Technical Note

Endoscopic Revision Subtalar Arthrodesis

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Abstract: Varus malunion after subtalar arthrodesis is considered to be the worst deformity in hindfoot alignment. Poor clinical outcome is expected if there is more than 10° of varus malunion with lateral column overload. Open revision subtalar arthrodesis is associated with high rates of complications, especially involving soft tissue and nonunion. The purpose of this Technical Note is to describe the technical details of endoscopic revision subtalar arthrodesis in which the correction of varus malunion is performed with a minimally invasive technique, which may reduce the risk of soft tissue complications and nonunion.

Subtalar arthrodesis is an effective treatment for pathology of the hindfoot including post-traumatic arthritis, talocalcaneal coalition, posterior tibial tendon dysfunction, isolated subtalar joint instability, and inflammatory arthritis.[1] The aims of a subtalar arthrodesis are to treat constant pain by immobilization of the subtalar joint and to restore a painless and plantigrade foot that allows normal weight bearing with the fewest mobility limitations.[2] Bone block distraction arthrodesis of the subtalar joint can be performed to correct combined decreased heel height and hindfoot deformity associated with late complications of calcaneal fractures, nonunion, and/or malunion after subtalar joint arthrodesis; Charcot neuroarthropathy; and avascular necrosis of the talus.[3] Correct hindfoot alignment is one of the most important parameters required for a good outcome after subtalar arthrodesis.[1] However, malunion can occur in arthrodesis with or without bone block distraction, regardless of whether an open or arthroscopic technique is used for the procedure.[1,3,4]

Varus malunion after subtalar arthrodesis is considered to be the worst deformity in hindfoot alignment.[1] Poor clinical outcome is expected if there is more than 10° of varus malunion with lateral column overload.[1,5] Rotational periarticular wedge-shaped Dwyer calcaneal osteotomy has been proposed for correction of untreated loss of heel height and varus heel deformity after subtalar arthrodesis.[5] However, the correction is not at the apex of the deformity. Open revision arthrodesis is the standard procedure for correction of varus malunion after subtalar arthrodesis, and the correction is required at the apex of the deformity.[1,3,4] Open subtalar arthrodesis is associated with high rates of complications, especially involving soft tissue (necrosis, infection, saphenous nerve lesion) and nonunion.[6] Arthroscopic primary subtalar arthrodesis has been popularized as a means of improving open methods by using a minimally invasive technique, which theoretically preserves blood supply and reduces perioperative morbidity.[7] It significantly reduces rates of nonunion and soft tissue complications in patients undergoing primary subtalar arthrodesis.[6]

Table 1. Indications and Contraindications for Endoscopic Revision Subtalar Arthrodesis

Indications	Contraindications
1. Symptomatic varus malunion after subtalar arthrodesis	1. Valgus heel deformity 2. Significant limb length discrepancy 3. Severe varus deformity 4. Presence of implants requiring extensive incisions for removal 5. Markedly decreased heel height with shoe wear difficulty or anterior ankle joint impingement 6. Deformity caused by bony malunion

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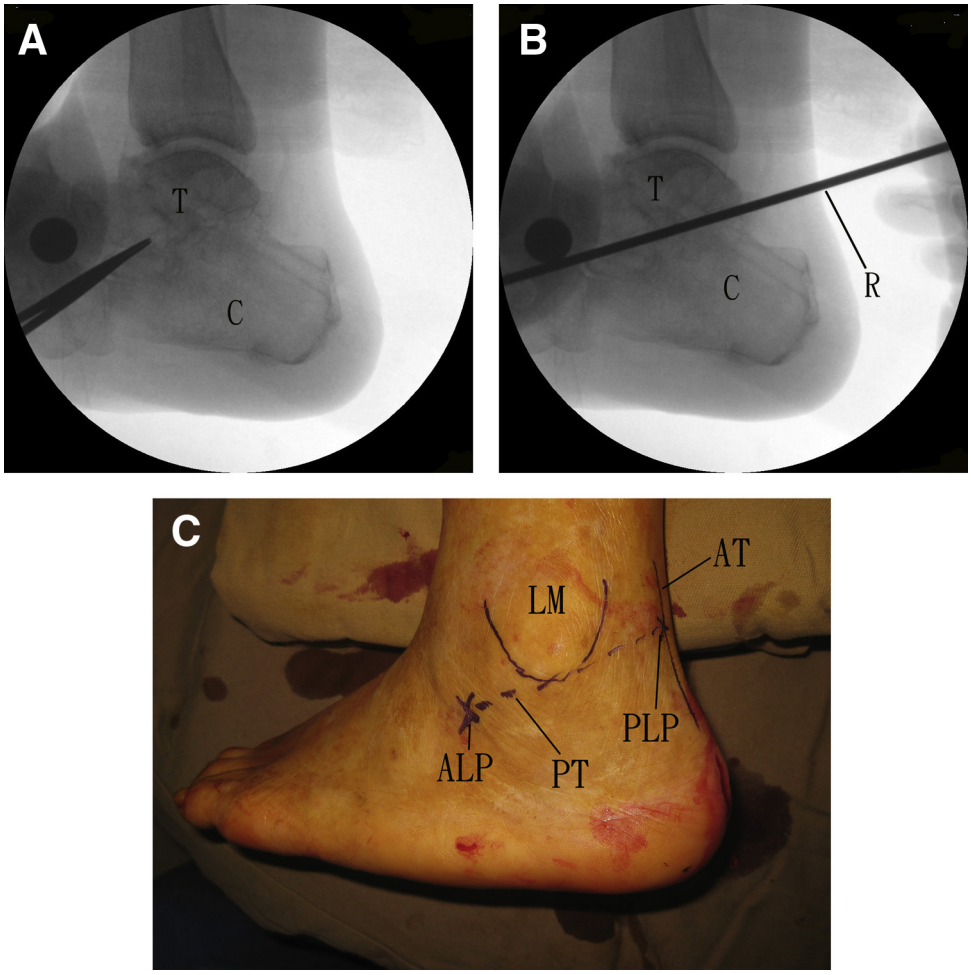

Fig 1. Endoscopic revision subtalar arthrodesis of the left foot. The patient is in the lateral position. (A) Fluoroscopic view shows that the anterolateral portal is at the angle of Gissane, just anterior to the previous posterior subtalar joint line (indicated by the hemostat). (B) The fused posterior subtalar joint line is marked by a metal rod under fluoroscopy. (C) The posterolateral portal is at the intersection between the fused posterior subtalar joint line and the lateral border of Achilles tendon. The portal tract between the portals is along the fused posterior subtalar joint line. (ALP, anterolateral portal; AT, lateral border of Achilles tendon; C, calcaneus; LM, lateral malleolus; PLP, posterolateral portal; PT, portal tract; R, metal rod; T, talus.)

The main criterion for sufficient function after an arthrodesis is the stability of the arthrodesis, which cannot be achieved without osseous consolidation.[2] However, open revision arthrodesis is considered to be a risk factor for pseudarthrosis.[2,8] Theoretically, the risk of nonunion can be reduced if the revision arthrodesis can be performed with a minimally invasive approach. The purpose of this Technical Note

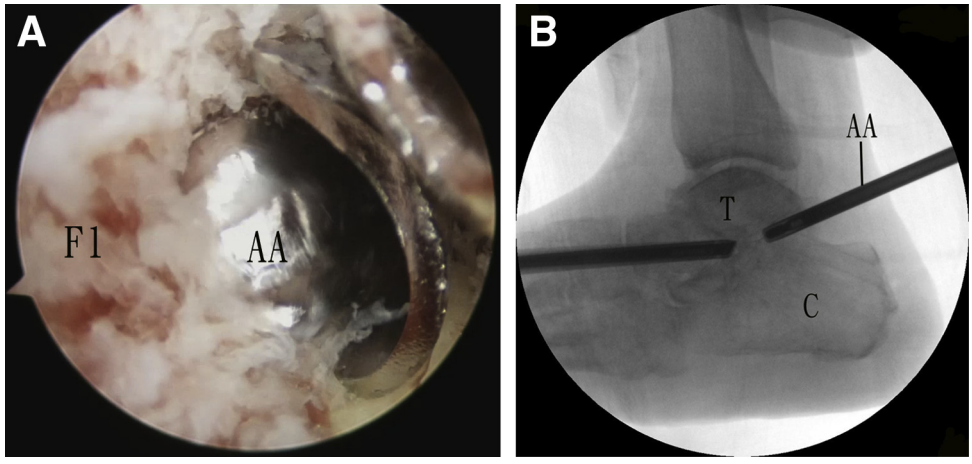

Fig 2. Endoscopic revision subtalar arthrodesis of the left foot. The patient is in the lateral position. The anterolateral portal is the viewing portal, and the posterolateral portal is the working portal. (A) A trough is made at the cortical bone of the posterior half of the fused posterior subtalar joint line with an arthroscopic acromionizer. (B) Position of the acromionizer is checked under fluoroscopy. (AA, arthroscopic acromionizer; C, calcaneus; F1, lateral cortex of fused posterior subtalar joint; T, talus.)

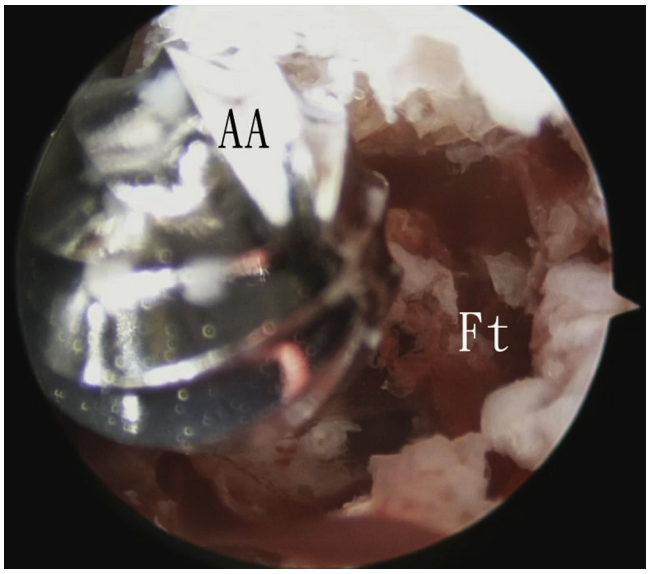

Fig 3. Endoscopic revision subtalar arthrodesis of the left foot. The patient is in the lateral position. The posterolateral portal is the viewing portal, and the anterolateral portal is the working portal. The trough of the fused posterior subtalar joint is identified. (AA, arthroscopic acromionizer; Ft, fused posterior subtalar joint.)

is to describe the technical details of endoscopic revision subtalar arthrodesis in which the correction of varus malunion is performed with a minimally invasive technique. It is indicated for symptomatic varus malunion after subtalar arthrodesis. It is contraindicated for patients with valgus heel deformity, significant limb length discrepancy, severe varus deformity, or implants requiring extensive incisions for removal. If the heel height is markedly decreased with shoe wear difficulty or anterior ankle joint impingement, bone block distraction arthrodesis is a more appropriate option.[1,5] The procedure is also contraindicated if the deformity is owing to bony malunion such as in cases of in situ subtalar arthrodesis for Stephens and Sanders type 3 malunion[9] (Table 1).

Technique

Preoperative Planning and Patient Positioning

Symptoms and signs of lateral column overload as a result of varus malunion should be checked preoperatively. Standing radiographs of the foot in the axial view are useful for analysis of the deformity. Computed tomography is sometimes needed to assess the deformity and healing of the previous arthrodesis.

The patient is placed in the lateral position with the legs spread. A thigh tourniquet is applied to provide a bloodless surgical field. Fluid inflow is by gravity, and no arthro-pump is used. A 4.0-mm 30° arthroscope (Dyonics; Smith & Nephew, Andover, MA) is used for this procedure.

Portal Placement

The procedure is performed via the anterolateral and posterolateral portals. Because the posterior subtalar joint is already fused, the portals should be located under fluoroscopy. The anterolateral portal is at the angle of Gissane, just anterior to the previous posterior subtalar joint line. The posterolateral portal is at the intersection between the fused posterior subtalar joint line and the lateral border of the Achilles tendon (Fig 1). The portals are coaxial with the portal tract along the previous posterior subtalar joint line.

Superficial Part of the Lateral Wedge Osteotomy

Five-millimeter incisions are made at the portal sites. The subcutaneous tissue is bluntly dissected. The soft tissue is stripped from the bone along the fused posterior subtalar joint line with a small periosteal elevator

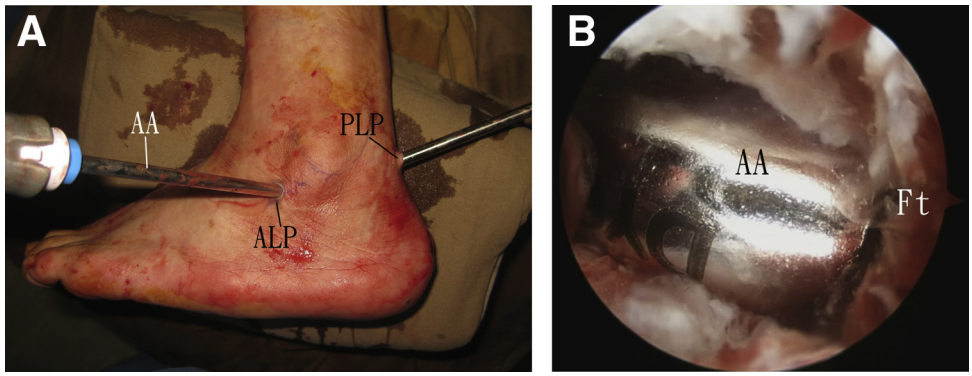

Fig 4. Endoscopic revision subtalar arthrodesis of the left foot. The patient is in the lateral position. (A) The posterolateral portal is the viewing portal, and the anterolateral portal is the working portal. (B) The anterior half of the trough of the fused posterior subtalar joint is deepened with an arthroscopic acromionizer. (AA, arthroscopic acromionizer; ALP, anterolateral portal; Ft, trough of the fused posterior subtalar joint; PLP, posterolateral portal.)

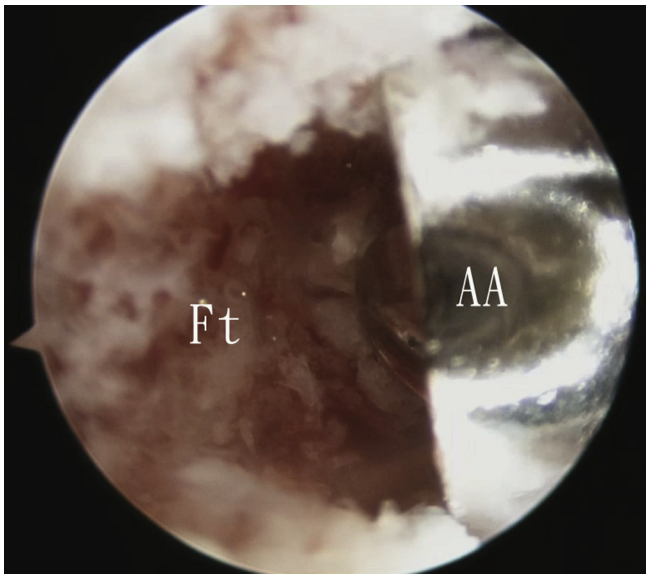

Fig 5. Endoscopic revision subtalar arthrodesis of the left foot. The patient is in the lateral position. The anterolateral portal is the viewing portal, and the posterolateral portal is the working portal. The posterior half of the trough of the fused posterior subtalar joint is deepened with an arthroscopic acromionizer. (AA, arthroscopic acromionizer; Ft, trough of the fused posterior subtalar joint.)

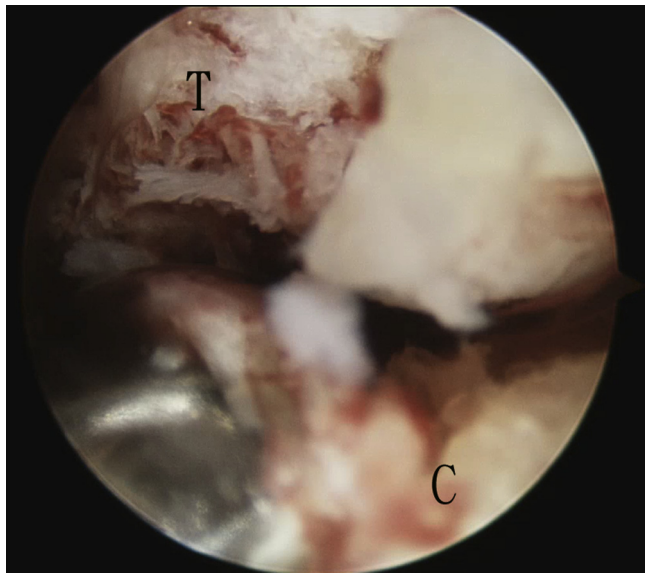

Fig 7. Endoscopic revision subtalar arthrodesis of the left foot. The patient is in the lateral position. The posterolateral portal is the viewing portal, and the anterolateral portal is the working portal. The adequacy of bone contact is checked endoscopically. (C, calcaneus; T, talus.)

via the portals. This creates the initial working space for the endoscopic procedure. The portals are interchangeable as viewing and working portals.

The anterolateral portal is used as the viewing portal. A trough is made at the cortical bone of the posterior half of the fused posterior subtalar joint line by using an arthroscopic acromionizer (Dyonics; Smith & Nephew) via the posterolateral portal. The position of the acromionizer should be frequently checked under fluoroscopy (Fig 2). After that, the arthroscope is switched to the posterolateral portal, and the trough is identified and extended anteriorly along the fused posterior subtalar joint line with the acromionizer via the anterolateral portal (Fig 3).

Deep Part of the Lateral Wedge Osteotomy

The posterolateral portal is used as the viewing portal. The anterior half of the trough of the fused posterior subtalar joint is deepened with the acromionizer via the anterolateral portal (Fig 4). The arthroscope is switched to the anterolateral portal, and the posterior half of the trough is deepened with the acromionizer via the posterolateral portal (Fig 5). These steps are repeated until the medial cortex is reached. The most important factor to consider in revision arthrodesis is the

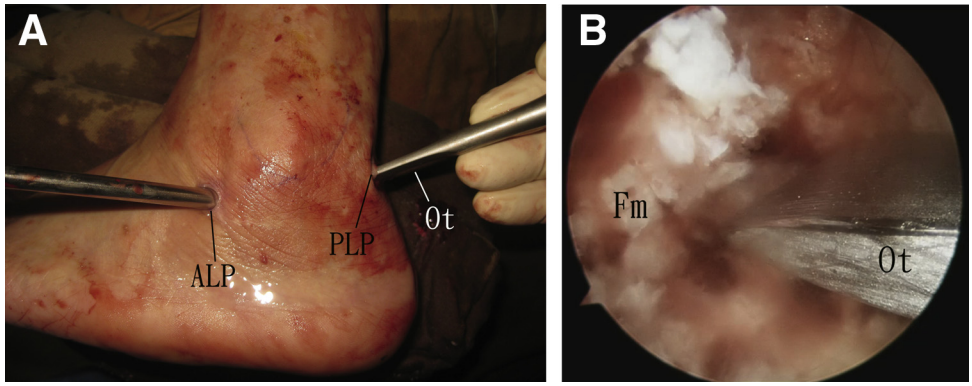

Fig 6. Endoscopic revision subtalar arthrodesis of the left foot. The patient is in the lateral position. (A) The anterolateral portal is the viewing portal, and the posterolateral portal is the working portal. (B) The medial cortex of the fused posterior subtalar joint is gently broken with an osteotome. (ALP, anterolateral portal; Fm, medial cortex of the fused posterior subtalar joint; Ot, osteotome; PLP, posterolateral portal.)

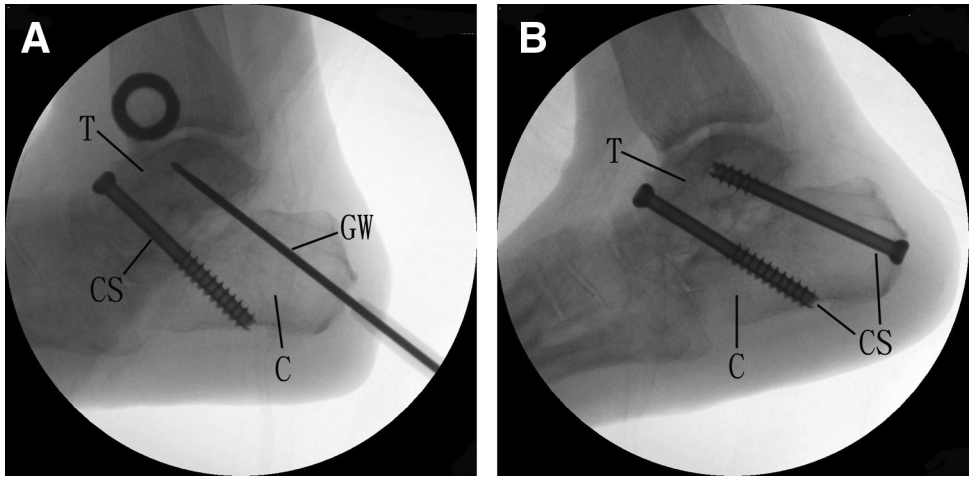

Fig 8. Endoscopic revision subtalar arthrodesis of the left foot. The patient is in the lateral position. (A) One 7.3-mm cannulated screw is already inserted across the talar neck and the calcaneus. A guidewire for the other cannulated screw is inserted. (B) The revision fusion site is transfixed with two 7.3-mm cannulated screws. (C, calcaneus; CS, cannulated screw; GW, guidewire; T, talus.)

preoperative bone vascularity, and all the avascular sclerotic bone at the fusion surfaces should be removed.[8]

Mobilization of the Medial Hinge of the Lateral Wedge Osteotomy

The anterolateral portal serves as the viewing portal, and the medial cortex is gently broken with the use of a small osteotome via the posterolateral portal to mobilize the medial hinge of the osteotomy (Fig 6).

Closure of the Osteotomy Site

The posterolateral portal is used as the viewing portal. The lateral wedge osteotomy is closed manually, and the degree of correction of the varus heel is assessed clinically and fluoroscopically. If the correction is inadequate, more bone is resected. The amount of bone resection is titrated by the degree of deformity correction required. After correction of the varus deformity, the lateral gutter is checked for any calcaneofibular impingement, and endoscopic lateral calcaneal ostectomy is performed, if indicated.[10,11]

The adequacy of bone contact can be checked endoscopically (Fig 7). Any bone void area can be grafted via the portals with a drill guide of appropriate size and length.

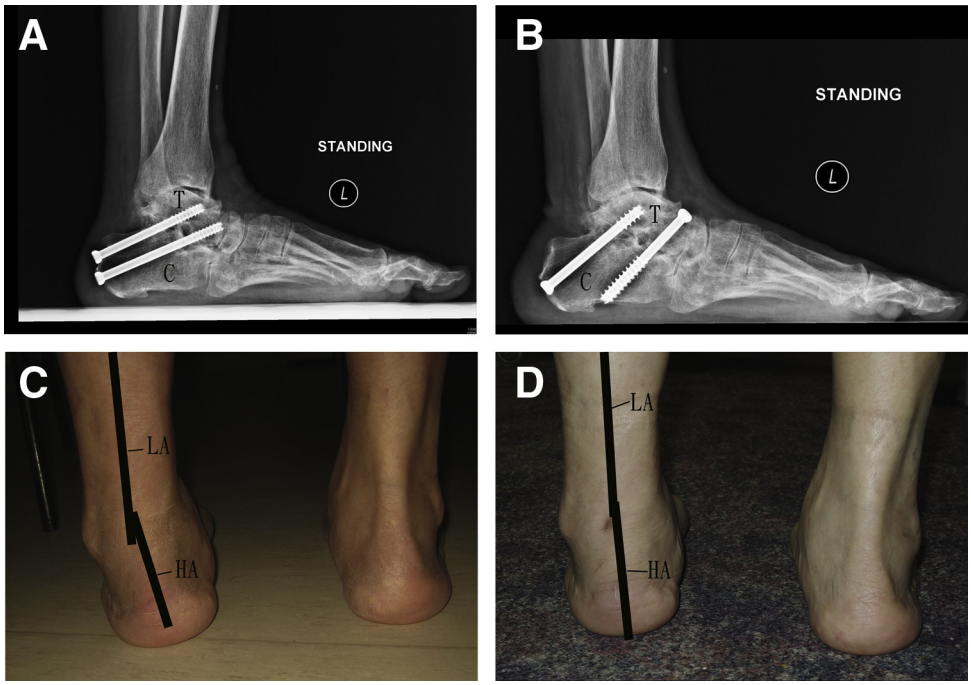

Fig 9. Endoscopic revision subtalar arthrodesis of the left foot. The patient is in the lateral position. (A) Standing lateral radiograph of the illustrated foot before revision shows varus foot deformity. (B) Standing lateral radiograph of the illustrated foot after revision shows the varus deformity corrected. (C) Preoperative clinical photo shows varus heel deformity. (D) Postoperative clinical photo shows the varus heel deformity corrected. (C, calcaneus; HA, hindfoot alignment; LA, leg alignment; T, talus.)

Table 2. Pearls and Pitfalls of Endoscopic Revision Subtalar Arthrodesis

Pearls	Pitfalls
1. The portals are located under fluoroscopy.	1. Excessive bone resection may lead to secondary calcaneoplasty.
2. The portal tract is along the fused posterior subtalar joint line.	2. Perforation of the medial cortex by the osteotome may injure the tibial neurovascular bundle and its branches.
3. The position of the acromionizer is frequently checked fluoroscopically.	
4. The amount of bone resected is titrated by the degree of deformity correction.	

Fixation

The revision fusion site is transfixed with two 7.3-mm cannulated screws (Depuy Synthes, West Chester, PA) via stab wounds (Fig 8). After the operation, the foot is immobilized with a short leg cast for 6 to 8 weeks. The patient is advised to practice non−weight-bearing walking during this period (Fig 9, Video 1, Table 2).

Discussion

Endoscopic revision subtalar arthrodesis is not a technically demanding procedure and can be attempted by average foot-and-ankle arthroscopists. Sometimes, the closure of the osteotomy site can be blocked by the intact anterior subtalar joint, especially if a higher degree of correction is needed. In this case, the plantar part of the talar head can be resected endoscopically by using the posterolateral portal as the viewing portal and the anterolateral portal as the working portal. The anterior and middle calcaneal facets are also prepared for fusion. This can also increase the total area of subtalar arthrodesis. After correction of the hindfoot deformity, any forefoot deformity should be checked and treated accordingly.

The advantages of this endoscopic technique include better cosmesis, less soft tissue dissection, and less postoperative pain. This can reduce the risks of soft tissue complications and nonunion. The potential risks include malunion, nonunion, and injury to the sural nerve, peroneal tendons, and/or flexor hallucis longus tendon (Table 3).

Table 3. Advantages and Risks of Endoscopic Revision Subtalar Arthrodesis

Advantages	Risks
1. Better cosmesis	1. Malunion
2. Less soft tissue dissection	2. Nonunion
3. Less postoperative pain	3. Injury to the sural nerve
4. Fewer soft tissue complications	4. Injury to the peroneal tendons
5. Decreased risk of nonunion	5. Injury to the flexor hallucis longus tendon

References

1. Joveniaux P, Harisboure A, Ohl X, Dehoux E. Long-term results of in situ subtalar arthrodesis. *Int Orthop* 2010;34:1199-1205.
2. Ziegler P, Friederichs J, Hungerer S. Fusion of the subtalar joint for post-traumatic arthrosis: A study of functional outcomes and non-unions. *Int Orthop* 2017;41:1387-1393.
3. Pollard JD, Schuberth JM. Posterior bone block distraction arthrodesis of the Subtalar joint: A review of 22 cases. *J Foot Ankle Surg* 2008;47:191-198.
4. Chahal J, Stephen DJ, Bulmer B, Daniels T, Kreder HJ. Factors associated with outcome after subtalar arthrodesis. *J Orthop Trauma* 2006;20:555-561.
5. Boffeli TJ, Abben KW. Modified Dwyer osteotomy with rotation and reinsertion of autograft bone wedge for residual heel deformity despite previous delayed subtalar joint arthrodesis after calcaneal fracture. *J Foot Ankle Surg* 2014;53:799-805.
6. Roussignol X. Arthroscopic tibiotalar and subtalar joint arthrodesis. *Orthop Traumatol Surg Res* 2016;102:S195-S203 (suppl 1).
7. Thaunat M, Bajard X, Boisrenoult P, Beaufils P, Oger P. Computer tomography assessment of the fusion rate after posterior arthroscopic subtalar arthrodesis. *Int Orthop* 2012;36:1005-1010.
8. Easley ME, Trnka HJ, Schon LC, Myerson MS. Isolated subtalar arthrodesis. *J Bone Joint Surg Am* 2000;82:613-624.
9. Stephens HM, Sanders R. Calcaneal malunions: Results of a prognostic computed tomography classification system. *Foot Ankle Int* 1996;17:395-401.
10. Lui TH, Chan KB. Arthroscopic management of late complications of calcaneal fractures. *Knee Surg Sports Traumatol Arthrosc* 2013;21:1293-1299.
11. Lui TH. Endoscopic lateral calcaneal ostectomy for calcaneofibular impingement. *Arch Orthop Trauma Surg* 2007;127:265-267.