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Special Article

Foot and ankle minimally invasive surgery what's up?

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Abstract

Minimally invasive surgery has become much more prevalent in foot and ankle surgery. The rate of publication has increased dramatically, and there is considerable interest in minimally invasive surgery. There are both proponents and critics, as well as benefits and potential complications. In this article, a review of the current literature on the evidence for and against minimally invasive surgery was conducted to present a balanced argument. I will also summarize my personal experience so that, upon reading this article, surgeons have a better understanding of why I have made this change and continue to evaluate outcomes, risks, and benefits.

Level of evidence I; Therapeutic studies - investigating the results of treatment

Keywords: Minimally Invasive Surgical Procedures; Foot; Ankle

Introduction

Why minimally invasive surgery?

My minimally invasive surgery experience started in 1998 at the beginning of my practice. During my residency and fellowship, minimally invasive surgery of the foot and ankle was not discussed or taught. The only technique considered was ankle arthroscopy performed by arthroscopic surgeons at the request of foot and ankle surgeons.

The only potential proponent was Dr. Bruce Sangeorzan, who at that time was performing percutaneous calcaneal fracture surgery[1].

After starting my practice in British Columbia, Canada, I was challenged by my patient population. The province has a population of five million and spans an area approximately 900 km wide and 3000 km north-south. As with all populations, there is diversity in patient morbidity and local pathology. As a new surgeon, I was immediately challenged with tertiary referrals from all corners of the province. With vigor, I approached all of these complex reconstructions open as I had been taught, and within three or four months, my clinic was full of wound complications. These were very difficult to manage in many of these patients who came from a distance away and had pathologies such as obesity and diabetes.

To try and better serve my patients, I approached a senior colleague who was on the Executive of the Arthroscopy Association of North America, Dr. Brian Day, who gave me videos on how to perform ankle arthroscopy. I also encountered diagnostic challenges in patients in which imaging and patient-reported outcomes did not align. Therefore, I felt that ankle arthroscopy would be the appropriate course of action. Arthroscopy assisted in the diagnosis of conditions such as high ankle sprains and osteochondral defects and enabled fusion without major incisions.

Arthroscopic ankle fusion significantly reduced the risk of wound complications; as a result, my practice expanded with the adoption of percutaneous techniques, as many patients previously considered unsalvageable due to wound risk became salvageable.

Study performed at the Department of Orthopedics University of British Columbia, Vancouver, Canadá.

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I also began lecturing at the Arthroscopy Association of North America on foot and ankle arthroscopy. As the need for teaching expanded, I was often asked to speak on new areas of practice such as fracture management, subtalar arthroscopy, or tendoscopy. To fulfil these areas, I began to explore other arthroscopic techniques, and rapidly, my arthroscopic practice expanded.

I found that arthroscopic treatment of fractures allowed better visualization and enabled percutaneous reductions, thereby preserving the soft-tissue attachments and, consequently, the blood supply of the various bones I operated on.

In 2017, the low-speed high-torque burrs became licensed in North America. Shannon and wedge burrs, as well as the associated hardware for osteotomy fixation, became available with simultaneous licensing in Canada and the United States. I quickly adopted the techniques and learned from the European experts, including Joel Vernois, David Redfern, and Olivier Lefenetre, amongst others.

The benefits of percutaneous osteotomies in foot and ankle reconstruction in the forefoot and hindfoot were the same as those of arthroscopic surgery. There were similar risks and challenges associated with the learning curve. Overall, the learning curve for percutaneous osteotomies is shorter than foot and ankle arthroscopy.

As a teacher of foot and ankle residents and surgeons, teaching arthroscopy and teaching percutaneous surgery became a unique challenge. When we educate residents and fellows through open surgery, they can observe the procedure and perform it while the surgeon directly visualizes their work. In arthroscopy, the skills are the most challenging, and learning to manipulate the scope and shavers to achieve a goal within the joint is difficult; a trainee's failure to achieve the goal requires direct handling of the scope and shaver.

To a certain extent, the learning curve for percutaneous osteotomy is relatively short. Surgeons can be trained to transition directly from visualization to C-arm use and palpation. The concepts are basically easier.

However, learning new techniques requires a unique relationship with patients. Full disclosure is required when switching from a proven technique to a new one. Fully engaging patients within this process and explaining to them the reason there is a change, as well as what the change is. How it may benefit them is also important to discuss. I often explain to them that I have performed many procedures of a particular type, such as triple arthrodesis, and many percutaneous surgeries, but that this is the first time I have performed it on this joint percutaneously. I have explained to them the benefit, and also the fact that I have booked extra operating room time, and should I struggle, I will convert back to an open procedure. With this explanation, patients rarely refuse percutaneous surgery. Because of my experience with percutaneous surgery, many patients are referred for this procedure; they are fully engaged in the discussion and typically request percutaneous techniques.

In managing patients remotely, minimally invasive surgery has become an important tool. While most readers of this article will be aware of the benefits of minimally invasive surgery for hallux valgus and forefoot surgery, the use of hindfoot fusions and reconstructions to achieve single-stage surgery with a lower risk of wound complications has become a major benefit (Figures 1-3).

Understanding the patient's perspective on percutaneous surgery is also important. While in studies we examine a primary outcome, patients consider the whole package. For example, in bunion surgery, patients perceive that open bunion surgery is painful. However, if we offer them a less painful operation, they are more engaged and potentially likely to undergo surgery that might benefit them. They also understand that there may be lower risks. This is not necessarily the surgeon's perspective, nor is it the perspective of outcome studies.

We therefore need to examine the evidence.

Evidence for minimally invasive surgery

Arthroscopic vs open ankle fusion

Studies from our group compared total ankle arthrodesis, arthroscopic ankle arthrodesis, and open ankle arthrodesis in patients with non-deformed ankles and no surrounding arthritis. The arthroscopic ankle arthrodesis had similar outcomes to total ankle replacement with respect to outcome scores (AOS), and open ankle arthrodesis had worse outcome scores[2].

A retrospective review of prospectively collected data over 15 years on 223 arthroscopic and 128 open ankle fusion showed a lower infection rate and a lower ankle arthritis scale score at one year for arthroscopic ankle arthrodesis[3]. The original pilot study showed better scores for arthroscopic ankle fusion vs open ankle fusion in a multicenter cohort of 30 patients in each cohort[4].

A meta-analysis published in 2025 showed shorter tourniquet times, shorter hospital stays, and lower infection rates for arthroscopic ankle arthrodesis in a review of 19 studies comprised of 719 open and 835 arthroscopic ankle fusions[5].

Arthroscopic or percutaneous tibiotalar calcaneal fusion

Halai et al.[6] reviewed all studies on tibiotalar calcaneal fusion done percutaneously. Sixty-five patients across five studies were identified with one deep wound infection and an 86% fusion rate in a high-risk cohort.

In a review of a prospective database of complex patients requiring tibiotalar calcaneal fusion, a total of 51 fusions were performed: 22 arthroscopically and 36 open. There were no reoperations in the arthroscopic group, whereas the open group had a 28% rate. Wound complications were less in the arthroscopic group, and outcome scores were comparable[7].

Figure 1. A case of Müller Weiss disease. This is challenging to treat, open, and address both the navicular cuneiform joint and the talonavicular joint. Because of the risk of non-union in an isolated talonavicular fusion, a full triple arthrodesis was performed. The talonavicular and navicular cuneiform joints can be accessed from a single portal lateral to the neurovascular bundle, and a blunt instrument can be passed medial to the neurovascular bundle. (A) Preoperative radiographs (B) Follow-up radiographs.

Arthroscopic vs open subtalar fusion

A meta-analysis was performed on arthroscopic vs open ankle fusion. A total of four studies, including 125 arthroscopic and 130 open subtalar fusions, were identified. There were trends towards fewer complications and a higher union rate in the arthroscopic cohort, which was not statistically significant[8].

Percutaneous Lapidus arthrodesis

Only one study has compared arthroscopic with open Lapidus procedures for hallux valgus. This study showed similar correction based on radiographic parameters and a trend toward higher fusion rates and lower wound complication rates in the arthroscopic cohort[9].

Percutaneous vs open distal metatarsal osteotomies for hallux valgus

Most publications have been on this surgery.

The largest and most comprehensive series of percutaneous metatarsal osteotomies was recently published in the Journal of Bone and Joint surgery[10]. The outcome scores were MOXFQ and radiographic scores, as well as adverse events in

Figure 2. A patient with prior wound healing issues on the opposite side after a triple arthrodesis. The patient lives in a remote community and has seronegative arthropathy. The triple arthrodesis and midfoot fusions were performed single stage in a surgery that took 3.5 hours. The patient was hospitalized for two days and was discharged home for follow-up via telehealth. Solid bone and wound healing occurred. The first metatarsophalangeal joint was treated open to allow soft-tissue release to correct the position of the joint into dorsiflexion.

Figure 3. A prior failed flatfoot reconstruction using an arthrodesis screw. The subtalar, talonavicular, and tarsometatarsal joints were fused using percutaneous techniques, demonstrating the ability to achieve a flatfoot reconstruction in a complex case. The patient lives in another province in Canada. All follow-up care was performed by telehealth.

729 feet. The recurrence rate was 4.3%, the complication rate was 6.1%, and the screw removal rate was 2.9%.

A meta-analysis of open vs percutaneous hallux valgus procedures by Alimy et al.[11] analyzed seven studies in 395 feet. There were no differences in radiographic and PROMS outcomes, and no differences in complication rates.

A more recent meta-analysis in 2025 compared six studies of 352 feet for open chevron (OC) and burr minimally invasive chevron for hallux valgus. There was a trend for better pain scores at early postoperative time points, and otherwise, there were no differences in complications between the two groups regarding radiographic correction, complications, and PROMS[12].

One potential benefit of percutaneous procedures is the correction of large deformities that are not correctable with open surgical techniques.

Lewis et al.[13,14] examined hallux valgus angles greater than 40 degrees and intermetatarsal angles greater than 20 degrees corrected by percutaneous distal osteotomies. Up to 100 percent displacement can be achieved with proximal screw insertion. Fifty-three feet were studied, with a 7.5% recurrence rate, appropriate radiographic correction, and high satisfaction rates.

The outcomes of percutaneous techniques are durable for more than five years. A study by Lewis et al.[14] looked at five-year outcomes after PECA in 78 feet. The recurrence rate was 7.7% (inter-metatarsal angle being over 15 degrees), and the complication rate was 4.8%[13]. A second study on a larger series showed similar results.

Choi et al.[15,16] compared a proximal percutaneous osteotomy with a distal osteotomy for moderate to severe hallux valgus deformity. They found that both procedures were effective, with the proximal osteotomy producing greater correction of the intermetatarsal angle but also increasing the distal metatarsal articular angle.

The learning curve for percutaneous surgery is a barrier to adoption. One review article suggests that this is in the 30 to 40 case range[17]. One recent paper found that the effect on PROMS and complications was negligible, but would clearly reflect the training performed by the surgeon before adoption[18].

Considerations

Percutaneous techniques and minimally invasive surgery have become more popular in foot and ankle surgery, and are largely patient-driven. Benefits are seen in fusion surgery, and equivalence is seen in forefoot surgery. Surgeons must determine whether the patient's request is appropriate and, if so, whether it should be accommodated, provided that the results may be equivalent. Patients seek less pain and shorter recovery times. To date, there are indications that this is the case, and until more outcomes are studied, it seems reasonable to consider the patient's requests.

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