**	1 (5.0%)	0.77	**<0.001**
	Wrong	0 (0.0%)	**2 (10.0%)**		
3	Right	**19 (95.0%)**	0 (0.0%)	--	--
	Wrong	1 (5.0%)	**0 (0.0%)**		
4	Right	**19 (95.0%)**	0 (0.0%)	1.00	**<0.001**
	Wrong	0 (0.0%)	**1 (5.0%)**		
5	Right	**17 (85.0%)**	1 (5.0%)	0.77	**<0.001**
	Wrong	0 (0.0%)	**2 (10.0%)**		
6	Right	**19 (95.0%)**	0 (0.0%)	1.00	**<0.001**
	Wrong	0 (0.0%)	**1 (5.0%)**		
7	Right	**19 (95.0%)**	0 (0.0%)	1.00	**<0.001**
	Wrong	0 (0.0%)	**1 (5.0%)**		
8	Right	**20 (100.0%)**	0 (0.0%)	--	--
	Wrong	0 (0.0%)	**0 (0.0%)**		
9	Right	**19 (95.0%)**	1 (5.0%)	--	--
	Wrong	0 (0.0%)	**0 (0.0%)**		
10	Right	**19 (95.0%)**	0 (0.0%)	--	--
	Wrong	1 (5.0%)	**0 (0.0%)**		

Note: the significance probability refers to Cohen's Kappa coefficient.

Table 3. Assessment of intra-observer agreement in relation to the presence of enthesophytes in the magnetic resonance imaging analysis

(1st assessment X 2nd assessment)					
Rater	1st assessment	2nd assessment		Kappa Coefficient	p
		Absent	Present		
1	Absent	**6 (30.0%)**	0 (0.0%)	1.00	**<0.001**
	Present	0 (0.0%)	**14 (70.0%)**		
2	Absent	**8 (40.0%)**	0 (0.0%)	0.90	**<0.001**
	Present	1 (5.0%)	**11 (55.0%)**		
3	Absent	**7 (35.0%)**	0 (0.0%)	1.00	**<0.001**
	Present	0 (0.0%)	**13 (65.0%)**		
4	Absent	**6 (30.0%)**	0 (0.0%)	1.00	**<0.001**
	Present	0 (0.0%)	**14 (70%)**		
5	Absent	**6 (30.0%)**	1 (5.0%)	0.78	**<0.001**
	Present	1 (5.0%)	**12 (60.0%)**		
6	Absent	**6 (30.0%)**	0 (0.0%)	0.89	**<0.001**
	Present	1 (5.0%)	**13 (65.0%)**		
7	Absent	**6 (30.0%)**	0 (0.0%)	1.00	**<0.001**
	Present	0 (0.0%)	**14 (70.0%)**		
8	Absent	**5 (25.0%)**	1 (5.0%)	0.88	**<0.001**
	Present	0 (0.0%)	**14 (70.0%)**		
9	Absent	**7 (3.5%)**	0 (0.0%)	0.89	**<0.001**
	Present	1 (5.0%)	**12 (60.0%)**		
10	Absent	**6 (30.0%)**	2 (10.0%)	0.68	**<0.001**
	Present	1 (5.0%)	**11 (55.0%)**		

Note: the significance probability refers to Cohen's Kappa coefficient.

Table 4. Assessment of intra-observer agreement in relation to the presence of enthesophytes in the x-ray analysis

(1st assessment X 2nd assessment)					
Rater	1st assessment	2nd assessment		Kappa Coefficient	p
		Absent	Present		
1	Absent	6 (30%)	0 (0%)	0.89	**<0.001**
	Present	1 (5%)	13 (65%)		
2	Absent	4 (20%)	1 (5%)	0.86	**<0.001**
	Present	0 (0%)	15 (75%)		
3	Absent	6 (30%)	0 (0%)	0.89	**<0.001**
	Present	1 (5%)	13 (65%)		
4	Absent	8 (40%)	0 (0%)	1.00	**<0.001**
	Present	0 (0%)	12 (60%)		
5	Absent	5 (25%)	0 (0%)	0.88	**<0.001**
	Present	1 (5%)	14 (70%)		
6	Absent	8 (40%)	0 (0%)	1.00	**<0.001**
	Present	0 (0%)	12 (60%)		
7	Absent	6 (30%)	0 (0%)	1.00	**<0.001**
	Present	0 (0%)	14 (70%)		
8	Absent	7 (35%)	0 (0%)	1.00	**<0.001**
	Present	0 (0%)	13 (65%)		
9	Absent	7 (35%)	0 (0%)	0.89	**<0.001**
	Present	1 (5%)	12 (60%)		
10	Absent	7 (35%)	1 (5%)	0.89	**<0.001**
	Present	0 (0%)	12 (60%)		

Note: the significance probability refers to Cohen's Kappa coefficient.

For instance, when evaluating Table 2, we noted that for most of the raters, a strong or almost perfect agreement was observed in relation to the diagnosis accuracy in evaluating the MRI image. It was not possible to calculate the Kappa coefficient for rater 3, who made an accurate diagnosis in the 1st and 2nd evaluations. Moreover, weak agreement was observed for rater 10, who expressed disagreement in the case of three patients. The analyses for the other graphs are similar.

Figures 1 to 4 and Tables 5 and 6 show the assessment of inter-observer agreement for each of the tests used, considering the accuracy of the diagnosis of the lesion and the presence of enthesophytes.

Regarding the analysis involving diagnosis accuracy, a weak agreement rate was observed in all situations (Table 5 and Figures 1 and 2).

In the analysis involving the presence of enthesophytes, a moderate or strong agreement rate was identified for the MRI results, with almost perfect agreement rates for the X-ray results (Table 6 and Figures 3 and 4).

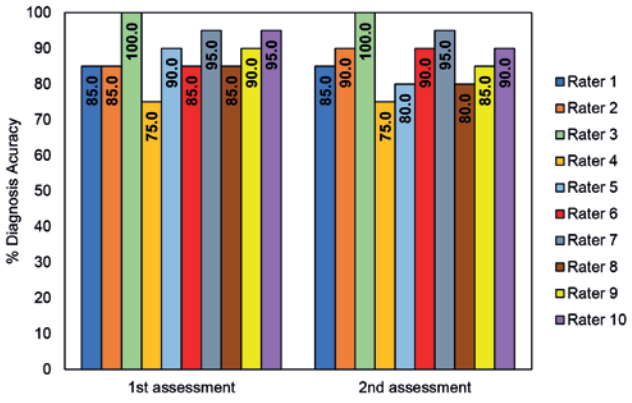

Figure 1. Survey of diagnosis accuracy in the magnetic resonance imaging analysis in the 1st and 2nd assessments.

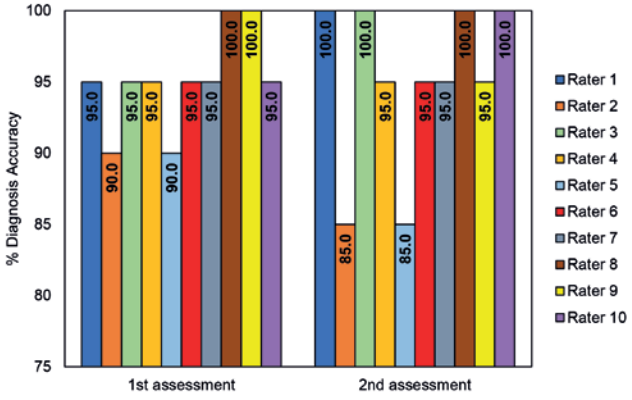

Figure 2. Survey of diagnosis accuracy in the X-ray analysis in the 1st and 2nd assessments.

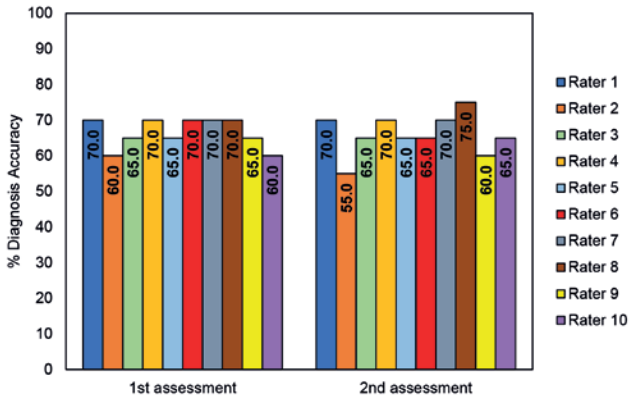

Figure 3. Survey of the presence of enthesophytes in the magnetic resonance imaging analysis in the 1st and 2nd assessments.

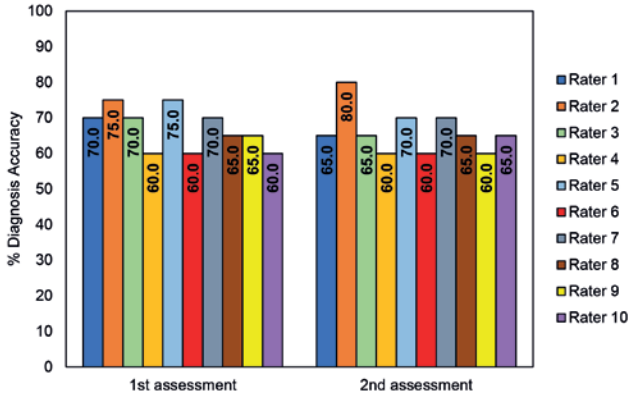

Figure 4. Survey of the presence of enthesophytes in the X-ray analysis in the 1st and 2nd assessments.

Table 5. Assessment of inter-observer agreement in relation to the accuracy of the diagnosis of the lesion considering each type of test and assessment

Type of test	Assessment	Kappa Coefficient	p
MRI	1st	0.20	**<0.001**
	2nd	0.17	**<0.001**
X-ray	1st	0.18	**<0.001**
	2nd	0.09	**0.008**

Database: 20 patients and 10 raters.
Note: the significance probability refers to Cohen's Kappa coefficient.

Table 6. Assessment of inter-observer agreement in relation to the presence of enthesophytes considering each type of test and assessment

Type of test	Assessment	Kappa Coefficient	p
MRI	1st	0.63	**<0.001**
	2nd	0.59	**<0.001**
X-ray	1st	0.82	**<0.001**
	2nd	0.81	**<0.001**

Note: the significance probability refers to Cohen's Kappa coefficient.

Discussion

The diagnosis of insertional Achilles tendinopathy, even in the hands of experienced surgeons, can be challenging. If the patient presents with a painful area upon palpation in the posterior and distal region of the calcaneal tendon, sometimes associated with swelling and hyperemia, a clinical diagnosis of insertional tendinopathy can be suspected[4].

Imaging tests are routinely used to assist in the diagnosis of insertional Achilles tendinopathy, ruling out differential diagnoses and serving as a guide for surgical scheduling. The presence of abnormalities in imaging tests, such as the presence of calcaneal enthesophytes and tendon enlargement, does not necessarily indicate the presence of clinical disease and vice versa, as demonstrated in the literature in several level II and level IV studies[12,13]. The reported percentages of asymptomatic tendons with positive findings for insertional Achilles tendinopathy on imaging tests range from 0% to 35%, and the percentages of symptomatic tendons without signs of Achilles tendinopathy on imaging tests range from 0% to 19%[12,14-16].

According to Fiamengo et al, the most common associated bone abnormality in insertional Achilles tendinopathy is an enthesophyte at the Achilles insertion in the calcaneus. It is present in about 8.13% of patients asymptomatic for insertional Achilles tendinitis[17]. This enthesophyte generally maintains a normal spinal signal in MRI images and tends to occur mainly at the tendon borders, and not in its central region[18].

Weight-bearing ankle and calcaneus radiography is the most commonly requested test. The anteroposterior view provides information about the presence of any axis deviation, such as varus or valgus deviation. The best view for visualizing the presence of enthesophytes is the lateral view[19]. Lateral radiographs of the heel and calcaneus are used to assess the presence and size of enthesophytes, intratendinous calcifications and Haglund's deformity[20].

Regarding MRI, a normal Achilles tendon reveals an average intrasubstance thickness of 6 mm, appearing thicker in tall patients, in men, and in the elderly. In sagittal images, the anterior and posterior margins of the Achilles tendon must be parallel and below the insertion of the soleus. In axial images, the anterior margin of the Achilles is concave for most of its course. In coronal images, the two sides of the Achilles are quite straight, and the tendon widens as it extends distally in the calcaneus[16]. MRI tests, in insertional tendinopathy, are often requested in order to assess soft tissues and the characteristics of the lesion in these tissues near the posterior region of the calcaneus, such as degree of tendon degeneration, neovascularization, bursitis and paratendinitis, as well as bone tissues and the implications of the disease in bone, such as bone edema, presence and features of enthesophytes, and intratendinous calcification[9].

In our study, the assessment of intra-observer agreement in relation to the accuracy of the diagnosis of insertional Achilles tendinitis due to the presence of enthesophytes in the MRI analysis, presented a K value with strong to almost perfect agreement (K from 0.62 to 1.00), while in the X-ray analysis in relation to diagnosis accuracy, the K ranged from 0.77 to 1.00, also showing strong to almost perfect agreement.

The assessment of intra-observer agreement in relation to the presence of enthesophytes in the MRI analysis showed a k coefficient ranging from 0.68 to 1.00, and intra-observer agreement on the X-ray ranging from 0.86 to 1.00, all with statistical significance.

The assessment of inter-observer agreement in relation to the diagnosis accuracy considering each type of test and evaluation had a weak agreement rate in all situations (K between 0.09 and 0.20). Inter-observer agreement regarding the presence of enthesophytes was identified as having a moderate or strong agreement rate (K of 0.59 and 0.63) for the MRI results, and almost perfect agreement rates for the X-ray results (K of 0.81 and 0.82).

The Kappa coefficient is heavily influenced when marginal totals are drastically unbalanced. In these cases, although we observed a high value for overall agreement, we have a low value for the Kappa coefficient. This happened to rater 10, who presented 85% (17/20) for overall agreement and a Kappa coefficient close to 0 (zero). If we consider the 1st assessment as a starting point, we have 19 correct diagnoses and only 1 incorrect diagnosis (marginal totals), i.e., very unbalanced marginal totals.

Thus, the results obtained from the analyses involving diagnosis accuracy were influenced by the imbalance of the marginal totals. As regards the results obtained from the analyses involving the actual diagnosis, we observed more balanced marginal totals.

Conclusion

Our intra-observer values for diagnosis accuracy comparing the MRI and X-ray tests showed a strong to almost perfect agreement, similar to the intra-observer agreement for evaluation of the presence of enthesophytes; however, the X-ray showed a greater agreement, ranging from 0.86 to 1.00. In both tests, the agreement was weak when comparing inter-observer agreement on the diagnosis accuracy, yet in the inter-observer assessment for the presence of enthesophytes, the X-ray agreement was greater than the MRI values.

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Original Article

"Double-bundle" tibialis anterior tendon transfer for prevention of pes equinus after Chopart amputation

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Abstract

Objective: Assess patient performance and quality of the stump after amputation at the Chopart (midtarsal) joint, with double-bundle transfer of the tibialis anterior muscle tendon to the talar neck.

Methods: This study evaluated the medical records of 5 patients who underwent Chopart amputation with double-bundle transfer of the tibialis anterior tendon to the talar neck, assessing pre and postoperative performance and gait.

Results: The patients were operated on between January 2008 and December 2018, and the data obtained from the survey allow us to conclude that, after the proposed procedure, all patients reported an improvement in walking, besides noting a significant reduction in the degree of stump equinus.

Conclusion: The surgical technique described in this article produced a significant improvement in patient performance as assessed by the AOFAS hindfoot score, and prevented the formation of ulcers in the anterior region of the stump.

Level of Evidence IV; Therapeutic Study; Case Series.

Keywords: Amputation; Tendon transfer; Equinus deformity; Foot deformities, acquired; Diabetic foot.

Introduction

Nowadays, due to the exponential increase in auto accidents and greater survival of diabetic patients, amputations of the foot due to high-energy trauma and complications of diabetes mellitus are increasingly present in the lives of orthopedists. Partial foot amputations aim at maintaining the greatest possible length of the lower limb, facilitating and reducing energy expenditure in gait[1]. In these amputations, the most proximal level that manages to preserve the height of the lower limb is amputation at the midtarsal (Chopart) joint complex (talonavicular and calcaneocuboid joints)[2,3]. For many years, this surgical technique did not have many advocates due to the equinus deformity that forms after this procedure. This equinus is a result of the muscle imbalance caused by the removal of midfoot bones, and consequently, of the tendons responsible for foot/ankle dorsiflexion, such as the tibialis anterior tendon[4]. Stretching and/or tenotomy of the calcaneal tendon, combined with transfer of the tibialis anterior tendon to the neck of the talus, are recommended to minimize this complication[1,3,5-8].

The tibialis anterior tendon has a very peculiar characteristic. It features a groove that divides it into two hemitendons, easily identified when we open its sheath. In the past Hoffer et al.[9] advocated the division of the tibialis anterior tendon into two hemitendons, and the transfer of one of these to treat spastic pes varus in cerebral palsy. Other authors have used this transfer to treat residual congenital clubfoot deformities[10,11].

The aim of this work is to assess patient performance and quality of the amputation stump achieved after performing the procedure through the Chopart joint, combined with

Study performed at the Faculdade de Medicina de São José do Rio Preto, São José do Rio Preto, SP, Brazil.

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double-bundle tibialis anterior muscle tendon transfer to the neck of the talus.

Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate) number: 12446219.0.0000.5415.

We performed a review of the medical records of patients operated on between July 1, 2008 and December 31, 2018 and selected 5 patients, all male, with a mean age of 52 years, ranging from 34 to 73 years, who underwent Chopart amputation with double-bundle transfer of the tibialis anterior tendon to the neck of the talus. Prior to the surgical procedure, all patients were clinically evaluated and answered a questionnaire, globally standardized by the American Orthopaedic Foot and Ankle Society (AOFAS) for patient stratification[12], which evaluates criteria of pain, gait, mobility (range of motion), stability and hindfoot alignment (Figure 1). The abovementioned questionnaire was reapplied at the postoperative assessment and a further physical examination was undertaken to evaluate and compare the pre and postoperative data. The preoperative questionnaire consisted of identification details and the patient's medical history, as well as a clinical evaluation of the amputation stump for the presence of ulcers, rating them according to the Wagner classification system, which is a validated system widely used to evaluate the extent of plantar ulcers as well as the presence of infection and/or gangrene.

We started the surgery by performing an Achilles tenotomy. A posterior incision was made in the ankle, about 2 to 4cm proximal to the Achilles tendon insertion in the calcaneus. The tendon was isolated and about 2cm of this tendon was resected, followed by rigorous hemostasis, mechanical wound irrigation and suturing through subcutaneous layers and skin.

Skin and subcutaneous dorsal and plantar incisions were made on a case-by-case basis. A common characteristic of all cases was the attempt made to preserve as much of the plantar skin and pad as possible to cover the stump (Figure 2), as the plantar skin, due to its special characteristics, is essential for the satisfactory progress of the stump during prosthesis fittings.

The tibialis anterior tendon was identified and disinserted in the medial cuneiform and base of the first metatarsal bone before opening its sheath.

Then the tibialis anterior muscle tendon was split into two hemitendons (Figure 3), in which sutures were applied using 3.0 nylon thread on their stumps (Figure 4). All other tendons were pulled and cut as proximally as possible, so that they included the stump upon retraction.

The surgery continued with the boring of two transosseous talar neck tunnels using 3.5mm drills, keeping a safe distance equivalent to the final size of the tunnel orifices.

The tunnels were widened using a small curette. In the next stage, the two hemitendons were passed through the talar tunnels, using an interference thread as a guide, and then sutured together at the bottom of the talus, characterizing their double-bundle reinsertion (Figure 5).

AOFAS ANKLE-HINDFOOT SCALE
(100 POINTS TOTAL)

Pain (40 points)
- No pain 0
- Mild, occasional 30
- Moderate, daily 20
- Severe, almost always present 0

Functional (50 points)
Restraints in activities, support required
- No restraints, no support 10
- No restraints in daily activities, restrained recreational activities, no support 7
- Restraints in daily and recreational activities, cane required .. 4
- Strong restraints in daily and recreational activities; walker, crutches, wheelchair, orthosis (ankle restraint, ankle immobilizer) 0

Maximum walking distance, in blocks
- More than 6 5
- 4 - 6 4
- 1 - 3 2
- Less than 1 0

Walking surfaces
- No difficulties in any surface 5
- Some difficulty on irregular floors, stairs, steeps and hills 3
- Strong difficulties on irregular floors, stairs, steeps and hills .. 0

Gait abnormality
- No abnormality, mild 8
- Evident 4
- Strong 0

Sagittal mobility (flexion + extension)
- Normal or slightly limited (30° or more) 8
- Moderate limitation (15° – 29°) 4
- Strong limitation (less than 15°) 0

Hindfoot mobility (inversion + eversion)
- Normal or slightly limited (75- 100% of the normal mobility)... 6
- Moderate limitation (25 – 74% of the normal) 3
- Strong limitation (less than 25% of the normal) 0

Ankle-Hindfoot stability (anteroposterior, varus-valgus)
- Stable 8
- Unstable 0

Alignment (10 points)
- Good, plantigrade foot, well-aligned forefoot and hindfoot 10
- Fair, plantigrade foot, some degree of misalignment of the ankle and hindfoot, asymptomatic 5
- Poor, non-plantigrade foot, strong and symptomatic misalignment 0

TOTAL SCORE: _____

Figure 1. AOFAS Scale.

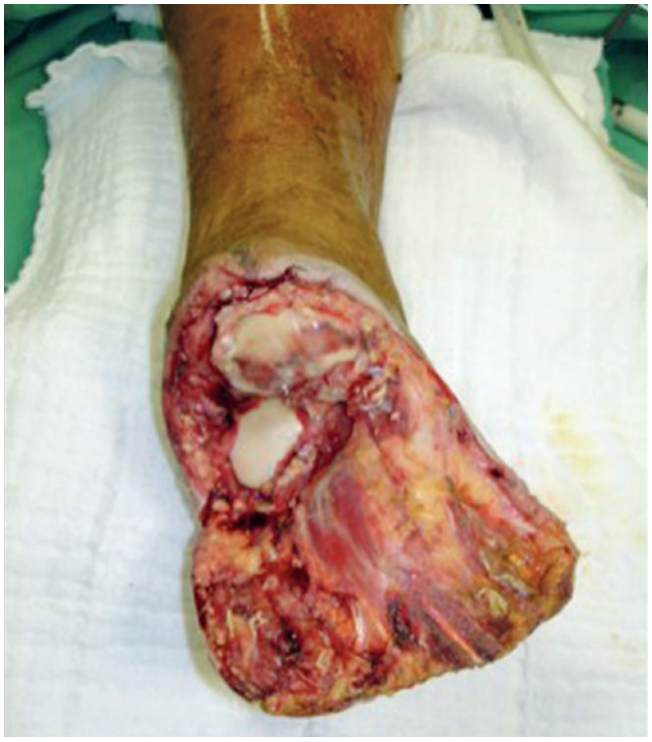

Figure 2. Creation of the flap.

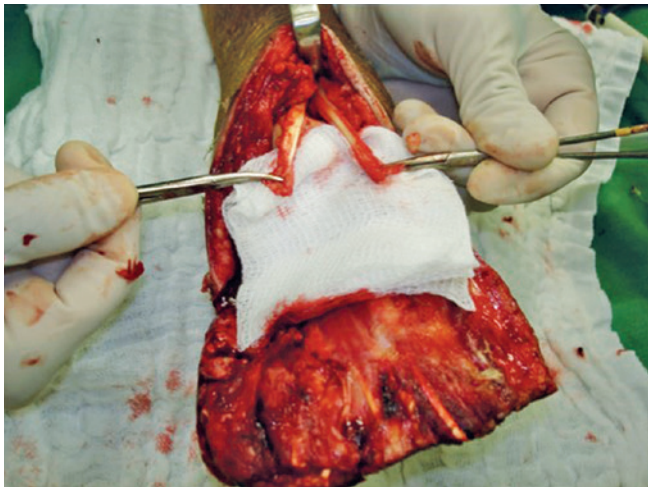

Figure 3. Division of the TA.

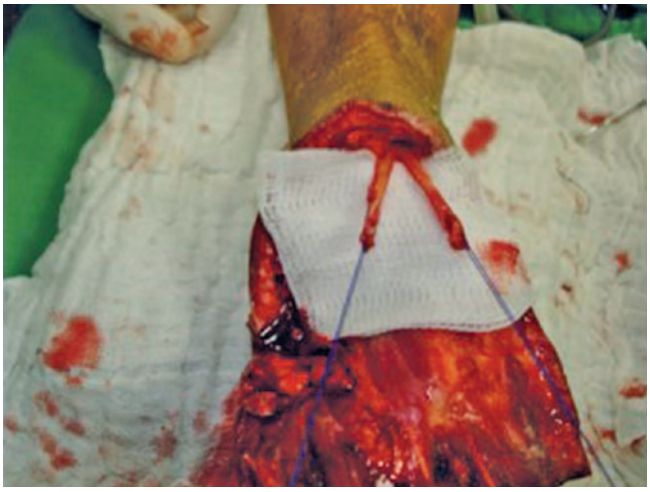

Figure 4. Suturing of the stumps.

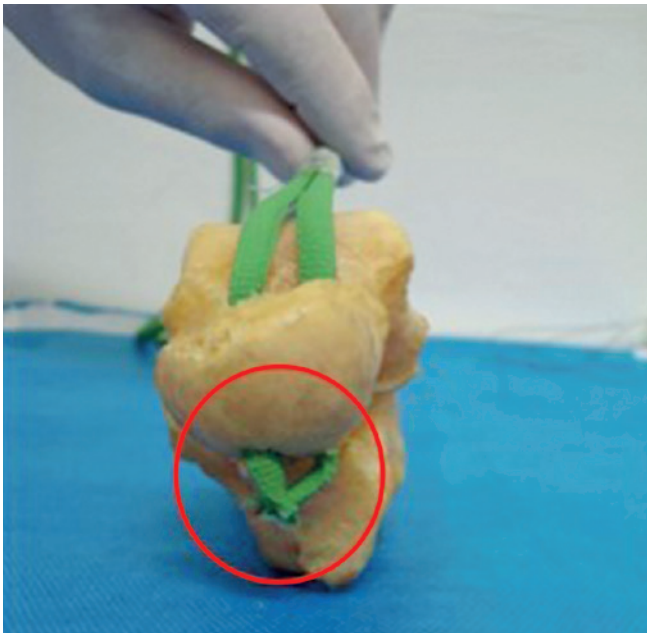

Figure 5. Suturing of the stumps below the neck.

We took care to position the stump in slight 5 degree dorsiflexion at this stage of the procedure. After suturing the distal stumps, we sutured the stumps in the area above the talar neck.

Having completed this step, we irrigated the surgical wound, performed hemostasis, inserted a suction drain and closed the stump, once again remembering to leave as much plantar skin from the anterior part of the stump as possible.

During the postoperative period, the patient wore a plaster splint at 5 degree dorsiflexion continuously for 6 weeks, with no weightbearing during this period. The time to removal of stitches ranged from 3 to 5 weeks. After 6 weeks, if the wound was already properly healed, physiotherapy rehabilitation began, starting gait training and already aiming at future prosthesis fitting[13]. Stump ulcers were treated with serial debridement, performed weekly with the application of dressings as directed by the wound dressing group of our institution.

Results

A total of 4 patients underwent the final assessment with the AOFAS method, since complications arose in 1 of the patients (dehiscence and infection), leading to the need for further surgical reinterventions, and culminating in a final level of transtibial amputation. Hence this particular patient could not be assessed by the score.

All patients had ulcers in the anterior region of the amputation stump prior to the procedure, while none of them experienced a further episode of ulceration after the procedure. The mean degree of equinus of the stumps was 16.3 degrees preoperatively and 7.3 degrees postoperatively.

In the performance assessment based on the preoperative AOFAS score, the minimum value obtained was 28 points and the maximum was 36 points, with a mean score of 33 points. In the postoperative assessment, the minimum value obtained was 62 points and the maximum was 73 points, with a mean score of 68 points.

Procedural complications included the abovementioned patient where the amputation had to be performed at a higher level, as well as 2 patients who had a small area of skin necrosis near the surgical incision. The latter had a good response to the treatment used by the wound dressing group.

After the double-bundle transfer, all patients reported an improvement when walking. All patients walked at home without needing to use a prosthetic device; 3 used a prosthetic device to walk outside the home and 1 did not even use a device to walk long distances. In the latter case, the patient reports not having adapted to the prostheses he tried to use. All patients were satisfied with the result achieved by the surgery and would have it done again if necessary.

Discussion

Defining the amputation level is not an easy task for the surgeon[14]. We know that the higher the amputation level, the greater the energy expenditure when walking, therefore every effort should be made to maintain the greatest possible limb length and thereby alter gait biomechanics only slightly, with consequent energy savings[1,2,14]. Another difficulty frequently observed in amputations at lower limb level is stump healing issues, which can affect up to half of all patients[15].

Among partial amputations of the foot, with the exception of fingers and rays, those that maintain the height of the limb are transmetatarsal procedures and Lisfranc and Chopart amputations. Boyd, Pirogoff and Syme amputations end up shortening the limb[3].

Transmetatarsal and Lisfranc amputations provide a better functional result due to the preservation of the muscle insertion of ankle flexors and extensors[14]. When these two more distal amputations cannot be undertaken, either due to excessive loss of soft tissue or infection, we can use Chopart's amputation.

One factor that caused Chopart's amputation to be relegated to the background for several years was equinus resulting from the muscle imbalance produced by the removal of midfoot muscle insertion points[4,5]. To minimize this complication, the stump must have its muscles rebalanced, performing stretching and/or tenotomy of the calcaneal tendon, combined with the transfer of another tendon to the talar neck in order to function as a dorsiflexor. Surgeons can use the fibularis brevis[3], extensor digitorum, or tibialis anterior tendon[1,3,5-7], with greater preference shown for the latter in the literature. Although our initial sample is small, the results are favorable since we were able to reduce residual stump equinus by more than 50%, a fact that is noteworthy as the act of reducing areas of plantar hyperpressure is one of the pillars of ulcer management, reducing their appearance and recurrence[16]. These figures encourage further studies to better assess and publicize the technique.

Some authors maintain that Chopart's amputation is a good alternative in nondiabetic patients who have sustained foot injuries, but they do not indicate the procedure for diabetic patients with Wagner grade 3 ulcers, mainly because the focus of infection may be very close to the foot pad, for which reason it cannot be kept intact. In diabetic patients with active infection (Wagner grade 3), in which there is viability of the foot pad, we recommend performing the procedure in two stages, keeping the surface of the stump open and moist with solid petroleum jelly or vaseline gauze, in the initial stage and after 48 to 72 hours, with improvement of the clinical outlook while maintaining adequate glycemic control, followed by further debridement of devitalized tissues, double-bundle transfer of the tibialis anterior tendon and closure of the stump.

The advantages of this procedure include the non-use of any type of metallic implant, such as screws, washers, interference screws, anchors or metal clamps used to fasten the tendon to the talus; this procedure can be performed when we do not have a sufficient tibialis anterior stump size to pass the tendon through the tunnel and suture the stump at a more proximal point (looping). Suturing between the two hemitendons in the lower part of the talus gives us a greater sense of security than transfer with fixation using transosseous sutures or with support by implants alone, yet we believe that further biomechanical studies are necessary to confirm our preliminary impression. Manufactured bone tunnels have a smaller diameter and by respecting a safe distance in their production, mentioned in surgical technique under the heading of methodology, we reduce the chance of iatrogenic talar neck fractures. In the past, this tunneling technique through the talar neck was believed to predispose patients to talar fractures; however, the occurrence of this type of event was not referred to by Sakaki et al.[8] We can also mention the preservation, albeit slight, of stump dorsiflexion, which considerably improves gait. As we noticed in our results, we were also able to prevent the formation of ulcers in the anterior region of the stump.

Early showed another procedure for the prevention of post-Chopart's amputation equinus, which consisted of performing tibio-talar-calcaneus arthrodesis fixed with a retrograde nail[1,2]. Problems involved in this procedure are the blocking of movement that occurs with arthrodesis and the long time needed for bone fusion[2].

A factor that can be considered negative in this procedure would be the quality of the final part of the tendon, which can result in loosening of stitches between the two hemitendons

and consequent maintenance of equinus. The clinical data, due to the small number of patients in the sample, are not statistically significant, yet these preliminary results encourage us to continue performing the procedure and, in the future, to gather more sample cases to confirm the effectiveness of this surgical technique.

Conclusion

The surgical technique described in this article produced a significant improvement in patient performance as assessed by the AOFAS hindfoot score, and prevented the formation of ulcers in the anterior region of the stump.

Authors' contributions: Each author contributed individually and significantly to the development of this article: DMM *(https://orcid.org/0000-0002-0159-9225) wrote the article, interpreted the results of the study, data collection; HI *(https://orcid.org/0000-0002-1179-4809) conceived and planned the activities that led to the study, approved the final version; MGF *(https://orcid.org/0000-0002-5163-1035) conceived and planned the activities that led to the study, data collection, approved the final version; RG *(https://orcid.org/0000-0001-7878-0711) data collection, statistical analysis; WRF *(https://orcid.org/0000-0002-2913-8367) data collection, statistical analysis; JALSA *(https://orcid.org/0000-0002-9927-7370) data collection, statistical analysis. *ORCID (Open Researcher and Contributor ID)

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Original Article

Radiographic study of Böhler and Gissane angles in the Brazilian population

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Abstract

Objective: Determine Böhler and Gissane angles in the Brazilian population and compare them with the data available in the literature.

Methods: A total of 800 weightbearing lateral radiographs of the calcaneus were evaluated in adult patients of both sexes. The angles were measured using the digital Picture Archiving and Communication System.

Results: The sample consisted of 800 patients; 554 (69.2%) were women and 246 (30.8%), men. In the sample evaluated, the Gissane angle is 110.6±11.9, while the Böhler angle is 32.6±6.1. No differences were observed in the angles in terms of the comparison between sex and age.

Conclusion: In the Brazilian population, the Gissane angle is 110.6±11.9, while the Böhler angle is 32.6±6.1. There is no statistically significant difference in the comparison between sex and age.

Level of Evidence IV; Therapeutic Study; Case Series.

Keywords: Calcaneus; Radiography; Population characteristics.

Introduction

The calcaneus is the most frequent tarsal bone to be fractured. The most common trauma mechanism is fall from height, which occurs frequently during professional activity and affects young men[1]. About 70% of these fractures are intra-articular, representing greater difficulty in treatment and a worse prognosis for patients[2].

The Böhler angle was described by Dr. Lorenz Bohler (1885-1973) in 1931[3] and is defined by a line drawn between the highest region of the anterior process and the highest part of the posterior articular surface, and a second line between the same point on the posterior articular surface and the highest point of the calcaneal tuberosity (Figure 1). The literature reports a wide normal range for AB, from 20 to 40 degrees[4,5].

The Gissane angle was described in 1947 by Dr. William Gissane (1898-1981)[6]. It is defined by two lines, the first of which extends from the lowest point of the posterior facet to the highest point, and a second from the lowest point of the posterior facet to the highest point of the anterior surface (Figure 2). Different normal ranges, such as 96°-152°, 100°-130°, 120°-145°, and 95°-105° are reported in different studies[7].

The Böhler and Gissane angles are used to assess calcaneal fractures in the preoperative period to evaluate joint impairment, and in the postoperative period to evaluate reduction quality[8].

The aim of this work is to determine the Böhler and Gissane angles in the Brazilian population and to compare them with the data available in the literature.

Study performed at the Hospital Santo Antonio, Obras Sociais Irma Dulce, Salvador, BA, Brazil.

Correspondence: Eurico Carneiro da Silca Louro. 1058 Prefeito Carlos Cruz Av., Franciscanos, Juazeiro do Norte, CE, Brazil, Zip Code: 63050-030. E-mail: euricocsl@gmail.com. **Conflicts of interest:** none. **Source of funding:** none. **Date received:** January 16, 2020. **Date accepted:** March 19, 2020. **Online:** April 30, 2020.

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Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate) number: 79836417.5.0000.0047.

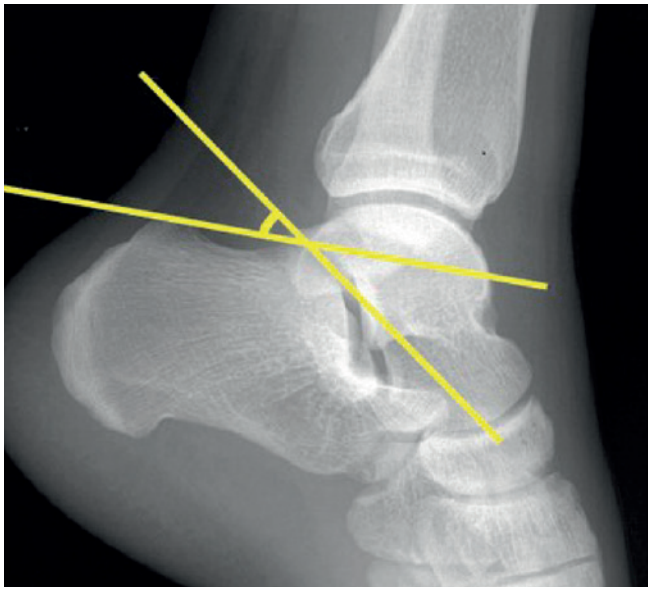

Figure 1. Böhler Angle.

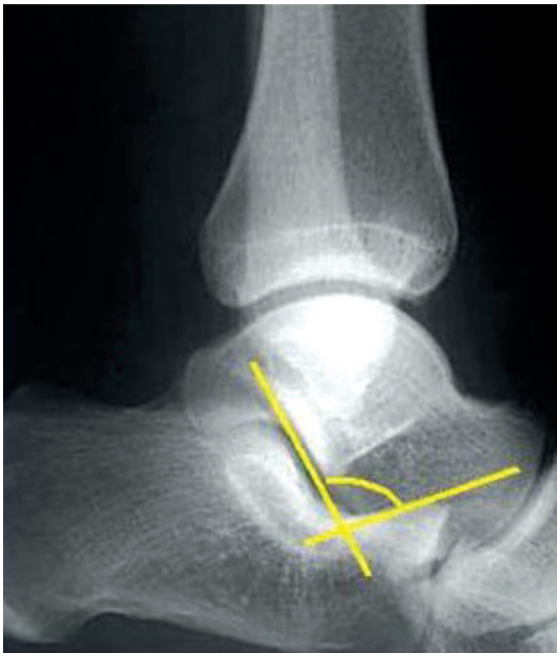

Figure 2. Gissane Angle.

A prospective study was carried out between June 2017 and June 2019 in which 800 weightbearing lateral radiographs of the calcaneus were evaluated in adult patients of both sexes. Convenience sampling was performed by recruiting patients treated at the Foot and Ankle Medical and Surgical outpatient clinic during the study period. Patients with a history of hindfoot (calcaneal or talar) and ankle fracture or radiological signs of subtalar osteoarthritis, characterized by joint space narrowing, osteophyte formation reaction or subchondral sclerosis, were excluded. A total of 86 patients were excluded, 27 due to a history of fracture and 59 because they showed signs of osteoarthritis on the radiographs. Angles were measured using the digital Picture Archiving and Communication System.

For statistical analysis, a definition of normality was made through graphical analysis and the Shapiro-Wilk test. For descriptive analysis, quantitative variables with normal distribution were represented by their mean and standard deviation. Intergroup comparisons were performed using Student's t-test and ANOVA.

Categorical variables were represented through frequencies and percentages. The Chi^2 test was applied to perform an intergroup comparison.

Box plots were drawn up comparing the genders of the subjects and the Böhler and Gissane variables.

Results

Table 1 shows that among the 800 patients, 554 (69.2%) were women and 246 (30.8%) men. The mean age of the patients was 50.2±16.0. Among the age groups, Table 1 shows the predominance of elderly patients. In the sample evaluated, the Gissane angle is 110.6±11.9, while the Böhler angle is 32.6±6.1.

Table 1. Sample Characterization

	Total (n=800)
Age	50.2±16.0
Gissane	110.6±11.9
Böhler	32.6±6.1
Sex	
Female	554 (69.2)
Male	246 (30.8)
Age Groups	
18-20	26 (3.2)
21-30	74 (9.2)
31-60	126 (15.8)
41-50	160 (20.0)
51-60	199 (24.9)
61-92	215 (26.9)

Table 2 shows that the age among women was 51.6±15.3, while the group of men assessed is younger (46.9±17.0), with a statistically significant difference having been observed. On the other hand, there was no statistically significant difference in the value of the Böhler (Figure 3) or Gissane (Figure 4) angles between males and females.

When the different age groups were compared, no statistically significant difference was observed for the Böhler and Gissane angles (Table 3).

Studies carried out in different parts of the world have evaluated the Böhler angle of their populations, while others have evaluated both Böhler and Gissane angles. The results presented in Table 4 show that there is no statistically significant difference when we compare the Böhler angle found in Brazil with the Nigerian[9], Turkish[10], and Croatian[11] populations. There was a statistically significant difference in relation to the Gissane angle found in all the studies evaluated, and in the Böhler angle when compared with American[12], Ugandan[13], Saudi[7], Egyptian[14], Serbian[15], Australian[16], British[17], and Indian subjects[18].

Discussion

The Böhler and Gissane angles were described in 1931 and 1947 respectively, before the creation of computed tomography in the 1960s. Therefore, for a long time they were the only radiographic parameters used to assess joint impairment in calcaneal fractures. Today, now that the use of tomography has become increasingly popular in many parts of the world,

Table 2. Comparison between genders

	Total (n=800)	Female (n=554)	Male (n=246)	p value
Age	50.2±16.0	51.6±15.3	46.9±17.0	<0.001
Gissane	110.6±11.9	110.8±11.7	110.0±12.4	0.391
Bohler	32.6±6.1	32.4±6.1	33.1±6.1	0.165
15-20	26 (3.2)	12(2.2)	14(5.7)	
21-30	74 (9.2)	39(7.0)	35(14.2)	
31-60	126 (15.8)	84(15.2)	42(17.1)	
41-50	160 (20.0)	113(20.4)	47(19.1)	
51-60	199 (24.9)	149(26.9)	50(20.3)	
61-92	215 (26.9)	157(28.3)	58(23.6)	

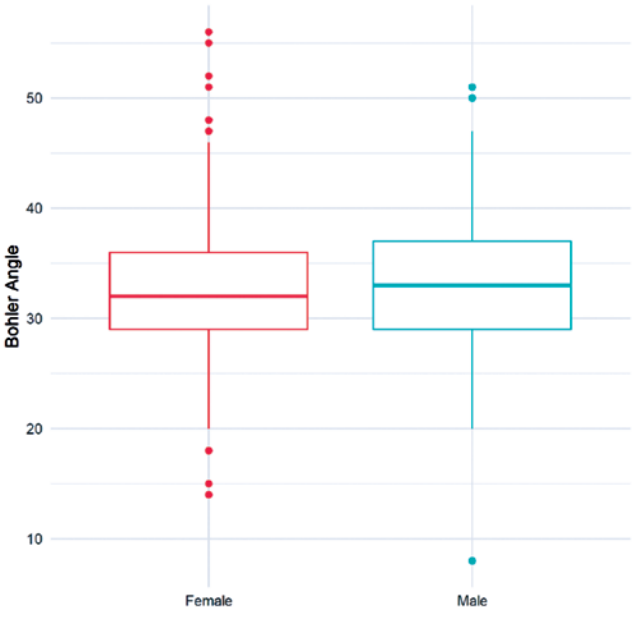

Figure 3. Böhler compared between sexes.

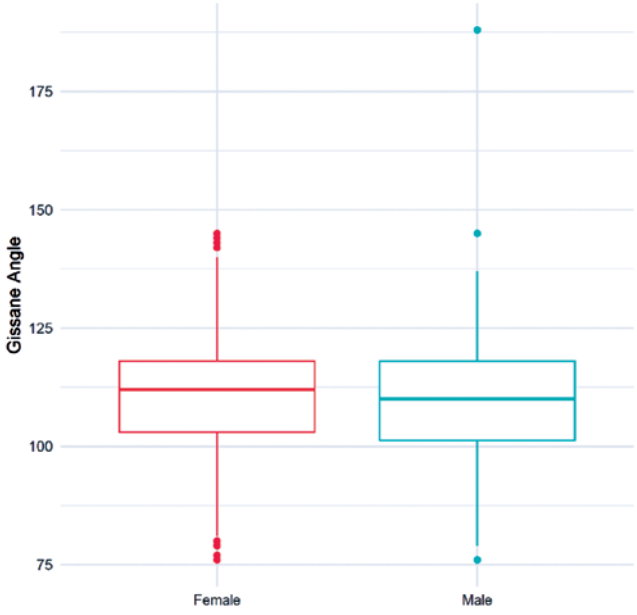

Figure 4. Gissane compared between sexes.

Table 3. Comparison between age groups

Age groups	Cases (%)	Böhler angle	Gissane angle
18-20	26 (3.2)	33.2±8.7	114.7±19.7
21-30	74 (9.2)	34.0±5.5	106.7±11.0
31-60	126 (15.8)	32.9±5.7	110.9±10.7
41-50	160 (20.0)	32.5±5.7	111.7±12.3
51-60	199 (24.9)	31.8±6.9	111.3±11.1
61-92	215 (26.9)	32.9±5.5	109.6±12.0
P		0.011	0.151

Table 4. Comparison with the literature

Population	no	Mean (º)	p
Chen et al. (American)	120	BA: 30±6	0.001
Igbigbi and Mutesasira (Uganda)	114	BA: 35.1±7.5 (F) BA: 37.6±5.6 (M)	0.001 <0.001
Didia and Dimkpa (Nigerian)	302	BA: 32.8±2.8	0.533
Khoshhal et al. (Saudi)	229	BA: 31.2±5.6 GA: 116.2±8.5	<0.001 <0.001
Seyahi et al. (Turkish)	308	BA: 33.8±4.8 GA: 115.0±6.5	0.026 <0.001
Shoulry et al. (Egypt)	220	BA: 30.15±4.18 GA: 122.92±6.9	<0.001 <0.001
Macuzic et al. (Serbian)	225	BA: 34.1±4.2	<0.001
Isaacs et al. (Australian)	212	BA: 29.4±4.1	<0.001
Willmott et al. (British)	127	BA: 36.4±4.2	<0.001
Sengodan et al. (Indian)	324	BA: 30.62±5.77 GA: 126.79±7.88	<0.001 <0.001
Simunovic et al. (Croatian)	130	BA: 33.73±5.17	0.030

they are still being used to assess these fractures, helping orthopedists make therapeutic decisions, and to assess the outcome of surgical treatment. Studies have shown a relationship between normalization of the Böhler angle in the postoperative period and better clinical and functional outcomes[19,20]. In addition, a biomechanical study found a correlation between the Gissane angle after restoration and the "Second Peak of Force", indicating that the better the reduction of this angle, the better the impulsion. A correlation was also found between the rating system proposed by the American Orthopaedic Foot & Ankle Society (AOFAS) and the First Peak of Force (ground reaction force upon initial contact of the foot in the support phase), showing that the better the clinical outcome, the better the hindfoot support[21].

Although they have been described and used for many decades, including in Brazil, there were no studies determining normal values in this population. The sample evaluated here (800 patients) is the largest when compared to other studies available in the literature, and enabled us to determine that the value of the Gissane angle in the Brazilian population is 110.6±11.9, while that of the Böhler angle is 32.6±6.1. No difference was observed between different age groups and between males and females, showing that no variation in these values is expected after skeletal maturity. These findings are compatible with other studies available in the literature[7, 9,10,14].

In the statistical comparison with the results of 11 published articles that assessed different populations, it is important to note that a statistically significant difference was observed between the Gissane angle in the Brazilian population and all others available in the literature. Regarding the Böhler angle found in this particular study, no statistically significant difference was observed in the comparison only with the Nigerian[9], Turkish[10] and Croatian populations[11]. There was a statistically significant difference with the other eight studies evaluated.

Despite the importance of plain radiography and the pre- and postoperative evaluation of the Böhler and Gissane angles, tomography plays an increasingly essential role in the management of this complex lesion. In the preoperative evaluation, tomography enables us to accurately locate the different fractured bone fragments, facilitating surgical planning. Consequently, there is better joint alignment in patients undergoing osteosynthesis with prior tomographic evaluation when compared to those who have undergone radiographs alone[22].

These findings show the importance of studies assessing the particularities of the radiographic parameters of the musculoskeletal system in different populations, since the data available in the literature may not be suitable for certain regions.

The main limitation of the study concerns the fact that it was carried out with a convenience sample of patients from a single Orthopedics and Traumatology clinic, and was not preceded by a pilot study.

Conclusion

In the Brazilian population, the Gissane angle is 110.6±11.9, while the Böhler angle is 32.6±6.1. There is no statistically significant difference in the comparison between sex and age.

Authors' contributions: Each author contributed individually and significantly to the development of this article: ECSL *(https://orcid.org/0000-0003-1230-8769) conceived and planned the activities that led to the study, wrote the article; TBF *(https://orcid.org/0000-0002-6122-3609) conceived and planned the activities that led to the study, wrote the article; TMP *(https://orcid.org/0000-0003-1644-2244) participated in the review process, approved the final version; LDSF *(https://orcid.org/0000-0002-4019-2639) participated in the review process, approved the final version; RGZ *(https://orcid.org/0000-0003-1555-2038) participated in the review process, approved the final version; TAA *(https://orcid.org/0000-0002-0124-3448) participated in the review process, approved the final version. *ORCID (Open Researcher and Contributor ID).

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Original Article

Minimally invasive repair of acute Achilles tendon injury: description of technique and evaluation of outcomes

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Abstract

Objective: Describe a minimally invasive surgical technique for acute repair of Achilles tendon injuries, and evaluate outcomes.

Methods: Nine subjects with primary Achilles tendon injury who underwent the minimally invasive repair technique between July and October 2018 were assessed. All subjects were followed up, and the SF-36 quality of life questionnaire was applied after the first postoperative year to evaluate treatment outcomes.

Results: The participants had average scores greater than 90 points in the SF-36 questionnaire, with widespread treatment adherence. Only one subject had an infectious complication in the postoperative period.

Conclusion: The technique described for acute Achilles tendon repair is simple, uses basic materials, is a low-cost method and, in this series, produced good clinical outcomes measured by the SF-36 Questionnaire.

Level of Evidence IV; Therapeutic Study; Case Series.

Keywords: Achilles tendon/injuries; Achilles tendon/surgery; Rupture/surgery; Tendon Injuries/surgery; Minimally invasive surgical procedures; Treatment outcome.

Introduction

An aging population together with the growing number of sports activities undertaken by the elderly has contributed to the high rates of Achilles tendon injuries[1]. This injury is one of the most common involving tendons, and can be observed in individuals who take part in sports such as: soccer, handball and tennis[2].

The techniques used to treat such an injury have been studied at length[3-8]. In theory, the ideal procedure involves low cost, short hospital stay, limited tissue damage from the surgery, and the possibility of the patient quickly resuming their daily activities, with functional results close to normal. However, the best form of treatment for Achilles tendon injuries is still controversial[8-10], ranging from conservative treatment to open repair and extending with newer techniques with minimally invasive surgical treatment possibilities[6,7,11-13]. The latter, despite showing excellent results[6,7,11-13], were mostly presented using specific instruments that have not yet been provided by the public health system.

Thus, the aim of the study is to describe a percutaneous surgical technique for acute repair of Achilles tendon injuries, using basic materials that are easily accessible in the public health network, and to evaluate the outcomes.

Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate): 19432019.6.0000.5078. All the participants signed the Informed Consent Form (ICF).

Study performed at the Universidade Federal de Goiás, Goiânia, GO, Brasil.

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Nine participants aged over 18 years with primary Achilles tendon injury (traumatic or non-traumatic) occurring up to 21 days at the moment of surgery, were enrolled in the study. In addition, the lesion had to be located in the tendinous portion of the sural triceps, at a distance of least 2cm from its insertion in the calcaneus, with preoperative measurement by ultrasound and in the physical examination, methods used in the diagnosis and in the inclusion of sample cases. Injuries with a history of re-ruptures, cases with follow-up of less than 10 months, or patients who did not have details of the procedure or of adequate follow-up in their medical records were excluded.

Participants underwent surgery using the minimally invasive repair technique between the months of July and October 2018, and the sample size included all patients operated on in our department during that period, and who met the aforementioned inclusion criteria. This surgical technique is a variation of a procedure already solidly established in the medical literature, which uses specific and expensive materials[4].

Making use of surgical principles, the department developed a protocol with the application of basic surgical instruments, already existing in the unit, which could be re-sterilized for the treatment of patients with such an injury profile.

Basic and specific instruments were used during the surgical procedure. The basic instruments included: a box with hemostatic forceps, scalpel, scissors, Farabeuf retractors, suture material and grasping forceps, such as the Allis type. The specific materials were: three identical fenestrated metal tongue depressors (Figure 1), two arthroscopy guidewires (Figure 2), and six long-lasting absorbable suture threads (polyglactin nº 1). Materials for sterile dressings and a kit for making plaster casts were also needed.

The patient was placed in the prone position, after spinal anesthesia, with his or her feet hanging close to the table (about 10 to 15cm). After the aseptic procedures and placement of sterile drapes, the injury site was confirmed through physical examination by palpating the injury depression. A 2-3cm transverse incision was made in its center, and no tourniquet was applied on the lower limb to be operated. The stumps were identified and debrided, removing their most friable area. The tendon stumps were released from its sheath by blunt dissection with the surgeon's finger, and its excursion was observed. The proximal stump of the tendon was seized with grasping forceps, then two tongue depressors were positioned from the incision, laterally and medially to the stump. A third depressor, identical to the two used internally on the patient, was positioned externally on the skin on the medial side and in perfect alignment with the others, the latter serving as a template. Keeping the tension applied on the stump and the alignment of the tongue depressors, an arthroscopy guidewire with a suture thread transfixed at the end was passed through one of the holes in the tongue depressor from the medial position to the corresponding hole in the lateral tongue depressor. When passing the absorbable thread through the lesion, through the arthroscopy guidewire, each thread was doubled at the point of entry and exit of the skin. Before completing the passage with the guidewire, a test was performed to ascertain whether it had been passed correctly through the holes in the tongue depressors, in an attempt to remove the depressors (when the procedure is carried out correctly, the depressor is trapped by the guidewire). Two more sutures were passed through the proximal stump, using different holes in the tongue depressor, producing a total of three double-filament sutures, and the depressors were removed symmetrically under traction, to enable the absorbable sutures to accompany those trapped by the holes, and to exit the incision. The images of the surgical procedure are shown in Figure 3.

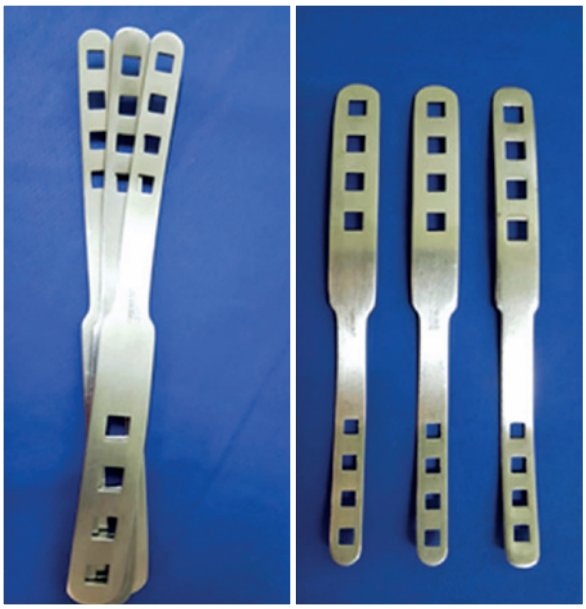

Figure 1. Metal tongue depressors.

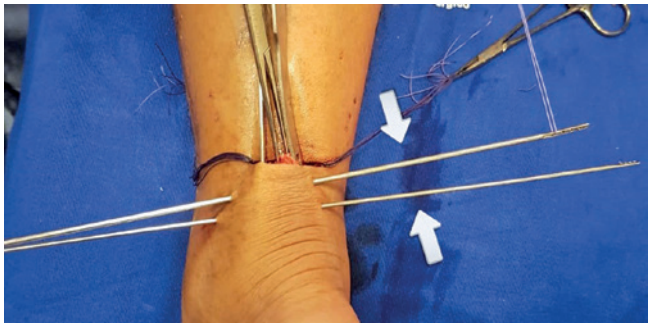

Figure 2. Arthroscopy guidewires.

All subjects who underwent this protocol had their surgical procedure noted down in their medical records along with their preoperative, postoperative, and outpatient follow-up assessment, with a specific rehabilitation protocol. The pa-

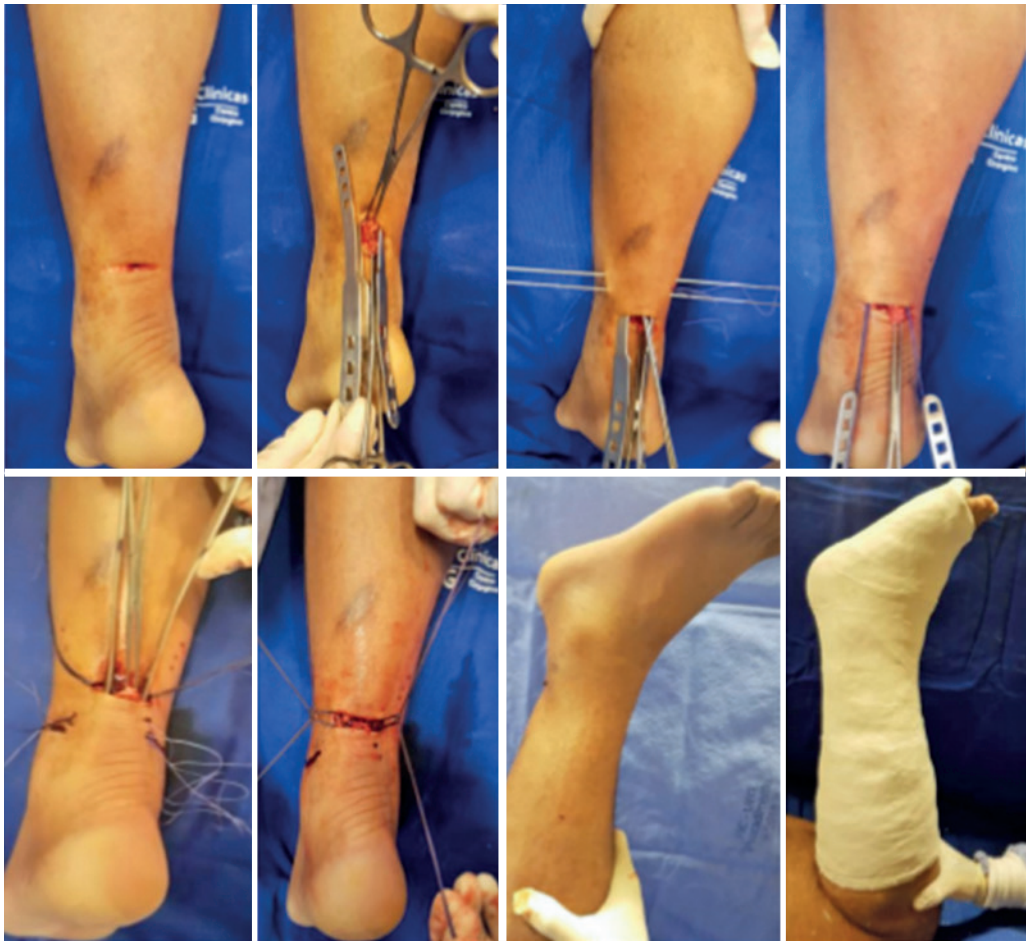

Figure 3. Sequence of images of the surgical procedure in order of occurrence.

tient was instructed to start walking in a plaster cast at 30 degrees of plantar flexion, made at the end of the surgery, and were allowed to bear their full bodyweight after the fourth postoperative day, taking care to use a rubber sole, with a heel measuring approximately 2cm in the hindfoot area, to protect the plaster from breaking. The patient was reassessed after two weeks to detect the presence of early complications and to evaluate his or her adherence to the rehabilitation protocol. After four weeks, at the second return visit, the plaster cast and surgical stitches were removed, the surgical wound was inspected, and a long walker boot was fitted to allow the patient to walk with the foot in a plantigrade position. This was continued for another four weeks until the time of a further assessment, when the patients were normally allowed to begin walking without the use of a protective orthosis. Physiotherapy sessions were started under the supervision of a qualified professional.

At the end of the first postoperative year, the attending physician applied the SF-36 quality of life questionnaire to assess treatment outcomes in the patients. The questionnaire contains 36 items grouped into 8 domains, and reflects a final score from 0 to 100 (zero is the worst and 100 the best health status)[14]. Information was also collected about the time to resumption of activities of daily living, early and late complications, subjective impression of the treatment, and epidemiological data. The patient's adherence to the rehabilitation protocol proposed by our technique was also assessed, computing use of the plaster cast, orthosis and the length of assisted physical therapy both adequately and in a timely manner, and having the attending physician note down this data in the patient's medical records.

Results

The mean age of the patients was 32 years, and the average follow-up time was 12 and a half months. Only one patient had less than one year of follow-up. A description of the epidemiological data can be found in Table 1.

Only one subject had an infectious complication, which was suspected at the return visit to the emergency room four days after surgery. This was the only case that developed sural nerve deficit (without a description of its status prior to

the procedure), and had the particularity of having been an open injury caused by direct trauma. The therapeutic approach had a good outcome, with removal of the cast, removal of alternate stitches, and oral antibiotic therapy for 14 days, and without any sign of infection during this period. A new cast was made to restart the four-week protocol.

Two subjects resisted weight-bearing as directed, claiming "fear of compromising the surgery". This was corrected by the third week, and did not compromise the treatment outcome.

The mean physical therapy treatment duration was 19 sessions, ranging from zero to 40 sessions. Two patients did not undergo rehabilitation, claiming lack of access via the Unified Health System, but there was no difference in the assessment of quality of life in comparison to the other patients at the end of one year of follow-up. Perioperative assessment is described in Table 2.

The data relating to the application of the SF-36 Quality of Life Questionnaire are presented in Table 3.

Table 1. Epidemiological data

Patient	Variables analyzed							
	Age	Sex	Laterality	Athletic Level	Systemic Diseases	Prodromes	Smoker	Trauma
1	38	M	Right	Recreational	No	No	No	Indirect
2	37	M	Right	Professional	No	Yes	No	Indirect
3	32	M	Left	Professional	No	No	No	Indirect
4	30	M	Right	Recreational	No	No	No	Indirect
5	18	M	Left	Sedentary	No	No	No	Direct
6	37	M	Right	Sedentary	No	No	No	Indirect
7	38	M	Right	Recreational	No	No	No	Indirect
8	41	M	Left	Sedentary	No	No	No	Direct
9	22	M	Left	Recreational	No	No	Yes	Indirect

Table 2. Perioperative assessment

Patient	Variables analyzed							
	TIS (months)	Intraoperative outcome	Postoperative protocol	Infection	PTP	Re-rupture	Pain - VAS	Follow-up (months)
1	15	Good	Followed	No	9	No	Absent	14
2	5	Good	Followed	No	20	No	Absent	14
3	12	Good	Followed	No	40	No	<3	12
4	11	Good	Followed	No	40	No	Absent	13
5	6	Good	Partial	No	No	No	Absent	13
6	16	Good	Followed	No	No	No	Absent	13
7	9	Good	Partial	No	15	No	Absent	12
8	3	Good	Followed	Yes	20	No	Absent	12
9	8	Good	Followed	No	30	No	Absent	10

TIS (Time from injury to surgery); PTP (Physical therapy sessions); VAS (Visual Analog Scale).

Table 3. Quality of life assessment (SF-36 Questionnaire)

Aspects analyzed	Subjects									Mean
	1	2	3	4	5	6	7	8	9	
Functional capacity	100	100	95	100	100	100	100	95	100	**98.88**
Physical limitation	100	90	95	100	100	100	100	100	100	**98.33**
Pain	100	100	85	100	100	100	100	100	100	**98.33**
General health	90	100	90	100	100	95	100	100	100	**97.22**
Vitality	80	100	90	90	100	90	100	90	100	**93.33**
Social aspects	95	95	100	100	100	100	100	100	100	**98.88**
Emotional aspects	100	80	100	90	100	100	100	100	100	**96.66**
Mental health	95	75	100	90	100	95	100	95	100	**94.44**

Discussion

Many articles address therapeutic approaches for the treatment of Achilles tendon injuries[3-8]. There are those that advocate in favor of open surgery[11,15], while others prefer less aggressive techniques with early limb mobilization[3,5,10-13]. The latter have shown low rates of re-rupture, with less muscle atrophy, fewer infectious complications and earlier walking, with early return to work. In the long term, functional results are similar to traditional repair techniques[4].

Accordingly, the surgical technique presented in this article represents a good treatment option, due to the use of basic, inexpensive and re-sterilizable materials, which facilitate its applicability because it does not represent a high cost for the department and does not entail sacrificing a high-quality surgical outcome. Furthermore, it introduces the use of the template to facilitate the identification of the correct guidewire trajectory, an innovation that has not previously been described in any study where a minimally invasive technique was used[5,7]. In addition, the passage of the double-filament suture through the guidewire, in theory, also represents a biomechanical advantage of greater resistance when compared to techniques that use percutaneous prethreaded sutures (consisting of a single thread).

Some challenges, however, must be highlighted. Of 12 cases treated and referred for the minimally invasive procedure, three were excluded in the intraoperative period, opting instead for traditional open surgery. This decision was made when the surgeon made the mini-incision and noted considerable tendon degeneration, with significant failure after debridement and inability to draw the stumps closer to one another without excessive tension. Since this is an unforeseeable event, it is crucial for the surgeon to be prepared instrumentally and technically for the conversion. In the latter case, we extended the incision longitudinally on opposite sides of the initial transverse incision, and had no local complications.

Care in the positioning of tongue depressors must also be considered. The two internal depressors must be in direct contact with the Achilles tendon stump, and must therefore be positioned inside the muscle fascia. Otherwise, when the sutures are pulled they will transfix the fascia, which can cause of difficulty in tendon excursion during gait and postoperative pain. It is advisable to apply traction on the tendon stump using forceps, and to produce detachment without the use of sharp instruments with the lateral finger and medially to the tendon, at the site where the depressors will be positioned. It is also necessary to ensure that these are placed in their positions under direct visualization.

Finally, a crucial step for the success of the procedure consists of passing the guidewire through the holes in the depressors, which entails a considerable risk of error. If an error occurs, when the depressors are pulled the sutures will not accompany them, making the subsequent stages of the surgery impossible. To correct the error, attention must be paid to the correct positioning of the tongue depressor outside the skin, as it must be in perfect alignment with the two internal depressors, and function as a template. It is considered essential to check this passage, made with the guidewire transfixed through the tendon, attempting to remove one internal tongue depressor at a time. If the guidewire is actually positioned inside the hole, the depressor will be fixed and will not come out under traction. The surgeon then completes the tendon transfixation and repeats these steps with each guidewire that is passed.

As regards the postoperative period, patients were provided with guidance on the protocol from the time of their admission, and encouraged to follow it, with good success in adherence. Care is needed when reinforcing the plaster, as the cast needs to be designed considering the fact that walking is encouraged in the postoperative period.

A frequent complication of percutaneous surgery is iatrogenic injury to the sural nerve, which is around 19%[16]. In this particular study, only one of the nine subjects developed this complication (representing 11% of the total sample), which would be below the values stated in the literature. However, due to the small number of cases studied, it is not possible to assert that this difference has statistical significance. It is also noteworthy that this particular case sustained a sharp force injury due to trauma, which raises the question whether this participant had already presented with the deficit as a result of the trauma, since there had been no reports of specific research on this deficit before the surgery.

The results of the application of the SF-36 questionnaire were high (average >90), demonstrating that this technique has a positive impact on the quality of life of individuals with this type of injury undergoing this treatment. It is worth mentioning that the questionnaire was applied about a year after the procedure, and not over the months of follow-up, making it impossible to record details of patient progress periodically. There is also a lack of studies that assess the quality of life of subjects with the same instrument used in this study. Furthermore, there are limitations to defining whether the technique described in this particular study really enabled an advantage over early rehabilitation and return to work activities. These study limitations include: small sample, short follow-up, and the fact that the sample size was not calculated, the results were not compared with a control group, and a functional evaluation of the tendon itself was not performed.

Conclusion

The minimally invasive surgical technique described for acute repair of the Achilles tendon in this study requires basic, inexpensive materials, and does not present major technical difficulty in its execution, facilitating its reproducibility. The results obtained confer a positive impact on the 1-year postoperative follow-up, and patients show good outcomes related to quality of life at the end of this period, according to the application of the SF-36 Questionnaire.

Authors' contributions: Each author contributed individually and significantly to the development of this article: RLO *(https://orcid.org/0000-0001-7222-1070) conceived and planned the activities that led to the study, wrote the article, interpreted the results of the study, approved the final version; JSM *(https://orcid.org/0000-0003-4742-1905) conceived and planned the activities that led to the study, participated in the review process, approved the final version; PHMS *(https://orcid.org/0000-0002-8970-4439) wrote the article, participated in the review process, approved the final version. *ORCID (Open Researcher and Contributor ID).

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Original Article

Insertional Achilles tendinopathy: evaluation of postoperative outcomes

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Abstract

Objective: Retrospectively analyze surgical procedures performed on patients with insertional Achilles (calcaneal tendon) tendinopathy, focusing on outcomes and the impact on the patients' functional quality.

Methods: A descriptive, retrospective, case series study drawn up by collecting data directly from the patients' medical records. For the functional analysis of patients, we used the questionnaire of the adapted American Orthopaedic Foot and Ankle Society Ankle-Hindfoot Scale (AOFAS). An assessment was carried out on each of the patients who underwent surgery at our hospital from 2010 to 2019, using the surgical technique described in this article, i.e., resection of the affected portion of the tendon with its subsequent reinsertion.

Results: All surgical patients achieved an improvement in their AOFAS score and in pain levels, with good functional performance only three months into the postoperative period, from 50.1 to 83.75 ($p<0.001$).

Conclusion: The use of the technique proved very effective, particularly in terms of the maintenance of foot function and important improvement in pain levels, thus producing a relevant increase in function among patients.

Level of Evidence IV; Therapeutic Study; Case Series.

Keywords: Calcaneal tendon/pathology; Tendinopathy/surgery; Calcaneus.

Introduction

The calcaneal tendon is the strongest and most resistant tendon in humans[1]. It is formed by the junction of the soleus and gastrocnemius muscles, and measures approximately 15 to 17cm in length, with its insertion in the posterior calcaneal tuberosity[1]. The exact cause of tendon degeneration with or without the presence of posterior calcaneal exostosis is unknown, but is associated with repetitive use of the tendon and metabolic disorders (gout, diabetes, obesity)[2].

The complaint reported is pain in the distal insertion of the calcaneal tendon, usually with edema, local swelling, pain on palpation, and especially pain when walking or playing sports. The presence of a posterior bone exostosis (Haglund's deformity) is a common occurrence. The diagnosis is eminently clinical, and imaging tests, X-rays and MRI scans, are routinely requested only in cases refractory to clinical treatment and with indication for surgical treatment[2].

Several surgical techniques can be found in the literature. In our department, we prefer the technique consisting of distal resection of the calcaneal tendon, posterior exostectomy (when Haglund's deformity is present), lengthening of the myotendinous junction, using a modified Vulpius procedure[3], and reinsertion of the distal stump in the posterior calcaneal tuberosity after debridement of all soft tissue around the posterolateral and medial aspect of the calcaneus, using two 5mm anchors for reinsertion of the healthy stump of the calcaneal tendon[4].

Study performed at the Conjunto Hospitalar do Mandaqui, São Paulo, SP, Brazil.

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This study was conducted with the aim of evaluating the effectiveness of the technique employed in the department.

Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate) number: 29089020.6.0000.5551.

The patients in this study routinely underwent at least three months and at most six months of conservative treatment before surgical treatment was indicated. The conservative treatment protocol in our department consists of the use of non-hormonal anti-inflammatory drugs (where not contraindicated), use of shoes with a 2.5cm-3cm heel, with a soft heel pad, cessation of intense physical activity, avoidance of pressure or direct trauma to the calcaneus, and physical therapy (US, TENS, stretching exercises) (Figure 1).

The patients were all asked questions before and after the physical therapy treatment. Those who maintained complaints of pain and inability to engage in everyday and sports activities were referred for surgical treatment.

Twenty feet were assessed in 19 patients with a clinical diagnosis of insertional Achilles tendinopathy, confirmed by nuclear magnetic resonance. They had previously received at least three months and at most six months of clinical treatment, and had been operated on between 2010 and 2019, by the same surgeon. We assessed patients both preoperatively using the adapted AOFAS scale (Table 1), and 90 days postoperatively, in addition to mean age, laterality, prevalence of sex, comorbidities, average time of symptoms before surgery, and complications. All patients who had undergone prior surgery or had previously ruptured their calcaneal tendon were excluded.

The surgical technique started with the patient in prone position, applying a tourniquet at the top of the thigh, making a medial incision to the calcaneal tendon with inverted "L" extension (Figure 2) and a 4-cm accessory longitudinal incision at the myotendinous transition. In the proximal route, the small saphenous vein and the sural nerve are moved aside to perform a Vulpius-type inverted "V" cut to increase the length of the calcaneal tendon.

A distal portion of 3 or 4cm of the calcaneal tendon is surgically removed (observing the injured length, assessed

Figure 1. Stretching of the calcaneal tendon affected (right).

Table 1. Score according to AOFAS criteria

PAIN: 40 points	
None	40 points
Mild, occasional	30 points
Moderate, daily	20 points
Severe, always present	0 points
FUNCTION: 45 points	
A. Activity	
No limitations, no support	15 points
Limited recreational activities, does not use cane	7 points
Limited recreational activities, uses cane	4 points
Severe limitation, uses walker, crutches	0 points
B. Shoe	
Conventional, without insole	5 points
Comfortable, with insole	3 points
Modified or orthesis	0 points
C. Metatarsophalangeal joint mobility	
Normal or mild restriction (≥75º)	10 points
Moderate restriction (30-74º)	5 points
Severe restriction (<30º)	0 points
D. Interphalangeal joint mobility (plantar flexion)	
No restriction	5 points
Severe restriction	0 points
E. Metatarsophalangeal joint stability	
Stable	5 points
Unstable	0 points
F. Metatarsophalangeal Callosity	
Absent or present and asymptomatic	5 points
Present and symptomatic	0 points
ALIGNMENT: 15 points	
Good, Hallux well aligned	15 points
Fair, some degree of malalignment, asymptomatic	8 points
Poor, severe malalignment, symptomatic	0 points
Overall TOTAL	**100 points**

through MRI observation), including its insertion in the distal calcaneus. All the soft tissue in the posterolateral and medial region of the calcaneus must be thoroughly cleaned, and the site cauterized (Figure 3).

An important step is the cleaning of the posterior calcaneal tuberosity, removing bony excrescences (Figure 4), (only as necessary), leaving the proximal stump reinsertion site open. This step is followed by the insertion of two parallel 5.0 millimeter anchors with a 45 degree inclination (south Texan fence line type). Sutures are inserted in the medial and lateral region of the distal stump of the tendon, using the Krackow technique, with the foot at 15 degrees of plantar flexion (Figures 5 and 6). We finished by cleaning the wound with saline solution, closing it with separate stitches and placing a plaster cast on the equinus described.

The average length of stay for all patients was 24 hours. The stitches were removed after an average of 21 days. During this phase we remove the plaster cast and fitted the patient with an AFO boot. The patient was not allowed to bear weight on the foot until the 30th postoperative day, when we started weight-bearing with crutches until the 45th - 50th postoperative day. During this phase, we removed the orthosis and started physiotherapy (mobility exercises, gait training without crutches, proprioception exercises and gentle stretching). After 15 sessions on average (around the 60th postoperative day), patients were already walking relatively normally without the use of an orthesis.

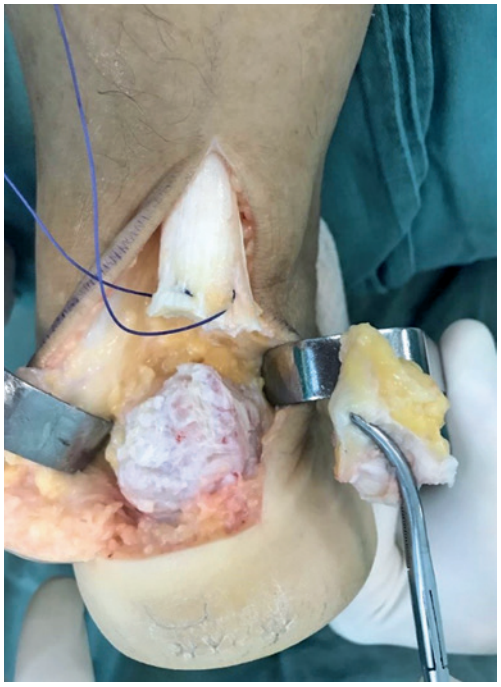

Figure 3. Exeresis of 3 or 4cm distal portion of the calcaneal tendon, including its insertion into the distal calcaneus, and cleaning of all surrounding tendon tissue.

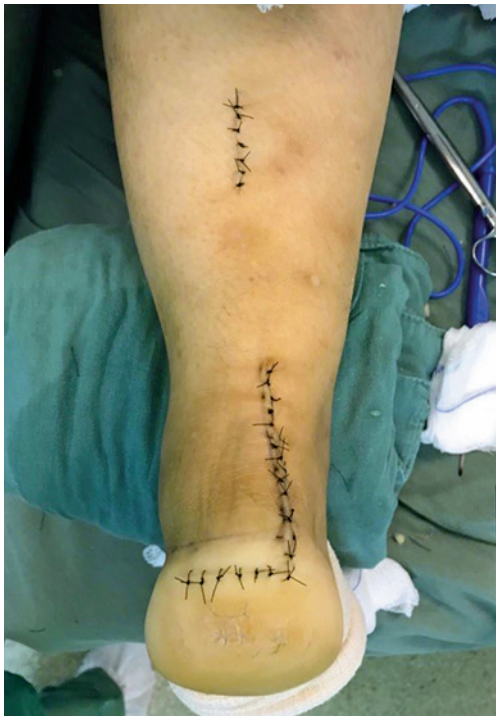

Figure 2. Medial incision in the calcaneal tendon with inverted "j" extension, 4cm accessory longitudinal incision.

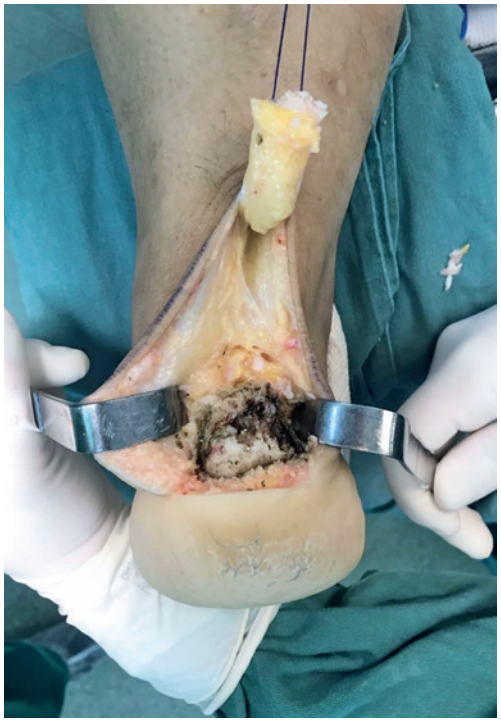

Figure 4. Cleaning the posterior calcaneal tuberosity, removing bone excrescences (only as necessary).

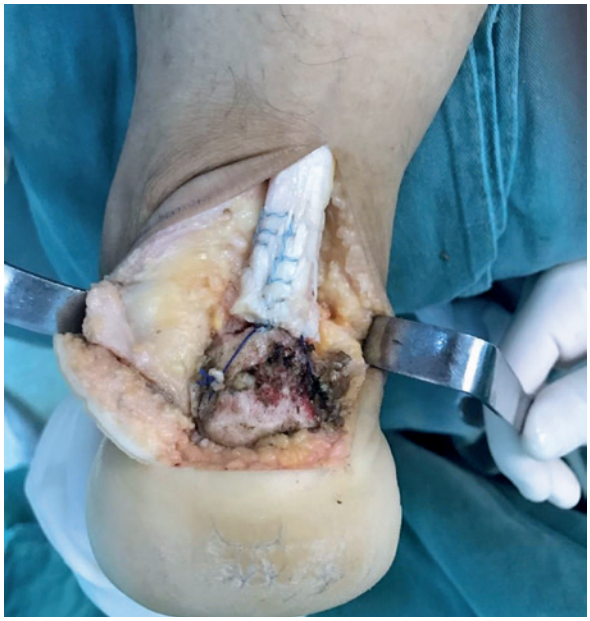

Figure 5. Reinsertion of the Calcaneal Tendon after medial and lateral "Krackow" suturing, done firmly and with the foot at maximum plantar flexion of 15 degrees.

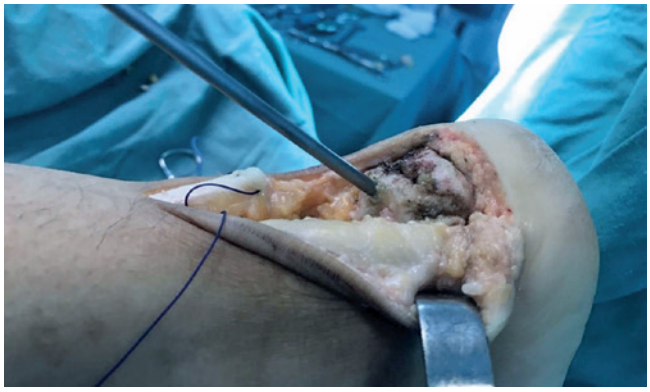

Figure 6. Insertion of two parallel 5.0 millimeter anchors with 45 degree inclination (south Texan fence line).

Normal distribution of the data collected was obtained by descriptive statistics for the pre and postoperative period, and the Student's t test was applied, yielding a p-value of <0.001 (Table 2).

Table 2. Descriptive statistics of the AOFAS results in the pre and postoperative periods

Mean	50.15	83.75
Median	53	80
SD	14.47421	10.24374

Results

We assessed 20 feet of patients who had undergone surgery (Table 3), 35% of whom were male and 65% female. The mean age was 56 years (ranging from 38 to 73 years). The average time of pain and disability before the indication for surgical treatment was 24 months; the right side was affected in 60% and the left side in 40% of the patients. Of the 20 feet, only one did not have shortening of the calcaneal tendon (5%) measured by the Silfverskiöld test preoperatively. The mean AOFAS score adapted in the preoperative period was 50.15, ranging from 14 to 70, and the postoperative score was 83.75, ranging from 68 to 100 (P<0.001). Of the 20 feet, 8 (40%) had Haglund's deformity. As regards comorbidities, the most common were diabetes (20%), rheumatoid arthritis (5%), and SAH (5%). Of the 19 patients, seven were smokers (35%). The minimum follow-up was eight months and the maximum follow-up nine years, averaging 5.6 years. All of the patients who engaged in some form of sport resumed their normal activities seven months after surgery.

Regarding complications, there were five cases of superficial suture dehiscence (25%), three of which were in the distal incision and two in the proximal incision. All were resolved with outpatient debridement and dressing changes. We did not observe any deep infections or tendon re-ruptures.

Discussion

Insertional Achilles tendinopathy is quite common and difficult to resolve with conservative treatment. It causes significant disability across a very wide range of age groups[3]. Frequently seen in foot and ankle outpatient clinics, it behaves like a severe disability, and is common in female patients, who can no longer wear ordinary women's shoes[4].

Comparing our work with the literature, we noticed that few studies took into account the very common comorbidities in this type of problem, and did not apply the Silfverskiöld test, which assesses the shortening of the gastrocnemius/soleus complex, a frequent finding in patients with insertional tendinopathy (95% of our cases). Our preoperative assessment had a much lower AOFAS score than the mean score found in the literature studied (50.1 versus 56.4), which partly explains why our final score was below the mean recorded in the literature (83.75 versus 90.0), as our patients were potentially more severe cases who had been disabled for longer[5-11].

Another factor that contributed to our lower improvement score is that we assessed our patients at 3 months postoperatively, while all the others[5-11] were assessed at 24.4 months on average. Nonetheless, the improvement achieved with surgical treatment was significant from 50.1 to 83.75 (p<0.001). In the study by Ahn et al. (2015)[10], the mean age of the patients undergoing surgery was 33.1 years, which influences the final result obtained. Our mean age was 56 years, consistent with other studies.

Our postoperative recovery time was compatible with the literature (around 60 days)[7,9-11], with the exception of the article by Rigby et al.[9], 2013, who achieved partial weight-bearing just 10 days postoperatively.

Table 3. Results of the study

Name	Sex	Number	Age	Side	Stage	Duration of preoperative pain	Surgery	Complication + Risk Factor	Date of surgery	Pre AOFAS	Post AOFAS
CRPAS	M	909060	58	R	III	14 months	Resection + Vulpius	Shortening	07/07/2010	70	96
VLPO	F	99353	54	L	III	24 months	Resection + Vulpius	Shortening	24/05/2010	58	81
AIRDSDR	F	11548	45	L	III	12 months	Resection + Vulpius	Shortening	08/11/2011	51	79
SC	M	104421	49	R	III	19 months	Resection + Vulpius	Shortening	02/08/2011	46	77
SCR	F	60786	53	R	III	14 months	Resection + Vulpius	Shortening + HAGLUND	12/04/2011	46	77
PAC	F	38529	38	R	III	09 months	Resection + Vulpius	NO	18/05/2011	67	100
AAD	M	64866	44	L	III	08 months	Resection + Vulpius	Shortening + HAGLUND	21/03/2011	70	100
ALF	M	103349	61	R	III	36 months	Resection + Vulpius	Shortening	11/03/2011	33	75
MDLGR	F	18171	65	R + L	III	48 months	Resection + Vulpius	Shortening	02/03/2010 (L) 04/05/2012 (R)	46(L) 46(R)	77(L) 77(R)
YPC	F	113201	74	L	III	32 months	Resection + Vulpius	Shortening + HAGLUND	07/10/2013	30	75
CCC	F	91949	62	L	III	18 months	Resection + Vulpius	Shortening + HAGLUND	27/05/2014	58	85
MRG	F	119449	73	R	III	48 months	Resection + Vulpius	Shortening + DIABETES	24/02/2015	58	97
ITL	F	122900	65	L	III	36 months	Resection + Vulpius	Shortening + DIABETES	01/02/2016	30	75
CRSDR	F	102114	68	L	III	36 months	Resection + Vulpius	Shortening + HAGLUND + DIABETES + RA	12/04/2016	14	68
RRL	F	125193	47	R	III	12 months	Resection + Vulpius	Shortening	19/12/2016	55	86
SZ	F	127141	67	R	III	18 months	Resection + Vulpius	Shortening	31/01/2017	50	72
RBB	M	68959	61	R	III	18 months	Resection + Vulpius	Shortening + HAGLUND + DIABETES	03/04/2017	55	86
GBDS	M	136423	43	R	III	24 months	Resection + Vulpius	Shortening + HAGLUND	08/04/2019	60	96
EBM	M	122965	43	R	III	10 months	Resection + Vulpius	Shortening + HAGLUND	08/05/2019	60	96

Our surgical approach enables us to correct the shortening of the gastrocnemius/soleus complex, which is not mentioned in other works. Another noteworthy difference is seen in the technique used, in which the diseased segment of the Achilles tendon is removed. This is evident when we analyze the magnetic resonance images and is confirmed by anatomic pathology in all patients who underwent surgery in our series.

Complications were superficial suture dehiscence in five cases, treated on an outpatient basis, a fact similar to the literature studied. There were no tendon reinsertion ruptures in our cases.

Conclusion

The surgical technique requires little material and had excellent results based on the AOFAS score, when compared to the literature. Although there was superficial dehiscence of the wounds in five of 20 patients who underwent surgery, all were successfully treated on an outpatient basis without sequelae. The technique proved to be a good treatment option for insertional Achilles tendinopathy.

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Original Article

Patients' expectations with regard to the quality of orthopedic medical care

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Abstract

Objective: To assess, through the Surgical and Medical Experience Questionnaire translated and adapted into Portuguese, the opinions and expectations of patients with regard to the treatment protocols and medical training of the foot and ankle orthopedic specialist.

Methods: This cross-sectional observational study assessed, through the application of a questionnaire, the opinions and expectations of patients with regard to orthopedic protocols adopted by the foot and ankle specialist.

Results: One hundred and thirty patients were selected. Among the participants, 33.8% were male and 66.2% female. The predominant characteristics of a good physician were good outcomes, according to 31% of the participants, followed by quality of care according to 28.6%, and qualities of a good surgeon, chosen by 27.6%. Approximately 89% of patients do not conduct any research on their physician. Correlation was found between the study level and the choice of physician.

Conclusion: The demand for physicians with highly specialized skills has increased over the years. It is evident that in the case of better educated patients, a physician's resume is much more important, unlike less educated patients. It is possible to observe that, for patients, there are still multiple barriers and variables.

Level of Evidence V, Therapeutic Study; Expert Opinion.

Keywords: Problem-based learning; Patient preference; Practice patterns, physicians; Physician-patient relations.

Introduction

Hippocrates developed and systematized the clinical method in the year 500 BC. Through anamnesis and physical examination, he provided a script for physicians to use as a basis to structure and define their actions. Two thousand years later, in 1895, Roentgen discovered "X-rays", a discovery that aided medical development, and allowed the improvement of specialties. Tomography was invented by Ambrose and Hounsfield in 1971, and, in 1973, magnetic resonance imaging was presented by Lauterbar. Despite all this progress, the medical consultation is still essential for the doctor-patient relationship, and remains a personal choice to be made by the patient, based on opinions, options available in the market, and economic values[1-5].

The medical consultation, per se, is an assessment method in which the patient transposes not only their confidence in the professional, but also their familiarity with and expectations in regard to their problems. For the physician, confidentiality, responsibility for correctly defining a diagnosis, and for determining treatments and surgeries, are part of the routine and challenges of the profession[6-12]. At the same time, for the patient, the simple choice of a professional already raises

Study performed at the Hospital de Trabalhador da Universidade Federal do Paraná Curitiba, PR, Brazil.

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many questions: which physician is the best; is this specialist qualified to practice? Although this is considered a simple question by physicians, patients see it as one of their priorities and requirements[13-17].

But what really influences the patient to choose their physician? In this study, we have attempted to identify the determinations and opinions of patients in regard to this choice; in this case, in relation to an orthopedic foot and ankle surgeon[18-23].

Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate) number: 26223519.7.0000.5225.

This study has a cross-sectional observational design and assessed, through the application of a questionnaire, the opinions and expectations of patients in regards to orthopedic protocols, in relation to the foot and ankle specialist. In other words, the capacity, expected by the patient, that the foot and ankle specialist must have to carry out their daily medical activities and treatment protocols.

All patients who participated in this study were being followed up for their orthopedic comorbidities, specifically involving the foot and ankle, in a tertiary referral hospital. They all agreed to the terms of the Informed Consent Form (ICF) provided prior to the submission of the questionnaire.

The analysis was carried out based on the information collected through the questionnaires, which were fully completed by the patients after the outpatient assessment.

The inclusion criteria used were patients over 18 years of age who had undergone or were undergoing orthopedic foot and ankle treatment in the outpatient clinic of a tertiary referral hospital, and who had signed the ICF, with no maximum age limit.

Patients who did not fully complete the ICF and the questionnaire, or did not agree to participate in the project, were excluded.

The analysis of this study was carried out based on the information collected only through the questionnaires that were fully completed by the patients after the outpatient assessment.

The statistical program R (R Core Team 2019), a free and open source software, was used in all analyses. The descriptive analysis is performed with the presentation of quantities, values, minimums, first quartile, median, second quartile, maximum values, mean, and standard deviation. All of these measures are useful to perceive the characteristic of the information as a whole.

Multiple group comparison, in statistics, has the ANOVA (Analysis of Variance) method as its main tool. This technique allows comparison considering groups, times or combinations, including those with other variables. It is especially useful when comparing at least 3 sets.

The p-value is used as a reference for decision, where p-values <0.05 indicate evidence of significant difference. Nevertheless, this test alone does not reveal the specific location of differences. A post-hoc test is required for this purpose.

In cases where all groups are compared with one another, the Tukey method is the post-hoc test of choice.

The Tukey test presents evidence of the comparison of every two groups. Among the existing groups, the reference adopted to assert the presence of significance is the p-value <0.05.

Results

Based on the patient selection criteria, a total of 255 would be eligible to take part in this study. Only 176 agreed to participate in the project by signing the ICF. However, only 130 patients completed the questionnaire correctly.

Of the participants, 33.8% were male and 66.2% female. The minimum age of the study is 18 years and the maximum 83, averaging 41.6. 50% of the people in this study are between 30 and 55 years of age (Table 1).

Regarding the level of education, 2.3% of subjects are illiterate, 0.8% have a master's degree, and the others are classified as either incomplete elementary/middle school education or complete higher education. Of the respondents, 32.8% are unemployed and 67.2% are employed.

All 130 patients had undergone surgical treatment on the foot or ankle. Of this total, 33.9% had undergone other surgeries in the past, while 66.1% had not (Table 2).

Regarding the minimum consultation time, the predominant time was 10 minutes, with 40% of respondents choosing this alternative. 32.8% answered 15 minutes and 15.2% identified the most appropriate minimum time for a medical consultation as 30 minutes. For the item "good medical consultation", it was noted that the sub-item "medical history + physical examination + radiographic testing" was the one with the highest percentage (42.7%). It is also noted in relation to this

Table 1. Descriptive analysis of Age

	N	Min	1st Quartile	Median	3rd Quartile	Max	Mean	SD
Age	130	18	30	39	55	83	41.63	15.83

Table 2. Quantitative analysis and percentage of patients who have undergone other surgeries

	Quantity (%)
Patient has already undergone other surgeries	
No	80 (66.1)
Yes	41 (33.9)

criterion that consultation in combination with a thorough physical examination was chosen by the lowest number of participants, only 6.5% (Table 3).

The predominant characteristic of a good physician was that of good outcomes, chosen by 31% of participants, followed by attentive chosen by 28.6%, and good surgeon by 27.6%. Respondents were able to choose more than one alternative for this criterion (Table 3).

Another characteristic observed in Table 3 is that 89% of patients do not conduct research on their physician. However, of those who do, 89.5% of patients use the Internet or social networks for this purpose.

According to the patients, in the context of the minimum number of surgeries that a foot and ankle specialist must have undertaken in order to properly perform their duties, Achilles tendon injury surgery corresponded to the highest number (mean of 14.31) while ankle prosthesis corresponded to the lowest number with a mean of 12.98.

Table 3. Quantitative analysis and percentage of characteristics of satisfaction and research on the quality of the physician

	Quantity (%)
Consider the orthopedic consultation good	
Medical history + physical examinations + radiography	53 (42.7)
Medical history + physical examinations + radiography+ tomography	37 (29.8)
Medical history + physical examinations + radiography+ tomography + magnetic resonance imaging	26 (21)
Medical history + suitable physical examinations	8 (6.5)
Minimum time considered satisfactory	
5 min	11 (8.8)
10 min	50 (40)
15 min	41 (32.8)
30 min	19 (15.2)
1 hour	4 (3.2)
Characteristics of a good physician	
Attentive	41 (28.3)
Good surgeon	40 (27.6)
Good outcomes	45 (31)
Third-party recommendation	4 (2.8)
Punctual	15 (10.3)
Conducted research on the physician	
No	89 (70.1)
Yes	38 (29.9)
Channels used to research physician	
Friends	4 (10.5)
Internet/social media	34 (89.5)

A comparison was made between the average score for each of the questions between the levels of education - in order to have a more relevant sample size, the levels of education were grouped. The ANOVA test was applied first and the p-value of this test is represented in the table below (Table 4). A significant difference was noted for the score relating to the surgeon's sex and resume.

Table 4. ANOVA comparison for Level of education in relation to scores awarded to most important factors in identifying an excellent surgeon

	Illiterate or Elementary/ Middle School Education	High School	Higher Education or Master's Degree	p-value
Name of college/ university/Medical Residency				0.337
Quantity	46	52	30	
Mean	5.28	5.27	6.27	
Deviation	2.9	3.21	3.63	
Age				0.123
Quantity	46	53	29	
Mean	4.11	3.34	2.62	
Deviation	3.44	2.91	2.8	
Hospital Reputation				0.249
Quantity	46	53	30	
Mean	5.65	5.83	6.73	
Deviation	2.77	2.97	2.84	
Years Professionally Active				0.798
Quantity	46	52	30	
Mean	3.89	4.25	3.83	
Deviation	3.06	3.31	3.11	
Sex				**0.018**
Quantity	46	53	30	
Mean	2.63	1.79	0.83	
Deviation	3.34	2.4	1.86	
Ethnicity				0.177
Quantity	46	53	30	
Mean	1.59	1.64	0.6	
Deviation	3.04	2.7	1.45	
Reputation				0.818
Quantity	45	52	30	
Mean	3.89	4.31	4.2	
Deviation	3.25	3.43	3.18	
Appearance				0.563
Quantity	46	53	30	
Mean	3.85	3.11	3.57	
Deviation	3.67	3.44	3.01	
Recommendation				0.839
Quantity	45	52	30	
Mean	4.96	5.21	5.4	
Deviation	3.44	3.3	2.87	
Resume				**0.002**
Quantity	46	53	30	
Mean	5.02	6.04	7.67	
Deviation	3.29	3.04	2.64	

The Tukey test was used afterwards to compare the levels of education in relation to the score given for the importance of the surgeon's sex. The greatest difference in this criterion was between "Higher Education or Master's Degree" compared to "Illiterate or Elementary/Middle School Education", with a mean difference of -1.8 (p-value = 0.014). On average the score of the first was 0.83 and the second 2.63, indicating that the higher the level of education, the lower the perception that sex interferes with the quality of the surgeon (Table 5).

Likewise, we have the comparison of the score awarded for the importance of the Resume in relation to the level of education; here again we observed a significant difference (p <0.001) between the most extreme levels of education. On average, people with a higher level of education assigned 2.64 points more than people with less education to the importance of the resume in being a good surgeon (Table 6).

Discussion

Patient satisfaction with their medical consultations is determined by characteristics and opinions, which are sometimes subjective. Yet the importance of these factors, however indirect, makes the difference between choosing physician "X" rather than physician "Y". But it is not just about the medical consultation. The patient's estimation of their physician, as well as their perception of the physician's behavior, are essential factors. What makes a doctor efficient and capable, according to the patients themselves? According to Little et al.[1] (2015), who evaluated medical behavior, a medical consultation with an attentive physician who provides information about the patient's condition, produces greater confidence in the physician. Concomitantly, in this particular study, it can be seen that the patient holds greater appreciation for a physician who requests additional tests to the detriment of a good anamnesis and physical examination. Approximately 92% of patients assessed need at least one imaging test to consider their recent consultation satisfactory.

It is a widely established fact that producing good outcomes, as well as being a good surgeon, are qualities both required and sought by patients. Good outcomes are necessary for the patient's discernment when considering a physician to be good or bad. However, it was also noted that, for about 40% of respondents, being attentive was one of the essential characteristics for the medical profession. According to Gulbrandsen et al. (2020)[2], a favorable atmosphere in a medical consultation, in conjunction with attentiveness and an appreciation of patients' complaints, leads to greater adherence to treatment in combination with better outcomes. Therefore, having a healthy doctor-patient relationship is essential. Moreover, the physician's attentiveness towards the patient produces greater adherence and also improves the patient's opinion of the specialist's image.

According to Turrentine et al. (2019)[3], in a patient's evaluation of the physician's gender - male or female - in gynecologists and obstetricians, it is evident that being a male physician, in this case, not only has a negative impact on outpatient volume, but also leads to a lack of faith or confidence in the medical protocol. In the same way, our study shows that, according to the level of education, the physician's gender and resume are important characteristics. In other words, more knowledgeable people with a higher level of education attach more weight to the quality of the physician and their resume. Comparatively, less knowledgeable people with a lower level of education attach more weight to the physician's gender - showing greater confidence in male physicians (p<0.001). Therefore, the difference between patient's levels of education and the factors that determine the choice of physician is noteworthy.

In this study, we also noted that few patients conducted any previous research on their physicians. Only 29.9% claim to have carried out some kind of research. Within this percentage, 89.5% conduct research on the Internet or social networks. These numbers may demonstrate a type of bias in the study. All patients who participated were part of the Brazilian Unified Health System (SUS), and were therefore either referred by the primary care division of health units, or for immediate tertiary care due to trauma related to their conditions. Therefore, no choice of specialist was made, as such.

The demand for medical specialists with super-specialties has increased over the years. For patients, simple attentiveness during a medical consultation already generates satisfaction and shows appreciation for the medical image. In addition to

Table 5. Tukey comparison for score assigned to importance of Sex in being an excellent surgeon in relation to the level of education of the respondent

	Mean (A)	Mean (B)	diff	p-value
High School-Illiterate or Elementary/Middle School Education	1.79	2.63	-0.84	0.269
Higher Education or Master's Degree-Illiterate or Elementary/ Middle School Education	0.83	2.63	-1.8	**0.014**
Higher Education or Master/s Degree-High School	0.83	1.79	-0.96	0.263

Table 6. Tukey comparison for score assigned to importance of the Resume in being an excellent surgeon in relation to the level of education of the respondent

	Mean (A)	Mean (B)	diff	p-value
High School-Illiterate or Elementary/Middle School Education	6.04	5.02	1.02	0.227
Higher Education or Master's Degree-Illiterate or Elementary/Middle School Education	7.67	5.02	2.64	**<0.001**
Higher Education or Master's Degree-High School High School	7.67	6.04	1.63	0.054

assessment and knowledge, a patient's interest in a physician is based on their own opinions and values that allow such a choice. Because the study was carried out in a tertiary referral hospital that caters exclusively to patients from the public health system, the interviewees did not appear to be sufficiently interested in their physicians to undertake research. However, this particular study demonstrated that consultations completed within 10 minutes on average, in combination with a request for at least one imaging test, highlight a particular specialist. Nonetheless, for this choice, it can be seen that more educated patients assign more weight to a physician's medical resume, unlike patients with a lower level of education, where the specialist's gender is a major distinguishing factor in this choice. Therefore, it is possible to observe that patients still face multiple barriers and variables, whether social or intellectual, in determining the choice of their physician.

Authors' contributions: Each author contributed individually and significantly to the development of this article: LAFM *(https://orcid.org/0000-0002-0861-9401) wrote the article, interpreted the results of the study, participated in the review process, approved the final version; BABM *(https://orcid.org/0000-0002-3244-5472) conceived and planned the activities that led to the study, participated in the review process, approved the final version; JLVS *(https://orcid.org/0000-0002-9038-2895) participated in the review process, approved the final version; EDS *(https://orcid.org/0000-0002-4238-8539) participated in the review process, approved the final version; EHB *(https://orcid.org/0000-0002-6547-8422 participated in the review process, approved the final version. *ORCID (Open Researcher and Contributor ID).

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Original Article

4-in-1 and 5-in-1 blocks in percutaneous forefoot surgery

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Abstract

Objective: To analyze the effectiveness of peripheral nerve blocks in the ankle in percutaneous forefoot surgery and their potential complications.

Methods: Retrospective study with a survey of the medical records of patients who underwent percutaneous orthopedic surgery on the forefoot between 2009 and 2015, performed by the orthopedic foot and ankle surgery group of our hospital, in which 4-in-1 and 5-in-1 anesthetic nerve blocks were used. We evaluated 239 cases, consisting of 222 female and 17 male subjects with a mean age of 61.2 years, seeking to observe the effectiveness and potential complications of the anesthetic technique.

Results: Complications were observed in 3.34% of the 239 patients, with seven cases of neuritis and one case of tachycardia. Regarding the anesthetic technique, there were nine cases of block failure (3.76%), with four cases requiring supplementary local anesthetic, one case spinal anesthesia, and four cases general anesthesia.

Conclusion: Having observed the low rate of complications and the almost complete success of 5-in-1 blocks in percutaneous forefoot surgery, we concluded that it is a safe and effective anesthetic technique.

Level of Evidence IV, Therapeutic Study; Case Series.

Keywords: Anesthesia; Nerve block; Peripheral nerves; Forefoot; Minimally invasive surgical procedures.

Introduction

In forefoot deformities, which can be corrected by percutaneous techniques, when surgical treatment is indicated, it is imperative to plan the surgical intervention carefully. The intention is to reduce surgery and anesthesia risks, since due to an aging population and a greater number of obese individuals, the incidence of comorbidities, especially those of a cardiovascular and pulmonary nature, is increasing[1-3].

In general, peripheral nerve blocks are very useful in urgent procedures (sharps injuries or removal of a foreign body). In the ankle, small volumes of local anesthetics in perineural regions promote analgesia and anesthesia over an extensive area, corresponding to the cutaneous topography of the nerve.[2] When applied to orthopedic forefoot surgery, they are also of practical interest, as they are relatively safe and easy to perform, when specific standards are followed. This technique avoids spinal and general anesthesia and has a lower operative and postoperative risk, especially in elderly patients or individuals with comorbidities[3].

The aim of this study was to analyze the effectiveness of peripheral nerve blocks in the ankle when performing percutaneous forefoot surgery and their potential complications.

Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate) number: 28597920.0.0000.5501.

Study performed at the Hospital Universitário de Taubaté, Taubaté, SP, Brazil.

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Retrospective study with survey of medical records of patients in which we indicated 5-in-1 anesthetic nerve block at ankle level, who underwent percutaneous orthopedic surgery on the forefoot between 2009 and 2015, performed by the orthopedic foot and ankle surgery group of our hospital and at a private clinic owned by one of the authors. We evaluated 239 patients, 222 of whom were female and 17 male, with a mean age of 61.2 years, a minimum age of 14 years and a maximum age of 84 years, seeking to observe the effectiveness and potential complications of the anesthetic technique and its adverse effects. For the anesthetic doses commonly administered in this study, there are no absolute contraindications for the use of this technique except for a history of hypersensitivity to one of its components. However, we emphasize the following relative contraindications: skin infections or wounds at the nerve block sites; patient's inability to cooperate during the procedure.

The anesthetic technique was used to perform percutaneous forefoot surgery, as follows: 185 cases of hallux valgus, seven cases of hallux rigidus, four cases of hallux valgus interphalangeus, 138 claw toes, 10 bunionettes, four cases of Morton's neuroma, one of Freiberg's disease, and 109 patients with metatarsalgia, distributed as follows (48 of the second metatarsal, 40 of the third, 25 of the fourth, and one of the fifth): 17 rheumatoid feet, five neurological feet, one case of shortening of the second and third toes and one case of digital callus. In those cases where we operated only on the first and second rays of the foot, we used a 4-in-1 block without sural nerve block. When the condition affected the third and/or fourth and/or fifth ray, we supplemented the anesthesia with sural nerve block, thereby performing a 5-in-1 block.

The anesthetics used for the blocks were 10ml of 2% lidocaine combined with 10ml of 7.5mg/ml ropivacaine, both without a vasoconstrictor, thus preventing complications arising from their use. The anesthetic infusion material consisted of a 5ml syringe attached to a long, thin, flexible needle with a 27Gx1.5" blunt tip. In the first 50 blocks we used a conventional 30x0.7mm needle.

All patients were prepared before the anesthetic procedure, placing them in the horizontal supine position, with the limb to be operated on extended over the operating table. The other limb was placed off the side of the operating table on a rest, keeping it at 90 degrees of knee flexion. From this point on, the surgical team performed a surgical skin prep on the foot and ankle, followed by asepsis and antisepsis, then marked the topography of the nerves to be blocked before administering the anesthetic drug infusion. Having established the effectiveness of the anesthesia, we commenced the surgery.

To identify specific nerve block landmarks we made use of previous anatomical knowledge and anatomical reference points inherent to the target nerve.

The tibial nerve block was performed after positioning the patient's ankle in external rotation, followed by palpation of the medial malleolus in the posteroinferior direction until the posterior tibial artery pulse was palpated, located 0.5 to 1cm posterior to the artery. The needle was then introduced at an angle of 45 degrees in the mediolateral plane, distributing the anesthetic in a fanwise manner (Figure 1).

To perform the deep fibular nerve block, we placed the patient's ankle in neutral position. First, we requested the patient to actively extend the toes. Then, we palpated the extensor hallucis longus and extensor digitorum longus. Locating the deep fibular nerve in the lateral part of the extensor hallucis longus, over the proximal segment of the first and second ray, the surgeon was able to palpate the dorsalis pedis artery of the neurovascular bundle (Figure 2) as a reference, and create a bleb of local anesthetic.

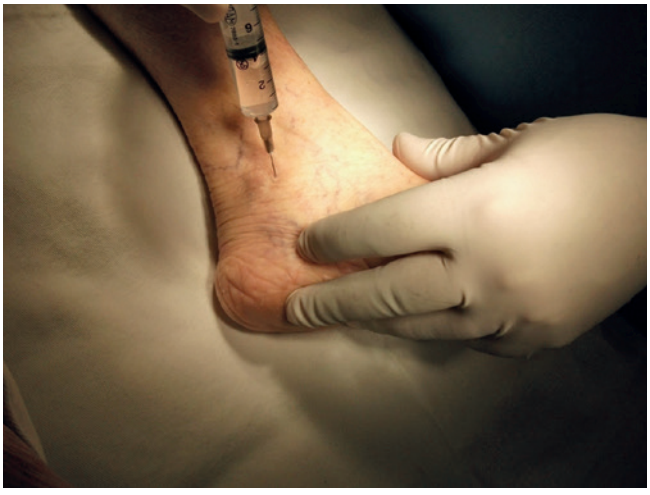

Figure 1. Site of posterior tibial nerve block in the medial retromalleolar region of the ankle.

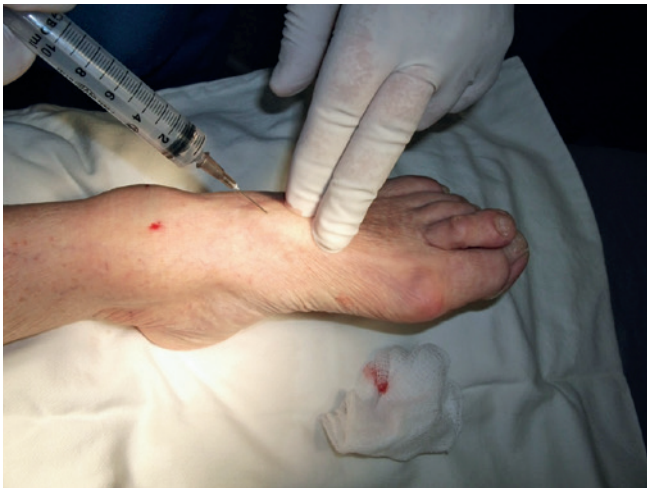

Figure 2. Site of deep fibular nerve block on the dorsum of the foot.

In order to identify the saphenous nerve block landmark, the patient's ankle was positioned in slight external rotation. We palpated the medial malleolus and the saphenous vein. We then inserted the needle about 1.5cm anterior and proximal to the medial malleolus in the direction of the anterior tibial tendon, forming a subcutaneous ring with the anesthetic solution between these reference points.

The superficial fibular nerve block was marked while positioning the patient's ankle in internal rotation, identifying an imaginary line joining the lateral to the medial malleolus. We identified the superficial fibular nerve between the lateral malleolus and the tibialis anterior. We inserted the needle in the region anterior to the lateral malleolus and proceeded towards the medial malleolus with infiltration, forming a subcutaneous ring up to 4cm from the medial malleolus (Figure 3).

The sural nerve block was performed using a bleb of local anesthetic, with internal rotation of the ankle, after marking and identifying a 1.5cm retromalleolar space lateral to the fibular tendons in the distal direction (Figure 4).

In all the blocks performed, aspiration was undertaken prior to infusion to avoid accidental intravenous infiltration. In cases where the patient reported an electric shock-like sensation when the needle was inserted, we retracted the needle 3 to 5mm and resumed the block procedure.

All surgeries started only after the patients confirmed the success of the anesthesia in the areas stimulated by the orthopedic team. In cases where insufficient anesthesia was observed, we combined other techniques such as reinforcement of the locoregional block, spinal anesthesia, or general anesthesia.

All participating patients were apprised of the objectives of the study and were asked to sign an informed consent form.

Results

In the 239 blocks performed, we observed eight cases of complications (3.34%), including seven cases of neuritis (six of the tibial nerve and one of the deep fibular nerve), which progressed to full recovery after the use of neuroprotectors. There was also one case of intraoperative tachycardia, promptly reversed by the anesthetist present. Of the seven cases in which traumatic neuritis occurred, we used conventional needles in five and blunt-tipped needles in two. We did not observe any complications such as infection, hemorrhage, or inadvertent intravascular infusion.

Regarding the anesthetic technique, the anesthesia was effective in 96.26% of the blocks, enabling us to perform the proposed surgical procedures. Failure of the anesthetic block only occurred in nine cases (3.76%), necessitating supplementation with local anesthetic in four cases, spinal anesthesia in one case, and general anesthesia in four cases.

Discussion

A number of recent authors advocate the percutaneous surgical approach to correct forefoot deformities, due to the good results shown with this technique[3-5].

Since the mean age of these patients is usually high (as shown in our sample: 61.2 years) and sometimes accompanied by comorbidities, peripheral nerve blocks of the ankle are a good option for interventions in these cases, due to the lower risks to the patient,[1-3] and as they are easy and safe to execute when the technique described in this study is respected.

Peripheral blocks are widely used for surgical anesthesia, as well as for postoperative analgesia[3]. There has been significant growth in the use of this technique in surgeries in

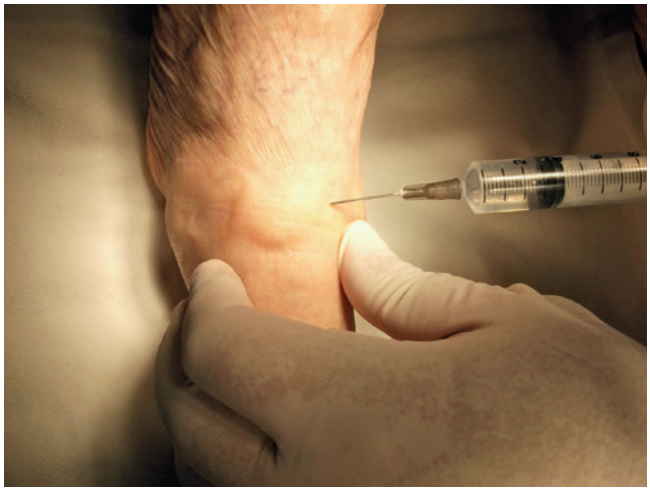

Figure 3. Site of superficial fibular and saphenous nerve block by means of anesthetic cord injection, in the anterior region of the ankle.

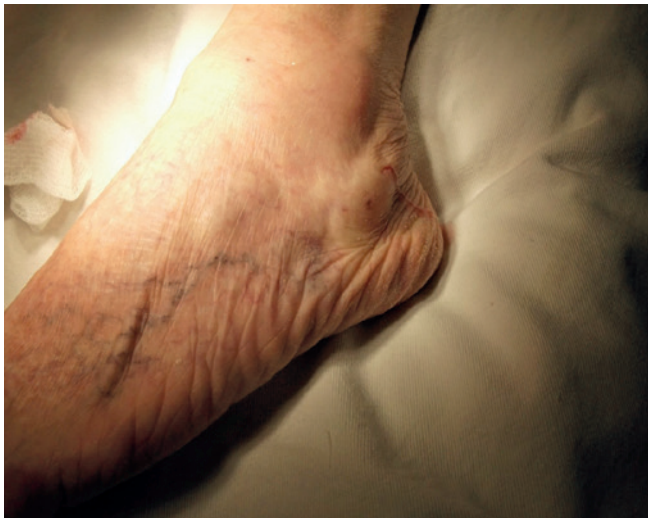

Figure 4. Site of saphenous nerve block in the lateral region of the ankle below the fibular tendons.

specific areas such as orthopedic, vascular, and dermatological procedures[6-8]. Nowadays, regional anesthesia in the lower limbs is considered preferable to general anesthesia. Postoperative recovery and length of stay are shorter, while hospital costs are lower[8].

Ultrasound/electrostimulation-guided peripheral nerve blocks, used alone or in combination, have gained popularity in the last decade due to their simplicity and precision, and particularly in the technological advancement of their portability. They are beneficial in settings where the nerves are deeply positioned. However, they do not substitute experience and knowledge of the relevant anatomy. In certain scenarios, ultrasound may not offer additional benefit, and a substantial amount of time may be spent attempting to find relevant structures, or the procedure may even provide a false sense of security, especially to an inexperienced operator[9]. In the hospital where we work, we do not have this resource in the surgical unit (ultrasound), hence all blocks were performed seeking the anatomical landmarks of the nerves to be blocked. On the other hand, ultrasound-guided anesthesia has several advantages compared to the conventional 5-in-1 block, including fewer needle punctures with the needles for infiltration, the need for a smaller volume of local anesthetic, less tissue distortion, and consequently a lower risk of systemic toxicity[2].

When compared to general anesthesia, its advantages are: absence of complications involving the airways, as these are not manipulated; fewer postoperative respiratory complications, as there is no mechanical ventilation, and a reduction in postoperative delirium, nausea, and vomiting[2]. In comparison to spinal anesthesia, the technique involves fewer hemodynamic complications (changes in blood pressure and/or heart rate) and neurological complications (neuritis), especially in patients with comorbidities[10].

Some of the disadvantages in comparison to the techniques used for truncal blocks of the ankle described in the literature are: long anesthetic latency time[1,10] (20min); the risk of inadvertent intravascular injection of anesthetic[1]; and the risk of nerve damage caused by the needle. Because it is a superficial and purely sensitive block, it allows the patient to move his/her foot, often hindering the procedure, even under sedation. The nerve block may be incomplete or ineffective in 5% of cases [2,11,12], requiring conversion to spinal anesthesia or general anesthesia in this situation.

We had 3.34% of complications. The seven cases of neuritis progressed with spontaneous resolution, treated only with simple analgesics and neuroprotective drugs. We must emphasize that five of these cases belong to the group of the first 50 patients, in whom we used a conventional 30x0.7mm needle rather than a flexible blunt needle. The percutaneous procedure proved difficult in a patient diagnosed with Parkinson's disease anesthetized with peripheral block, since tremors and involuntary movements did not cease.

The anesthetic technique was effective and the anesthesia was only insufficient in nine procedures (3.76%), which is lower than the percentage encountered in the study presented by Teixeira et al.[2] (5%). Supplementation with local anesthetic was required in four of these cases, conversion to spinal anesthesia in one case, and to general anesthesia in the other four. In one of the cases that switched to general anesthesia, after the patient regained consciousness, we noted that the previously blocked limb was anesthetized, perhaps as a result of the longer latency period presented by the drugs used.

As a limitation of this study, we observed a lack of control groups for a real comparison of the effectiveness of the anesthesia administered, as well as its risks and complications.

The low rate of complications and the success achieved in anesthesia in which we performed peripheral nerve blocks for percutaneous forefoot surgery, encourage us to maintain this anesthetic technique, as it is safe and easy to execute.

Conclusion

Peripheral nerve blocks used in percutaneous forefoot surgery have proven to be highly effective with low complication rates.

Authors' contributions: Each author contributed individually and significantly to the development of this article: CLO *(https://orcid.org/0000-0002-9723-5302) wrote the article, interpreted the results of the study, participated in the review process, approved the final version; LCATF *(https://orcid.org/0000-0002-0778-2506) interpreted the results of the study, participated in the review process, approved the final version; LCRL *(https://orcid.org/0000-0003-1158-2643) conceived and planned the activities that led to the study, wrote the article, participated in the review process, approved the final version; GLFC *(https://orcid.org/0000-0001-5470-8379) interpreted the results of the study, participated in the review process, approved the final version; RNF *(https://orcid.org/000-002-2103-1733) interpreted the results of the study, participated in the review process, approved the final version; LFL *(https://orcid.org/0000-0003-1048-7134) wrote the article, interpreted the results of the study, participated in the review process, approved the final version. *ORCID (Open Researcher and Contributor ID).

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Special Article

Study of the radiographic parameters of normal ankles: literature review and technical recommendations

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Abstract

Objective: The authors carried out a bibliographic search for the radiographic parameters used to determine tibiotalar joint alignment, and suggest a set of parameters that constitute the minimum radiographic evaluation sufficient for the proper assessment of tibiotalar alignment.

Methods: The search was conducted between May 2019 and January 2020 on the online platforms PudMed and Google Scholar with the following terms, used separately or jointly: "ankle arthritis, radiographic measurement, ankle alignment, alignment, anterior ankle instability, X-ray, and ankle injury".

Results: We selected twelve studies evaluating radiographic patterns of normal ankles, and identified a total of 15 radiographic measurements.

Conclusion: The authors believe that a minimum radiographic assessment of tibiotalar alignment should include the following parameters on the anteroposterior radiograph: the distal tibial articular angle, the talar tilt and talus center migration. On the lateral radiograph, it should include: lateral distal tibial angle and lateral talar station.

Level of Evidence V; Diagnostic Study; Expert Opinion.

Keywords: Ankle; Ankle joint; X-rays; Radiography; Arthritis.

Introduction

Joint degeneration is a condition that is detrimental to the quality of life and functionality of affected patients[1]. Among the lower limb joints, knee and hip ailments are well known and widely discussed in the literature. In contrast, ankle arthrosis, which corresponds to 6 to 13% of arthrosic processes, is studied infrequently, despite being just as limiting as knee and hip ailments, if not more so[2,3].

Ankle arthrosis can be primary or secondary. Primary or idiopathic causes are rare, and generally affect subjects over 40 years of age[4]. Secondary causes are more common and include post-traumatic conditions, dysplasia, inflammatory conditions, infections and hemophilia, yet trauma is the main cause of ankle arthrosis and is related to 70% of cases[1,4].

The treatment of ankle arthrosis includes conservative measures (drug and orthotic treatment), orthobiologic resources[5] and surgical procedures (joint debridement, arthrodiastases, supramalleolar osteotomies, en bloc autologous cartilage transplantation, total arthroplasty and ankle arthrodesis)[6-12]. Surgical treatment prognosis depends, among other factors, on the degree of joint damage, patient characteristics, and tibiotalar joint realignment[6]. In order to make the joint more closely resemble the anatomy of a normal ankle, the definition of radiographic parameters of normality is extremely important.

Study performed at the Hospital Israelita Albert Einstein, São Paulo, SP, Brazil.

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Ankle joint alignment parameters are based on clinical and radiographic aspects. Clinical evaluation detects ectoscopic changes in the long axis of the lower limb as a whole, allows the assessment of hindfoot positioning (varus or valgus) relative to the leg (normal calcaneal alignment with the leg rotates around 10° of valgus)[13], and allows the determination of the degree of joint mobility and possible dynamic misalignments.

The main limitation of clinical evaluation is its inability to accurately define the specific characteristics of bone deformities and classify joint misalignments, and even to define exactly which joint or joints participate in the deformity complex.

Radiographic goniometry is extremely important in the assessment of ankle deformities due to its precision in determining the angles that express the relationship between the distal tibia and the talus, besides changes in the actual distal articular surface of the tibia[6,7,13].

There are plenty of parameters for assessing tibiotalar joint alignment described in the literature, yet they are seldom used in clinical practice. The association between the use of these radiographic parameters in surgical corrections and good patient prognosis has already been demonstrated in the literature[8-10].

After a bibliographic search to collect the parameters of radiographic goniometry relative to normal ankles, the authors suggest the standardization and use of a minimum protocol of parameters, aimed at improving surgical outcomes in patients with ankle deformities.

The parameters used for the assessment of ankle alignment are based on upright anteroposterior and lateral radiographs, in which anatomical points are used as a reference to define lines and axes from which angles or distances will be measured[6,7].

Methods

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate) number: 18371319.0.0000.0071.

The authors carried out a bibliographic search of the radiographic parameters used to determine tibiotalar joint alignment. The study was conducted in a single department.

The search was conducted between May 2019 and January 2020 on the online platforms PudMed and Google Scholar with the following terms, used separately or jointly: "ankle arthritis, radiographic measurement, ankle alignment, alignment, anterior ankle instability, X-ray, and ankle injury".

The parameters mentioned in the literature for radiographic assessment of ankle alignment are:

1. Anteroposterior and/or internal oblique (mortise) views:

- Tibial articular angle[7];
- Angle between the medial malleolus and the long axis of the tibia[7];
- Talar tilt, Tibiotalar angle or Convergence angle of tibia and talus[7,13,14];
- Medial distal tibial angle[8, 14,15];
- Lateral distal tibial angle[14,16];
- Talocrural angle[14];
- Talus center migration[8].

2. Lateral View:

- Lateral distal tibial angle, anteroposterior distal tibial angle or Anterior distal tibial angle[7,8,14,16];
- Lateral talar station[11];
- Talar center of rotation relative to the anatomical axis of the tibia (TibCOR)[17];
- Angle between the long axis of the tibia and talus[11,14];
- Angle between posterior tibial line and the talus[11];
- Angle between the long axis of the tibia and the lateral process of the talus[11].

3. Saltzman View:

- Distance between the tibia and the calcaneus[13];
- Tibiocalcaneal angle[13];
- Line of convergence between the tibia and the talus[13];

Based on the ease of the measurements, the authors suggest a set of parameters that constitute the minimum radiographic evaluation sufficient for the proper assessment of tibiotalar alignment.

The recommendation was based on a study of parameters of normality of tibiotalar alignment, assessing 156 radiographic images of normal ankles, the subject of another study that will be published soon.

Results

We selected 12 studies assessing radiographic patterns of normal ankles, and identified a total of 15 possible radiographic measurements[6-17].

Discussion

Anteroposterior and lateral radiographs should be taken in compliance with the appropriate criteria for patient positioning, alignment of X-ray equipment, and film positioning, in order to conduct tests with ideal quality, without which the measurement becomes inefficient[15].

The authors indicate the following parameters as the ideal radiographic evaluation for determining tibiotalar alignment:

- In the anteroposterior view, the distal tibial articular angle, the talar tilt, and the talus center migration.

The long axis of the distal tibia in the anteroposterior view can be determined from the center of a circle that touches the medial and lateral cortices 10 cm proximal to the ankle joint, and the center of a second circle tangent to the 3 cortices of the distal tibial metaphysis, as shown by Ahn[8]. The line connecting both centers is the long axis of the tibia in the

anteroposterior view. We chose to evaluate the long axis of the distal tibia using this technique due to the better reproducibility and greater ease of execution.

The medial distal tibial articular angle in the coronal plane is determined by the measurement between the long axis of the tibia and the straight-line tangent to the distal tibial articular surface (Figure 1)[9]. The angle considered is medial to the long axis of the tibia[8,9].

This angle allows the assessment of the presence of medial or lateral tilt of the distal tibia and, when suggesting mechanical overload, can negatively influence the prognosis of surgical procedures[8,9].

The talar tilt angle is determined by the measurement between the straight line that touches the distal articular surface of the tibia, and another that touches the dorsal articular surface of the talus in the coronal plane (Figure 2)[9].

This parameter allows an adequate assessment of the presence of medial and lateral ankle instability in the arthrosic process[7], a situation that must be properly corrected.

Talus center migration is defined as the shortest distance between the center of the talus and the long axis of the tibia (Figure 3)[8,10]. Medial displacements are considered positive and lateral displacements negative[8].

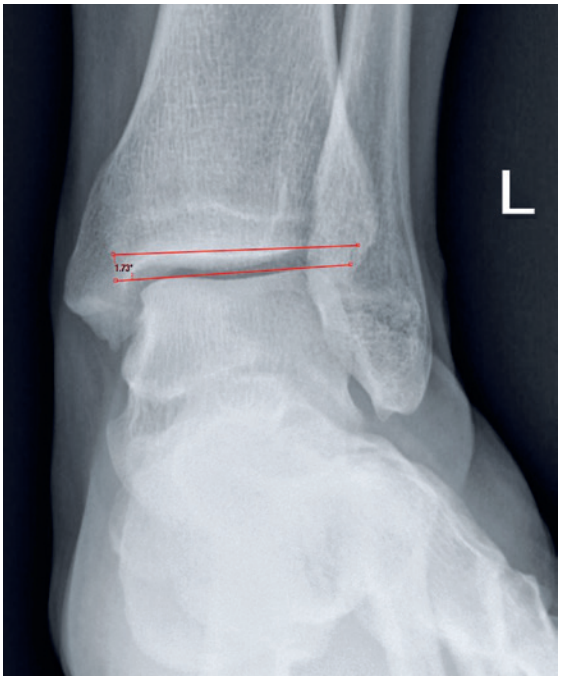

Figure 2. Talar tilt.

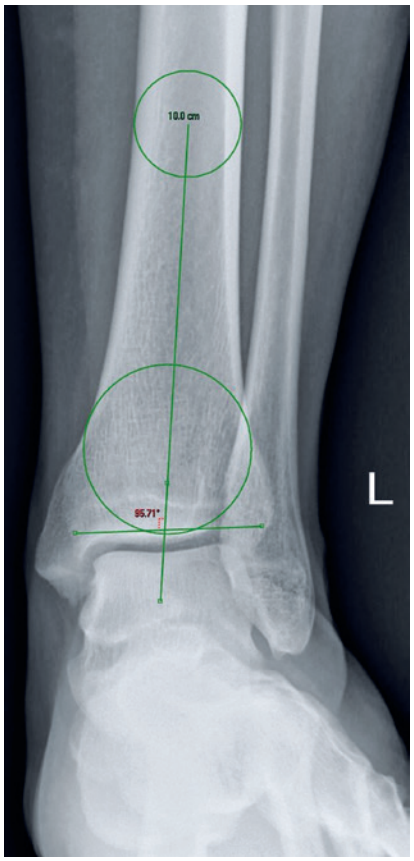

Figure 1. Distal tibial articular angle.

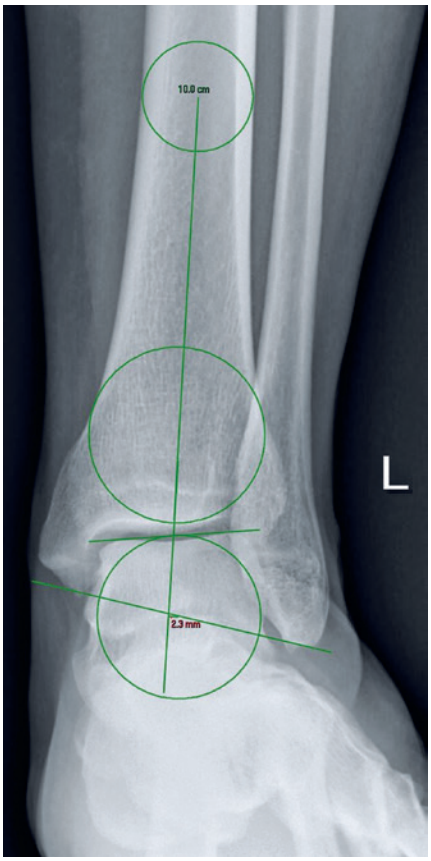

Figure 3. Talus center migration.

This measurement allows us to assess the presence of medial or lateral displacement of the talus within the malleolar pincer, usually associated with deviations secondary to fractures, or the presence of major ankle instabilities.

The center of the talus in the anteroposterior view corresponds to the center of a circle that touches the midpoint of the talar dome (which in the anteroposterior view is seen as a plateau), and at the same time coincides with one of the points that make up the straight line that touches both tibial and fibular malleoli from below[8,10].

- In lateral radiographs, the lateral distal tibial articular angle and the lateral talar station[11].

The long axis of the tibia in the lateral view can be determined by joining the center of a circle adjusted to the anterior and posterior tibial cortices, located 10cm above the ankle joint, and the center of a second circle, also adjusted to the anterior and posterior tibial cortices, 5cm above the ankle joint[11].

The lateral distal tibial articular angle is formed between the long axis of the tibia and the articular surface of the distal tibia[7], which is determined by a line tangent to the articular surface in the lateral view (Figure 4).

This angle allows us to assess the presence of anterior or posterior deviations of the distal tibia joint related to vicious fracture consolidations, post-fracture sinking of articular surfaces, or the presence of a more severe degenerative disease.

The lateral talar station is defined as the distance measured perpendicularly between the line of the long axis of the tibia and the center of rotation of the talus. The center of rotation is defined as the center of a circle adjusted to the talar dome (Figure 5)[11]. Anterior displacements to the long axis of the tibia are considered positive values, while posterior displacements are deemed negative[11].

This distance is useful in the assessment of anterior or posterior talar displacements within the malleolar pincer.

Conclusion

The authors believe that a minimum radiographic evaluation of tibiotalar alignment should include the following parameters:

- In anteroposterior radiography: distal tibial articular angle, talar tilt and talus center migration;
- In lateral radiography: lateral distal tibial articular angle and lateral talar station.

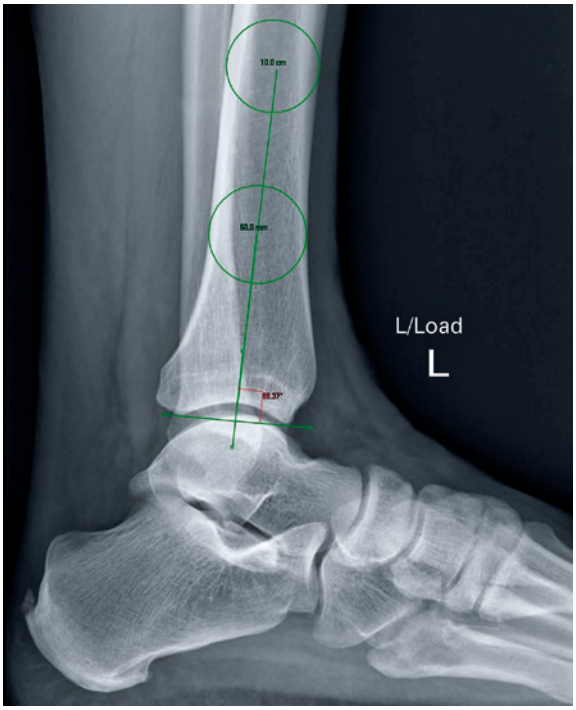

Figure 4. Lateral distal tibial articular angle.

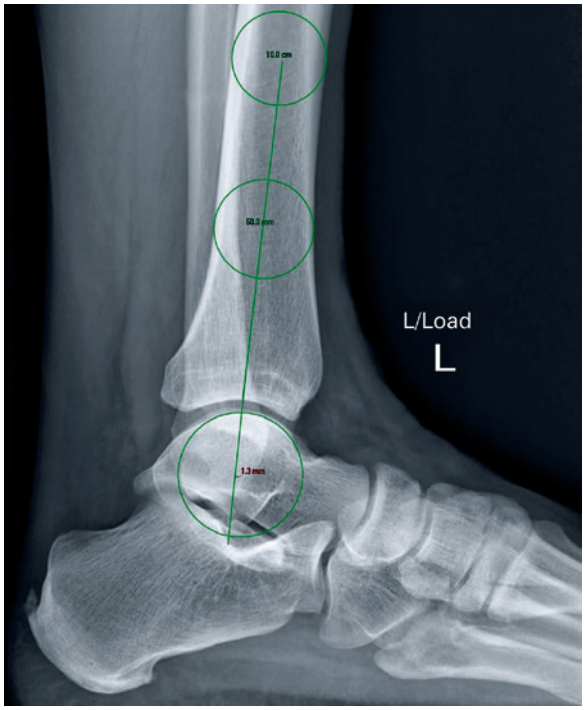

Figure 5. Lateral talar station.

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Special Article

Total ankle arthroplasty in Brazil. Current aspects and future prospects

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Abstract

Total ankle arthroplasty as a surgical treatment option for end-stage ankle osteoarthrosis has gained increasing prominence, especially in countries such as Brazil, where the technique is not yet widely disseminated due to various factors.

Level of Evidence V; Therapeutic Study; Expert Opinion.

Keywords: Ankle injuries/complications; Osteoarthritis/epidemiology; Arthroplasty, replacement, Ankle/epidemiology; Arthrodesis.

Introduction

Total ankle arthroplasty (TAA) for the treatment of end-stage ankle osteoarthrosis (AOA) is well established. According to recent studies, there is currently no gold standard for the treatment of end-stage AOA[1-3], which represents around 1% of ankle pain symptoms in the adult population[4]. Several systematic review studies published recently demonstrate that, in addition to reducing pain and improving ankle range of motion, TAA has a survival rate of around 84% at 10 years of follow-up[1], especially in countries where arthroplasty is already widespread. Accordingly, both tibiotarsal arthrodesis and total ankle arthroplasty (TAA) are options, with good results, for the surgical treatment of AOA[5]. It is true that many issues still need to be resolved and are being studied, with these countries facing the current challenge of achieving social approval of total ankle arthroplasty.

The aim of this article is to carry out an updated review on total ankle arthroplasty in Brazil, reviewing some basic aspects and the main guidelines for the execution and consolidation of the technique.

In mid-2005, as a result of an alliance between two important foot and ankle departments in the state of São Paulo (Universidade de São Paulo and Escola Paulista de Medicina), a series of ten cases were conducted with the Hintegra® prosthesis (Newdeal-France), with an average follow-up of four years until the publication of results in 2015[6]. Despite the good functional outcomes achieved, minor and major complications were recorded in 80% of subjects in the study[6]. At the time, arthrodesis was the gold standard for treating ankle osteoarthrosis in Brazil, with acceptable results in the medium term[7], despite the high rate of complications and degeneration of adjacent joints observed in long-term studies[5]. Therefore, many Brazilian orthopedists maintained ankle arthrodesis as the first treatment option for AOA. In addition, as the authors themselves mention in the study, the high cost of implants, the lack of training centers in the country, which makes it difficult to transpose the natural learning curve that the technique requires, around 50 cases, among other factors, meant the prosthesis ceased to be a viable option for the surgical treatment of AOA in Brazil.

Nevertheless, in the following years, some orthopedic surgeons in Brazil sought to improve this technique in other countries, managing to perform it in their respective hospitals, which were mostly private. Brazil does not have a single disease reporting center and procedures like some countries, such as England and Canada, nor does it have certification centers for performing the technique, as in the United States

Study performed at the Hospital das Clínicas, Faculdade de Medicina de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto, SP, Brazil.

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and some European countries. Through information obtained from prosthesis manufacturers and distributors, at present Anvisa (Brazilian National Health Surveillance Agency) has granted authorization for the marketing of four types of prosthesis in Brazil:

Inbone II: (Wright Medical Technology - United States, Anvisa registration: 80491360042), Infinity: (Wright Medical Technology - United States, Anvisa registration: 80491360071), Taric: (Implantcast - Hamburg, Germany, Anvisa registration: 80454380015), and Zenith: (Corin, Cirencester, United Kingdom, Anvisa registration: 80012450017).

According to information from manufacturers, from 2005 to 2020, no more than 500 total ankle arthroplasties were performed in Brazil.

To enable us to transform the history of the ankle prosthesis into a reality in Brazil, certain precautions, such as the correct selection of patients, implant and location (adequate infrastructure), and especially medical staff training, are essential.

Patient assessment and selection

Thus, the first step is a good preoperative assessment of the candidate for total ankle arthroplasty. The patient's clinical evaluation begins with an examination of the alignment of the entire limb, followed by foot/hindfoot with the patient standing, sitting, and walking. Hindfoot alignment is essential to determine whether the hindfoot is in neutral position, or if there is any varus or valgus deformity that must be corrected in the same surgical procedure. Joint stability also needs to be considered, conducting stress and anterior drawer tests, determining the concomitant need for ligament releases or reconstructions. The assessment of pain in other joints and of mobility, especially of the subtalar joint, must be documented. Ankle range of motion should be assessed at the end, with maximum plantar flexion (around 30-35 degrees) and maximum dorsiflexion (around 10-15 degrees). It is known that an ankle range of motion (ROM) of around 25 degrees is required for activities of daily living, while a ROM of around 37 degrees is necessary for walking on sloping floors, climbing or descending stairs[8]. The decrease in dorsiflexion can usually be related to a bone block or shortening of the triceps surae complex, which may be lengthened during the surgery.

A radiological evaluation protocol must be requested next, including: conventional weight-bearing foot and ankle radiographs (AP, true AP and lateral ankle; AP, lateral foot), in addition to the Saltzman view, to determine inframalleolar and hindfoot alignment. Alignment of the distal part of the tibia and the tibiotarsal joint in the coronal plane must be measured through the distal tibial angle. The normal angle in the sagittal plane, formed by the long axis of the tibia and the joint line, is 80° +/- 3°. An increase or decrease means recurvatum or antecurvatum, respectively. In the coronal plane, the tibiotalar angle is 89° +/- 3°, with an increase or decrease signifying valgus or varus deformity, respectively. The request for tomography and magnetic resonance imaging is optional, and can provide additional information on the articular part (subchondral cysts and bone quality) and ligament (Figure 1).

Correct patient selection, especially for surgeons who are starting their learning curve, is essential to avoid poor outcomes. The ideal patients for beginners are those with degenerative ankle arthrosis, older than 65 years, who have not responded to conservative treatment, with good bone quality, good soft tissue conditions, neutral alignment of the joint, good stability, and some degree of ankle mobility (Figure 2). In this initial phase, surgeons should avoid operating on patients with a severe ankle deformity, such as varus or valgus greater than 10 degrees, or even severe foot deformities, such as severe pes planovalgus or pes cavus, which require surgical correction; obese patients or smokers; patients with poor bone quality due to routine use of corticosteroids, or even patients who engage in high-level sports activities, as the rates of complication in these patients, particularly aseptic loosening of the implants, are high[9]. Cases of primary or degenerative arthrosis are usually present in older patients (over 65 years), affecting the hips and knees more than the ankle itself. Post-traumatic arthrosis, on the other

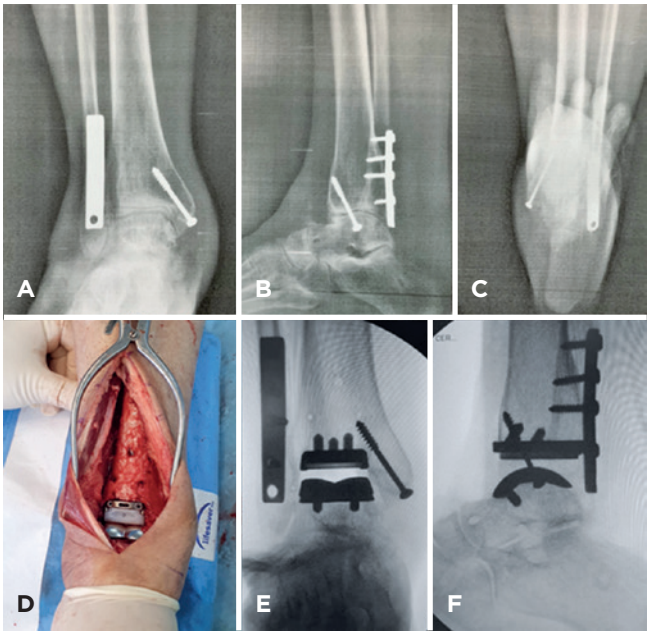

Figure 1. "Ideal case". 63-year-old patient, five years after osteosynthesis of the right ankle, ankle arthrosis with dorsiflexion block, without comorbidities. A. AP ankle radiograph showing a reduction in ankle joint space and good alignment in the coronal plane; B: Lateral ankle radiograph showing ankle arthrosis, the presence of an anterior osteophyte with dorsiflexion block. C. Saltzman radiograph showing good hindfoot alignment. D: Intraoperative image after implantation of the ankle prosthesis (Infinity®). D. Fluoroscope image in AP view of the ankle with good implant alignment and restoration of the joint line. E and F. Fluoroscope image in lateral view of the ankle with good implant alignment and positioning.

hand, is more prevalent in the ankles of young patients (under 50 years of age), where implant longevity is a factor to be weighed, since these patients are more active and tend to experience more "wear and tear" of the implants, with a higher revision rate.[1] However, Demetracopoulos et al.[10] not only found similar rates among young and elderly patients undergoing TAA, but also verified that young patients, under 55 years of age, coped with the revision better than older patients, probably due to the improvement in quality of life conferred by arthroplasty, as suggested by the study.

In addition to the factors commented on for correct patient selection, there are also absolute contraindications[1], which include cases with acute or chronic infection, with or without osteomyelitis, extensive talar osteonecrosis (greater than one third), neuromuscular disorders, neuroarthropathies (e.g., Charcot foot), and patients with ligament instabilities or deformities that cannot be corrected intraoperatively. In these cases, ankle arthrodesis should be suggested.

Choice of implant

Once the patient has been properly assessed and arthroplasty indicated, the choice of implant is the next step. As already mentioned, in Brazil there are four implant options, of which two are mobile-bearing implants (Taric® and Zenith®), or considered three-component implants (tibial component, talar component, and polyethylene), and two are fixed-bearing implants (Inbone II® and Infinity®), in which the polyethylene is fixed to the tibial component. Of these, only Inbone II has a modular intramedullary nail in the tibial component, and the talar component is of the flat type, different from the others, where the talar component is of the resurfacing type, i.e., follows the curvature of the talar domes. The Inbone II prosthesis is more constricted than the others and can be used in some primary prosthesis revision cases and in poor bone quality cases. According to Nunley et al.[11], there are no differences in functional outcomes or implant survival rates with respect to polyethylene mobility or lack of mobility. In this level I study, reoperations were more frequent with mobile-bearing implants, used more often for treating minor complications, such as removing the impact or treating cysts, than for replacing the implant.

Infrastructure and surgical technique

Some points concerning the hospital infrastructure and surgical technique are important. In addition to standard and desirable care for all orthopedic procedures, such as antibiotic prophylaxis, some points are essential to avoid post-arthroplasty infection, which, although widely published, is not yet well established, and may vary from 2 to 14%[12]. Accordingly, measures must begin with the preparation and correct selection of the patient, preoperative planning and training of the entire surgical team (doctors, nurses and technicians). A step-by-step review with all team members before the start of the procedure, in addition to increasing involvement, also makes it easier to obtain images and, consequently, carry out the procedure. The use of disposable surgical gowns and ventilated protective devices for face protection are desirable, as they prevent contamination of the medical team and of the surgical field. Regarding the surgical technique, all prosthetic options available in Brazil are to be implanted through an anterior approach, with the posterior approach reserved for some exceptional cases. In this anterior approach the surgeon must identity and repair the superficial fibular nerve, and enter the gap between the extensor hallucis longus tendon and the anterior tibial tendon, avoiding opening the sheath of the latter. In the deep plane, the neurovascular pedicle must be identified and detached laterally, together with the extensor tendons (Figure 3).

The articular capsule must be incised longitudinally and preserved for closure after the procedure. The entire joint must be visualized, with good exposure of the medial malleolus and about 8cm from the distal third of the tibia (Figure 3).

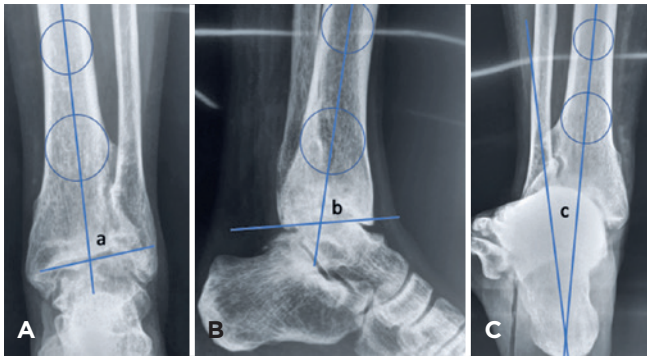

Figure 2. Preoperative radiographic evaluation. A. AP ankle radiograph with measurement of the tibiotalar angle. B. Lateral ankle radiograph with measurement of the distal tibial angle, slope. C. Radiograph in Saltzman view with measurement of the tibial angle with the long axis of the calcaneus. Note: Radiographs should preferably be taken under weight-bearing conditions.

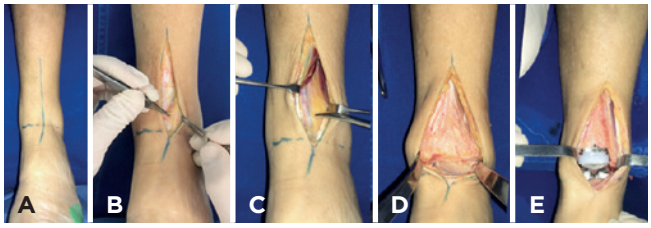

Figure 3. Anterior approach. A. Marking of the anterior approach on the ankle measuring approximately 10 cm across the joint line. B. Identification of the superficial fibular nerve. C. Deep plane with identification of the neurovascular pedicle. D. Exposure of the entire joint with good visualization of the joint and medial malleolus. E. Image showing the implants (Inbone II®).

The correct positioning of the image intensifier device, with the ankle always placed in the center of the screen, either in AP or lateral view, facilitates the correct positioning of the cutting guides and consequently, the correct sizing and positioning of the implants. At the end, joint stability and range of motion must be assessed, and additional procedures undertaken to ensure neutral hindfoot alignment, joint stability, and a functional range of motion, with at least 10-15 degrees of dorsiflexion and 20-30 degrees of plantar flexion of the ankle. A suction drain is not normally used. The articular capsule, the extensor retinacula, and the dorsal fascia, must be sutured with separate stitches. Subcutaneous layer and skin are closed carefully to avoid trauma to the skin. A bulky dressing is applied together with a plaster cast splint, keeping the ankle at 90 degrees.

Postoperative period and follow-up

In the postoperative period, most authors recommend immobilization of the limb for six weeks, with the main purpose of protecting soft tissues and achieving implant-bone integration. Walking can be encouraged with the use of two crutches with partial weight-bearing on the operated limb, and with the use of a walking boot. After the stitches are removed, which should occur after approximately three weeks, some degree of assisted passive mobility should be initiated. Antithrombotic agents are administered during the immobilization period[13]. Once the first six weeks have elapsed, the patient undergoes a clinical and radiological examination (Figure 4). Depending on the patient's progress, a more intense physiotherapy program is instituted for the following purposes: encouraging the patient to walk, gradual increase in weight-bearing, proprioception exercises, gain in active and passive ankle mobility with stretching and strengthening of the sural triceps, in addition to measures to reduce lymphedema, such as lymphatic drainage and daytime use of compression stockings. The resumption of low-impact physical activities such as walking, swimming and cycling, is encouraged soon after the patient starts full weight-bearing without the help of crutches or use of a walking boot. According to the most recent studies, total ankle arthroplasty promotes an increase in ankle range of motion when compared to the preoperative period, which is more evident one year after surgery[14]. The development of new physiotherapy protocols, with an earlier start of activities and a better follow-up of these patients in the postoperative period, will probably promote the maintenance of the degrees of movement achieved during the surgery, but which is often lost in the first postoperative weeks[14].

Clinical and radiological reevaluations are performed at 3, 6 and 12 months after surgery and annually thereafter. Careful observation of the maintenance of implant positioning in subsequent radiographs, formation of subchondral bone cysts, radiolucent lines around the tibial and talar components, fractures due to malleolar insufficiency, presence of heterotopic ossification or osseous impact in the gutters, must be investigated and combined with the patient's clinical evaluation at each return visit. The decision to undertake revision surgery must be taken early, always with an attempt at prosthesis salvage[15]. According to recent studies, TAA survival rates range from 70-90% at 10 years[1], with variations related to the learning curve and the design of some implants[16].

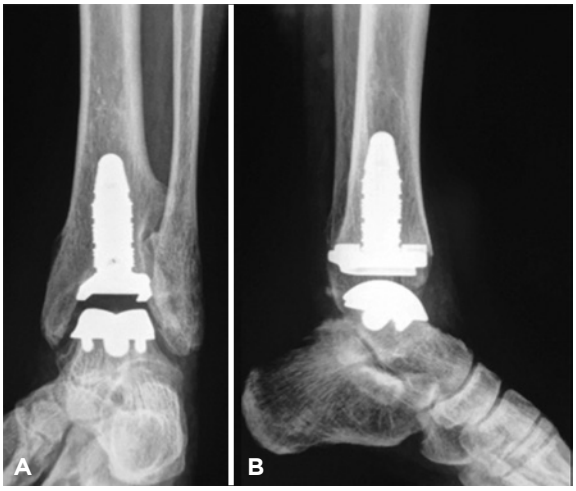

Figure 4. Radiographs six weeks after TAA surgery (Inbone II®). A. AP non-weight-bearing ankle radiography showing good implant alignment and positioning, in addition to the free spaces in the medial and lateral gutters. B. Lateral ankle radiograph with good implant alignment and positioning.

Final message

Currently, there is no gold standard for the treatment of end-stage ankle osteoarthrosis. Treatment options that promote pain reduction, reestablish function and improve patients' quality of life will be increasingly sought after by physicians and patients. Correct patient/implant selection and the physician's self-assessment to undertake total ankle arthroplasty in an appropriate hospital setting, will make it easier for this technique to "mature" in a safe and responsible way in Brazil, to achieve social approval, and to produce results similar to those of countries where its use is already widespread.

Acknowledgements

Leap of faith!

Leaving my academic, professional, family and social life behind to spend one year in New York City was a tough decision for a 45-year-old orthopedic foot and ankle surgeon. Even knowing that I would be spending a year at the best and most reputable orthopedic hospital in the world (HSS), I was terrified and reluctant to face the challenge.

Now back in my beloved Ribeirao Preto, I am able to realize just how fantastic and unique that opportunity was. I had the chance to learn the details of multiple total ankle replace-

ment implants and techniques from the experts. Constantine Demetracopoulos, Jonathan Deland, Scott Ellis, please accept my heartfelt gratitude for the invaluable opportunity and the intense and profound training. Thanks to you, I now feel more confident and prepared to apply what I have learned for the good of Brazilian patients with end-stage ankle arthritis.

I would strongly recommend international experiences to all my colleagues, even for old dogs like me. We can definitely learn new tricks!

During this very critical period of the COVID-19 pandemic throughout the world, but especially in New York City, my thoughts go out to you New Yorkers, who so warmly welcomed me last year.

Thanks again for everything and take care!

Authors' contributions: Each author contributed individually and significantly to the development of this article: RC *(https://orcid.org/0000-0003-3199-4055) conceived and planned the activities that led to the study, wrote the article, interpreted the results of the study, data collection, bibliographic review. *ORCID (Open Researcher and Contributor ID) .

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Special Article

Impact of chronic plantar fasciitis on work-related activity: a literature review

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Abstract

Objective: Compare the real need for rest of chronic plantar fasciitis patients with the leave of absence time and criteria used by national and international technical medical expert examination manuals.

Methods: We conducted a review of the medical literature from 2013 to 2018, selecting only randomized controlled clinical trials on the treatment of chronic plantar fasciitis. National and international medical expert examination manuals were also selected. The treatment time for chronic plantar fasciitis was then compared with the leave of absence time recommended by the manuals.

Results: Of the six articles selected, we ascertained that three articles evaluating second-line treatment managed to reduce the VAS by 60% after 4 weeks, one after 3 months, one after 6 months, and one that showed no improvement at all. In all studies, no control group receiving first-line treatment alone achieved a 60% reduction in the VAS during the follow-up period. The evaluated manuals recommend leave from work ranging from zero to 21 days, with only two using the criterion of the type of work performed by the employee for the expert decision.

Conclusion: We observed that none of the medical expert examination manuals provides support for the medical expert to grant leave to workers with chronic plantar fasciitis from their work-related activities to receive secondary treatment for at least four weeks. In addition, stratification by acute or chronic disease is not observed. Two manuals scale leave time by type of activity.

Level of Evidence III; Economic and Decision Analyses; Analyses Based on Limited Costs and Alternatives.

Keywords: Fasciitis, plantar; Occupational diseases; Social security.

Introduction

Pain in the area of the heel is one of the main reasons workers seek appointments with orthopedists in emergency rooms and outpatient clinics. Among the various diseases related to this symptom, such as Achilles tendinopathy, tarsal tunnel syndrome and plantar fascia ruptures, the most common is plantar fasciitis[1,2].

Plantar fasciitis is defined as an inflammatory and degenerative disorder located in the proximal region of the central band of the plantar fascia[1,3,4]. Studies deduce that it affects approximately one million Americans every year, accounting for 1% of all orthopedic appointments in the United States (US), at an annual cost of 192 to 376 million dollars[2-6].

Of as yet unknown etiology, plantar fasciitis is believed to be multifactorial, and is more common in elite runners and workers who spend long periods standing, such as guards, nurses and postmen. The main risk factors are being female and/or aged between 40 and 60, limitation of ankle dorsiflexion and obesity[1,3,7,8].

Study performed at the Lab. Prof. Manlio Mario Marco Napoli, Instituto de Ortopedia e Traumatologia, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo, SP, Brazil.

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The diagnosis is usually clinical, with typical symptoms being pain in the plantar region of the heel, which is more intense in the morning when starting to walk and improves when starting a particular activity, such as walking[9,10]. First-line conservative treatment is based on rest, cryotherapy, insoles, non-steroidal anti-inflammatory drugs (NSAIDs), stretching exercises, myofascial releases, and others[7,11-13].

This treatment is satisfactory in 90% of people diagnosed with plantar fasciitis[14]. However, the rest of those undergoing first-line conservative treatment who progress with little or no improvement after two months, are diagnosed with chronic plantar fasciitis[15]. Among other reasons, this fact is associated with the delay in treatment initiation, obesity, and bilateral foot involvement[16].

In this phase, the recommended treatment is the maintenance of analgesics, insoles, more suitable shoes and stretching exercises combined with second-line treatment, such as infiltrations, shockwave therapy, needling, low-level laser therapy, ultrasound, and others[14,17-20].

Patients refractory to conservative treatment for more than six months may require surgical treatment, such as plantar fascia release or gastrocnemius lengthening[21-23].

Company employees who remain standing for long periods of time during their workday often develop chronic plantar fasciitis, since they are generally people with restricted access to health services who wear inappropriate shoes at work. Because chronic plantar fasciitis causes pain that is hard to manage, with a detrimental effect on the employee's work activity, this fasciopathy generates a high rate of absenteeism[24].

Temporary leave of absence is requested in order to improve a worker's quality of life and provide them with more effective treatment. However, disability allowance is often denied[25].

According to Brazilian legislation, once the grace period has elapsed, all employees who pay social security contributions to the National Institute of Social Security (INSS) and are up to date with their payments are entitled to disability allowance/sick pay for the treatment of their medical conditions, subject to proof from the medical expert of the INSS unit responsible for their case.

As the risk factors for plantar fasciitis are not well known and the condition requires long-term treatment, INSS experts do not usually classify the individual with plantar fasciitis who is undergoing the examination as unable to work. This prompts the employee to resume his duties, with reduced work capacity.

With the intention of providing experts with guidance on the necessary treatment time for a wide variety of medical conditions, i.e., duration of leave of absence from work of a particular individual undergoing examination, governments of several countries draw up technical manuals for experts at their social security entities.

The purpose of this study is to evaluate the duration of chronic plantar fasciitis treatment instituted by the various means described in the orthopedic literature, and to compare them with the technical manuals of social security experts.

Methods

This is a literature review study where we will be analyzing information about time to improvement of pain in the treatment of chronic plantar fasciitis.

Therefore we used the Pubmed database, and carried out the advanced search according to the descriptor (MESH) *fasciitis, plantar*. After this first selection, we used the advanced search tool of the Pubmed platform to select only randomized controlled clinical trials published in the last five years. These articles were evaluated individually, excluding those that did not fulfill the inclusion and exclusion criteria.

As inclusion criteria, we chose only randomized controlled clinical trials, with publication date in the last five years (2013 to 2018), follow-up time greater than or equal to three months, in patients with a clinical diagnosis of chronic plantar fasciitis, such as pain in the plantar region of the calcaneus, in which the pain starts in greater intensity when the patient stops resting and stands upright, progressing with partial improvement after walking. As criteria for the term chronic plantar fasciitis, we used patients refractory to first-line conservative treatment, such as analgesics, anti-inflammatory drugs, insoles and stretching exercises for at least eight weeks.

As exclusion criteria, we excluded retrospective, cross-sectional and observational articles and pilot studies. Non-randomized uncontrolled articles and articles with patients undergoing surgical treatment were not accepted either.

In those studies that met the inclusion and exclusion criteria, we collected information such as: sample size, disease duration, type of randomization, follow-up time and time to improvement of pain in the intervention and control group. As a parameter of time to improvement of pain, we decided to use the target of the time needed to reduce the initial Visual Analog Scale (VAS) score by 60%[26-28].

A search for national and international technical medical expert examination manuals was carried out simultaneously. These manuals contain suggestions on the average time of disability/sick leave, helping experts decide on the time needed to treat a particular condition in the person under examination.

Those data were compared with national and international technical medical expert examination manuals in order to correlate the time needed to treat the chronic plantar fasciitis patient to the leave of absence time recommended by the current manuals.

Results

We accessed the Pubmed database, performed an advanced search based on the descriptor (MESH) *fasciitis, plantar*, and found 728 articles which, after being filtered through the advanced options of the research platform, were narrowed down to randomized controlled trials published in the last 5 years (2013-2018), totaling 56 articles.

After this process, the 56 articles were analyzed individually. Of these, six fulfilled the inclusion and exclusion criteria. These

articles record 536 feet diagnosed with chronic plantar fasciitis. The follow-up time was three months to two years.

As an add-on therapy to first-line treatment, the studies used shockwave therapy, infiltrations with corticosteroids, platelet-rich plasma (PRP), polydeoxyribonucleotide (PDRN) or autologous conditioned plasma in the topography of the calcaneal insertion of the plantar fascia.

Among the manuals used to assess leave of absence time, we used the following: Manual de Procedimento de Perícias Médicas (UNESP – BRAZIL), Disability Duration Guidelines (WCB - US), Return to Work & Disability Duration Guideline (US) and Tiempos Estándar de Incapacidad Temporal (INSS – SPAIN).

Discussion

Plantar fasciitis is the most common cause of heel pain in adults, leading to reduced work capacity of employees worldwide[29], and is responsible for 10-15% of foot-related symptoms[14]. The increase in sedentary habits in the global population, associated with weight gain and aging, may contribute to an increase in the prevalence of plantar fasciitis, since obesity and age between 40 and 60 years are known risk factors[3]. In addition, many occupations require workers to remain standing for long periods, thus adding risk factors for the development of plantar fasciitis.

It is widely known that the conservative treatment of plantar fasciitis is satisfactory in most cases[30], yet a small portion of these progress to chronic plantar fasciitis. The rehabilitation of these patients is often difficult, as pain generates dissatisfaction and changes in medical staff in search of other therapies. There is also an increase in the cost of treatment due to the need to perform more expensive procedures, such as shockwave therapy, infiltrations, laser treatments, and others. The number of work absences rises as a result of this problem.

Although studies claim that plantar fasciitis is a self-limiting condition that resolves without intervention in approximately one year, some people remain symptomatic for longer. Ibrahim et al.[23], in a prospective, randomized, placebo-controlled study, monitored 47 patients with chronic plantar fasciitis, diagnosed at least six months previously and refractory to first-line conservative treatment, for two years. Persistent pain was observed in their control group, with an average score of 5.6 points on the VAS scale at the end of their work. The other articles analyzed in this study, despite having a shorter follow-up time, show similar data[16,28,31-33]. This shows the relevance of plantar fasciitis in a worker's life, making it difficult for them carry out their work activities, especially those workers who need to remain standing for long hours during their workday.

The therapeutic approach to chronic plantar fasciitis is based on maintaining first-line treatment in combination with more invasive procedures. A multicenter therapeutic study followed up 146 patients with this condition for three months, during which time half of the sample underwent shockwave therapy and the rest of the participants received placebo treatment. A statistically significant reduction in the VAS score was observed in 69% of patients undergoing the procedure, as compared to only 35% of the control group[28]. Ibrahim et al.[23] observed a more substantial reduction in pain among patients undergoing shockwave therapy in their sample, with a mean VAS score of 8.52 prior to the procedure, dropping to a mean of 0.64 after four weeks, and remaining at low levels throughout the two-year follow-up period (Table 1).

Table 1. Results of randomized controlled trials

Author	Year	Sample size	Follow-up time (weeks)	Groups	Time for 60% reduction of VAS (weeks)
Ibrahim et al.[23]	2017	50	104	Shockwave therapy	4
				Placebo	not observed
Karimzadeh et al.[31]	2017	36	12	Corticosteroid infiltration	4
				PRP infiltration	4
				Stretching	not observed
Mahindra et al.[16]	2016	75	12	PRP infiltration	12
				Corticosteroid infiltration	4
				Placebo infiltration	not observed
Gollwitzer et al.[28]	2015	146	12	Shockwave therapy	12
				Placebo	not observed
Kim et al.[32]	2015	40	12	Polydeoxyribonucleotide (PDRN) infiltration	not observed
				Placebo	not observed
Chew et al.[33]	2013	54	24	Shockwave therapy	not observed
				PRP infiltration	24
				Stretching	not observed

Among the articles that met the inclusion and exclusion criteria imposed in this study, two evaluated the treatment with corticosteroid and platelet-rich plasma (PRP) concentrate infiltration in the painful area of the foot. The first one randomized 75 people with a clinical diagnosis of plantar fasciitis refractory to first-line treatment, dividing its sample into three randomized groups, in which all participants underwent infiltration of the plantar region, one group with saline solution (placebo group), another with corticosteroid, and the last with PRP, with a three-month follow-up period. A statistically significant reduction in the VAS score was observed only in the patients from the groups undergoing the proposed treatment, with the VAS decreasing from a mean score of 7.7 prior to the procedure to 2.84 in the corticosteroid therapy group after just three weeks. The PRP group also experienced a reduction in the mean VAS score from 7.4 to 3.7 in the same circumstances, and a mean of 2.52 after completing three months of follow-up[16].

The second article presents a sample of 36 patients diagnosed with chronic plantar fasciitis. The researcher randomized the sample into three statistically similar groups, one receiving corticosteroid infiltration, another PRP infiltrate, and the control group, in which there was no infiltration of placebo substance, just continuing with the first-line treatment. All were reassessed after one and three months, with the best results with statistical significance being observed in the groups receiving infiltration, with a decrease of approximately 60% in the VAS score three months after the procedure. Conversely, in the control group there was a small decrease in the VAS score, without statistical significance[31].

Kim et al.[32] showed an important improvement in pain after three months of Polydeoxyribonucleotide (PDRN) infiltration in a sample of 40 patients with chronic plantar fasciitis refractory to conservative treatment for at least six months. A significant improvement in pain was observed in the group receiving infiltration in the fourth week after infiltration, yet with a more substantial improvement after three months of follow-up. The placebo group, as other studies have shown, progressed with limited pain relief according to the VAS score. However, the decrease in the VAS score did not fall below 60% throughout the follow-up period of the groups. This shows us that first- and second-line treatment can prove insufficient in these patients, requiring additional second-line therapies or even surgical treatment.

When evaluating national and international medical expert examination procedure manuals, we observed that the guidelines for leave time of workers with plantar fasciitis range from zero to three weeks[34-37]. No distinction was observed with regards to disease duration, or whether the condition was acute or chronic. American manuals distinguish between the types of work activity performed by the professional, recommending longer leave for those who perform heavier jobs[35,36]. Because plantar fasciitis is more prevalent in workers who need to remain standing for long periods, we consider this criterion necessary when making the decision regarding the necessary duration of leave (Table 2).

Table 2. Manuals of evaluated procedures and respective recommended leave times

Manual	Time
Manual de Procedimento de Perícias Médicas	10 days
Return to Work & Disability Duration Guideline	0-14 days
Disability Duration Guidelines	0-21 days
Tiempos Estándar de Incapacidad Temporal	20 days

Although some studies show that pain control is achieved after just four weeks of second-line therapy, we observed that this improvement is more relevant over the course of the third month of follow-up. Other controlled studies are needed to objectively assess the impact of the worker's continuing to work on the treatment of chronic plantar fasciitis. However, we are of the opinion that to achieve a more reliable assessment of the necessary duration of leave, in addition to categorizing leave times by the type of work, as is the case in the American manuals, the assessment of treatment time would be beneficial in deciding on the necessary leave time.

Conclusion

We observed that pain management in patients with chronic plantar fasciitis is a difficult task if we use conservative first-line treatment alone, as these cases generally progress with significant improvement in pain after four to 12 weeks when the treatment is combined with effective second-line treatment. Expert medical examination procedure manuals recommend an average leave time of zero to 21 days, with only two scaling leave time according to the type of work. None of the manuals took into account the period of treatment already undergone by the worker.

Authors' contributions: Each author contributed individually and significantly to the development of this article: EAP *(https://orcid.org/0000-0001-6008-8671) data collection, wrote the article and approved the final version; CSMGM *(https://orcid.org/0000-0002-4266-0117) participated in the review process and approved the final version; RSB *(https://orcid.org/0000-0003-1085-0917) interpreted the results of the study and approved the final version; FCF *(https://orcid.org/0000-0002-8907-0472) interpreted the results of the study, wrote the article and approved the final version; ALGS *(https://orcid.org/0000-0002-6672-1869) participated in the review process and approved the final version; TDF *(https://orcid.org/0000-0002-9687-7143) participated in the review process and approved the final version

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Case Report

Desarthrodesis of ankle and subtalar stabilization with a flexible system: a functional surgical proposal

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Abstract

Patients who have undergone ankle arthrodesis frequently suffer from alterations in the adjacent joints and functional limitations. A 56-year-old female with a 22-year history of ankle arthrodesis underwent a conversion of ankle arthrodesis to total ankle replacement, followed by stabilization of the subtalar joint with a flexible system. The FAAM scale preoperative and eight-week postoperative scores were 39/100 and 88/100, respectively, and the SF-36 scale preoperative and eight-week postoperative scores were 37.52 and 73.61, respectively. In this case, ankle function was recovered after the conversion of ankle arthrodesis to total ankle replacement. With this technique, we obtained satisfactory functional results.

Level of Evidence V; Therapeutic Study, Expert Opinion.

Keywords: Ankle joint; Subtalar joint/surgery; Joint instability/surgery; Arthrodesis; Arthroplasty, replacement, ankle; Treatment Outcome.

Introduction

With arthrodesis of the ankle there is an increase in the mobility of the neighboring joints, which during the first year may cause an increase in subtalar joint movement of approximately 11°. Such an increment in movement, specifically in the posterior facet, can be the cause of early arthrosis[1,2]. Subtalar arthrosis is one of the most reported complications[1,3], however to our knowledge there are no reports about subtalar instability associated with arthrodesis of the ankle in the literature.

The subtalar joint together with the ankle make up the hindfoot functional unit, and thanks to its complex anatomy it plays a very important role in the regulation of the movements of the rest of the foot, since it has three facets and a complex ligament system that permits triaxial movement, i.e. inversion/eversion, flexion/extension and abduction/adduction[2,4]. The typical injury mechanism of subtalar instability is an acute trauma with forced inversion and dorsiflexion of the foot, however, a repetitive microtrauma of the talocalcaneal interosseous ligament can lead to chronic laxity and subsequent subtalar instability[5]. We assume that the hypermobility of said joint as a consequence of arthrodesis of the ankle may cause that repetitive microtrauma and the resulting subtalar instability that precedes subtalar arthrosis.

Different surgical proposals to give stability to the subtalar joint have been published, all focused on reconstruction of the different ligaments with auto-or allografts[4,6-8] and most of them are technically highly demanding and with long surgical times.

There is a wide range of surgical treatments to correct the complications resulting from tibiotalar arthrodesis, among them conversion of arthrodesis to total ankle arthroplasty[1,3]. The objective of our article is to present a subtalar stabilization technique with a flexible system in a patient who underwent conversion from tibiotalar arthrodesis to total ankle arthroplasty.

Study performed at the Santana Medical Center, Bogotá D. C., Departamento Cundinamarca, Colombia.

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Case report

Female patient 56 years of age, with a history of ankle arthrodesis evolving over 22 years. She had pain, difficulty walking, an equinus foot deformity that was not passively reducible, hindfoot varus and compensatory genu recurvatum (Figure 1).

The radiographic examination showed complete consolidation of the ankle arthrodesis and neutral sagittal and coronal planes, and a dorsal osteophyte of the talonavicular joint and abnormal aperture of the subtalar joint in the sagittal projection (Figure 1).

With these clinical-radiographic findings, a decision was made to perform surgery to convert the tibiotalar arthrodesis to a total ankle arthroplasty with a primary fixed-bearing insert prosthesis of anatomical design, flexible stabilization of the subtalar joint and periarticular arthroplastic remodeling, including resection of the talonavicular joint osteophyte.

Description of the surgery

Under local anesthesia, in dorsal decubitus and pneumatic ischemia, a dorsal approach to the ankle is performed, the extensor retinaculum is incised, medial retraction of the anterior tibial tendon and lateral retraction of the extensor digitorum longus together with the anterior tibial neurovascular bundle are performed; identification of the distal end of the tibia and the lateral and medial malleoli; next, with the distal access expansion, the talus neck and the talonavicular joint are identified. Under fluoroscopic vision, the level of what would correspond to the tibiotalar joint and the medial and lateral ankle gutters are identified. Placement of the external guide for sequential cuts is performed. Placement of the guide devices and recreation of the tibiotalar space and the lateral and medial gutters with an oscillating saw. The height corresponding to the talar dome is established and a cut is made with the oscillating saw. Extraction of the bone block and removal of the periarticular capsule until there is evidence of passive mobility of the neoarticulation (Figure 2). The device is coupled to define the size of the tibial component through which perforations are made for its pegs. Placement of probes to define the size of the talar component and the fixed insert. Placement of guide for posterior cut of the talus, which is performed with the oscillating saw and anterior sequential cuts, which are performed with the drill for this purpose.

Definitive implant of the total ankle prosthesis and fluoroscopic verification of the position of its components.

An osteophyte of the talonavicular joint is identified. Arthroplastic remodeling and verification of the viability of the remaining cartilage.

Manipulation of the neck and head of the talus is performed, reducing the normal aperture of the subtalar joint and fitting the talus together with the navicular bone in anatomical form. Having accomplished the objective of peritalar stabilization manually, it is fixed definitively with a flexible system of the TightRope® (Arthrex, Inc, Naples, FL) type guiding it from

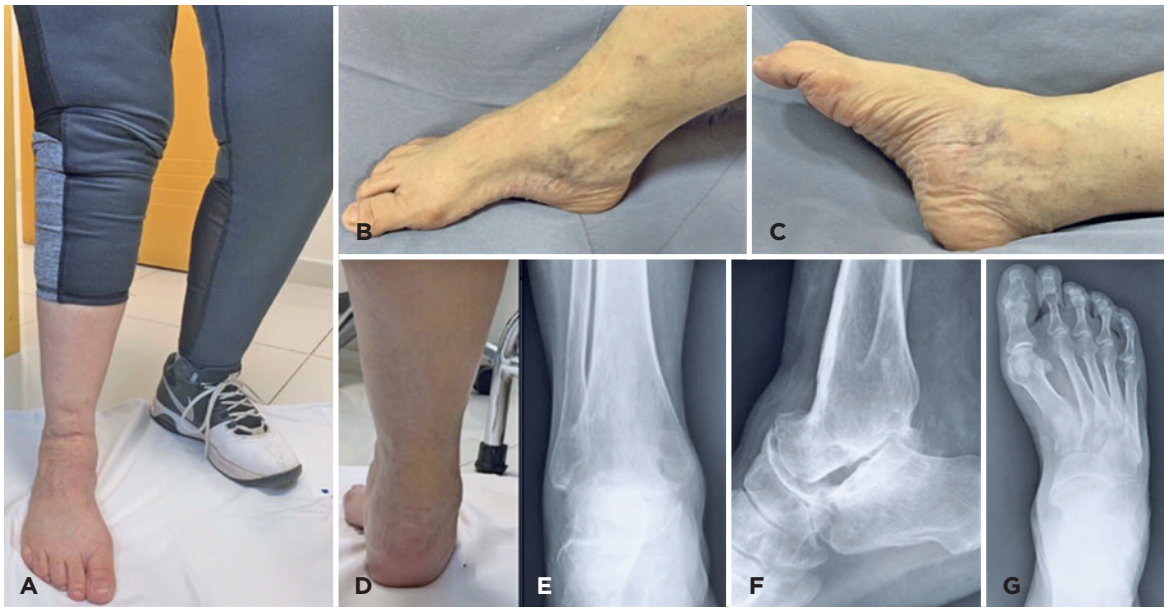

Figure 1. A. Patient standing with both feet on the ground with an equinus foot and compensatory genu recurvatum. B and C. Foot at rest. D. Posterior aspect of the foot with support on the varus. E. Anteroposterior radiograph of the ankle with consolidated arthrodesis. F. Lateral radiograph of the ankle showing an increase in the subtalar joint space. G. Dorsoplantar radiograph of the foot with adduction of the forefoot and incipient arthrosic changes.

the neck of the talus in its dorsal aspect, via the posterior facet of the subtalar joint and in its most anterior part, terminating in the posterior cortical and plantar part of the heel.

Satisfactory tests of tibiotalar and hindfoot stability are conducted under fluoroscopic control (Figure 3). Removal of the pneumatic ischemia, flushing and hemostasis, closure of the extensor retinaculum with separate sutures and closure of the subcutaneous cell tissue and the skin with anti-tension sutures. Immobilization with a bulky splint in the neutral position.

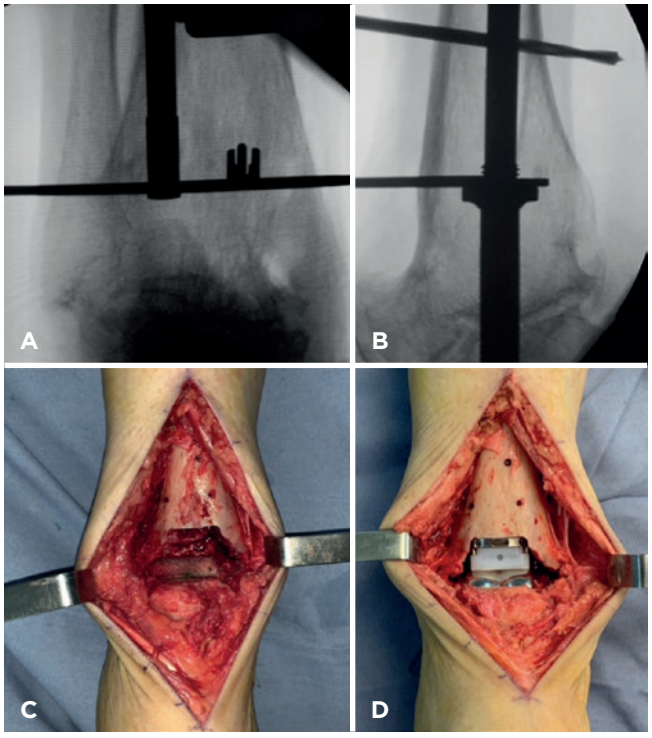

Figure 2. A and B. Fluoroscopic view of the guide to define the height of the cut for desarthrodesis. C. Neoarticulaction. D. placement of the definitive prosthetic elements.

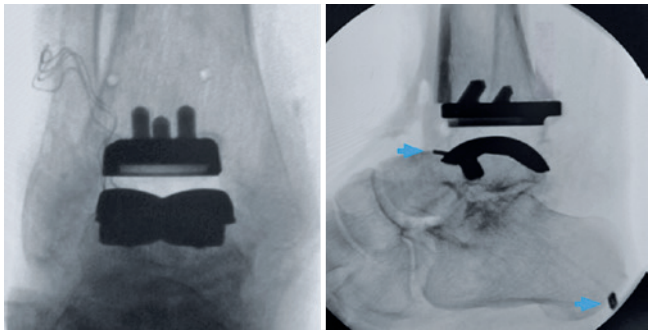

Figure 3. Fluoroscopic view with the definitive implants showing the tibiotalar neoarticulation, talonavicular and subtalar joints in anatomical position, the latter stabilized with the flexible system (the arrows indicate system plates).

The first postoperative control to review the surgical wound takes place seven days after the intervention. Removal of the bandages two weeks following surgery. Progressive support is permitted, protected with a removable boot in the neutral position. Physical therapy is initiated in the third week to improve gait pattern, ranges of motion, balance, proprioception and strengthening.

Results

The tools to measure the state of health can be classified into two large groups: generic and specific. The former are independent of the diagnosis and can be used in various types of patient and populations. In the SF-36 Health Survey or SF-36, its items detect both positive and negative states of physical and mental health in 8 dimensions.[9] The Foot and Ankle Ability Measure, FAAM, is a tool to evaluate the physical function of patients with musculoskeletal pathology in the legs, ankles and/or feet, on a scale of 0 to 100.[5]

The patient was assessed pre- and postoperatively with the SF-36 and Foot and Ankle Ability Measure (FAAM), obtaining SF-36 scores of 37.52 and 73.61 and FAAM scores of 39/100 and 88/100, respectively.

Discussion

We recommend a functional surgical proposal for the ankle and hindfoot joints, by means of a joint preservation surgery. It will be difficult for ankle movement to reach normal ranges following desarthrodesis and a limited active tibiotalar range of movement (22° to 24°)[1] is expected. In addition, in the immediate postoperative period these movements will be mainly passive flexion and extension during the mid swing of the gait cycle and as a response to the ground reaction force during full support, a situation that will make a difference in biomechanics when walking, preventing genu recurvatum and exaggerated flexion of the hip in the first swing of the cycle. Markus Preis reported movements in his desarthrodesis case series with 5-year follow-up of 23° ± 7° (dorsiflexion of 8.5° ± 3° and plantar flexion of 15° ± 5°), further emphasizing that those patients who had fixed equinus achieved dorsiflexion of at least 5°[3].

Fusion of any hindfoot joint will always affect the neighboring joints because they are mechanically linked[10], which is why the most functional alternative is sought when choosing treatment. When exploring the subtalar joint, no cartilage damage was found on the joint surface, so a decision to stabilize was made. The treatment options for subtalar instability are focused on the reconstruction of the lateral ligament complex of the ankle (especially the calcaneofibular ligament) or the subtalar ligaments. Many of these techniques involve the weakening of the secondary ankle stabilizers (e.g. peroneus brevis tendon) and wear to bone structures (e.g. talus) from tunnels that are created during the said reconstruction[4]. A viable solution for subtalar instability is a flexible fixation system, which in addition to providing stability, allows movement, which is extremely important for the accommodation of the foot on uneven terrain.

In the talonavicular joint, the dorsal osteophyte was resected, eliminating the mechanical stop that was preventing normal accommodation of the talus within the navicular bone, thereby recovering the plantigrade position of the foot and correcting equinus and forefoot adduction. After exploring the joint surface, it was discovered that approximately 75% of the cartilage was still preserved. This joint (talonavicular), also called the "key to movement", is considered the most important in the hindfoot because it has the greatest effect on the neighboring joints[10]. Therefore, once its stability was confirmed, a decision was made not to arthrodese it.

To reiterate, we believe that functional treatment in patients with pathology of the foot is the best option. In our patient, we observed satisfactory passive mobility results starting in the immediate postoperative period, having a favorable effect on the biomechanics of gait, which in turn improved both her physical and mental health considerably, which should be the main objective of any treatment.

Conclusion

Our surgical technique for subtalar stabilization in ankle desarthrodesis presents favorable immediate and short-term results.

Authors' contributions: Each author contributed individually and significantly to the development of this article: ASGF *(https://orcid.org/0000-0003-0296-5263) conceived and planned the activities that led to the study, performed the surgery, participated in the review process, approved the final version; OGT* (https://orcid.org/0000-0001-7651-1841) wrote the article, interpreted the results of the study, participated in the review process and approved the final version; LAGC *(https://orcid.org/0000-0002-0812-2497) assisted in the surgery, follow-up of the patient and participated in the review process. *ORCID (Open Researcher and Contributor ID).

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Case Report

Proteus Syndrome in the minimal form: atypical case report

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Abstract

This is the case report involving a 14-year-old male patient with Proteus syndrome. In an outpatient consultation, the patient complained of pain in the right foot on exertion. On physical examination, the findings were gigantism observed through lateral growth of the right foot, hemangioma on the back, and lipomas on the forearm. Clinical follow-up and orthotic measures were introduced after clinical and baropodometric analyses, achieving total relief of complaints. The minimal form of Proteus syndrome is rare and its diagnosis is hard. Its diverse manifestations constitute an obstacle to a systematic approach, hence its treatment must be individualized for each particular patient.

Level of Evidence V; Therapeutic Study; Expert Opinion.

Keywords: Hamartoma syndrome, multiple; Hamartoma; Gigantism.

Introduction

Proteus syndrome is a congenital hamartomatous disease, originally described in two patients by Cohen and Hayden in 1979[1], characterized by progressive and disproportionate growth of certain parts of the body[2].Due to the considerable clinical variability in affected patients, the name of the syndrome, given by Wiedemann in 1983, is a reference to Proteus, a god in Greek mythology with the ability to change shape at will[3].

Records currently show that there are less than 500 people affected worldwide; hence the syndrome is considered a rare disease[4,5]. Its abnormalities affect tissues of any germinative lineage, but especially the skeleton, skin, adipose tissue, and central nervous system. In most individuals symptoms are absent or subtle at birth, but develop substantially in childhood, causing localized overgrowth[2] besides other typical tumors[4]. Pulmonary complications and predisposition to thromboembolic events are also associated with the syndrome[2].

We explore here the case of a patient with a localized form of Proteus syndrome, known as minimal, which reflects the broad spectrum of variability in the presentation of this syndrome and represents an even rarer set of signs and symptoms.

Case report

This study was approved by the Institutional Review Board and registered on the Plataforma Brazil database under CAAE (Ethics Evaluation Submission Certificate) number: 19811619.9.0000.0096, and through the application of an Informed Consent Form (ICF).

Patient R.C.P., male, born on September 17, 2001. The patient was admitted to the orthopedic unit of our hospital at the age of 14, complaining of disproportionate feet, with the right foot appearing significantly larger in its lateral portion (Figure 1). It was ascertained that, even during childhood growth, the patient wore the same shoe size on both feet, despite the fact that the side of the right foot was markedly enlarged.

Study performed at the Hospital de Clínicas da Universidade Federal do Paraná, Curitiba, PR, Brazil.

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Family members report that such an increase was noted after birth, with the deformity growing in proportion to the patient's growth during childhood. The patient complained of mild pain present only on exertion, especially in the region of the lateral edge of the right foot when running, without any symptoms at rest. There were no other complaints related to other body segments, although an extensive hemangioma on the back (Figure 2) and lipomas on the forearm were found during physical examination (Figure 3).

No abnormalities were noted during neuropsychomotor development in childhood, with weight gain, gait, and other developmental milestones observed at appropriate times. The patient denied other comorbidities or previous hospitalization, allergies, use of continuous medications and drug addiction. During family history taking, it was ascertained that the parents were not consanguineous and there was no other family member with signs or symptoms resembling those of the patient.

On physical examination the patient's size was considered normal for his age. Gigantism was observed through lateral growth of the right foot, accompanied by a slight increase in the ipsilateral leg. In addition, there was an extensive hemangioma on the right side of his back (Figure 2), for which the patient had received no prior treatment and that, according to his mother's reports, had grown gradually during early childhood with slight regression from the age of five. Two circumscribed nodules were also observed in the ulnar region of the right forearm, of consistencies compatible with lipomas (Figure 3), in addition to asymmetric distribution of adipose tissue on the trunk (Figure 4). The patient walked without requiring support and there was no evidence of abnormalities in ankle and toe mobility or functional limitations in active and passive mobilization. No facial abnormalities were noted.

To supplement the diagnosis a baropodometry test was performed to study weight distribution and forces applied to the feet, revealing an important weight-bearing deviation in the right foot when static (Figure 5). In the dynamic state, the test revealed a deviation of the center of gravity of the left foot from the calcaneus to the head of the second and third metatarsals and to the hallux. On the right side we also observed displacement of the center of gravity for the second toe and not for the hallux (Figure 6). A pronation force vector was observed on both sides.

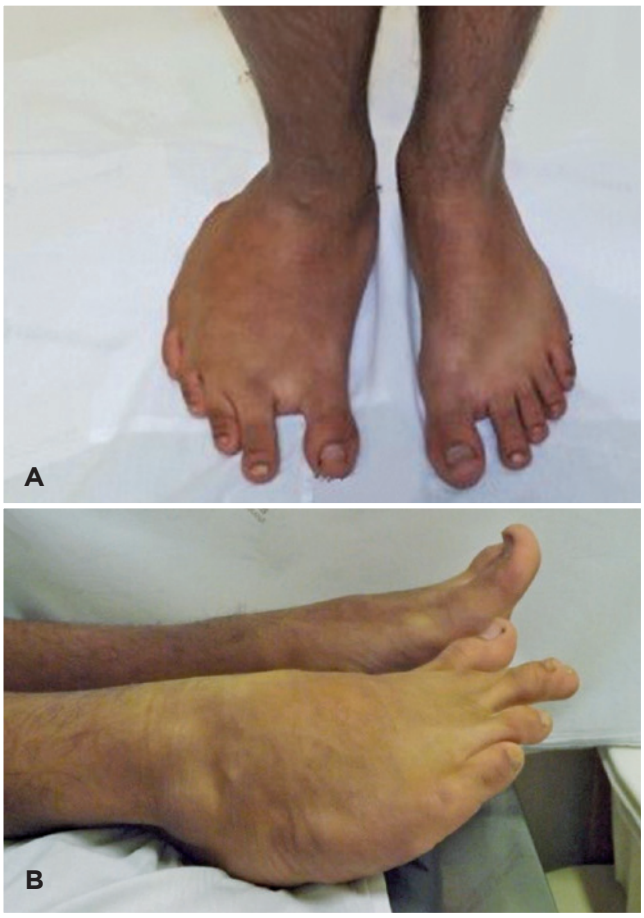

Figure 1. The patient's feet, showing gigantism observed through growth of the lateral edge of the right foot (A) and the abnormal growth of the edge of the right foot in the lateral view, with slight enlargement of the right ankle (B). There are no signs of growth abnormalities in other parts of the body.

Discussion

Patients with Proteus syndrome represent a clinical and diagnostic challenge, not only due to the broad spectrum of the disease, but also because of the lack of clear diagnostic criteria, leading to underdiagnosis[6]. For this reason, the First Conference on Proteus Syndrome was held in Bethesda, Maryland, in 1998. As a result, recommendations for confirmation, differential diagnoses, evaluation and management of patients were gathered[7] and used for the diagnostic approach of our patient. These recommendations are presented in this report.

Diagnosis of the syndrome is based on mandatory clinical criteria and specific characteristics that may or may not be

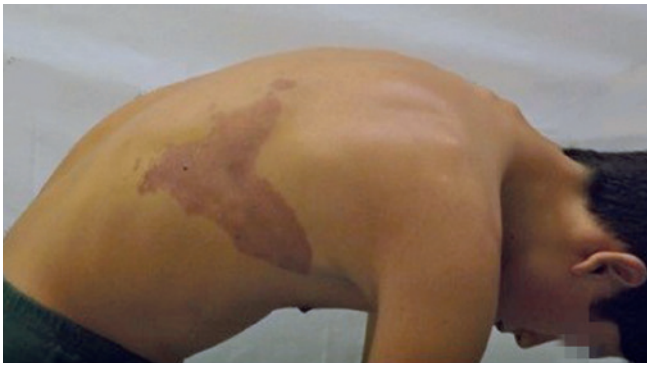

Figure 2. Extensive hemangioma present on the patient's back, in right posterolateral view. The presence of hemangiomatous alterations is part of the minor clinical criteria for the clinical diagnostic characterization of Proteus syndrome.

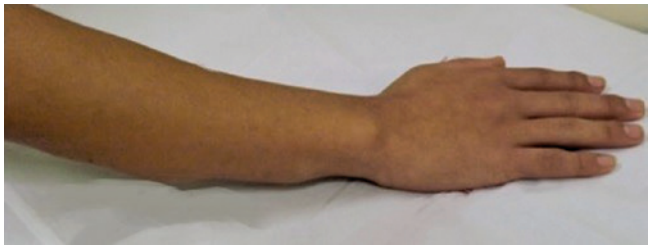

Figure 3. Image of the patient's right forearm, showing two lipomas in the ulnar region of the forearm. The presence of lipomatous disease is part of the minor clinical criteria for the clinical diagnosis of Proteus syndrome.

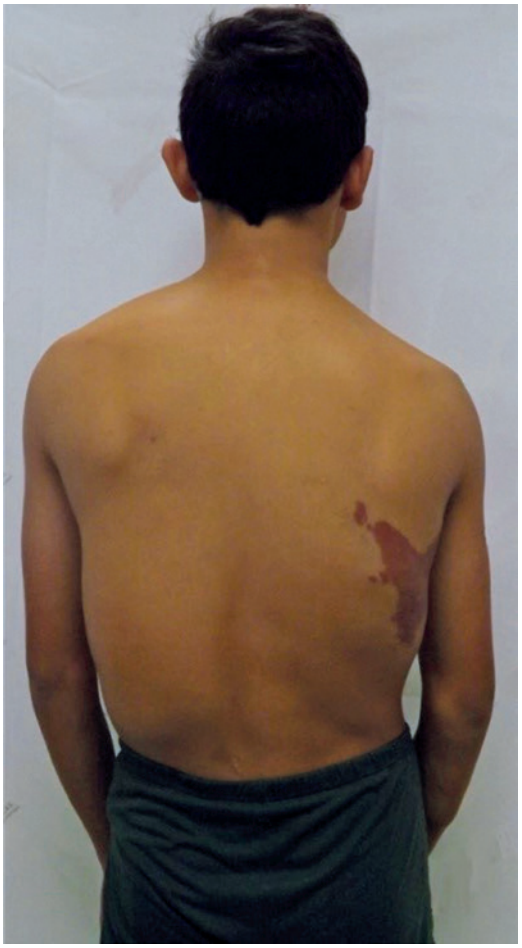

Figure 4. Patient's dorsal region with clear asymmetric distribution of adipose tissue on the trunk and part of the hemangioma in the right posterolateral region.

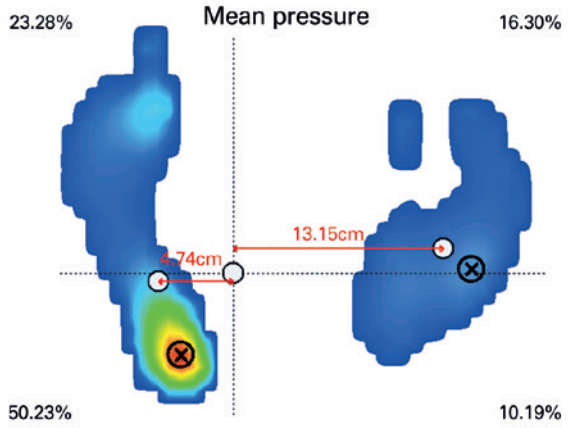

Figure 5. Image of the static baropodometric analysis with lateral deviation of the base of the right foot.

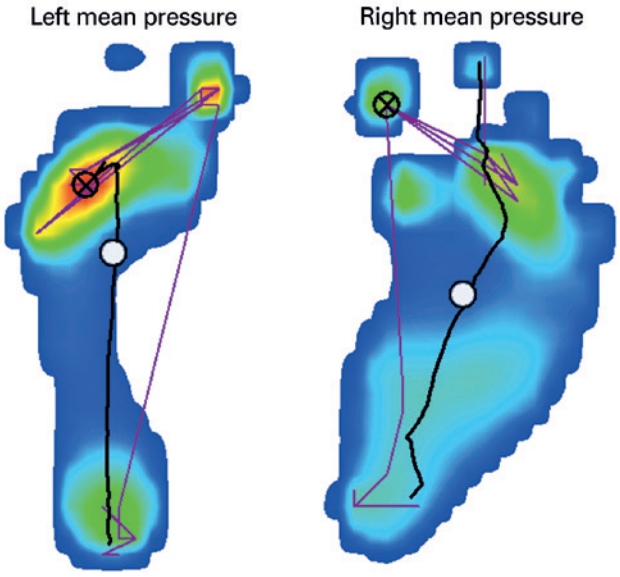

Figure 6. Dynamic baropodometry showing a normal line of displacement of the center of gravity to the left and right. A pronation force vector can be seen on both sides.

present. If a patient has the three mandatory clinical conditions and some of the sporadic characteristics, it is possible to consider a diagnosis of Proteus syndrome. The three mandatory criteria are: 1) Mosaicism, which means areas of excessive growth visible in a fragmented manner; 2) Sporadic occurrence, i.e., there are no other affected family members; 3) Progressive course, which indicates that overgrowth visibly and progressively alters the appearance or that new areas of overgrowth will appear over time[8]. The patient presented in this case report meets all the essential primary requirements for the diagnosis of this syndrome.

The characteristics of sporadic presence, in turn, are grouped into three categories: A, B and C. Connective tissue nevi are included in category A. Category B contains three criteria: linear epidermal nevi, asymmetric, disproportionate growth, and specific tumors occurring in the first decade of life. Category C also contains three criteria, namely: irregular adipose tissue, vascular malformations and facial phenotype characteristics. The diagnosis of Proteus syndrome requires, in addition to the mandatory characteristics, the presence of at least one criterion from group A, two from group B or three from group C[7]. The presence of hemangioma, irregular distribution of adipose tissue and the presence of lipomas in the patient from this particular case report is compatible with some of the minor criteria for the clinical diagnosis of the syndrome.

The minimal form of the disease, which is even rarer, may not present the major physical disfigurements that are typical of the syndrome, as in the case presented in this report, in which the patient presented with localized deformity of the right foot, which was vital for clinical suspicion, in addition to a negative family history. The treatment of localized deformities is nonspecific and individualized, and surgical indications can be limited in cases with no significant functional limitation. Because the patient has localized distortion, we instituted clinical management through baropodometric evaluation to study the distribution and concentration of force in the plantar region and the use of compensation insoles, with improvement of complaints, opting for a series of reassessments during the growth phase.

In 2011, a localized and sporadic mutation that causes the disease was identified in the AKT gene. A spontaneous mutation at the time of embryogenesis, in which only cells descended from the affected parent will express the disease. Accordingly, the individual will have a population of normal cells and another of mutated cells, thus developing a genetic mosaic[9]. The severity of disease manifestation depends on the stage of embryonic development when the mutation occurred and in which part of the body it developed. The newborn may appear normal, yet symptoms appear in the first two years and may increase susceptibility to typical tumors[5,9]. Such characteristics were observed in the patient in this report, since he presented with typical benign tumors and developed disproportionate growth of the right foot during childhood.

Due to the essentially musculoskeletal manifestations, it is important for orthopedists to become familiar with this syndrome, since they will often be the specialist approached initially, as in the case presented here. In addition, it is advisable to adapt the treatment on a case-by-case basis to decide on the best intervention, and be aware that surgical treatment will not always be indicated. As in this particular case report, despite the appearance, in the absence of major functional limitations, patients can be treated conservatively with serial monitoring, physiotherapy and orthoses to improve gait, since the surgical risk of an intervention can outweigh the real benefits in these specific cases with limited deformities. After the adoption of measures such as insoles, guidance on gait and posture, and clinical follow-up, the patient showed an improvement in the initial complaints, and no new abnormalities or progression of existing deformities were found during outpatient follow-up.

Conclusion

Therefore, we conclude that the physician must have a high degree of clinical suspicion in order to confirm this rare syndrome, especially when present in its minimal form, and must rely on clinical criteria for the diagnosis. When available and in cases of diagnostic uncertainty, genetic tests may also be carried out. In addition, surgical treatment will not always be the choice, especially in minimal cases of disease presentation, characterized by localized deformities, and clinical treatment may produce good results.

Authors' contributions: Each author contributed individually and significantly to the development of this article: CC *(https://orcid.org/0000-0002-2742-7448) bibliographic review, wrote the article, approved the final version; JLVS *(https://orcid.org/0000-0002-9038-2895) clinical examination, participated in the review process, approved the final version; LM *(https://orcid.org/0000-0003-3377-7919) clinical examination, interpreted the results of the study, participated in the review process, approved the final version; RAF *(https://orcid.org/0000-0002-5549-8294) wrote the article, bibliographic review, approved the final version; LAMC *(https://orcid.org/0000-0002-1808-5749) participated in the review process, approved the final version. *ORCID (Open Researcher and Contributor ID).

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Technical Tips

Supraintercondylar fracture of the proximal phalanx of the hallux

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Abstract

Toe phalanx fractures are prevalent worldwide. The proximal phalanx of the hallux requires different treatment from the other four lateral phalanges. Poor positioning of rotation and angulation is not acceptable for this bone, since it can result in significant functional deficit. Indications for surgical treatment are: joint fractures with deviations greater than 2 mm, metadiaphyseal fractures with rotational and/or angular deviation, open fractures and unstable fractures. The classic medial approach in surgical treatment involves some high-risk neurovascular structures and does not allow the correct positioning of osteosynthesis systems in some cases. The aim of this study is to present an option for the surgical treatment of deviated and unstable supraintercondylar fractures of the proximal phalanx of the hallux by the dorsolateral approach, with a traction screw through the plate and a lateral neutralization plate.

Level of Evidence V; Therapeutic Study; Expert Opinion.

Keywords: Hallux/surgery; Osteotomy/methods; Fracture fixation, internal.

Introduction

Phalanx fractures of the toes are common, representing 3.6 to 8% of lower extremity injuries[1]. Of these, the phalanges of the hallux represent the largest proportion of all phalanx fractures of the toes (38-56%)[2].

In general, with appropriate initial treatment, diaphyseal fractures of the proximal phalanx of the hallux tend to consolidate in a good position. However, if proper treatment is not applied, clinical outcomes with significant functional sequelae, such as delayed union accompanied by pain, nonunion and angular deformity, are expected[3-5]. As the peak of plantar pressure at the moment of detachment of the foot during normal gait passes through the hallux, the anatomical reduction of this injury is important to avoid gait disturbances and forefoot disability in the future[6].

Diaphyseal fractures of the proximal phalanx of the hallux are not usually treated surgically, as reduction (generally closed) is acceptable[7].

The main indications for surgical treatment of the proximal phalanx of the hallux are:

- Joint fractures with deviation greater than 2mm;
- Metadiaphyseal fractures with rotational deviation;
- Metadiaphyseal fractures with angular deviation;
- Open fractures;
- Unstable fractures.

Open reduction and stable internal fixation (ORIF) is ordinarily the best option when treatment is surgical.

Internal fixation can be performed with one or more compression screws or a neutralization plate. The plate increases

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the degree of fixation and allows a higher degree of weight bearing, which facilitates functional rehabilitation. Whenever possible, the insertion of a traction screw through the plate further improves the rigidity of the assembly[7,8].

Alternatively, closed reduction using fixation with two or more Kirschner wires can be performed. This can be indicated in patients with significant soft tissue damage or major medical comorbidities[7,8].

The classic medial approach to the hallux is indicated for fractures of the two phalanges of the hallux with or without joint involvement. It can also be used for ORIF procedures involving the medial sesamoid bone or distal fractures of the first metatarsal bone, and in the treatment of hallux rigidus (cheilectomy, osteotomy, or fusion)[7].

Some anatomical structures such as vessels and nerves are at risk in this approach. The head of the first metatarsal bone receives its blood supply from an artery that enters the metatarsal head in the plantar aspect of the distal metaphysis[7].

The dorsomedial (collateral) digital nerve (in most cases a branch of the deep fibular nerve) runs in the dorsal half of the medial side, and the medial plantar sensory nerve of the hallux runs along its plantar aspect.

Other approach options are needed for the proper surgical planning of some fractures[7].

The aim of this study is to present an option for the surgical treatment of deviated and unstable supraintercondylar fractures of the proximal phalanx of the hallux, through the dorsolateral approach.

Surgical technique

The technique is indicated for supraintercondylar fractures of the proximal phalanx of the hallux (AO 88.1.2) involving instability, angular and rotational deviation.

In the case used to illustrate the technique, there was a metadiaphyseal fracture with lateral deviation and intact medial cortex (Figure 1). The ideal surgical planning strategy is to use an intercondylar traction screw and a neutralization plate on the side of the deformity/deviation - lateral surface of the phalanx, introduced through the dorsolateral approach.

1. The surgical procedure is performed with the patient in the supine position under general anesthesia in combination with local nerve block;
2. Pneumatic tourniquet positioned at the root of the thigh 270mmHg;
3. Dorsolateral L-shaped approach incision made along the lateral edge of the hallux (Figure 2);
4. The neurovascular bundle is protected and moved to the side, and the extensor hallucis longis and brevis tendons are not touched (Figure 2);
5. Distal traction is exerted on the hallux and a 1.5mm Kirschner wire is used for temporary fixation (Figure 3A);

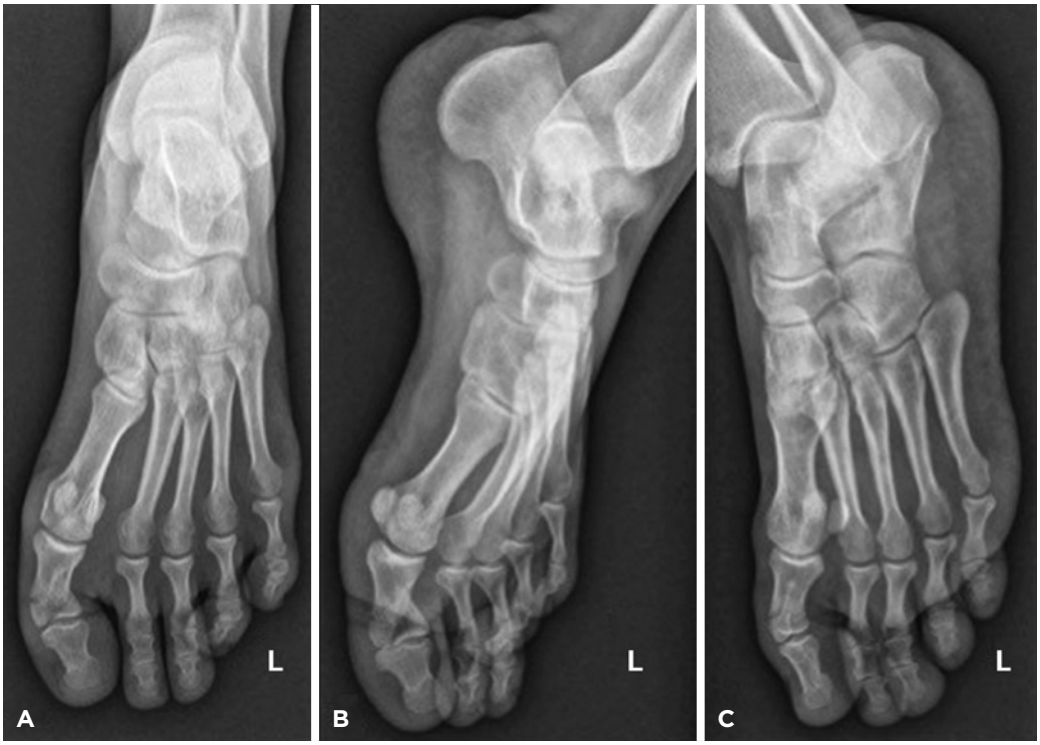

Figure 1. Laterally deviated metadiaphyseal fracture and intact medial cortex.

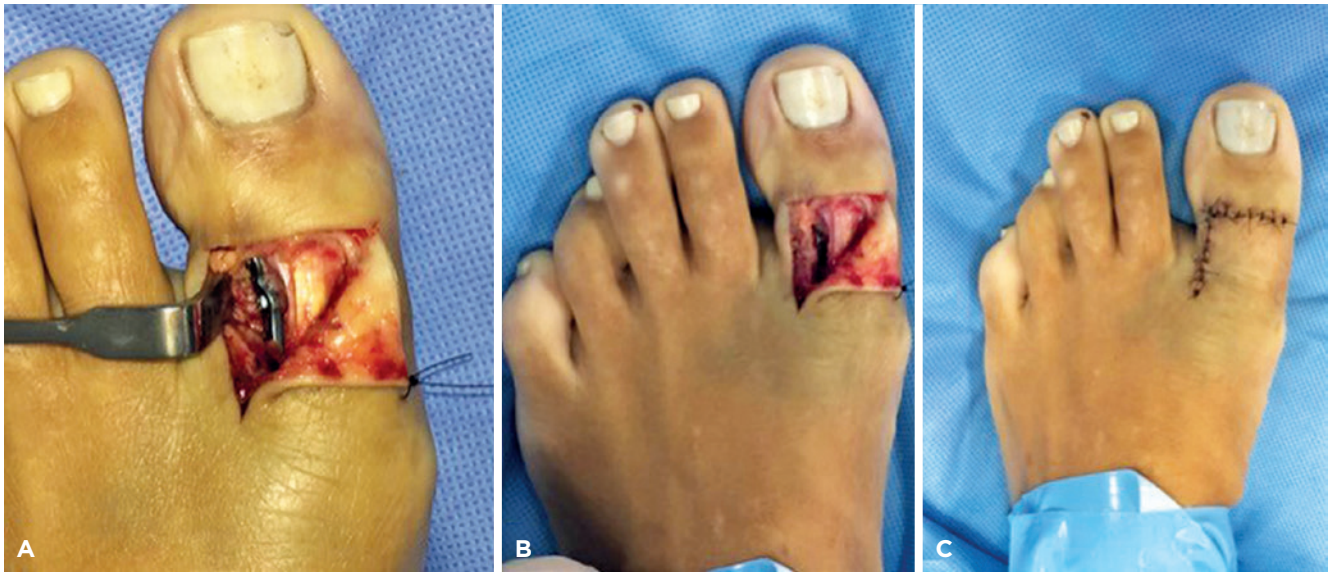

Figure 2. A and B. L-shaped dorsolateral approach incision made along the lateral edge of the hallux. C. Closure of surgical wound.

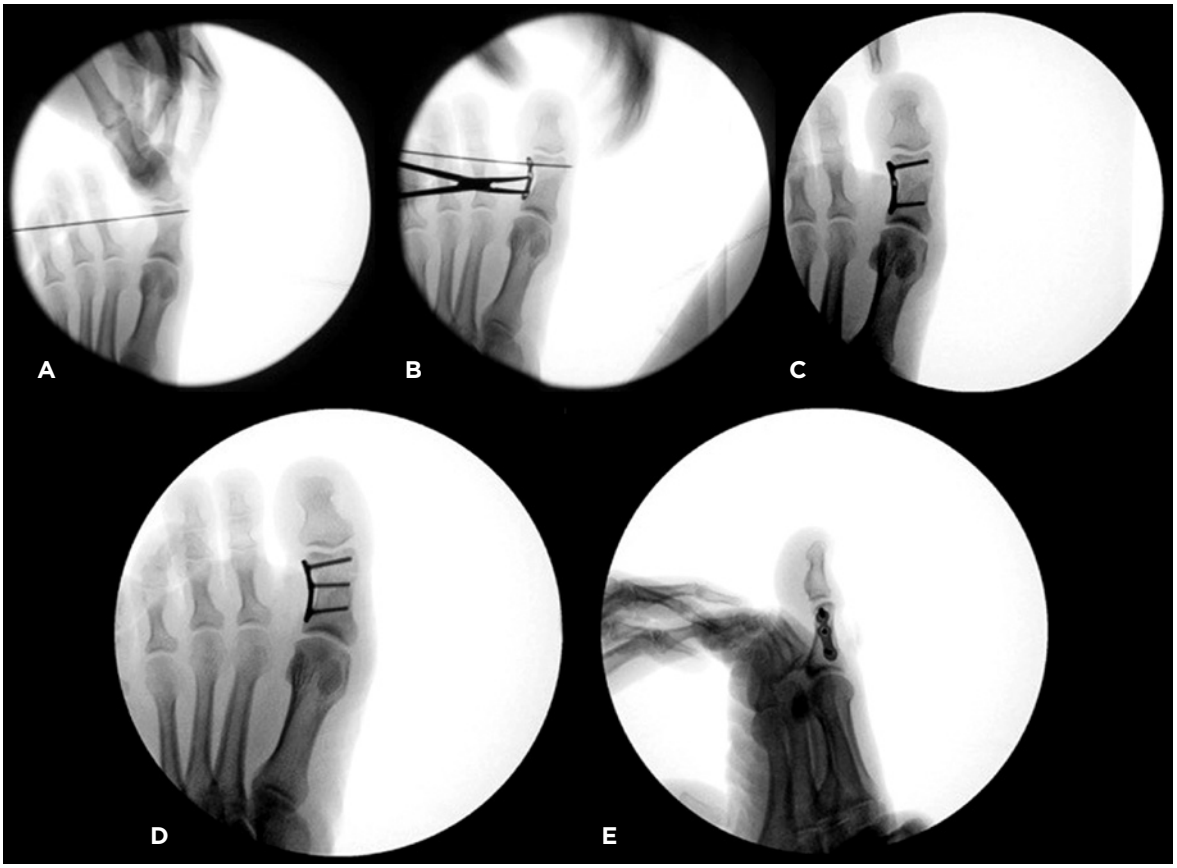

Figure 3. A. Temporary fixation with 1.5mm Kirschner wire. B. 2.0mm plate positioned on the lateral surface of the proximal phalanx of the hallux. C. Introduction of traction screw through the plate in the distal hole. D and E. Reduced articular surface.

6. The 2.0mm plate is positioned on the lateral surface of the proximal phalanx of the hallux, in order to function as a neutralization device (Figure 3B);
7. With the anatomical reduction of the joint surface maintained, a 2.0mm cortical screw is inserted through the most distal hole in the plate, in order to produce traction force (Figure 3C);
8. Once joint and metadiaphyseal reduction have been checked once again, a cortical screw is inserted in the most proximal hole in the plate, then a third locking screw is inserted in the central hole of the plate (Figures 3C, 3D and 3E);
9. The wound is irrigated with 0.9% saline solution and the approach is sutured with subcutaneous colorless 3.0mm vicryl and mononylon 4.0 in the skin (Figure 2C);
10. An occlusive dressing is made with cellulose acetate mesh impregnated with a petrolatum-based emulsion (Adaptic®) and sterile gauze covering the first commissure and hallux and protecting the surgical incision. The pneumatic tourniquet is then released with good peripheral perfusion.

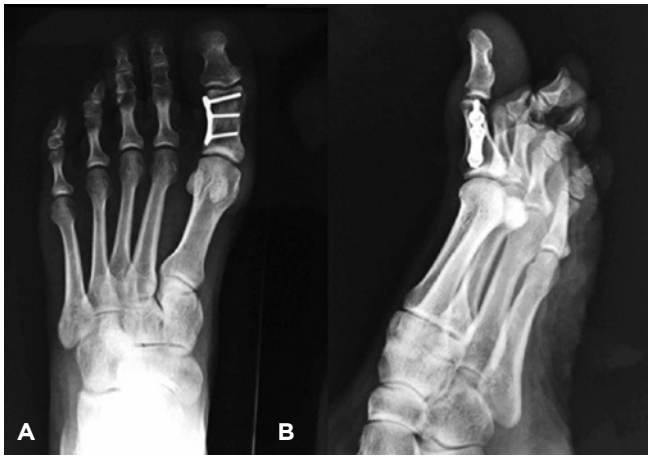

Figure 4. Five years after surgery. Fracture consolidated and without signs of mechanical failure of the implant.

The patient was followed up over a period of 5 years postoperatively with clinical and radiographic controls. Fracture consolidation was achieved with no signs of mechanical failure of the implant (Figure 4).

Discussion

Fractures of the phalanges of the hallux and toes are frequent injuries. They correspond to about 5.5% of foot and ankle fractures.[1] Although most injuries occur as a result of low-energy trauma, these fractures are often overlooked in polytrauma patients[8].

Some authors separate fractures of the phalanx of the hallux from fractures of the smaller toes[9]. There is consensus regarding the need for surgical treatment of unstable and deviated fractures of the hallux due to the importance of stability and mobility of the first ray for physiological gait[10,11].

The use of more rigid implants allows the maintenance of alignment during the consolidation process, reducing the risk of loss of reduction and treatment failure[12,13].

Two articles showed the use of a miniplate on the medial surface of the phalanx of the hallux as an alternative method for osteosynthesis in the treatment of fractures of the proximal phalanx of the hallux[14,15]. Ideally, however, the plate should be applied on the stress side of the fracture, in order to generate compression forces during plantar weight bearing, thus constituting the ideal surgical approach[15-17]. As scant subcutaneous tissue is present on the proximal phalanx, the plate must have a low profile to reduce soft tissue irritation. Moreover, the use of locking plates and screws allows for greater rigidity during cyclic loading[18].

Thus, we advocate that fractures with medial deviation should be fixed with implants positioned medially. On the other hand, fractures with lateral deviation should be fixed with implants positioned laterally. The surgical approach can be done through the medial, dorsal, dorsomedial[19] or dorsolateral route[7]. The best approach indication will depend on the fracture pattern, the size of the fragments and the surgeon's experience.

Our technique allows the use of the 2.0mm plate with neutralization function on the lateral surface of the proximal phalanx of the hallux.

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