Technical Note

Management of Bone Cyst of Talar Body by Endoscopic Curettage, Nanofracture, and Bone Graft Substitute

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Abstract: Large bone cyst of the talar body is frequently associated with an osteochondral lesion. The talar bone cyst can be an incidental radiologic finding. However, when the talus is extensively destroyed, there is a risk of pathologic fracture and damage to the articular cartilage, leading to persistent swelling and pain of the subtalar joint and ankle joint. Open debridement and bone grafting frequently requires extensive soft-tissue dissection or even different types of malleolar osteotomy for proper access to the lesion. The purpose of this Technical Note is to describes the technique of endoscopic curettage, nanofracture, and filling the cyst with injectable bone graft substitute. This minimally invasive approach has minimal disruption of the normal cartilage surface.

Large bone cyst of the talar body frequently is associated with an osteochondral lesion (OCL).[1] It can be developed by the valve mechanism of the damaged cartilage, allowing unidirectional intrusion of joint fluid into the subchondral bone.[1] Both stress-shielding by pressurized fluid and osteocyte death may cause cyst growth.[2] By this mechanism, a large subchondral bone cyst can be formed with a small defect in the subchondral plate.[1]

The talar bone cyst can be an incidental radiologic finding. However, when the talus is extensively destroyed, there is risk of pathologic fracture and damage to the articular cartilage, leading to persistent swelling and pain of the subtalar joint and ankle joint.[3] For symptomatic cyst recalcitrant to conservative treatment, surgery is indicated. Because most of the area of the talus is covered with articular cartilage, it is rather difficult to conduct surgical procedures without damaging the cartilage of the talus.[3] Open debridement and bone grafting frequently requires extensive soft-tissue dissection or even different types of malleolar osteotomy for proper access to the lesion.[3,4] Arthroscopic treatment is a possible solution to reduce the surgical trauma and eliminate the need of osteotomy.[3,4] As compared with fluoroscopic-guided curettage and bone grafting of the talar cyst,[5] the arthroscopic approach can have better assessment of completeness of debridement and can manage the associated OCL.[6] The previously reported arthroscopic techniques approach the bone cysts through the osteochondral lesion.[7-10] This is feasible for a large OCL with the bone cyst immediately underneath the lesion. For small- to moderate-sized OCL, to achieve adequate visualization and debridement of the bone cyst via the standard ankle arthroscopy portals, the normal cartilage adjacent to the OCL may need to be removed.[6] Subsequent reconstruction of the chondral articular surface is difficult if not impossible. To preserve the normal articular cartilage, different arthroscopically assisted or arthroscopic approaches have been proposed.[3,4,6] This Technical Note describes the technique of endoscopic curettage, nanofracture, and filling the cyst with injectable bone graft substitute. This minimally invasive approach has minimal disruption of the normal cartilage surface.[6,11] This is indicated for large bone cyst

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Table 1. Indications and Contraindications of Management of Bone Cyst of Talar Body by Endoscopic Curettage, Nanofracture, and Bone Graft Substitute

Indications	Contraindications
Large bone cyst of the anteromedial talar body associated with small to moderate OCL.	No chondral lesion
	The cyst is just underneath a large OCL
	Significant osteoarthrosis of the ankle joint

OCL, osteochondral lesion.

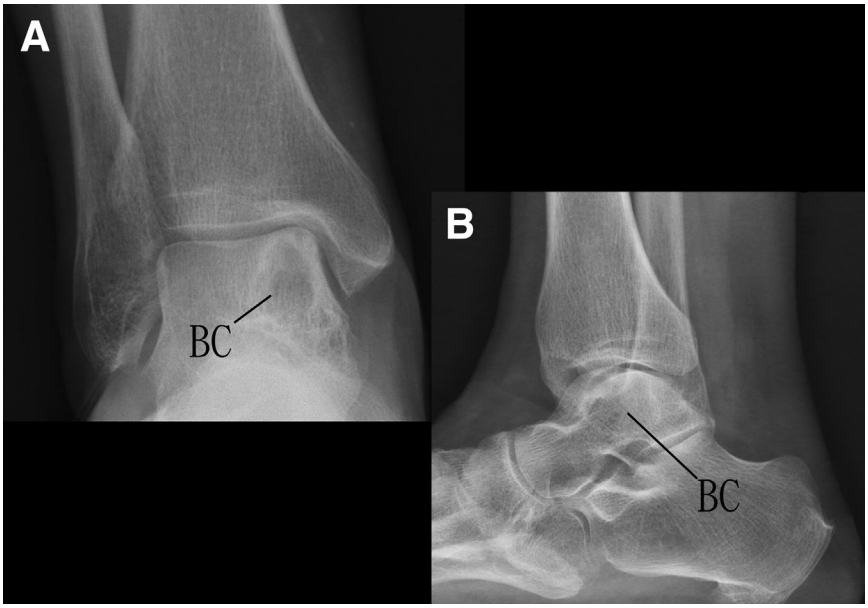

Fig 1. Management of bone cyst (BC) of talar body of the right ankle by endoscopic curettage, nanofracture, and bone graft substitute. The patient is in the supine position with the legs spread. The ankle is plantarflexed. Preoperative radiographs of the illustrated case showed BC at medial part of the talar body. (A) Anteroposterior view; (B) lateral view.

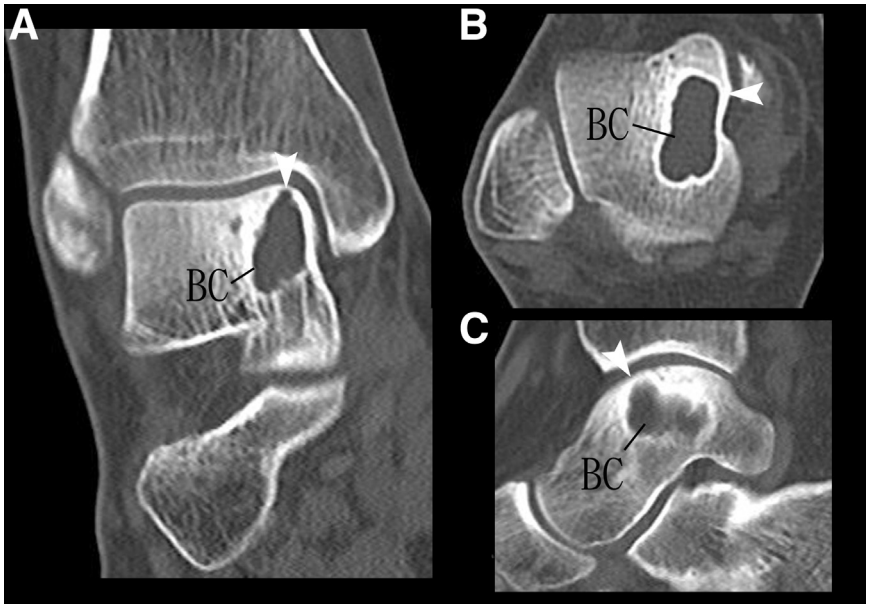

Fig 2. Management of bone cyst (BC) of talar body of the right ankle by endoscopic curettage, nanofracture, and bone graft substitute. The patient is in the supine position with the legs spread. The ankle is plantarflexed. Preoperative computed tomography of the illustrated case showed BC at medial part of the talar body. Arrowheads show the sites where the cyst is closest to the cortex or subchondral bone, corresponding to the anteromedial bone portal and the trans-OCL portal. (A) Coronal view; (B) transverse view; (C) sagittal view.

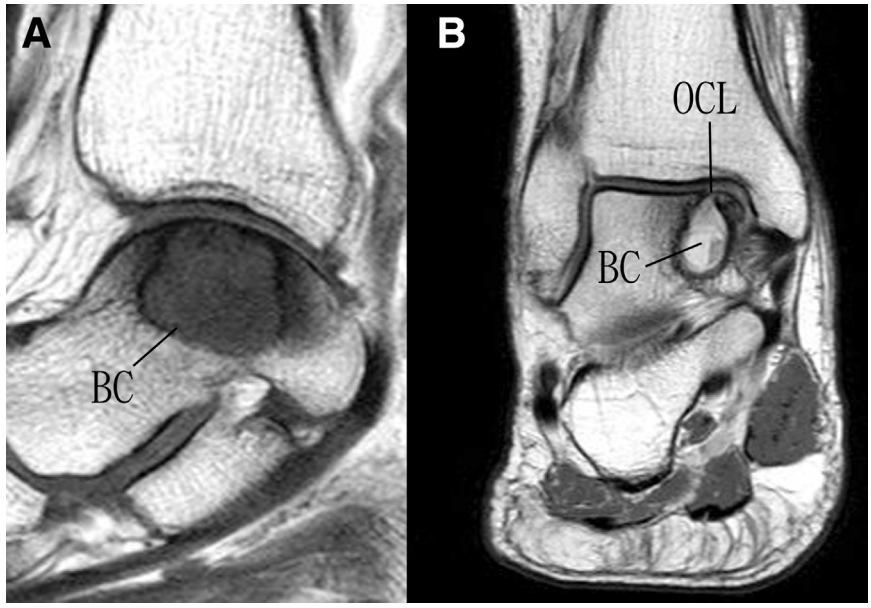

Fig 3. Management of bone cyst (BC) of talar body of the right ankle by endoscopic curettage, nanofracture, and bone graft substitute. The patient is in the supine position with the legs spread. The ankle is plantarflexed. Preoperative magnetic resonance imaging of the illustrated case shows BC at medial part of the talar body communicating with the osteochondral lesion (OCL). (A) Sagittal view; (B) coronal view.

of the anteromedial talar body associated with small-to-moderate OCL. This is contraindicated if there is no chondral lesion or the cyst is just underneath a large OCL or there is significant osteoarthrosis of the ankle joint (Table 1).

Surgical Technique

Preoperative Planning and Patient Positioning

Preoperative radiographs (Fig 1), computed tomography (CT) (Fig 2), and magnetic resonance imaging (Fig 3) are important to confirm the diagnosis and study the anatomy of the cyst. These investigations help the surgeons to determine the optimal arthroscopic approach and portals to be used.[4,6,11] The portals chosen should be closest to the cyst wall so that minimal bone resection is needed for access to the bone cyst. The portals should be spaced out to avoid crowding of instruments and incomplete visualization and curettage and reduce the risk of iatrogenic fracture of the talus.[6] Lateral radiograph and sagittal CT view of the involved ankle with the ankle in maximal plantarflexion helps to determine whether the OCL can be approached arthroscopically with ankle plantarflexion and whether the trans-OCL portal can be established. A 2.7-mm 30° arthroscope (Henke Sass Wolf GmbH, Tuttlingen, Germany) is used. A thigh tourniquet is applied to provide a bloodless operative field. Fluid inflow is driven by gravity and no arthropump is used.

Portal Placement

The procedure starts with ankle arthroscopy via the anteromedial and anterolateral portals, which are at the medial side of tibialis anterior tendon and the lateral side of peroneus tertius tendon, respectively. The sites where the cyst wall is just subchondral are located by CT, and these sites are corresponded to the trans-OCL portal and anteromedial bone portal (Figs 2 and 3). The bone cyst is accessed via these 2 portals. The

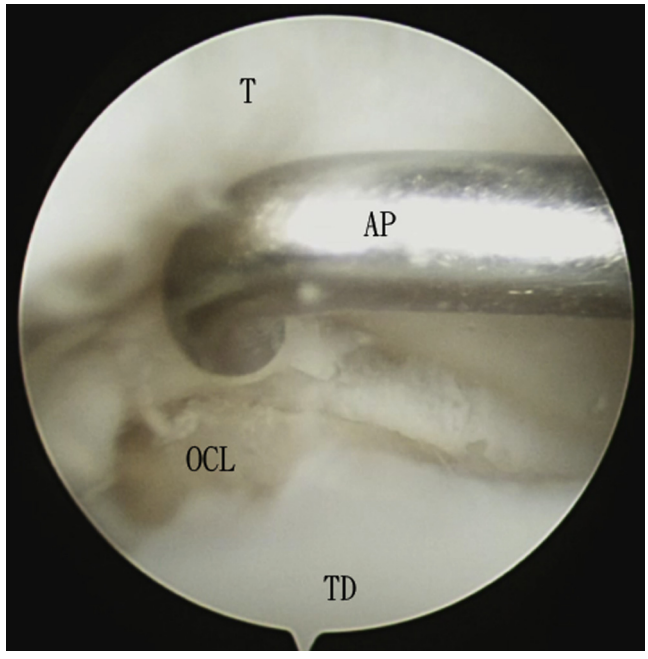

Fig 4. Management of bone cyst of talar body of the right ankle by endoscopic curettage, nanofracture, and bone graft substitute. The patient is in the supine position with the legs spread. The ankle is plantarflexed. The anterolateral portal is the viewing portal and the anteromedial portal is the working portal. The osteochondral lesion is debrided with an arthroscopic probe. (AP, arthroscopic probe; OCL, osteochondral lesion; T, distal tibia; TD, talar dome.)

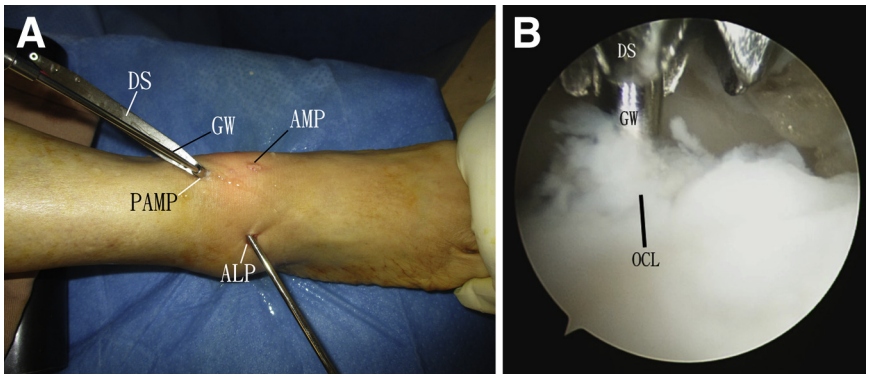

Fig 5. Management of bone cyst of talar body of the right ankle by endoscopic curettage, nanofracture, and bone graft substitute. The patient is in the supine position with the legs spread. The ankle is plantarflexed. (A) The anterolateral portal is the viewing portal and the proximal anteromedial portal is the working portal. A guidewire with a drill sleeve is inserted into the ankle joint. (B) The anterolateral portal is the viewing portal and the proximal anteromedial portal is the working portal. The guidewire is drilled through the osteochondral lesion to the bone cyst. (ALP, anterolateral portal; AMP, anteromedial portal; DS, drill sleeve; GW, guidewire; OCL, osteochondral lesion; PAMP, proximal anteromedial portal.)

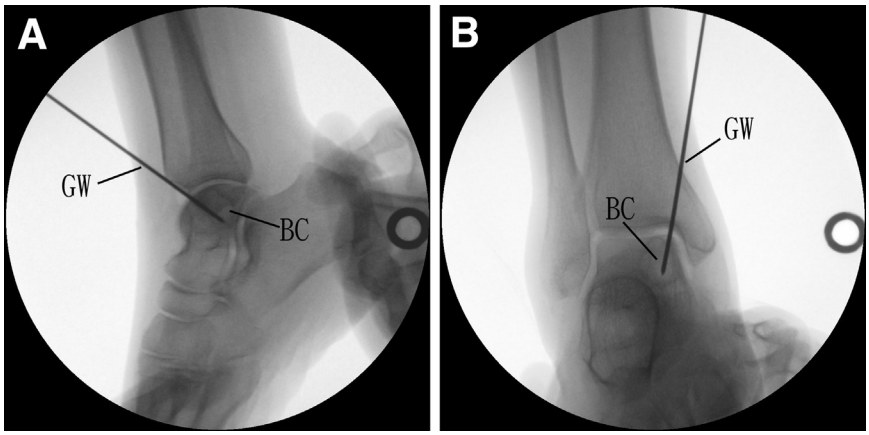

Fig 6. Management of bone cyst (BC) of talar body of the right ankle by endoscopic curettage, nanofracture, and bone graft substitute. The patient is in the supine position with the legs spread. The ankle is plantarflexed. After insertion of the guidewire (GW) into the BC, correct positioning of the wire is confirmed under fluoroscopy. (A) Lateral view; (B) anteroposterior view.

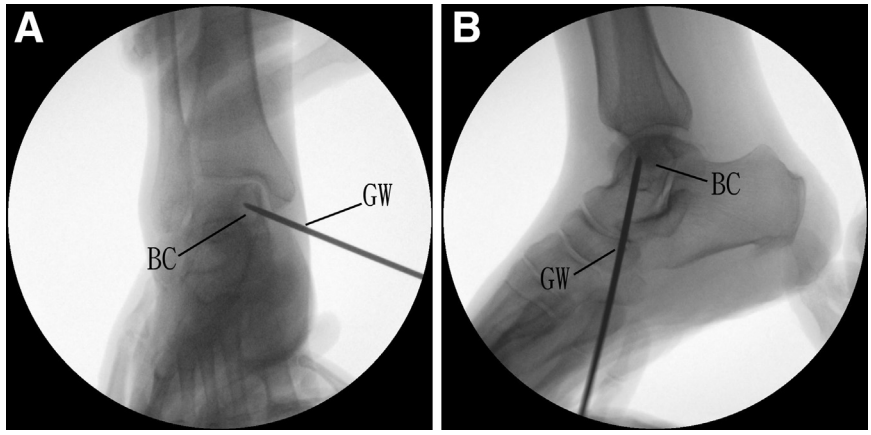

Fig 7. Management of bone cyst (BC) of talar body of the right ankle by endoscopic curettage, nanofracture, and bone graft substitute. The patient is in the supine position with the legs spread. The ankle is plantarflexed. Insertion of the guidewire (GW) through the medial talar facet (anterior to the medial malleolus) to the BC under fluoroscopy. (A) Anteroposterior view; (B) lateral view.

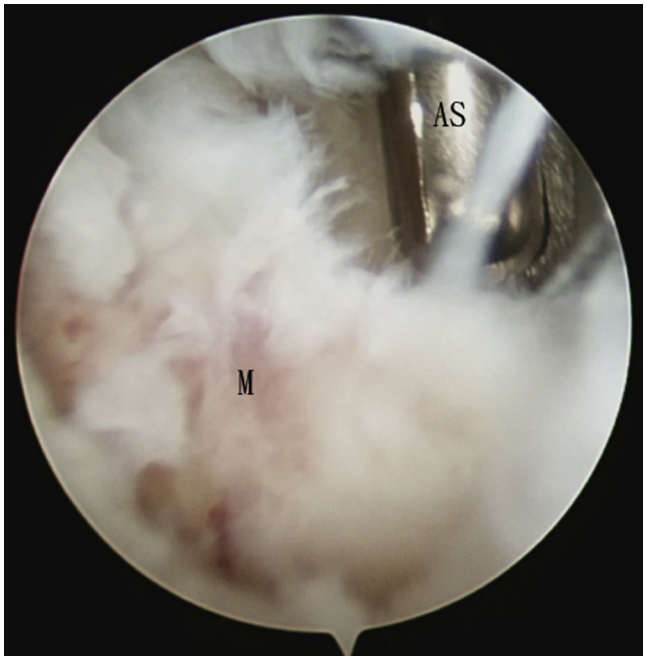

Fig 8. Management of bone cyst of talar body of the right ankle by endoscopic curettage, nanofracture, and bone graft substitute. The patient is in the supine position with the legs spread. The ankle is plantarflexed. The anteromedial bone portal is the viewing portal and the trans-OCL portal is the working portal. The membranous lining (M) of the cyst is debrided with the arthroscopic shaver (AS).

instrument is inserted into the trans-OCL portal via the proximal anteromedial portal (skin portal), which is about 2.5 to 3 cm proximal to the anteromedial portal and medial to the tibialis anterior tendon. The ankle should be plantarflexed during debridement of the osteochondral lesion and throughout the endoscopic procedure of the bone cyst.

Ankle Arthroscopy and Debridement of Osteochondral Lesion

The anterolateral portal is the viewing portal and the anteromedial portal is the working portal. Three- to four-millimeter skin incisions are made at the portal sites and the subcutaneous tissue is bluntly dissected down to the ankle joint capsule with a hemostat. The capsule is perforated by the tip of the hemostat. The ankle is plantarflexed to expose the OCL. The OCL is debrided with an arthroscopic probe (ACUFEX; Smith & Nephew, Andover, MA) and arthroscopic shaver (Dyonics) (Fig 4).

Creation of Trans-OCL Bone Portal

With the anterolateral portal as the viewing portal, a 1.25-mm guidewire (Synthes, West Chester, PA) is inserted percutaneously into the ankle joint from a point 2.5 to 3 cm proximal to the anteromedial portal and medial to the tibialis anterior tendon. Accessibility of OCL by the guidewire is confirmed arthroscopically. The guidewire is removed, and a 6- to 7-mm skin incision is made at the guidewire insertion point and this forms the proximal anteromedial portal (skin portal). The underlying soft tissue is bluntly dissected down to the ankle joint with the hemostat. The guide wire is inserted again with the 1.25-mm drill sleeve (Synthes) down to the OCL and drilled through the subchondral bone to the bone cyst (Fig 5). The correct positioning of the guidewire into the bone cyst is confirmed fluoroscopically (Fig 6). The 1.25-mm drill sleeve is removed and a 2.7-mm cannulated drill bit (Synthes) is inserted along the guidewire together with the 2.7-mm drill sleeve (Synthes) and the subchondral bone is drilled down to the cyst. After that, the 1.25-mm guidewire is exchanged to a 2.8-mm guidewire (Synthes). The bony passage to the cyst is enlarged by drilling with a 5-mm

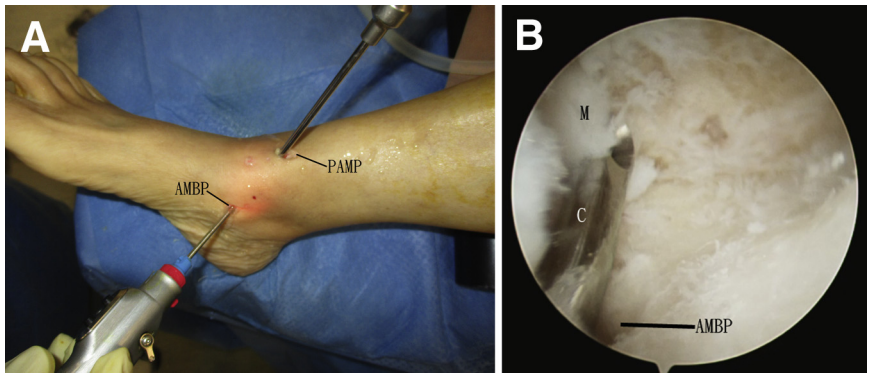

Fig 9. Management of bone cyst of talar body of the right ankle by endoscopic curettage, nanofracture, and bone graft substitute. The patient is in supine position with the legs spread. The ankle is plantarflexed. (A) The arthroscope is inserted through the proximal anteromedial portal to the trans-OCL portal. The arthroscopic shaver is inserted into the anteromedial bone portal. (B) The trans-OCL portal is the viewing portal and the anteromedial bone portal is the working portal. The membranous lining of the cyst is debrided with a small curette. (AMBP, anteromedial bone portal; C, curette; M, membranous lining; PAMP, proximal anteromedial portal.)

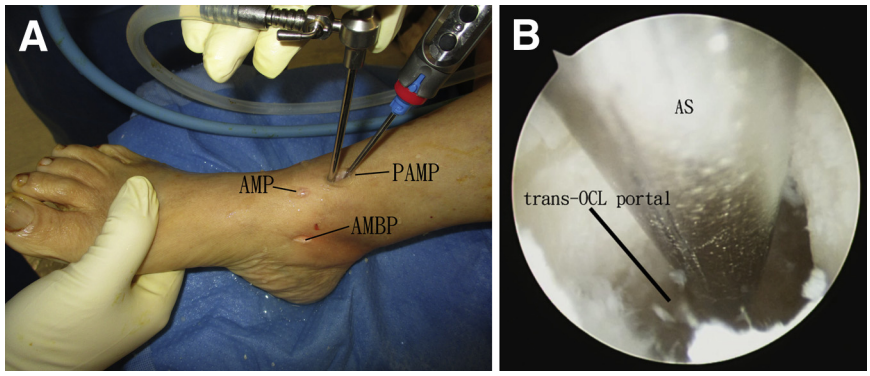

Fig 10. Management of bone cyst of talar body of the right ankle by endoscopic curettage, nanofracture, and bone graft substitute. The patient is in supine position with the legs spread. The ankle is plantarflexed. (A) Both the arthroscope and arthroscopic shaver are inserted into the proximal anteromedial portal. The arthroscopic shaver is inserted deeper through the trans-OCL portal into the bone cyst. (B) The proximal anteromedial portal is the viewing portal. The arthroscopic shaver is inserted via the trans-OCL portals into the bone cyst and the fibrous tissue and membranous lining of the cyst is debrided. (AMBP, anteromedial bone portal; AMP, anteromedial portal; AS, arthroscopic shaver; PAMP, proximal anteromedial portal.)

cannulated drill bit (Synthes). This creates the trans-OCL portal (bone portal).

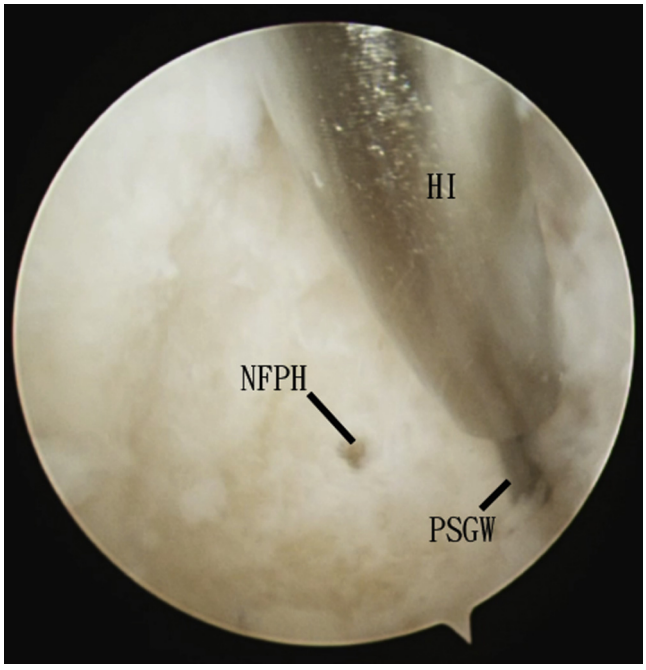

Fig 11. Management of bone cyst of talar body of the right ankle by endoscopic curettage, nanofracture, and bone graft substitute. The patient is in supine position with the legs spread. The ankle is plantarflexed. The anteromedial bone portal is the viewing portal and the trans-OCL portal is the working portal. Nanofracture of the cyst wall is performed with PleuriStik Guide Wire via the Hand Instrument. (HI, hand instrument; NFPH, nanofracture penetration hole; PSGW, PleuriStik Guide Wire.)

Creation of Anteromedial Bone Portal

The 1.25-mm guidewire is inserted into the bone cyst from a point just anterior to the medial malleolus. The correct positioning of the guidewire into the bone cyst is confirmed fluoroscopically (Fig 7). A 4-mm skin insertion is made at the insertion point and the underlying soft tissue is bluntly dissected down to the medial talar facet. The anteromedial bone portal is created by drilling of the subchondral bone with a 2.7-mm cannulated drill along the guidewire. After that, the 1.25-mm guidewire is exchanged with a 2.8-mm guidewire. The trans-OCL portal is enlarged with a 5-mm cannulated drill along the 2.8-mm guidewire.

Endoscopic Curettage of Bone Cyst

Three endoscopic approaches of the bone cyst via the 2 bone portals are employed to thoroughly debride the cyst. The anteromedial bone portal is the viewing portal and the trans-OCL portal is the working portal. The fibrous tissue and membranous lining of the cyst is debrided with the arthroscopic shaver, small curette and small periosteal elevator (Fig 8).

The trans-OCL portal is the viewing portal and the anteromedial bone portal is the working portal. The fibrous tissue and membranous lining of the cyst is debrided with the arthroscopic shaver, small curette and small periosteal elevator (Fig 9).

The proximal anteromedial portal is the viewing portal. The arthroscopic shaver is inserted via the proximal anteromedial and trans-OCL portals into the bone cyst and the fibrous tissue and membranous lining of the cyst is debrided (Fig 10).

Nanofracture

The anteromedial bone portal and the trans-OCL portal are interchangeable as the viewing and working portal. After complete resection of the soft tissue of

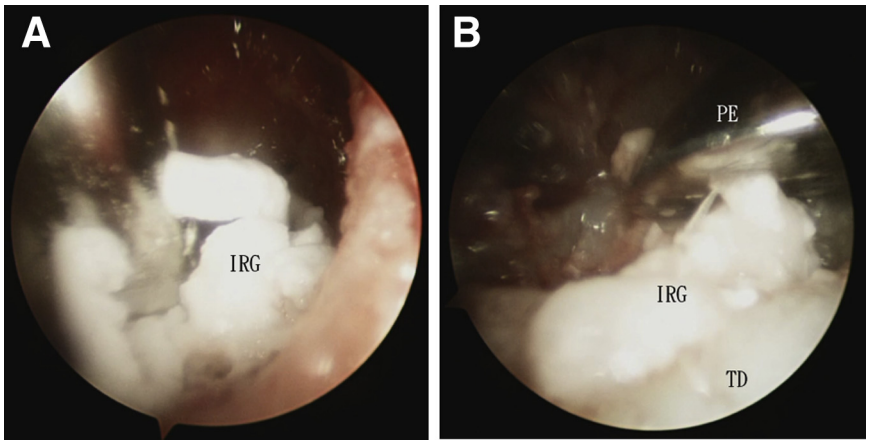

Fig 12. Management of bone cyst of talar body of the right ankle by endoscopic curettage, nanofracture, and bone graft substitute. The patient is in the supine position with the legs spread. The ankle is plantarflexed. It is converted into dry arthroscopy and endoscopy. (A) The anteromedial bone portal is the viewing portal. The fluid inflow is switched off and the blood of the cyst is sucked out. The PRO-DENSE injectable regenerative graft (Wright, Memphis, TN) is injected into the cyst via the proximal anteromedial and trans-OCL portals. (B) Ankle arthroscopy is repeated with the anterolateral portal as the viewing portal. The injectable regenerative graft is packed into the cyst by a periosteal elevator via the anteromedial portal. (IRG, injectable regenerative graft; PE, periosteal elevator; TD, talar dome.)

the cyst, nanofracture of the cyst wall is performed with a PleuriStik Guide Wire (Arthrosurface, Franklin, MA) via the Hand Instrument (Arthrosurface) (Fig 11).

Injection of Bone Graft Substitute

The procedure is converted into dry arthroscopy and endoscopy. The anteromedial bone portal is the viewing portal. The fluid inflow is switched off and the blood of the cyst is sucked out. The PRO-DENSE injectable regenerative graft (Wright, Memphis, TN) is injected into the cyst via the proximal anteromedial and trans-OCL portals. Ankle arthroscopy is repeated with the anterolateral portal as the viewing portal. The injectable regenerative graft is packed into the cyst by a periosteal elevator via the anteromedial portal (Fig 12). The excessive graft is removed. Postoperatively, the ankle is immobilized in a short leg cast for 2 weeks (Fig 13, Video 1, Table 2).

Discussion

Bone marrow stimulation alone is not an effective treatment option for osteochondral lesion of the talus associated with a large subchondral cyst.[12] Careful

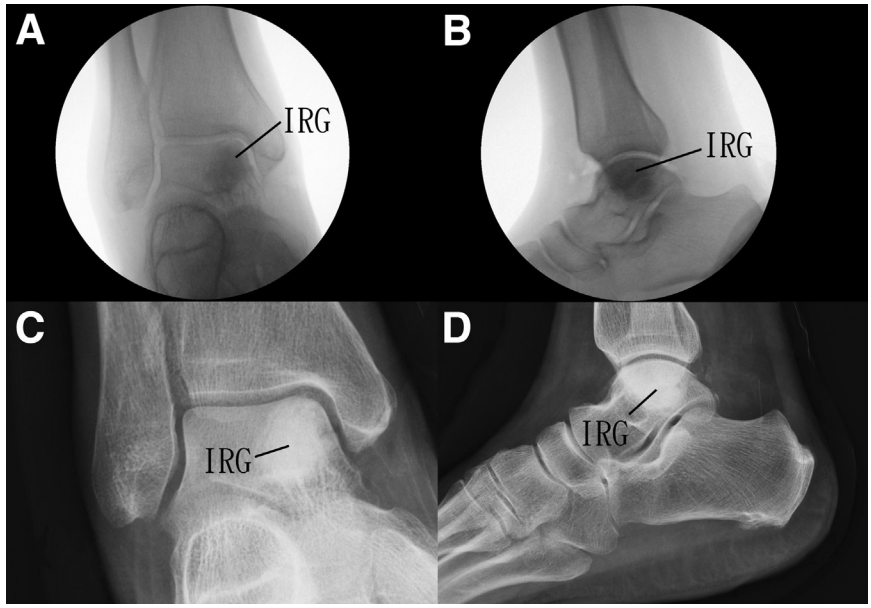

Fig 13. Management of bone cyst of talar body of the right ankle by endoscopic curettage, nanofracture, and bone graft substitute. The patient is in the supine position with the legs spread. The ankle is plantarflexed. Intraoperative fluoroscopy (A: anteroposterior view; B: lateral view) and post-operative radiographs (C: anteroposterior view; D: lateral view) shows the talar bone cyst is filled up with injectable regenerative graft (IRG).

Table 2. Pearls and Pitfalls of Management of Bone Cyst of Talar Body by Endoscopic Curettage, Nanofracture, and Bone Graft Substitute

Pearls	Pitfalls
Careful preoperative planning with computed tomogram is the key to success.	It is not suitable for bone cyst just underneath a large OCL.
Trans-OCL portal can approach the bone cyst and eliminate the valve mechanism of OCL.	It is not suitable in case of significant osteoarthrosis of the ankle.
Ankle should be kept plantarflexed during the bone cyst endoscopy	

OCL, osteochondral lesion

preoperative planning with CT is the key of success for arthroscopic management of the talar bone cysts.[6] Debridement of the OCL and resection of the underlying subchondral bone create the trans-OCL portal (5 mm in size) which forms an access to the underlying bone cyst. However, it alone cannot simultaneously provide adequate visualization and debridement of the cyst. It is disadvantageous to increase the size of the portal by removal of the adjacent normal cartilage of the major weight-bearing articular surface of the ankle joint. Instead, we create another bone portal at the medial talar facet, which is a relatively less important force transmission facet of the ankle joint. Creation of the trans-OCL portal can also destroy the valve mechanism of the subchondral bone defect which has been proposed as a mechanism of bone cyst formation.[1,11] Future development of this technique can focus on improvement of intraoperative accuracy of bone portal tract placement. 3-dimensional printed lesion models and individualized guide system[13] and intraoperative 3-dimensional imaging[11] can be helpful for proper placement of the osseous portal tracts.

In this technique, technique of nanofracture is used because deeper perforation can be achieved and we believe the risk of iatrogenic fracture is less as the perforation holes are smaller than those of microfracture. Injectable regenerative graft instead of autograft is used in order to eliminate donor morbidity, shorten the operation and eliminate risk of dropping of bone graft into the ankle joint. The injectable regenerative graft is based on combinations of the fast-dissolving calcium sulfate and the stronger and more slowly remodeling calcium phosphate compounds. This might enhance vascular infiltration and replacement of the graft by new bone, whilst providing osteoconductive and mechanical support.[14] Although extracellular matrix cartilage allograft is an effective adjunct of bone marrow stimulation for treatment of osteochondral lesion, it is not used in our technique because the osteochondral lesion and the underlying bone cyst is filled up by regenerative graft and the effect of covering the regenerative graft by the extracellular matrix cartilage allograft is questionable.[15]

Table 3. Advantages and Risks of Management of Bone Cyst of Talar Body by Endoscopic Curettage, Nanofracture, and Bone Graft Substitute

Advantages	Risks
Better cosmetic result	Iatrogenic fracture of the talus
Minimal soft-tissue dissection	Injury to the superficial deltoid ligament of the ankle
Fewer wound complications	Injury to the superficial peroneal nerve
No osteotomy needed	Injury to the saphenous nerve
Preservation of the normal articular cartilage	Recurrence of the cyst
Clear visualization of the cyst	Dropping of the graft into the ankle joint

The advantages of this minimally invasive technique include better cosmetic result, minimal soft-tissue dissection, fewer wound complications, clear visualization of the cyst, no osteotomy, and preservation of the articular cartilage. The potential risk of this technique includes iatrogenic fracture of the talus, injuries to the superficial deltoid ligament of the ankle, superficial peroneal nerve and the saphenous nerve, recurrence of the cyst, and dropping of the graft into the ankle joint (Table 3). This technique is not technically demanding and can be attempted by the averaged foot and ankle arthroscopists.

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