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Future of Minimally Invasive Surgery in Foot and Ankle in Indian Population: A Review Article

Pradeep Moonot[1], Kunal Chaudhari[1], Sagar Chaudhari[1], Lulu Damsas[1], Nishant Jaiswal[1]

Abstract

Introduction: Minimally invasive surgery (MIS) has significantly advanced foot and ankle surgery by offering reduced soft-tissue trauma, faster recovery, and improved cosmesis. In India, with a rising demand for early return to function and a high prevalence of diabetes, MIS provides a compelling alternative to traditional open techniques.

Methods: This review highlights the role of non-arthroscopic MIS procedures in foot and ankle surgery, focusing on techniques such as MIS bunion correction (simple, effective, reproducible, and inexpensive, Chevron–Akin), distal minimally invasive metatarsal osteotomy (DMMO), cheilectomy, Zadek osteotomy, hindfoot and midfoot fusion, triple fusion, and lesser toe deformity correction. Emphasis is placed on Indian-specific considerations, including soft-tissue quality, patient compliance, and resource availability.

Discussion: MIS techniques have demonstrated clinical outcomes comparable to open procedures while minimizing wound complications and promoting faster rehabilitation. Procedures such as MIS DMMO and Zadek osteotomy are particularly useful in high-volume Indian outpatient settings. MIS-assisted midfoot Charcot fusion and hindfoot arthrodesis offer safe alternatives in diabetic or neuropathic patients where soft tissue is critical. With growing access to instrumentation and training, MIS is gaining traction in urban and rural Indian centers.

Conclusion: MIS in foot and ankle surgery holds significant promise for the Indian population. With further integration into training programs and broader access to equipment, MIS can enhance outcomes and meet the evolving needs of both patients and surgeons.

Keywords: Minimally invasive surgery, Foot and ankle, India, Distal minimally invasive metatarsal osteotomy, Minimally invasive surgery fusion, Zadek osteotomy, Charcot foot, Hallux valgus correction, triple fusion, Double fusion, Hindfoot arthrodesis, Cheilectomy.

Introduction

During the last two decades, orthopaedic surgical techniques have evolved with marked growth, emphasizing minimally invasive surgery (MIS). In the Foot and Ankle Society, patients have a shift toward better cosmetic outcomes with a demand for faster recovery, and earlier return to daily activities with improved clinical outcomes and reduced soft-tissue handling. For a long time, arthroscopy has been the cornerstone for what is classified as MIS in the field of orthopaedics; however, in recent advances, non-arthroscopic MIS techniques, which include percutaneous and mini-open burr-based systems specially designed for the foot and ankle, have gained popularity. These techniques are redefining the management of common foot and ankle disorders globally, and increasingly, in India.

With the increasing availability of better armamentarium, better training, and awareness, a wide range of foot and ankle surgeries can now be approached effectively using MIS. Several conditions can be treated using MIS techniques. Hallux valgus correction with bunionectomy using MIS simple, effective, reproducible, and inexpensive (SERI) osteotomy, META, or MIS Chevron and Akin procedure has proven to have excellent outcomes with the advantage of reduced complication rates, reduced rehabilitation duration, and significant reduction in infection rates as compared to open procedures [1, 2].

[1]Mumbai Knee Foot and Ankle Clinic, Mumbai, Maharashtra, India.

Address of Correspondence
Dr. Kunal Chaudhari,
Mumbai Knee Foot and Ankle Clinic, Mumbai, Maharashtra, India.
E-mail: kunalschaudhari@gmail.com

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Figure 1: AR-200 power unit, Arthrex minimally invasive surgery console, and foot pad (Arthrex Inc, Naples, FL, USA).

Even lesser toe deformities (such as hammer toes, mallet toes, and claw toes) may be treated now with percutaneous distal minimally invasive metatarsal osteotomy (DMMO), which includes MIS osteotomies of the metatarsal and phalanges with adjuvant tenotomise [3]. In Haglund deformity patients, posterior heel exostectomy through MIS techniques avoids the extensive dissection of open procedures and enables earlier return to activity [4].

Calcaneum osteotomies can now be done percutaneously (such as a Zadek, MDCO, and LDCO) under fluoroscopy guidance using high-speed MIS burr-based systems with results comparable to open techniques [5,6].

India has a huge load of diabetic patients, such as diabetic foot and equinus deformities, which can be easily managed using MIS techniques with minimal soft-tissue compromise, which is essential as these patients are at high risk of wound complications [7].

In the Indian healthcare landscape, these advancements have profound implications. With a high prevalence of foot and ankle disorders among a diverse patient population – from diabetic patients in rural clinics to athletes in metropolitan centers – MIS offers faster recovery, fewer wound complications, and shorter hospital stays. As MIS instrumentation becomes more affordable and MIS-focused training becomes more accessible, India is well-positioned to become a leader in this space.

This article explores the expanding role of MIS in foot and ankle surgery in India, examining its procedural scope, current adoption trends, advantages over traditional approaches, and the challenges that must be addressed to ensure its broader implementation.

Materials and Methods

As part of our preparation for this manuscript, we conducted a focused literature search using keywords including "minimally invasive surgery (MIS)," "foot and ankle," "India," and "burr-based MIS." During our literature review, we identified a significant gap in existing research from India on burr-assisted MIS in the foot and ankle area. So far, there appears to be no original research published by Indian institutions that specifically focuses on burr-assisted MIS techniques in this anatomical region. We also found no case reports or cadaveric studies describing the use of burrs for joint preparation, osteotomies, or malunion correction, nor any studies presenting outcome data related to such procedures. Furthermore, there is a lack of Indian literature comparing open versus burr-assisted MIS approaches for the ankle or hindfoot.

Discussion

In the past decade, non-arthroscopic MIS in the foot and ankle has transitioned from being an upcoming innovative option to a research-proven technique efficient, viable, and practical option with an array of procedural options. India has proven to be a potential market showing a steady increase in the use of MIS techniques, especially in urban centers with access to good imaging machinery and surgical instrumentation options. In this paper, we discuss some key procedures and specialized instruments that have benefited from the use of MIS advances in the form of easy and better clinical outcomes.

Instrumentation: With recent advances in the field of MIS foot and ankle, multiple companies have now introduced a special instrumentation set, which includes a range of high-performance tools helping in minimal and percutaneous surgical precision. The system we mention in this paper is the Arthrex AR-200 power unit MIS System (Arthrex Inc., Naples, FL, USA) (Fig. 1).

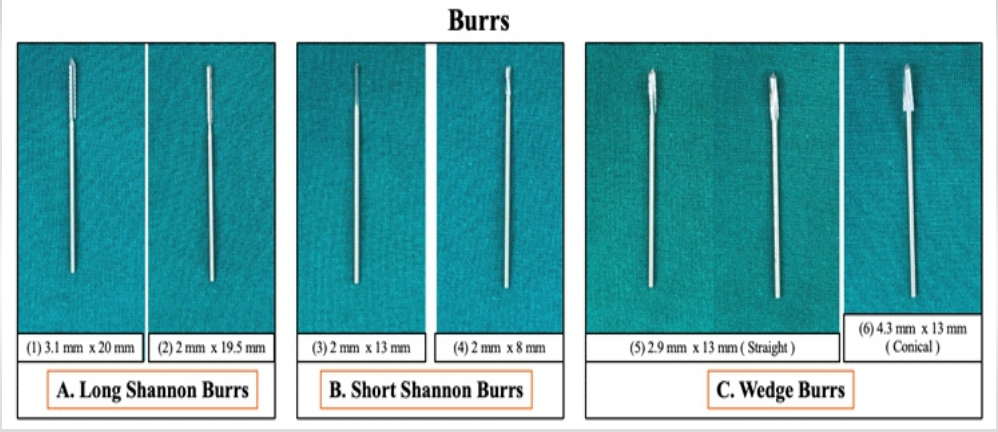

Figure 2: Various minimally invasive surgery – Burrs (a and b): Shannon Burrs – available in 2.0 mm, 2.2 mm, and 3.1 mm diameters, and (c): Wedge Burrs – offered in 2.9 mm and 4.3 mm sizes.

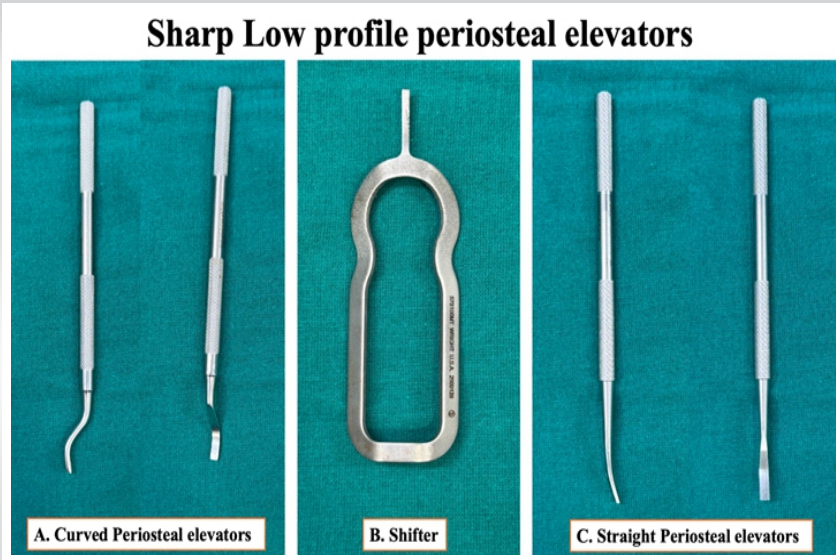

Figure 3: Low profile sharp instruments used for minimally invasive surgery (MIS)-assisted surgeries (a) curved/bent periosteal elevators, (b) MIS Hallux valgus shifter, (c) straight periosteal elevator.

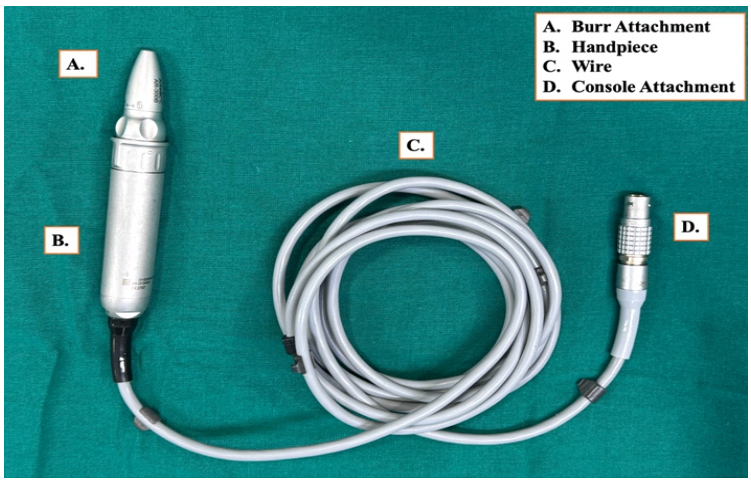

Figure 4: Handpiece and attachment.

Table 1: Burrs sizes and uses

S. No.	Burr	Size	Uses
1	Shannon burr, Straight	2 mm×13 mm	Akin osteotomy, metatarsal osteotomy
2	Shannon burr, Straight	2 mm×19.5 mm	1st metatarsal/chevron osteotomy
3	Shannon burr, Straight	3.1 mm×20 mm	Calcaneal osteotomy (MDCO/LDCO, etc.)
4	Shannon burr, Straight	2 mm×8 mm	DMMO
5	Shannon burr, Straight	2.2 mm×12 mm	DMMO
6	Wedge burr, Conical	4.3 mm×13 mm	Bone resection/cheilectomy
7	Wedge burr, Straight	2.9 mm×13 mm	Bone resection/cheilectomy
8	Oval burr	5 mm×15 mm	Large bone resection

A cornerstone of the MIS system is the high-torque, low-speed burr system, powered by the MIS handpiece. This ergonomically designed device operates at speeds up to 12,000 RPM, offering controlled torque essential for delicate bony procedures. It connects to a centralized console with integrated irrigation, which cools the burr during operation to prevent thermal necrosis of the bone (Fig. 1).

Key burrs include (Fig. 2 and Table 1):

- Shannon burrs – Available in 2.0 mm, 2.2 mm, and 3.1 mm diameters. These are flat, double-sided cutting burrs, ideal for performing precise transverse or oblique osteotomies, commonly used in procedures such as DMMO, MICA, and Zadek osteotomy.
- Wedge burrs – Offered in 2.9 mm and 4.3 mm sizes. These have a scalloped profile and are particularly useful in creating angled cuts, as needed in cheilectomies or bone resection in Haglund excision or midfoot osteotomies.

Other instruments required include a selection of sharp low-profile periosteal elevators, which are critical for safe portal creation and subperiosteal dissection (Fig. 3):

- Sharp straight periosteal elevators – Used for precise and controlled stripping of periosteum over bone during initial portal dissection.
- Curved periosteal elevators – Designed to facilitate dissection around curved surfaces of the metatarsals or calcaneus with minimal trauma.
- Handpiece and burr attachment (Fig. 4).

These elevators aid in creating the subperiosteal tunnel through which burrs and guide wires are inserted, enabling targeted access with minimal incision size.

Complementary armamentarium required includes:

- Guide wires and cannulated reamers for screw placement.
- Headless compression screws or cannulated lag screws for stable internal fixation, inserted percutaneously under fluoroscopic guidance.
- Portal protectors and soft-tissue sleeves to minimize the risk of soft-tissue entrapment or thermal injury.

Procedures commonly done using MIS Techniques in the foot and ankle include:

Hallux valgus correction (Fig. 5)

Hallux valgus correction using MIS techniques includes the SERI osteotomy, percutaneous Chevron–Akin osteotomies, and the third-generation Minimally Invasive Chevron–Akin (MICA) technique. Under fluoroscopic guidance, using a high torque and low-speed

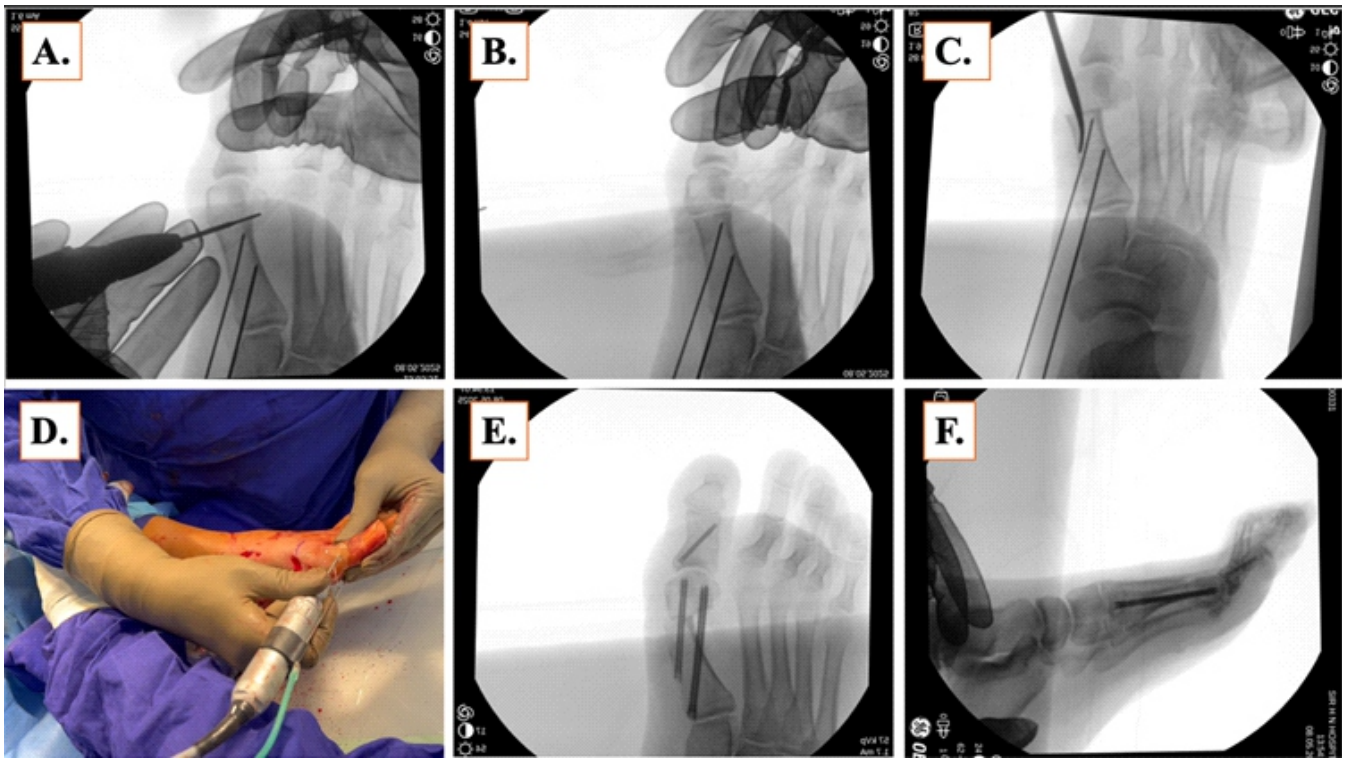

Figure 5: Steps for minimally invasive surgery (MIS) hallux valgus corrections. (a) MIS burr-assisted osteotomy, (b) osteotomy complete and distracted, (c) guidewires passed, (d) clinical picture of the MIS osteotomy with handpiece, (e) final (AP) post-operative X-ray, (f) final (Lat.) post-operative X-ray.

burr-based system (4000–6000 RPM), the 1st metatarsal realignment is done; this may be accompanied by selective soft tissue release along with shaving of the excess bony edges [1].

Recent studies have shown that MIS MICA procedures have a very good, comparable clinical and radiological correction outcome as compared to open techniques, with the added advantage of shorter operative time, reduced incidences of infection, lesser post-operative pain, and an earlier return to daily activities in footwear [1, 2]. The SERI technique, in particular, is praised for its simplicity and reproducibility, making it suitable even in resource-limited settings [3].

Recently, the incorporation of the 4th generation MIS techniques for hallux valgus correction represents the latest evolution in the surgical management of bunion deformities. These techniques aim for greater precision, better fixation, and reproducible outcomes while preserving the minimally invasive philosophy of less soft tissue trauma. Advantages of the MIS Hallux Valgus corrections include Precise correction of intermetatarsal and hallux valgus angles, along with Less post-operative pain, faster ambulation, and excellent cosmetic results (tiny incisions, minimal scarring). The distinct advantages of Internal fixation include a stable construct, allowing for earlier weight-bearing.

MIS cheilectomy for hallux rigidus (Fig. 6)

Percutaneous dorsal cheilectomy removes dorsal osteophytes to relieve impingement in early hallux rigidus (Grade I–II). The MIS using a wedge burr (straight or conical) approach

Figure 6: Minimally invasive surgery cheilectomy for hallux rigidus.

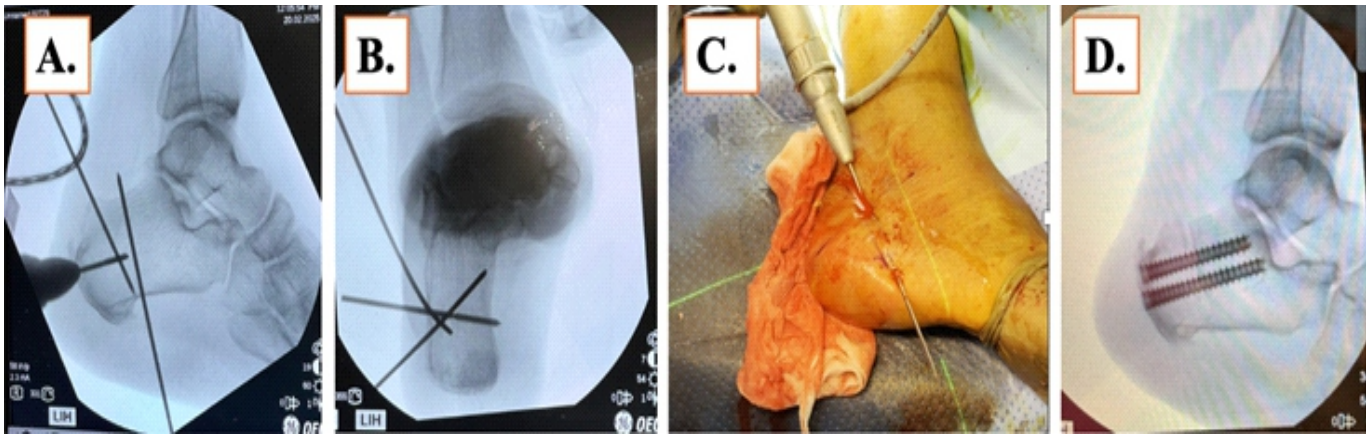

Figure 7: Minimally invasive surgery (MIS) Zadek Osteotomy for Haglund's deformity, (a) K-wires passed for the wedge guidance, (b) axial view checked with calcaneum 3.1 mm×20 mm Shannon burr, (c) clinical image of the Zadek osteotomy with MIS, (d) final (Lat.) post-operative X-ray.

preserves the joint and enhances dorsiflexion while reducing morbidity.

As demonstrated by Buda et al., burr-based MIS cheilectomy showed excellent results in pain reduction and range of motion (ROM) improvement [4]. Using a wedge burr, the stab incision may be used to approach the hallux rigidus and perform a cheilectomy. This helps early intervention in hallux rigidus patients and prevents the eventual anticipatory transformation to MTP fusion.

DMMO

DMMO is a percutaneous osteotomy of the lesser metatarsals using sharp Shannon burrs, used for metatarsalgia and transfer lesions in forefoot overload, which the surgeon may or may not choose to fix as per the case. DMMO avoids joint penetration and hardware fixation, relying on weight-bearing and soft–tissue ligamentotaxis for gradual metatarsal realignment, unlike Weil's osteotomies or open metatarsal osteotomies and fixations.

Redfern and Vernois presented that DMMO significantly reduced post-operative forefoot pain and offloaded overloaded rays in a dynamic, patient-friendly fashion with minimal damage to the soft tissue [3]. DMMO procedures have the advantage of being highly reproducible and ideal for high-volume Indian outpatient setups, and give the patients the advantage of faster recovery and early return to activities in forefoot offloader shoes. DMMO in Indian patients gives the option of earlier mobilization, as a major proportion of the population requires early return to daily activities.

MIS lesser toe deformity correction

Digital deformities (hammer, claw, and mallet toes) can be

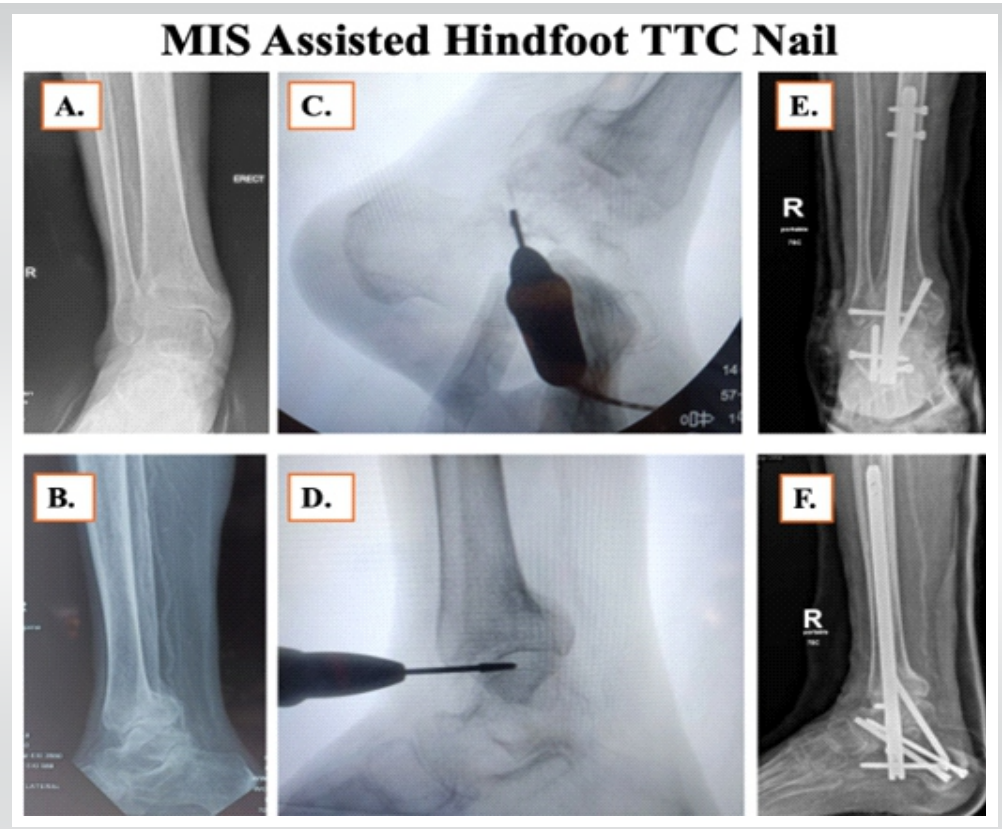

Figure 8: Minimally invasive surgery - assisted Hindfoot tibiotalocalcaneal nail arthrodesis, (a) final (AP) post-operative X-ray, (b) final (Lat.) pre-operative X-ray, (c) wedge burr used for subtalar joint preparation, (d) wedge burr used for ankle joint preparation, (e) final (AP) post-operative X-ray, (f) final (Lat.) post-operative X-ray.

effectively treated with MIS percutaneous phalangeal osteotomies and flexor/extensor tenotomies, especially in elderly or diabetic patients with poor soft tissue envelope, in patients with forefoot distal deformities. Bauer et al. presented significantly high satisfaction rates and minimal post-operative stiffness with these interventions in a prospective study [8].

MIS Midfoot Charcot fusion

India hosts a major proportion of the diabetic population, with increasing awareness and changing lifestyle, and in recent times has observed a significant increase in patients presenting with Charcot arthropathy. With the invention of MIS techniques, Percutaneous MIS midfoot reconstruction has emerged as a viable limb-salvaging option, especially for Eichenholtz Stage II and III Charcot neuroarthropathy. Beam screws are inserted percutaneously after burr-based (wedge burr and long Shannon burrs) joint preparation, reducing risks associated with large incisions in diabetic patients.

Wiewiorski et al. demonstrated that percutaneous midfoot fusion is feasible in carefully selected patients, offering adequate stabilization and deformity correction [7].

MIS calcaneal osteotomies (MDCO, LDCO, and Dwyer's)

MIS calcaneal osteotomies allow correction of cavus or valgus deformities through percutaneous wedge resection or medial displacement under fluoroscopy. These osteotomies maintain peroneal and sural nerve integrity and allow early mobilization. Conti et al. noted equivalent deformity correction with fewer wound complications versus open osteotomies [6].

MIS Zadek osteotomy for Haglund's deformity (Fig. 7)

A dorsal closing wedge calcaneal osteotomy or the Zadek osteotomy may be done percutaneously using a calcaneum Straight–Shannon burr, which offloads the posterior heel while maintaining Achilles integrity; however, with the added advantage of reducing the operative soft-tissue footprint, aiding in early healing and faster recovery [5]. A wedge burr may also be used to percutaneously excise any calcaneal spur or Haglund deformities. It is particularly effective in retrocalcaneal bursitis and Haglund's deformity.

MIS Zadek, described by Redfern, significantly reduces wound-related complications and allows faster recovery in active individuals [5]. Patients can start weight bearing in a walker boot by 2 weeks post-surgery.

MIS hindfoot fusion (subtalar and tibiotalocalcaneal [TTC] fusion) (Fig. 8)

In the Indian scenario, subtalar fusion or TTC fusion very commonly becomes a secondary procedure of choice in case of post-traumatic arthritis or charcot arthropathy affecting the hindfoot; however, this niche of patients often present with very poor skin conditions, hence, percutaneous hindfoot fusions are increasingly gaining popularity as the procedure of choice used for post-traumatic arthritis, hindfoot collapse, and neuropathic joints. Using small portals, the joints are prepared with a burr and stabilized with screws or a hindfoot nail. MIS is exceptionally useful in patients with poor skin conditions, such as post-traumatic skin grafting patients or flaps.

Chan et al. showed that MIS TTC fusion led to comparable union rates and significantly fewer wound complications compared to open approaches [9].

MIS triple arthrodesis

Even triple fusions (subtalar, talonavicular, and calcaneocuboid joints) are now feasible through percutaneous MIS-assisted techniques using MIS (straight and wedge) burrs under fluoroscopy guidance and may be indicated in rigid flatfoot, tarsal coalitions, and severe arthritis secondary to Charcot arthropathy, degenerative arthritis, or post-traumatic arthritis. A study by de Prado et al. noted improved wound healing and similar fusion rates compared to open triple arthrodesis, with

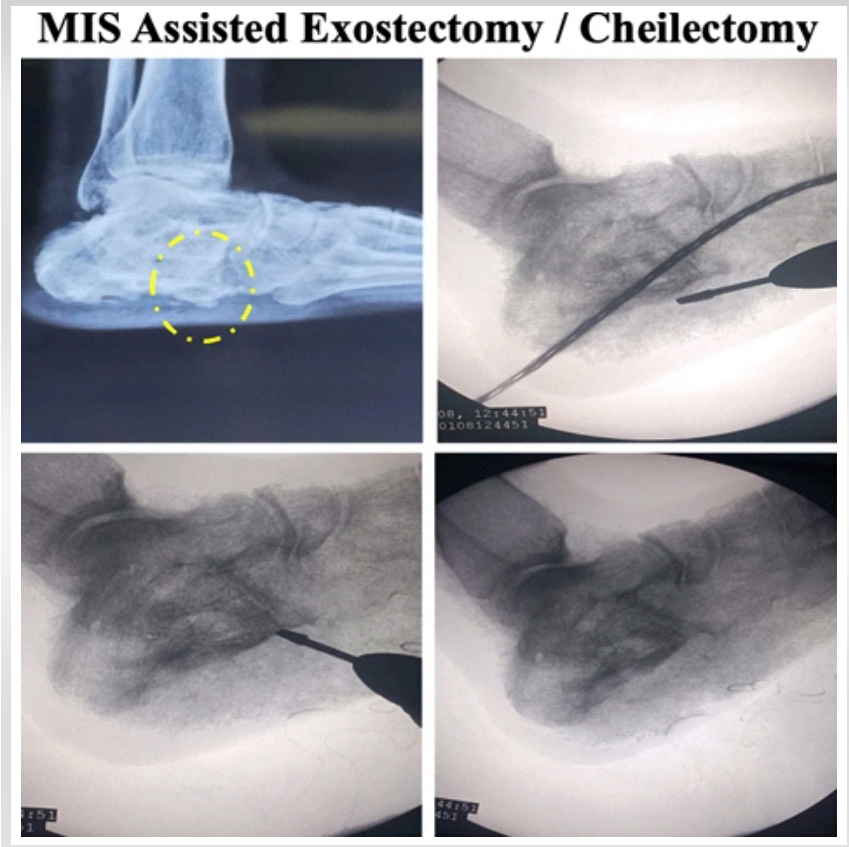

Figure 9: Minimally invasive surgery – assisted exostectomy in Charcot arthropathy using wedge burr.

better cosmetic outcomes [10].

MIS Lapidus fusion

In case of severe 1st TMT (tarsometatarsal) Joint instability or when patients present with severe hallux valgus deformity with TMT hypermobility, MIS Lapidus can be used as a procedure of choice. Using MIS techniques, Sharp, Shannon, and Wedge burrs are used to prepare the 1st TMT joint percutaneously and fused using Screws under fluoroscopy guidance [11].

These techniques significantly reduce soft tissue insult and help manage severe hallux valgus cases with 1st TMT instability percutaneously, which has proven increased fusion rates along with the added advantage of early mobilization in forefoot offloader shoes, thus resulting in early recovery. MIS Lapidus also helps in the correction of intermetatarsal angles and offers enhanced post-operative cosmesis and early recovery [11].

MIS exostectomy (Fig. 9)

Many times, bony prominences or osteophytes, which may be seen in consolidated midfoot charcot arthropathies, post-arthritic growths, retrocalcaneal spurs, Haglund's deformities causing impingement syndromes, or skin contact erosions, the author has found that these can easily be resected using percutaneous exostectomy MIS techniques with a combination of burrs through a 5 mm stab portal with minimal post-operative [12].

This approach is particularly useful in Indian patients with high risk for wound breakdown or in cosmetically sensitive individuals.

MIS Bunionette correction

Bunionette deformity, or Tailor's Bunion, is the deformity of the 5th metatarsal head. Correction with a small stab incision on the lateral aspect of the foot is osteotomized using MIS and translated medially under fluoroscopy guidance [13]. Indian patients are used to wearing narrow footwear, especially women with high weight-bearing demands; these patients become the target population that has the highest potential for benefit from the MIS-assisted surgeries.

Conclusion

In the field of foot and ankle, MIS has successfully ushered a paradigm shift in the addressing of a wide array of conditions, from deformity correction to joint preservation and fusion. MIS offers a very compelling solution in India, which hosts a very diverse patient population with limited resources and a high burden of diabetes-related foot problems, presenting unique challenges.

MIS offers the advantages of reduced soft-tissue insult, shorter recovery duration, reduced incidence of infection, and shorter hospital stays. MIS is not just a technological advancement but a practically feasible and reproducible tool for improving patient outcomes in both urban and rural Indian settings. Procedures such as MIS DMMO, cheilectomy, Zadek osteotomy, hindfoot and midfoot fusion, and triple arthrodesis are steadily proving their efficacy and safety in the Indian context, especially when performed by trained surgeons using proper imaging guidance and armamentarium.

With more and more Indian centers adopting MIS techniques and integrating image-guided systems into surgical practice, the technique is poised to become a cornerstone of modern foot and ankle care. With increasing motivation and emphasis on surgeon training, long-term outcome studies in Indian populations, and adaptation to local healthcare infrastructure will be key to unlocking its full potential.

The future of MIS in India is not just promising – it is necessary.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of Interest: NIL; **Source of Support:** NIL

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