A Simple Approach for Guiding the Direction of Bone Drill During Intramedullary Reaming in Indirect Fibular Groove Deepening: A Technical Tip

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Bin Wang[1], Bin Zhang[2]

[1]Department of Orthopaedics, Mianzhu City People's Hospital, 618200 Mianzhu, Sichuan, China
[2]Department of Orthopaedics, Sichuan Provincial People's Hospital, 610000 Chengdu, Sichuan, China

Various techniques have been developed to treat peroneal tendon subluxation or dislocation, including superior peroneal retinaculum (SPR) reinforcement and repair, tendon rerouting, tissue transfer, bone blocking, groove deepening, and indirect groove deepening. Indirect fibular groove deepening is typically performed by accessing the intramedullary cavity through the distal fibula. Precise control of drilling direction and depth during intramedullary reaming is critical. In this paper, we introduce a novel technique to guide the direction of the bone drill during indirect fibular groove deepening. This method improves upon the existing indirect fibular groove deepening technique, offering an economical, simple, and equipment-independent solution.

Keywords: peroneal tendon subluxation; peroneal tendon dislocation; fluoroscopy-guided groove deepening; fibular groove; case report

Introduction

Peroneal tendon subluxation or dislocation is an uncommon cause of ankle pain and functional impairment. Peroneal tendon subluxation, which accounts for only 0.3–0.5% of lateral ankle injuries, is prone to diagnostic oversight in clinical practice. In the absence of definitive surgical management, persistent dislocation may progress to recurrent subluxation and chronic ankle instability, thereby predisposing patients to develop persistent pain syndromes secondary to biomechanical derangement [1]. First described by Monteggia in 1803 in a ballet performer [2], this condition has led to the development of various therapeutic strategies [3–14]. Current surgical interventions for peroneal tendon subluxation can be divided into three categories: soft tissue reconstruction, fibular ligament restoration, and bone groove deepening [15]. Among these, our preference is the indirect groove deepening technique.

Shaween and Anderson pioneered the indirect groove deepening protocol [11], which involves introducing a large-diameter drill bit into the fibular apex to expand the posterior intramedullary channel. After reaming the distal fibula's cancellous bone, a bone tamp compresses the posterior cortex into a deepened trough while preserving the overlying retinaculum, positioning the peroneus brevis and longus tendons within the recessed groove. However, a significant limitation of this technique is the inability to precisely control drilling trajectory and depth, which potentially results in an asymmetrical peroneal groove.

Fig. 1. Implantation of a Kirschner wire at the tip of the lateral malleolus.

To address these challenges, we modified the technique by introducing a fluoroscopy-guided intramedullary wire placement system (Figs. 1,2), enabling real-time trajectory monitoring through three key components: (1) distal-to-proximal wire alignment parallel to fibular axis, (2) graduated cannulated reaming incremental sizing, and (3) tactile feedback-based cortical thinning. With this modification, we propose a refined method for directional control of the bone drill during intramedullary reaming. This modified protocol allows real-time adjustments of drilling orientation, eliminates the need for specialized instrumentation or ancillary staff, and incurs no additional costs. This

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Correspondence to: Bin Zhang, Department of Orthopaedics, Sichuan Provincial People's Hospital, 610000 Chengdu, Sichuan, China (e-mail: zbxva123@163.com).

Fig. 2. Placing an intramedullary guide pin in a distal-to-proximal orientation inside the fibula, parallel to the axis of the fibula, during intramedullary reaming.

study aims to: (i) develop a fluoroscopy-assisted directional control protocol, reducing groove asymmetry compared to conventional techniques; (ii) validate its clinical efficacy through quantitative metrics (American Orthopedic Foot and Ankle Society (AOFAS) score); and (iii) establish a reproducible learning curve model for surgical training.

Case Report

The patient is a 21-year-old male. He was admitted to the hospital on 20 January 2021 due to left peroneal tendon dislocation. One month before admission, the patient suffered from left ankle sprain and was immobilized with a plaster cast. During the immobilization period, he also experienced fibular tendon dislocation. Following some relevant preoperative examinations, the patient underwent surgery on 26 January 2021. The patient had no history of diabetes, hypertension, or other diseases, nor had he undergone any surgeries previously. He was diagnosed with left peroneal tendon subluxation (Figs. 3,4), but he reported no history of peroneal tendon subluxation prior to the injury.

During the surgery, the patient was positioned laterally, with a pneumatic tourniquet applied to the thigh at 245 mmHg. A 5–6 cm longitudinal incision was made along the posterior fibular margin. Superior peroneal retinaculum (SPR) was identified 4–5 cm distal to the fibular tip. A 3 mm tissue cuff was preserved for subsequent soft tissue approximation.

This case has been reported in line with the case report guidelines: Case Report (CARE) Guidelines to ensure the accuracy and completeness of the report (**Supplementary Material**).

Fig. 3. Peroneal tendon subluxation prior to operation. As indicated by the arrow in the picture: when the foot is plantar-flexed, the peroneal tendon can be seen to be dislocated.

Fig. 4. Magnetic resonance imaging revealing an injury to the superior peroneal retinaculum of the patient. As indicated by the arrow in the picture: the swelling and damage shown in the upper support band of the fibula.

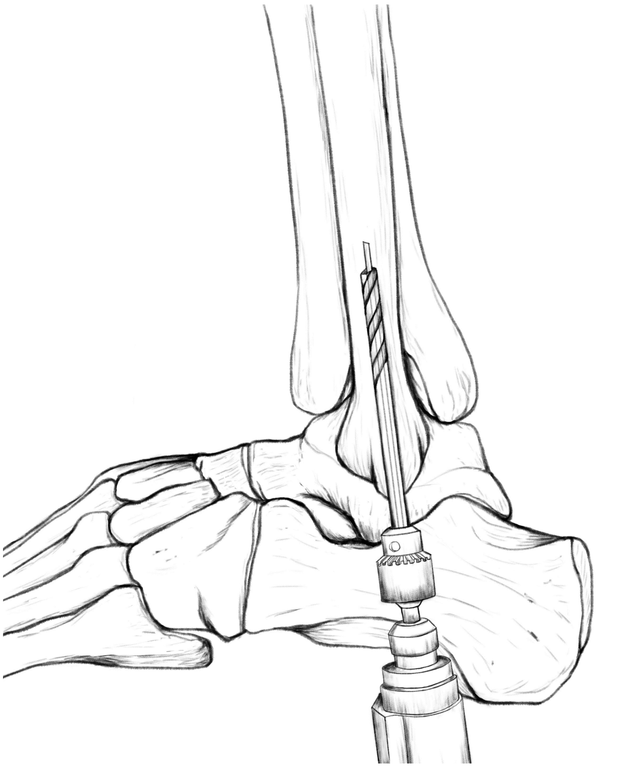

Fig. 5. Sequential intramedullary reaming to an appropriate size over the guide pin. A 2.7–5.8 mm hollow drill was used for progressive reaming.

Fig. 6. Making saw marks on the edges of the lateral and medial sides of the fibular groove using a saw blade.

After exposing the distal fibular apex, a minimal entry portal was created to facilitate sequential intramedullary reaming while protecting the calcaneofibular ligament. A Kirschner wire was inserted from the tip of the lateral malleolus. Using this Kirschner wire as the guiding needle, a hollow drill was subsequently inserted (Figs. 1,2). An intramedullary guidewire was inserted in a distal-to-proximal orientation, parallel to the fibular axis (Figs. 1,2). Progressive canal enlargement was performed using a 2.7–5.8 mm

Fig. 7. Closing of the superior peroneal retinaculum over the outer margin of the groove through suture anchors into the fibula.

cannulated drill system (Fig. 5). The cavity was expanded to the sub-cortical layer of the peroneal groove. Saw marks were made using a 1-mm thick saw blade along the inner and outer edges of the fibular groove without cutting through the cortical bone (Fig. 6). A small bone hammer was used to gently tap the fibular groove, causing it to collapse evenly and deepen. The long and short tendons of the peroneus muscles were reset to ensure that the peroneus tendons could slide smoothly without any obstructions. Special attention was given to inward compression of the distal fibular tip to prevent abrasive tendon contact during foot motion.

Fig. 8. Dorsiflexion of ankle joint.

Following fibular groove deepening, anatomical reduction of the peroneal tendons was achieved concurrently. A 3.5-mm suture anchor was secured to the posterolateral aspect

Fig. 9. Plantarflexion of ankle joint.

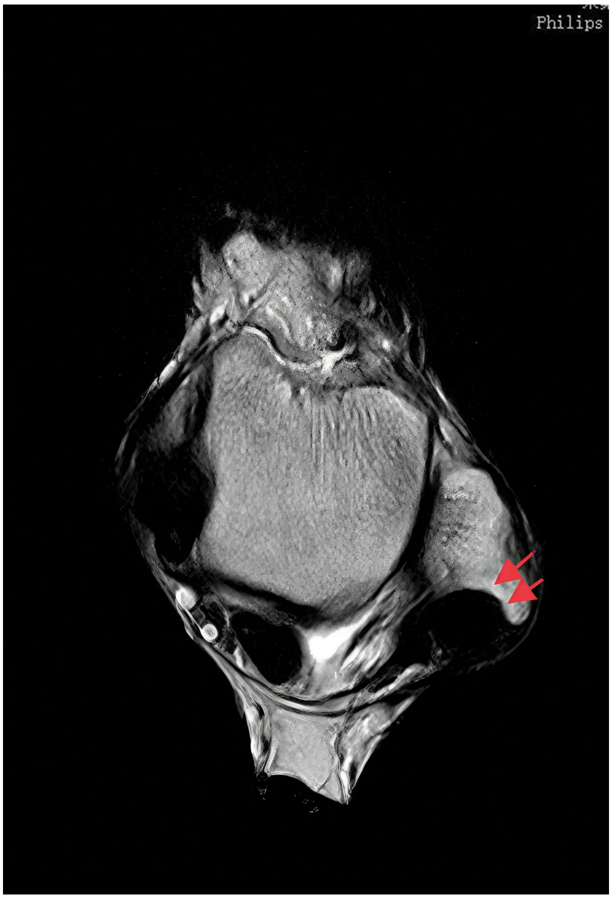

Fig. 10. A magnetic resonance imaging examination showing that the fibular tendon had filled up the deepened fibular groove in the ankle joint. As indicated by the arrow in the picture: the deepened fibular groove.

of the fibular malleolus, enabling reapproximation of the tension of the overlying peroneal retinaculum (Fig. 7). The lateral fibular deep fascia was subsequently plicated and reinforced with overlapping sutures to augment structural integrity. Intraoperative dynamic assessment through full ankle range of motion confirmed maintained tendon reduction without evidence of subluxation. The procedure was concluded with a standardized layered closure.

After the operation, the ankle joint was fixed in functional position with plaster for 3 weeks. After the plaster was removed, the patient was instructed to do active exercises for ankle flexion, extension and eversion to relieve ankle stiffness. At the 1-year follow-up, the patient showed no signs of peroneal tendon subluxation when dorsiflexing and plantarflexing his ankle joint (Figs. 8,9). One year after the surgery, a magnetic resonance imaging (MRI) examination of the ankle joint showed that the fibular tendon had filled up the deepened fibular groove (Fig. 10). Functional score for the patient was measured using the AOFAS scale at 1 year after the operation. The test revealed an increase in the ankle-hindfoot score from 54 points before the operation to 92 points one year after the operation.

Figs. 8,9 depict dorsiflexion and plantarflexion of the patient's ankle joint, revealing no signs of peroneal tendon subluxation.

Discussion

While no consensus exists for treating acute peroneal tendon dislocation, chronic recurrent instability typically requires surgical management. Although numerous surgical options are available [3–14], our modified indirect groove deepening technique offers distinct advantages. This approach combines precise drill guidance with SPR reconstruction, providing a reproducible protocol that enhances stability, facilitates early rehabilitation, and minimizes complications.

Preserving the fibular groove's serosal lining ensures optimal tendon lubrication and nutrient diffusion [16], while groove deepening improves biomechanical stability. The technique integrates SPR advancement with intramedullary reaming by repositioning the preserved retinaculum over the deepened groove using suture anchors. This combination ensures anatomical containment of the peroneal tendons while leveraging the mechanical depth of the groove for enhanced stability.

Meticulous dissection anterior to the sural nerve minimizes iatrogenic injury risks. The technique's simplicity, low complication profile (e.g., reduced swelling), and reproducible tendon reduction capacity [15] underscore its clinical utility. By maintaining retinacular integrity posteriorly, tendon adhesion risks are reduced. Limited fibular tip disruption further ensures minimal postoperative edema or hematoma formation. Compared with direct groove deepening or bone block augmentation, our technique avoids excessive cortical disruption, preserves anatomical contours, and minimizes the risk of postoperative adhesions. Unlike procedures requiring specialized guides or jigs, our method offers real-time drill adjustment using standard surgical tools.

While our modified indirect groove deepening technique demonstrates promising outcomes, several limitations warrant consideration. First of all, the study lacks longitudinal data to confirm the durability of groove deepening and tendon stability beyond the immediate postoperative period. Recurrent subluxation risks, particularly under high-stress conditions (e.g., athletic activities), remain unquantified. Secondly, precision in drill trajectory and cortical thinning requires familiarity with intramedullary reaming techniques. Surgeons inexperienced in directional drill control may risk asymmetrical groove formation or inadvertent cortical perforation, which potentially compromises the outcomes. Our surgical training recommendations address the technique's key complexities—intramedullary trajectory control, cortical thinning precision, and dynamic stability assessment—through a structured educational framework [17,18]. This framework integrates fluoroscopic-guided simulation (≤5° axis deviation), cadaveric practice (1 mm cortical preservation), and supervised clinical application, ensuring surgeons master the directional reaming and groove deepening critical to the method's efficacy. The proposed 4–5 simulated cadaveric procedures align with orthopedic skill acquisition studies, where 3–6 repetitions of intra medullary reaming in cadaveric models achieve basic trajectory control proficiency. This range balances cost and skill retention: fewer than three trials risk inadequate learning, while more than five offer diminishing returns. Cadaveric studies of ankle surgery offer further validation for the training protocol in refining bone tunnel placement and cortical thinning. The training protocol comprises three stages: (i) 2–4 hours of fluoroscopic-guided guidewire practice to achieve ≤5° fibular axis deviation (verified by 10 consecutive successful placements); (ii) 4–6 hours of cadaveric simulation focusing on 1 mm cortical preservation and tactile reaming control (assessed with ≤2% cortical breach rate and <0.5 mm groove depth symmetry); (iii) 3–4 supervised clinical cases (2–3 assisted procedures, 1–2 independent procedures), with <3° guidewire error, >95% groove symmetry, and ≥30-point AOFAS score improvement in 3 months.

Conclusions

The present study introduces a simple approach to guiding the direction of bone drill during intramedullary reaming in indirect fibular groove deepening. This technique incorporates three main technological innovations: (1) real-time fluoroscopy is used to confirm the alignment of the intramedullary guide needle along the anatomical axis of the fibula; (2) a gradually expanding hollow drill (2.7–5.8 mm) is used to gradually enlarge the medullary cavity while maintaining a 1 mm posterior cortical bone margin under dynamic X-ray monitoring; (3) intraoperative dynamic stress checks are conducted to verify the stability of the fibular tendon. In this clinical study, the scheme demonstrated a continuous anatomical tendon positioning effect at the 1-year follow-up, and the patient experienced no recurrent subluxation of the fibular tendon. This technique requires no additional special equipment, utilizes conventional fluoroscopy guidance, and provides an economical, efficient, and biomechanically optimized solution for fibular tendon stabilization.

Availability of Data and Materials

The data analyzed are available from the corresponding author upon reasonable request.

Author Contributions

BW performed the operations. Data collection and material preparation were performed by BW and BZ. First draft of the manuscript was written by BW, then BZ commented on important changes to its final version. Both authors gave final approval of the version to be published. Both authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

It was conducted adhering to the guidelines of the Declaration of Helsinki and was officially approved by the Ethics Committee of Mianzhu City People's Hospital (with the Approval Number being 2020-X-042). After being informed about the study's aims, all patients gave their informed consent.

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Conflict of Interest

The authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.62713/aic.4079.

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