DOI: https://doi.org/10.30795/jfootankle.2022.v16.1608

Technical Tips

One-stage correction of combined hindfoot, forefoot, and knee deformities: Joint preserving surgery

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Abstract

Combined angular deformities of the knee and foot are challenging clinical presentations for the orthopedic surgeon. We describe a surgical technique used in a 58-year-old man diagnosed with genu varum associated with progressive collapsing foot deformity and severe hallux valgus. The surgical team and the patient decided to perform a one-stage correction of all deformities. The procedure included corrective osteotomies with bone grafting and soft tissue reconstruction. The varus knee, hindfoot valgus, and hallux valgus were properly corrected intraoperatively with the surgical techniques described here. Satisfactory functional outcomes and excellent maintenance of the realignment were achieved at short-term follow-up.

Level of Evidence V; Therapeutic Studies; Expert Opinion.

Keywords: Foot deformities; Joint dislocations; Forefoot; Genu varum; Knee joint.

Introduction

Angular deformities of lower limb joints, such as the knee and foot, are a common clinical presentation in orthopedic practice. When deformities are combined, they determine the alignment of the lower limb as a whole and may lead to compensatory deformities in other joints of the lower limb[1]. There is solid evidence of the functional outcomes of surgical correction of deformities alone. However, scientific data on surgical correction of severe combined deformities, such as varus knee associated with progressive collapsing foot deformity and hallux valgus, are scarce.

In this article, we present a one-stage surgical technique used in the treatment of combined angular deformities of the knee, hindfoot, and forefoot in a 58-year-old patient.

Clinical and radiological findings

A 58-year-old businessman and former motorcycle racer complained of chronic pain in the left lower limb, mainly in the knee and foot, associated with difficulties to move around daily. The patient reported a left knee sprain with ligament injury 20 years ago and a right femur fracture 8 years ago, treated with a locked intramedullary nail. Physical examination showed bilateral varus knee deformity, more severe on the left side, associated with pain in the medial joint line, anterior instability, asymmetric left hindfoot valgus, valgus deviation, and pronation of the left hallux. Inspection showed loss of the medial longitudinal arch of the left foot (Figure 1A-H). Weight-bearing radiographs of the knees, ankles, and feet as well as a panoramic radiograph of the lower limbs were obtained. Radiographic evaluation of the left lower limb revealed severe varus knee, hindfoot valgus, presence of accessory navicular bone, loss of adequate talonavicular joint coverage, severe hallux valgus deformity, a break in Meary's line, and decreased calcaneal pitch (Figure 2A-H). Magnetic resonance imaging (MRI) of the knee showed a chronic anterior cruciate ligament (ACL) injury, moderate medial compartment knee osteoarthritis, and a degenerative medial meniscal tear. MRI of the hindfoot showed posterior tibial tendon dysfunction and extensive partial spring ligament tear.

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

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How to cite this article: Villar RUAT, Generoso TO, Fonseca FCP, Pires EA, Tirico LEP, Godoy-Santos AL. One-stage correction of combined hindfoot, forefoot, and knee deformities: Joint preserving surgery. J Foot Ankle. 2022;16(1):96-102

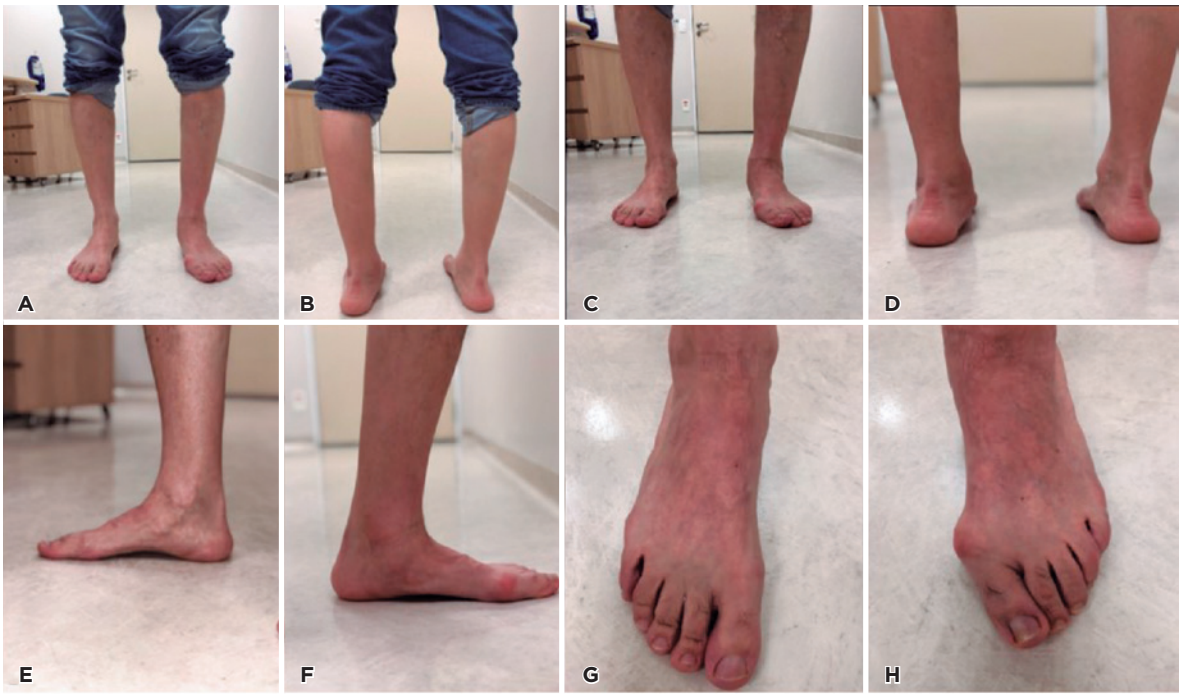

Figure 1. Clinical evaluation of a patient with bilateral genu varum, more severe on the left side, associated with hindfoot valgus, longitudinal arch collapse, and hallux valgus of the left foot.

Figure 2. Preoperative weight-bearing radiographs showing severe varus left knee, loss of adequate talonavicular joint coverage, severe hallux valgus, a break in Meary's line, and decreased left calcaneal pitch.

Technical tip

With the patient in the supine position under spinal anesthesia with a pneumatic tourniquet at the root of the limb, the knee joint was initially approached through an anteromedial incision at the level of the proximal medial tibia, and the gracilis and semitendinosus tendons were removed for ACL reconstruction. The 8-mm thickness grafts were prepared in a quadruple arrangement. After graft removal, anteromedial and anterolateral portals were created for the knee arthroscopy. The following injuries were found in the joint inventory: grade III chondral injury in the femoral trochlea and patellar apex, medial meniscal extrusion, and radial tear in the body of the medial meniscus, associated with a small flap in the meniscal body. These lesions were treated with debridement of the chondral injury in the femoral trochlea and partial medial meniscectomy. The femoral tunnel was created in anatomic position with an 8-mm FlipCutter (Arthrex®). Subsequently, biplane medial opening-wedge high tibial osteotomy was performed with the creation of a 12-mm opening wedge guided by radioscopy as planned preoperatively. The osteotomy was fixed with a Tomofix® plate with cortical locking screws. Iliac bone grafting was performed using tricortical grafts and a cancellous autologous bone graft. The tibial tunnel was then created with an 8-mm drill and the flexor tendon graft was advanced through it, fixed with an ACL TightRope (Arthrex®) in the femur and an interference screw (Arthrex®) in the tibia. The incisions were closed in layers.

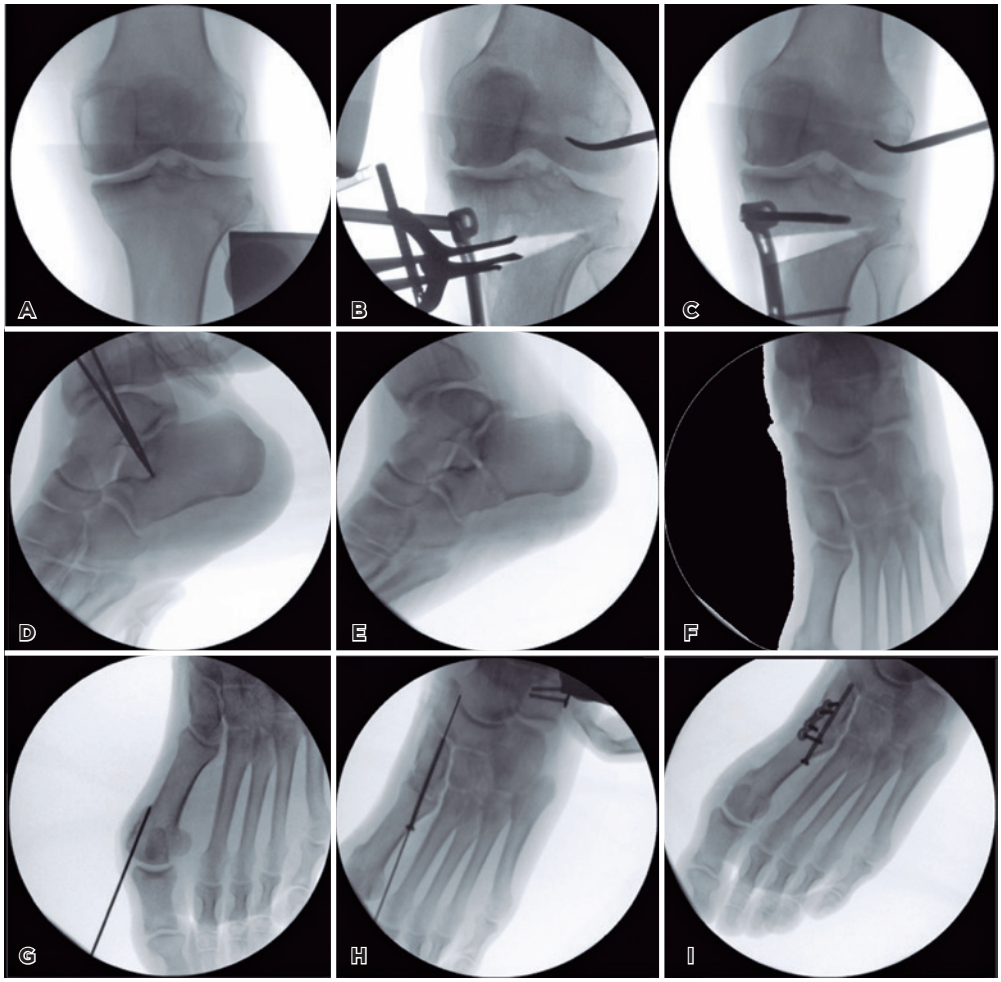

Figure 3. Intraoperative radioscopic images: A-C) Biplane medial opening-wedge high tibial osteotomy and fixation with a Tomofix® plate, with associated bone grafting. D-F) Lateral column lengthening following the technique described by Hintermann, showing adequate talonavicular joint coverage. The homologous bone graft is placed and fixed with an Aptus Foot locking plate (Medartis®). G-I) Approach to hallux valgus with bunionectomy and Lapicotton arthrodesis[2] using a bone bank graft and fixation with a 4-mm compression screw (Depuy-Synthes®) and an Aptus Foot dorsal locking plate (Medartis®).

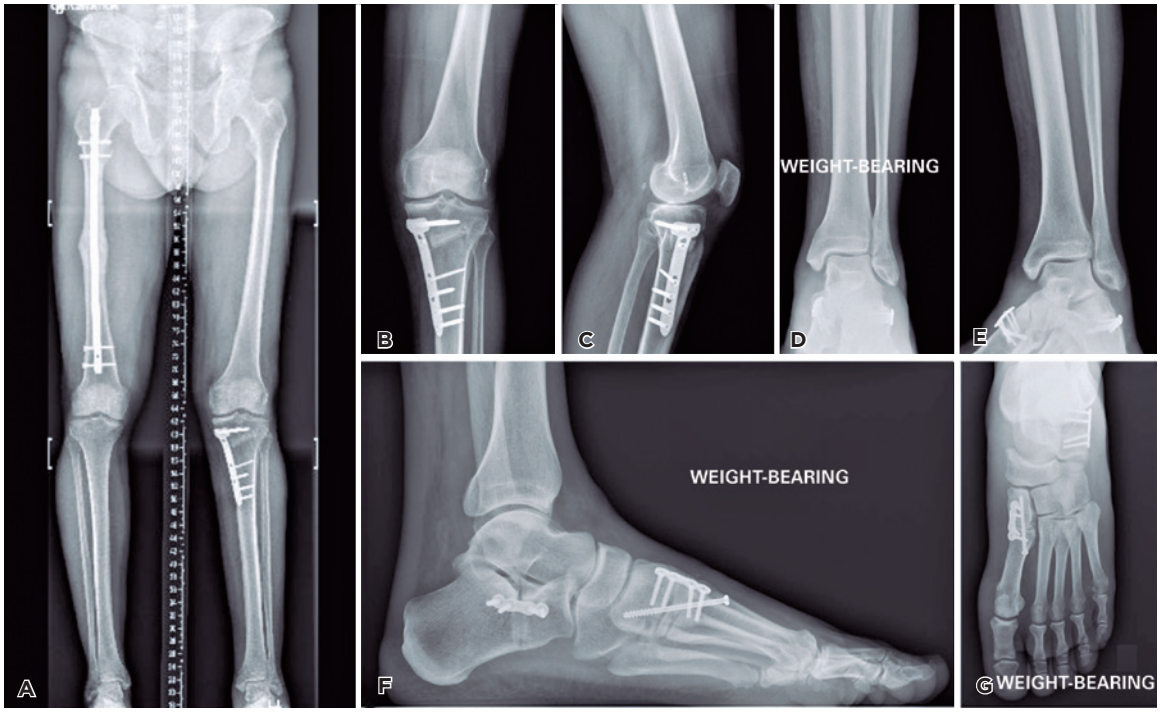

Figure 4. Postoperative weight-bearing radiographs showing successful correction of the mechanical axis of the left lower limb, with correction of the varus left knee and left ankle valgus, restoration of Meary's angle and left calcaneal pitch, and correction of the hallux valgus.

Figure 5. Postoperative CT scan. A-D) Proper correction of the posterior and medial subtalar joint and talonavicular joint congruence, and adequate talonavicular joint coverage. E-F) Union of the osteotomy of the anterior process of the calcaneus and the Lapicotton arthrodesis.

After 1 hour and 30 minutes, the knee deformities had been treated and the pneumatic tourniquet was deflated. After limb reperfusion, the tourniquet was reinflated. We then initiated the correction of flatfoot by lengthening the gastrocnemius fascia using the Strayer procedure. Subsequently, a medial incision was made along the posterior tibial tendon with resection of the accessory navicular bone, retensioning of the spring and deltoid ligaments, tenoplasty of the posterior tibial tendon with flexor digitorum longus tendon transfer, and reinsertion of this set into the navicular. A lateral hindfoot incision was made and lateral column lengthening was performed following the technique described by Hintermann. A spreader was used to open the osteotomy site, and adequate talonavicular joint coverage was observed with the aid of radioscopy. We then measured the size of the graft (7 mm) needed for apposition in the opening-wedge osteotomy. In this case, we used a bone bank graft and fixed the osteotomy with a locking plate using four 2.8 mm Aptus Foot screws (Medartis®). Finally, the forefoot deformity was approached through a medial incision at the hallux for bunionectomy and capsuloplasty. The correction of metatarsus primus varus and forefoot rotation was performed through a dorsal incision at the level of the first metatarsal-medial cuneiform joint, with joint decortication and Lapicotton arthrodesis as described by de Cesar Netto et al.[2] We used a bone bank graft and fixed the arthrodesis with a 4 mm compression screw (Depuy-Synthes®). A dorsal plate was locked with four 2.8 mm Aptus Foot screws (Medartis®) for neutralization (Figure 3A-I). The incisions were closed in layers. The pneumatic tourniquet was deflated after 1 hour and 40 minutes, and a soft-padded bandage was applied.

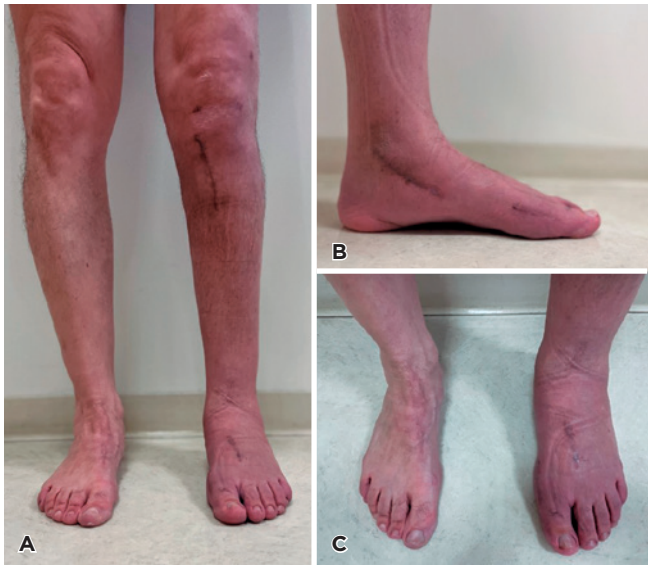

Figure 6. Postoperative clinical evaluation showing improved alignment of the left knee, ankle, and foot, with adequate surgical wound healing.

Postoperative protocol

Postoperative care included knee and foot immobilization in a flexible stance-control knee-ankle-foot orthosis and a rigid ankle-foot orthosis. The patient remained non-weight-bearing

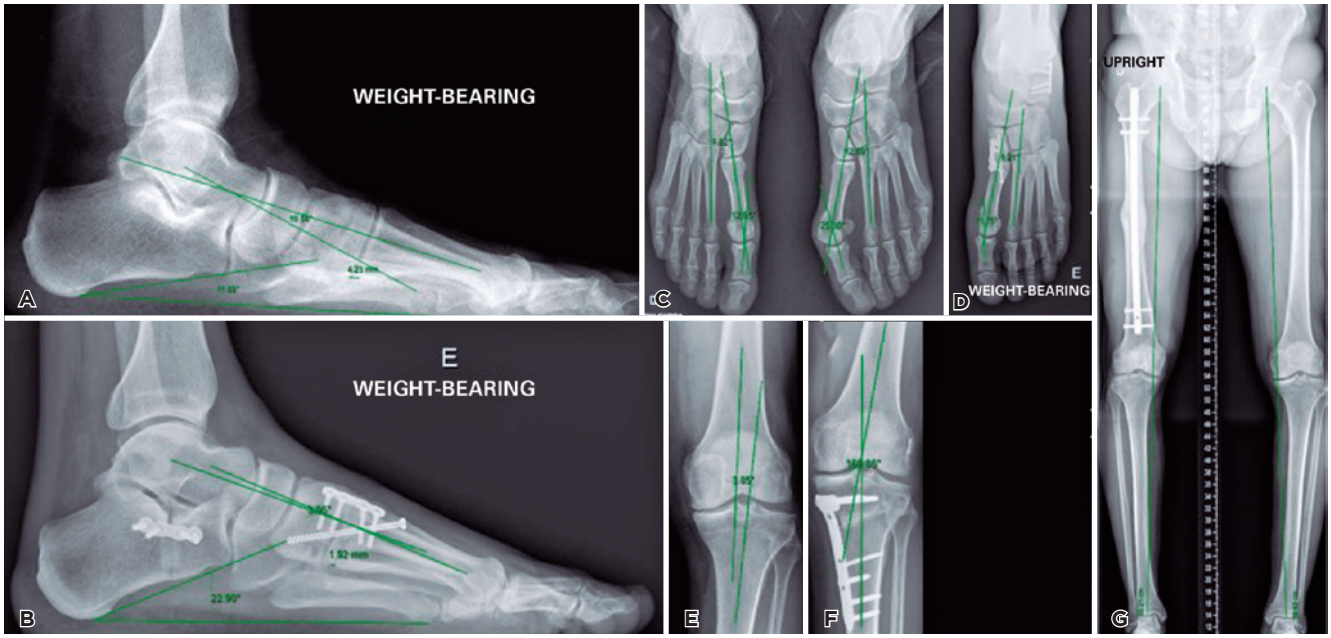

Figure 7. Preoperative and postoperative weight-bearing radiographic measurements.

for 4 weeks, with progressive partial weight-bearing with crutches from weeks 5 to 8. The protocol included encouragement of progressive return of the knee, ankle, and foot range of motion from the beginning of the postoperative course, with full range of motion of these joints being achieved after 8 weeks.

Clinical and radiographic evaluation

The evaluation of clinical and imaging outcomes was recorded at the 3-month follow-up visit.

The patient presented with excellent clinical alignment and no pain at the surgical wound sites (Figures 4-6).

Radiographic parameters showed normal angles with healing of the tibial and calcaneal osteotomies and the Lapicotton arthrodesis.

- Preoperative and postoperative ankle and hindfoot (Figure 7A-B)
  - Meary's angle: 10.58°/3.06°
  - Calcaneal inclination angle (calcaneal pitch): 11.88°/22.90°
  - Plantar gapping in the first tarsometatarsal joint: 4.23 mm/1.92 mm
- Preoperative and postoperative hallux valgus (Figure 7C-D)
  - Intermetatarsal angle (IMA): 12.69°/6.21°
  - Hallux valgus angle (HVA): 25.30°/11.75°
- Preoperative and postoperative knee (Figure 7E-F)
  - Anterior talofibular ligament (ATFL): 176.15°/169.86°

Discussion

The varus knee is a condition characterized by medial deviation of the mechanical axis of the lower limb from the center of the knee, resulting in an overload of the medial compartment, which is more prone to the development of degenerative changes. Studies indicate that knee misalignment significantly influences the ankle alignment, especially in patients with varus knee deformity, causing compensatory changes in ankle and hindfoot valgus, possibly accelerating the degenerative process of these joints[3-5].

For young patients with symptomatic degeneration of the medial compartment of the knee, valgus high tibial osteotomy is a validated surgical option aimed at laterally displacing the mechanical axis of the lower limb, transferring the load to the preserved lateral compartment, thus sparing the affected medial compartment, with improvements in knee pain and function[6], although it may also affect the ankle alignment[7].

Progressive collapsing foot deformity comprises a wide spectrum of tendon and ligament changes, especially of the posterior tibial tendon and spring ligament, which result in decreased plantar arch and associated ankle valgus[8,9]. It is a common condition affecting more than 10% of the population over 65 years of age. There is a broad spectrum of therapeutic approaches, from non-surgical treatment for milder cases, including changes in daily activities, physical therapy, and orthoses, to surgical treatment for more severe cases, with different techniques according to the underlying cause but often including medializing calcaneal osteotomy, lateral column lengthening, and spring ligament reconstruction[8].

Hallux valgus is also a common condition, affecting 2%-4% of the population, which has a multifactorial etiology and may be associated with flatfoot. It typically presents with valgus deviation, pronation of the hallux, and varus deviation of the first metatarsal and is a major reason for orthopedic medical consultation. Several bone and soft tissue procedures have been described for surgical treatment, according to the level of deformity.

Despite the high prevalence of these conditions alone, there is a lack of data on their simultaneous occurrence and therapeutic approaches for combined deformities. Questions could be raised about the optimal sequence to treat these deformities; whether all joint deformities should be treated surgically; the ability to redirect associated compensatory deformities after surgical correction of any of them; whether treatment should be performed in one or more surgical stages; and how different approaches may affect each other. Given the paucity of evidence and in the search for answers to these questions in order to find a safe and effective combined treatment option, we described here a surgical technique used in the simultaneous treatment of varus knee, ankle valgus, adult-acquired flatfoot, and hallux valgus in one patient treated at a tertiary care hospital in Brazil. The technique showed excellent results and can be a valuable alternative in specific cases.

Authors' contributions: Each author contributed individually and significantly to the velopment of this article: RUATV *(https://orcid.org/0000-0002-4563-5726) Conceived and planned the activities that led to the study, data collection, formatting of the article; TOG *(https://orcid.org/0000-0001-9277-7746) Conceived and planned the activities that led to the study, data collection, formatting of the article; FCPF *(https://orcid.org/0000-0002-8907-0472) Interpreted the results of the study, participated in the review process; EAP *(https://orcid.org/0000-0001-6008-8671) Interpreted the results of the study, participated in the review process; LEPT *(https://orcid.org/0000-0003-4067-319X) Performed the surgeries, approved the final version, participated in the review process; ALGS *(https://orcid.org/0000-0002-6672-1869) Performed the surgeries, approved the final version, participated in the review process. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID).

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