DOI: https://doi.org/10.30795/jfootankle.2026.v20.1966

Technical Tips

Modified posteromedial approach for combined posterior and lateral malleolar fixation in complex ankle fractures: A technical insight apropos a single clinical case

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Abstract

The fixation of posterior malleolar fractures has gained increased relevance over the past decade due to its essential role in restoring ankle joint stability and function. Various approaches and fixation strategies have been described in the literature, typically requiring multiple incisions, thereby increasing the complexity and risk of soft-tissue complications. The aim of this study is to present a technical note describing a single modified posteromedial approach for combined posterior, medial, and lateral malleolar fixation in complex ankle injuries. This technical note outlines the surgical steps of a modified posteromedial approach that enables the fixation of all three malleoli through a single incision. The approach provides access to posterolateral, posteromedial, and medial distal tibial surfaces as well as the lateral malleolus. The technique is demonstrated in a single representative clinical case of a complex trimalleolar ankle fracture.

Level of evidence V; Expert Opinion.

Keywords: Ankle fractures; Fracture Fixation, Internal; Orthopedic Procedures.

Introduction

Posterior malleolar fractures are complex injuries that require precise management to restore ankle congruency, joint stability, and function[1,2]. Traditionally, several surgical approaches and fixation techniques have been developed to address these fractures, including anterior-to-posterior fixation with lag screws and buttressing plates via posterolateral and/or posteromedial approaches[1,2]. However, these methods often require multiple incisions, potentially increasing surgical complexity and the risk of soft-tissue-related complications[1,3-5].

The posteromedial approach and, more recently, the modified posteromedial approach have emerged as valuable options for treating posterior malleolar fractures, offering direct access to the fracture with the advantage of a wider exposure of the posterior surface of the distal tibia. The posteromedial approach allows for effective visualization and reduction of posterior malleolar fragments (posterolateral, posteromedial, or both), making it a helpful choice in specific clinical scenarios[4]. Furthermore, the modified posteromedial approach offers a better attack angle than the traditional posterolateral approach for reducing small intercalary depressed fragments, which are frequently associated with posterior malleolar fractures[3]. Despite its potential advantages, the modified posteromedial approach is typically underutilized for combined posterior and lateral malleolar fixation, with the posterolateral approach being more commonly employed[2].

Study performed at the Department of the Locomotor System. Federal University of Minas Gerais, Belo Horizonte, MG, Brazil.

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How to cite this article: Pesántez R, Noguera AS, Pires RE. Modified posteromedial approach for combined posterior and lateral malleolar fixation in complex ankle fractures: A technical insight apropos a single clinical case. J Foot Ankle. 2026;20(1):e1966.

The posterolateral approach provides access to both the lateral malleolus and the posterolateral fragment of the posterior malleolus. However, it poses limitations in addressing posteromedial fragments due to restricted visibility. Moreover, the posterolateral approach can be associated with difficult rehabilitation for ankle dorsiflexion gain[3-7]. Consequently, there is a perspective to explore an alternative approach that can offer comprehensive fixation for both lateral and posterior malleolar fractures through a single incision

This study hypothesizes that combined lateral and posterior malleolar fixation can be effectively achieved through a single modified posteromedial approach. This technique aims to avoid the need for an isolated lateral approach and to mitigate the disadvantages of the posterolateral approach, particularly its limitations in addressing posteromedial and depressed intercalary fragments.

Methods

Informed consent and ethical approval were obtained for publication of the article.

Indications and surgical strategy

The modified posteromedial approach is indicated for pilon fractures with posterior components and for posterior malleolar fractures, including isolated posteromedial or posterolateral fragments, combined posteromedial and posterolateral fragments, and a single unique posterior malleolus extending across the entire posterior surface of the distal tibia. In this technical note, we thoroughly describe a technique to address combined lateral, posterior, and medial malleolar fractures using a single modified posteromedial approach.

Depending on the trauma energy and the soft-tissue condition, fixation can be performed in two stages, with a transarticular external fixation until the wrinkle sign appears, allowing for safe internal fixation.

Surgical technique

The patient is typically positioned prone, and a lazy-L skin incision is made 1 cm medial to the Achilles tendon insertion and extends proximally for about 15 cm along the medial border of the Achilles tendon. Distally, we continue the incision in a lazy-L fashion posterior and distal to the medial malleolus to expose the anteromedial tibia and address the medial malleolus and medial comminution. Then, we approach the superficial fascia to expose the Achilles tendon and the distal part of the soleus muscle. The Achilles tendon and its sheath are retracted laterally, and the posterior tibialis tendon is retracted medially, to expose the transverse intermuscular septum (the floor of the superficial posterior compartment) and open it longitudinally to access the deep posterior compartment. The posterior surface of the distal tibia is approached through the plane between the flexor hallucis longus (FHL) and the neurovascular bundle (NVB) (tibial nerve and posterior tibial artery). Care must be taken to protect the NVB throughout the procedure, and all efforts must be made to avoid excessive traction on the NVB and the soft tissues, especially when addressing the posterolateral fragment and the lateral malleolus using Hohmann retractors. To address the posterolateral surface of the distal tibia and the lateral malleolus, it is strongly recommended to extend the skin incision proximally by at least 10 cm. The proximal extension of the skin incision prevents excessive traction on the NVB. This proximal extension facilitates the exposure of the lateral aspect of the ankle. Short skin incisions require excessive traction on the soft tissues, increasing the risk of complications[7].

This approach enables the creation of multiple windows for fragment-specific fixation, carefully preserving soft tissues to minimize the risk of damage to the NVB. These windows, in addition to the reduction and the fixation strategies, will be described in detail below:

1. Identify the lateral border of the FHL and retract it medially to assess and reduce the posterolateral fragment and the lateral malleolus. Retracting the peroneal tendons laterally can help in exposing the fibula to fix the fractures.
2. Identify the medial border of the FHL and the NVB (protect the NVB using a vessel loop); retract the FHL laterally and the NVB medially to expose the posteromedial fragment.
3. Identify the lateral border of the flexor digitorum longus (FDL) tendon medially to the NVB to expose the medial border of the posteromedial fragment.
4. Identify the sheath and tunnel of the posterior tibialis tendon and, if necessary, open it to retract the tendon.
5. Anterior to the posteriorly opening tibialis sheath, the medial malleolus is exposed up to the anteromedial tibia. In cases of medial malleolus fractures, everting the medial malleolus can help in assessing impaction on the distal tibia medially and to assess articular reduction of the posterior malleolus.

Figure 1 illustrates three of the five possible windows for treating the posterior ankle fractures. The posterior malleolus is addressed first, reduced using a ball-spike pusher, and provisional key wires are applied, avoiding the area designated for plate placement. If impacted articular fragments of the posterior malleolus are present, the open book technique should be applied to reduce the impaction and fix the fracture.

Table 1 outlines the five potential windows for addressing posterior ankle fractures.

Fixation of the posterior malleolus is performed using isolated or combined 2.4- or 2.7 mm minifragment plates in a buttressing fashion, depending on the fracture pattern. Either straight, hook, or T-shaped plates can be utilized, depending on the specific requirements of the fixation.

Using a Hohmann retractor placed on the posterolateral surface of the lateral malleolus, the fibula can be addressed and reduced with small pointed clamps. A posterior straight

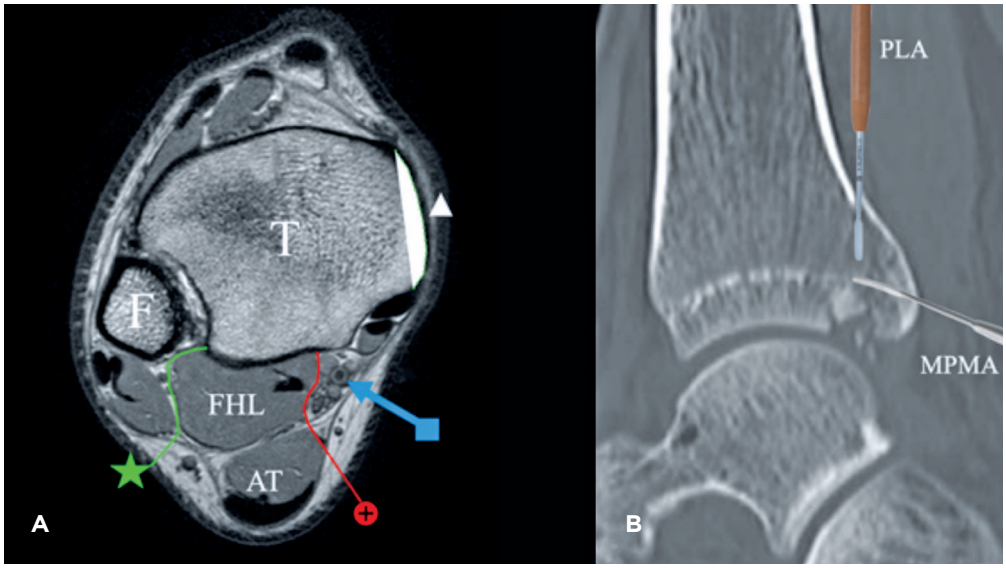

Figure 1. (A) Axial magnetic resonance imaging of the ankle illustrating the following structures: Tibia (T), Fibula (F), Achilles tendon (AT), and flexor hallucis longus (FHL). The green star and line represent the window to approach the posterolateral surface of the tibia and fibula. The red cross and line indicate the window between the FHL and the neurovascular bundle, which addresses the entire posteromedial surface of the distal tibia. The blue square and arrow identify the neurovascular bundle, while the white triangle marks the anteromedial aspect of the tibia, located anterior to the posterior tibialis tendon. (B) Note the difference in the reduction angles for the intercalary fragment between the posterolateral approach (PLA) and the modified posteromedial approach (MPMA). Observe that the reduction angle is more favorable when using the MPMA.

Table 1. Observe the anatomical windows that can be developed to address the posterior aspect of the ankle

Window	Interval	Application
1st	Peroneal tendons – FHL	Fibula/lateral malleolus Posterolateral fragment
2nd	FHL – NVB	Posterolateral fragment
3rd	NVB - FDL	Posterolateral fragment
4th	TPT subluxated medially – FDL laterally	Posterior colliculus
5th	FDL/TPT retracted laterally	Anterior colliculus Medial malleolus

FHL: Flexor hallucis longus; NVB: Tibial neurovascular bundle; TPT: Tibialis posterior tendon.

2.4 mm or 2.7 mm minifragment plate is then used to fix the fibula in a buttressing fashion. Wagstaffe fragments, anterior malleolar fractures, and equivalents (quadrimalleolar ankle fractures) can be addressed by flexing the knee and performing additional anterior approaches in an upside-down manner. If syndesmotic fixation is required, it can be performed as usual, applying either rigid or elastic constructs.

Postoperative rehabilitation protocol

The postoperative rehabilitation protocol includes early range of motion exercises. Weight-bearing is allowed with crutches and ankle protection in a boot, starting with touch-down weight-bearing and progressively increasing weight as the fracture heals. Full weight-bearing is permitted after complete fracture healing, typically around 6-8 weeks.

Case 1 illustrates the surgical technique

A 52-year-old male patient suffered a rotational injury to his left ankle following a fall down stairs. Upon admission to the emergency department, he was diagnosed with a dislocation and trimalleolar ankle fracture (AO/OTA 44B3.2). After closed reduction in the emergency department, immobilization was applied, and a computed tomography scan was performed to assess the fractures in detail. When soft tissues were amenable to open reduction internal fixation (on the sixth day), surgery was performed using a modified posteromedial

approach as described by Assal et al.[3,4], extending anteriorly with the windows described by Wang et al.[5]. Figures 2 and 3 provide an overview of the preoperative imaging.

Five windows were utilized to achieve adequate reduction and fixation of the fibula, posteromedial and posterolateral aspects of the tibia, and the medial malleolus (Figures 4-6).

Figure 2. (A) Radiographs of the left ankle demonstrating the fracture dislocation. (B) Radiographs of the ankle after reduction and provisional immobilization with a cast. (C) Axial computed tomography scan illustrating the complexity of the posterior malleolar fracture. (D) Coronal computed tomography scan illustrating the trimalleolar fracture. (E) Sagittal computed tomography scan illustrating the posterior malleolar fracture.

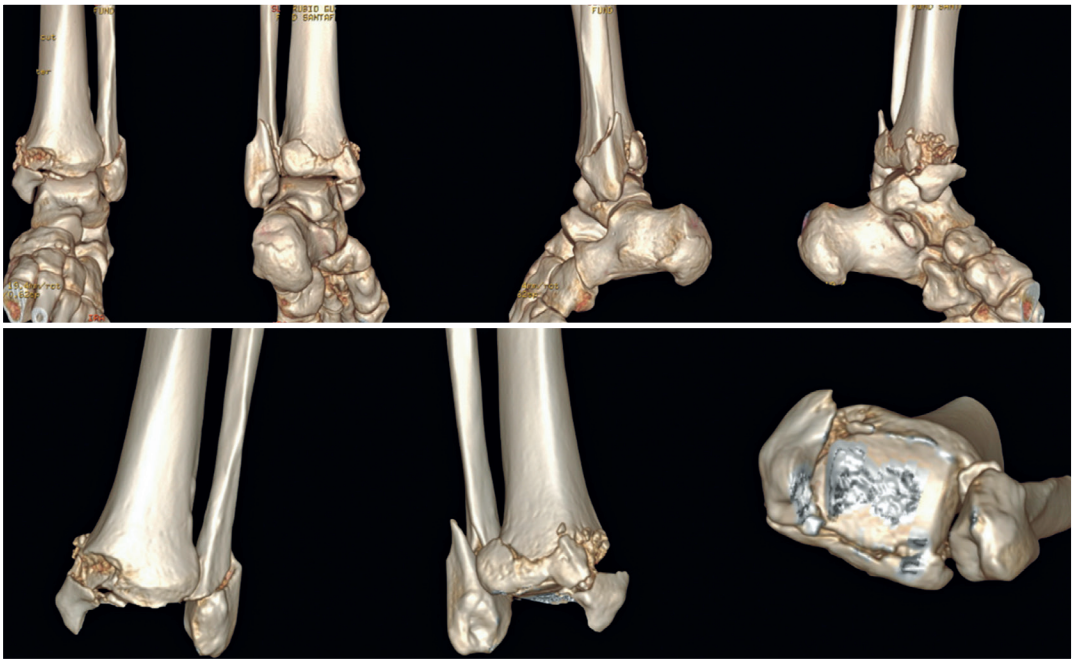

Figure 3. Three-dimensional computed tomography scan showing a trimalleolar fracture with detailed visualization of the fracture components.

Figure 6 illustrates the radiographs and the clinical aspect of the ankle after fracture healing.

Discussion

The fixation of posterior malleolar fractures has gained attention in recent years due to the crucial role these fractures play in ankle stability and function[1]. Traditional approaches, such as anterior-to-posterior fixation with lag screws and the use of posterolateral and posteromedial buttressing plates, have provided various strategies to address these complex injuries[1]. The posterolateral approach, in particular, has been widely adopted for its effectiveness in accessing both the lateral malleolus and the posterolateral fragment of the posterior malleolus[2]. However, this approach has limitations in addressing posteromedial fragments and can complicate rehabilitation due to restricted ankle dorsiflexion[3-7]. Moreover, impacted fragments of the posterior malleolus are challenging to address using posterolateral approaches due to the unfavorable angle to achieve and maintain reduction of the impacted fragment[1].

Our study focuses on the modified posteromedial approach, which has demonstrated significant advantages in treating posterior malleolar fractures. This approach allows direct visualization and effective reduction of the posterior malleolus while minimizing soft-tissue disruption. Assal et al.[3,4] have highlighted the benefits of this approach in providing a comprehensive view of the posterior tibia and facilitating the management of complex fracture patterns.

Assal et al.[4] compared exposure to the distal tibia using three approaches: posterolateral, posteromedial, and a modified posteromedial approach. The study found that the posteromedial approach provides superior exposure to the medial and central parts of the posterior malleolus, with a coverage of 83% and 61%, respectively, while the posterolateral approach offers better access to the lateral and central parts, covering 86% and 68%, respectively. However, the modified posteromedial approach combines

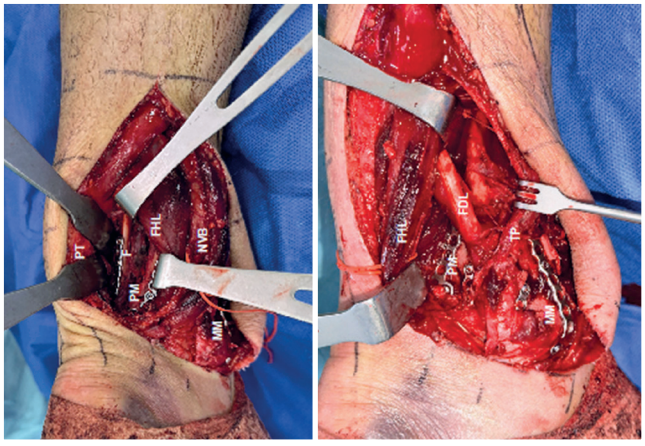

Figure 4. Intraoperative images highlighting the anatomical landmarks and the potential windows accessible through the modified posteromedial approach. **PT:** Peroneal tendons, **F:** Fibula, **PM:** Posterior malleolus, **FHL:** Flexor hallucis longus, **NVB:** Neurovascular bundle, **MM:** Medial malleolus, **FDL:** Flexor digitorum longus, **TP:** Tibialis posterior.

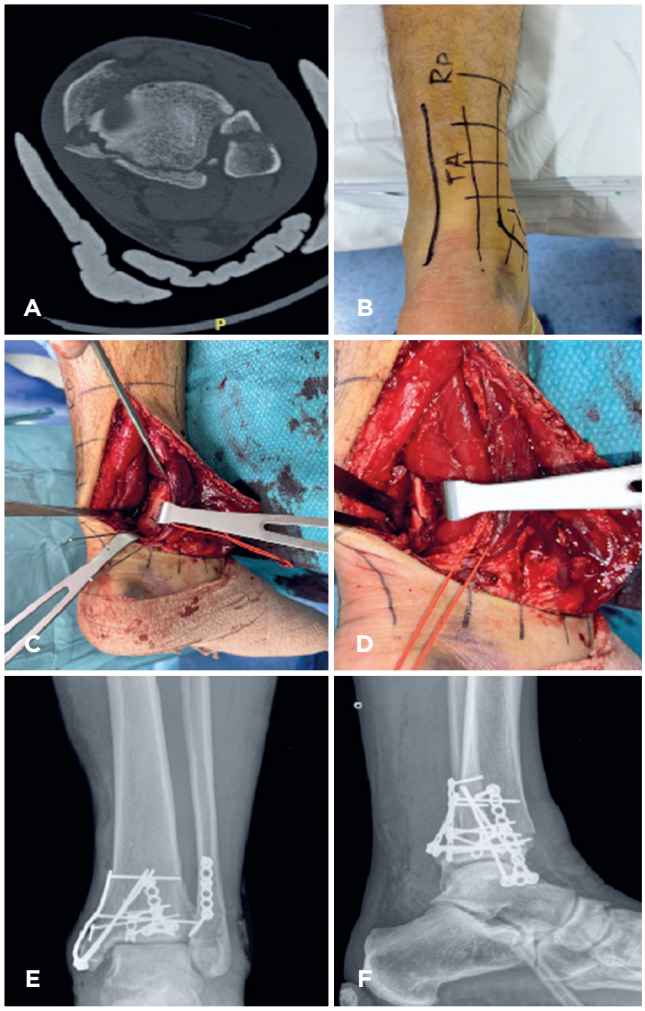

Figure 5. Technique used for the reduction and fixation of the trimalleolar fracture through the single modified posteromedial approach. (A) Axial computed tomography scan of all fracture components involving the posterior, medial, and lateral malleolus; (B) Preoperative skin marking; (C) Provisional fixation of the posteromedial fragment with K wires. Observe the interval between FHL and NVB; (D) Exposure of fibula fracture. Peroneal tendons are retracted laterally and FHL medially; (E-F) Final radiograph images. A buttress plate was applied to the lateral posterior malleolar fractures. The medial malleolus was fixated with an anti-gliding plate and two bicortical screws placed from the anteromedial to the posterolateral direction.

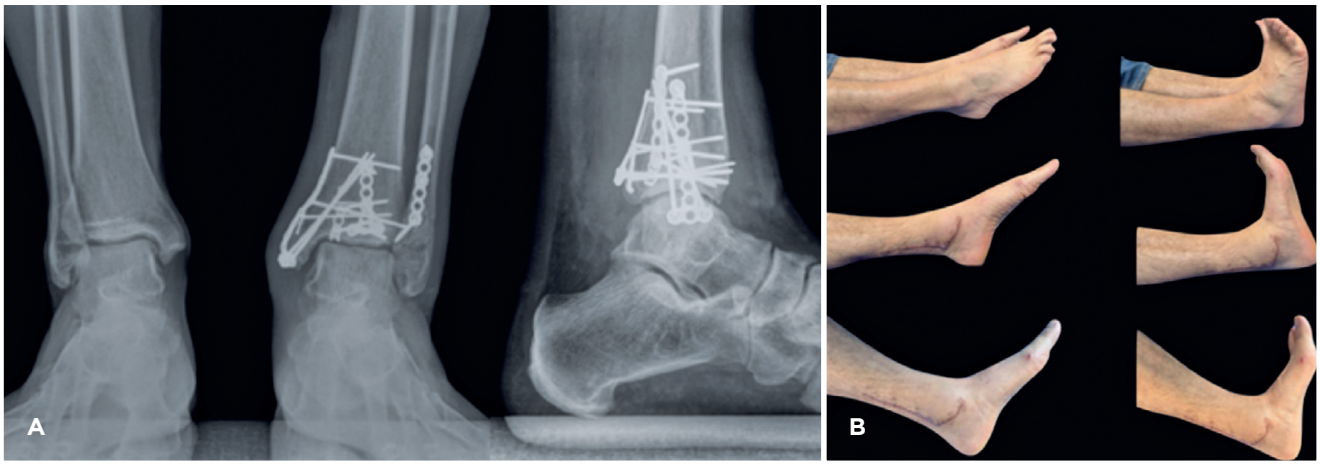

Figure 6. (A) Full-weight-bearing follow-up radiographs four months after surgery. (B) The surgical wound was completely healed at four months postoperatively, and ankle motion was clinically functional and nearly symmetrical when compared with the contralateral side.

the benefits of both, allowing for extensive visualization of the entire posterior surface of the distal tibia with an overall coverage of 92%. This comprehensive exposure is particularly advantageous for addressing combined fractures involving both posteromedial and posterolateral fragments, as it reduces the need for multiple incisions and minimizes the risk of soft-tissue complications.

Furthermore, Wang et al.[5] and Bois and Dust[7] have shown that the modified posteromedial approach can be safely used to address posterior pilon fractures and posterior fracture-dislocations of the ankle, respectively.

Although the posteromedial approach primarily utilizes the window between the NVB and the FHL, Mitsuzawa et al.[8] demonstrated in an anatomical study that the tension over the NVB generated by soft-tissue retraction with the modified posteromedial approach is lower compared to the posterolateral or the classic posteromedial approach.

There are some limitations of our study that deserve to be highlighted. The primary limitation is the lack of a comparative analysis with other surgical approaches, which would provide a more comprehensive understanding of the relative advantages and disadvantages of the modified posteromedial approach. Additionally, this is a technical note with limited evidence, requiring long-term follow-up and larger sample sizes to adequately evaluate the true benefits of a single posteromedial approach to address both posterior and lateral malleolar fractures. Despite recommending the proximal extension of the skin incision to prevent skin necrosis and excessive traction on soft tissues, such complications may still occur. Furthermore, the literature requires confirmation of the hypothesis that the rehabilitation process is indeed easier with posteromedial approaches than with posterolateral ones, particularly in achieving dorsiflexion of the ankle.

However, one of the key strengths of our study is the detailed technical description of the single modified posteromedial approach for combined posterior and lateral malleolar fixation. Potential benefits of this technique include avoiding the need for an isolated lateral approach and mitigating the disadvantages associated with the posterolateral approach, particularly its limitations in addressing posteromedial fragments[9-13]. In addition, proximal extension of the skin incision may facilitate exposure and reduce the risk of complications from excessive soft-tissue traction. As previously mentioned, the modified posteromedial approach also appears to provide a more favorable angle for reducing impacted posterior malleolar fragments[9-13].

Conclusion

We describe the use of a single modified posteromedial approach in a limited clinical scenario. In this case, the approach allowed adequate visualization and reduction of the fractures while avoiding additional surgical incisions. However, given the nature of this report and its inherent methodological limitations, these findings cannot be generalized. Future studies with larger sample sizes and comparative analyses are needed to further validate the safety and efficacy of this promising technique.

Authors' contributions: Each author contributed individually and significantly to the development of this article: RP*(https://orcid.org/0000-0002-5728-3115) Conceptualization, investigation, patient management, supervision, writing, editing; ASN *(https://orcid.org/0000-0002-9749-2624) Investigation, patient management, editing; REP *(https://orcid.org/0000-0002-3572-5576) Conceptualization, investigation, writing, editing, drawing of illustrations, reviewing. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID).

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