Treatment of Osteochondral Lesions of the Talus With Marrow Stimulation and Micronized Allograft Cartilage Matrix: An All-Arthroscopic Technique

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Abstract: Osteochondral lesions of the talus are a common cause of ankle pain. The optimum treatment for these injuries continues to evolve. The article describes an all-arthroscopic technique, which includes debridement, marrow stimulation, and application of a micronized allograft cartilage matrix with fibrin sealant. The procedure avoids potential disadvantages associated with other commonly performed procedures including necessity of arthrotomy or osteotomy, donor-site morbidity, increased cost, and need for multiple procedures. The technique is presented along with promising early clinical results.

Level of Evidence: Diagnostic Level 4. See Instructions for Authors for a complete description of levels of evidence.

Key Words: biocartilage, osteochondral lesion, osteochondral defect, cartilage, talus

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After participating in this CME activity, physicians should be better able to:

1. Assess the advantages of micronized allograft cartilage matrix in the treatment of osteochondral lesions of the talus.
2. Apply the technique of arthroscopic debridement, marrow stimulation, and application of micronized allograft cartilage matrix in the treatment of osteochondral lesions of the talus.
3. Evaluate situations in which standard debridement and marrow stimulation techniques may lead to poor results in the treatment of osteochondral lesions.

HISTORICAL PERSPECTIVE

Osteochondral lesions (OCLs) are well-known injuries and have been recognized in the ankle since 1922.[1]

The etiology of OCLs was originally thought to be secondary to a vascular insult; however, more current literature suggests a traumatic origin. Berndt and Harty[2] in their original study elicited a history of trauma in 90% of their patients. They were able to support this theory by recreating medial and lateral OCDs in a cadaveric study. Other authors have corroborated this premise.[3–5] Lateral lesions are more often related to trauma compared with medial lesions, and this finding may be related to increased cartilage thickness about the medial talus.[6,7] Early studies reported on OCL's incidence of 6.5% with ankle sprains, but with better technology including arthroscopy the true incidence is probably closer to 70%.[8–10]

Despite the abundant literature on OCLs the optimum treatment is still debated. Berndt and Hardy,[11] and Tol et al[12] demonstrated poor results in 75% and 45% of patients, respectively, who underwent conservative treatment for OCLs. These results, more than likely, are multifactorial and include poor vascular supply and relatively thinner cartilage surface compared with the hip and knee.[13] Nonetheless, conservative treatment consisting of non–weight-bearing immobilization may be attempted for nondisplaced lesions, which are at least partially attached.

Several current routine surgical treatments of symptomatic OCLs include arthroscopic debridement with marrow stimulation, allograft or autograft osteochondral transplantation, particulated juvenile cartilage allograft transplantation, and autologous chondrocyte implantation (ACI).

Arthroscopic debridement with marrow stimulation procedures has historically been popular in the treatment of OCLs. The technique is relatively simple, inexpensive, and achieves relatively good results in 65% to 85% of patients.[14–19] The reparative tissue generated is primarily fibrocartilage and of questionable durability. Second-look arthroscopy has shown that

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normal or near-normal cartilage is restored by microfracture in only 60% of patients.[20,21] These results, however, tend to deteriorate over time and are much less successful in cystic OCLs, lesions >150 mm^2, and revision situations.[17,19,22,23]

The concept of enhanced microfracture techniques has recently been introduced for the treatment of talar OCLs. This technique includes a standard arthroscopic debridement and marrow stimulation followed by placement of a micronized allograft cartilage matrix (BioCartilage; Arthrex, Naples, FL) in the defect. Several animal studies have shown the benefit of a porous allograft collagen scaffold in both the chondrogenic differentiation of adult progenitor cells as well as the repair of articular cartilage defects.[24–26] Valderrabano et al[27] reported good short-term results in the treatment of talar OCLs with the use of a collagen I/III matrix as an adjunct to standard marrow stimulation. Their technique required an arthrotomy or osteotomy. The procedure discussed in this article was developed to take advantage and enhance the accepted arthroscopic debridement and marrow stimulation technique, while avoiding potential disadvantages related to other procedures including necessity of an osteotomy or arthrotomy (allograft or autograft transplantation), donor-site morbidity (autograft transplantation), and need for multiple procedures (ACI). From an economic standpoint the use of micronized allograft cartilage matrix is a cost-effective option compared with other accepted treatments. The cost is approximately $750 and it has a 5-year shelf life. This is less expensive than other allograft procedures including bulk talar allograft, which is reported to cost approximately $6500, and ACI, which may cost >$16,000.[28,29] Particulated juvenile allograft transplantation is reported to cost approximately $4500 and has a maximum of 40-day shelf life.

INDICATIONS AND CONTRAINDICATIONS

The optimal candidate for this procedure is currently evolving; however, indications can be extrapolated from current recommendations for arthroscopic debridement and marrow stimulation surgery with a few exceptions. This technique may be used in any Berndt and Hardy stage I-IV lesion. Disappointing results have historically been reported with arthroscopic OCL debridement and marrow stimulation in lesions >150 mm^2, revision situations, and those with subchondral cyst formation.[17,19,22,30] The technique described has been used in all of these instances and early results appear promising. Therefore, these situations should not be considered as contraindications at this time. Noncorrectable ankle or hindfoot malalignment, diffuse osteoarthritic changes, history of infection, and inability to undergo anesthesia or comply with postoperative protocols should be considered contraindications.

PREOPERATIVE PLANNING

Standard detailed history and physical examination of the foot and ankle should be performed. Inquiry of frequent "turning" or "giving way" of the ankle may help establish a diagnosis of functional instability. Standing examination will allow assessment of hindfoot or ankle deformities. Range of motion and muscle strength should be recorded and compared with the contralateral extremity. Talar tilt and anterior drawer tests will help evaluate for physical ankle instability. The location of tenderness should be noted and confirmed to be consistent with imaging studies. If there is question if the OCL is the source of ankle pain verses extra-articular pathology, a local intra-articular anesthetic can be useful for evaluation.

Standard weight-bearing radiographs of the foot and ankle will help assess for deformities and will often reveal the osteochondral lesion. Size, location, fragmentation, and cystic formation of the OCD can often easily be noted with standard radiographs.

The optimal modality for further imaging of OCLs is controversial. Magnetic resonance imaging (MRI) is useful for assessment of the continuity of the articular surface and to identify other soft tissue pathology; however, MRI may exaggerate the size of the OCL (Figs. 1, 2). Computed tomography is useful in identifying the integrity of the subchondral bone and may more accurately identify the dimensions of the subchondral cyst. Both modalities will identify cystic formation, detachment of the OCL, and allow for precise location of the OCL. Pritsch et al[31] found arthroscopy to be the best method for staging OCLs and integral for planning appropriate treatment. Ferkel et al[32]

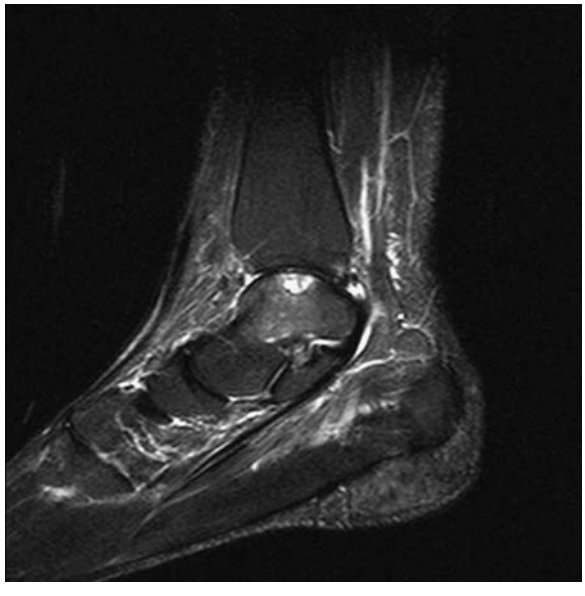

FIGURE 1. Patient positioning.

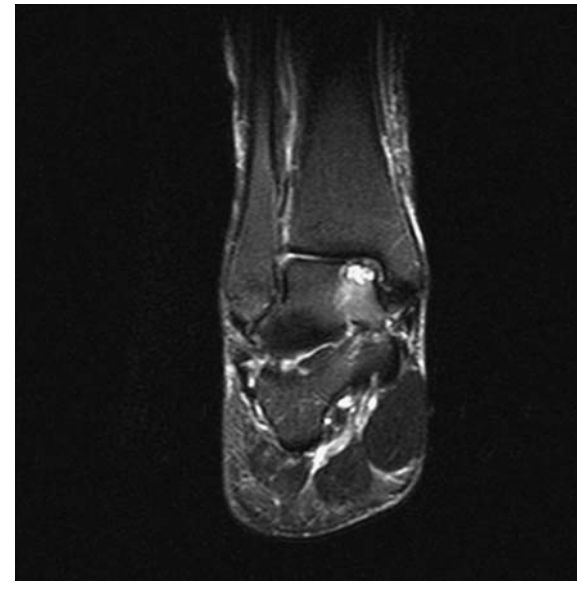

FIGURE 2. Sagittal magnetic resonance image of cystic-appearing osteochondral lesions.

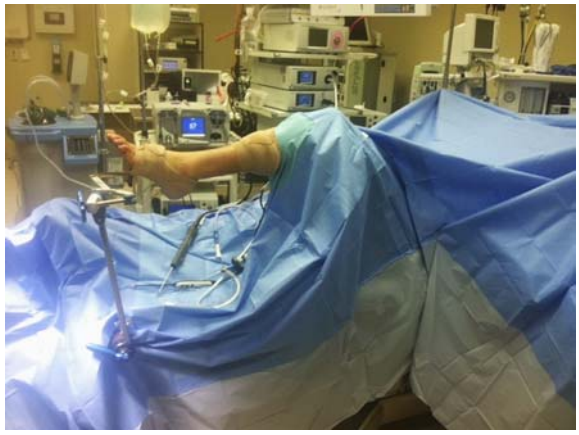

FIGURE 3. Coronal magnetic resonance image of Figure 2 osteochondral lesions.

showed that results after arthroscopy and marrow stimulation only correlated with arthroscopic grade, not MRI, computed tomography, or radiographic staging. (Arthroscopic grading: A, smooth and intact but soft; B, rough surface; C, fibrillation/fissures; D, flap present or bone exposed; E, loose, nondisplaced fragment; and F, displaced fragment.)

TECHNIQUE

The procedure can be performed under spinal or general anesthesia. A preoperative peripheral nerve block is useful in managing postoperative pain. The patient is placed in the supine position, with a bump under the ipsilateral hip if needed. A tourniquet is applied to the proximal thigh. The leg is placed in a padded thigh holder flexing the hip to approximately 90 degrees. This position provides a lever arm for traction and also allows access to the posterior aspect of the ankle if posterior portals are required. Removing the pad at the end of the table allows more working room, especially if posterior arthroscopy is performed. The leg is exsanguinated and an external ankle distraction device is applied (Fig. 3). Next, 5 to 10 mL of fluid is placed intra-articularly to distend the ankle. A 3-mm-incision is created through skin only just medial to the tibialis anterior tendon. A mosquito clamp is used to bluntly dissect to the level of the joint capsule which is then perforated. A blunt trocar is placed followed by the 2.7 mm arthroscope and the standard 21-point examination is performed. Accessory portals can be established with needle localization and then a nick and spread technique to prevent injury to neurovascular

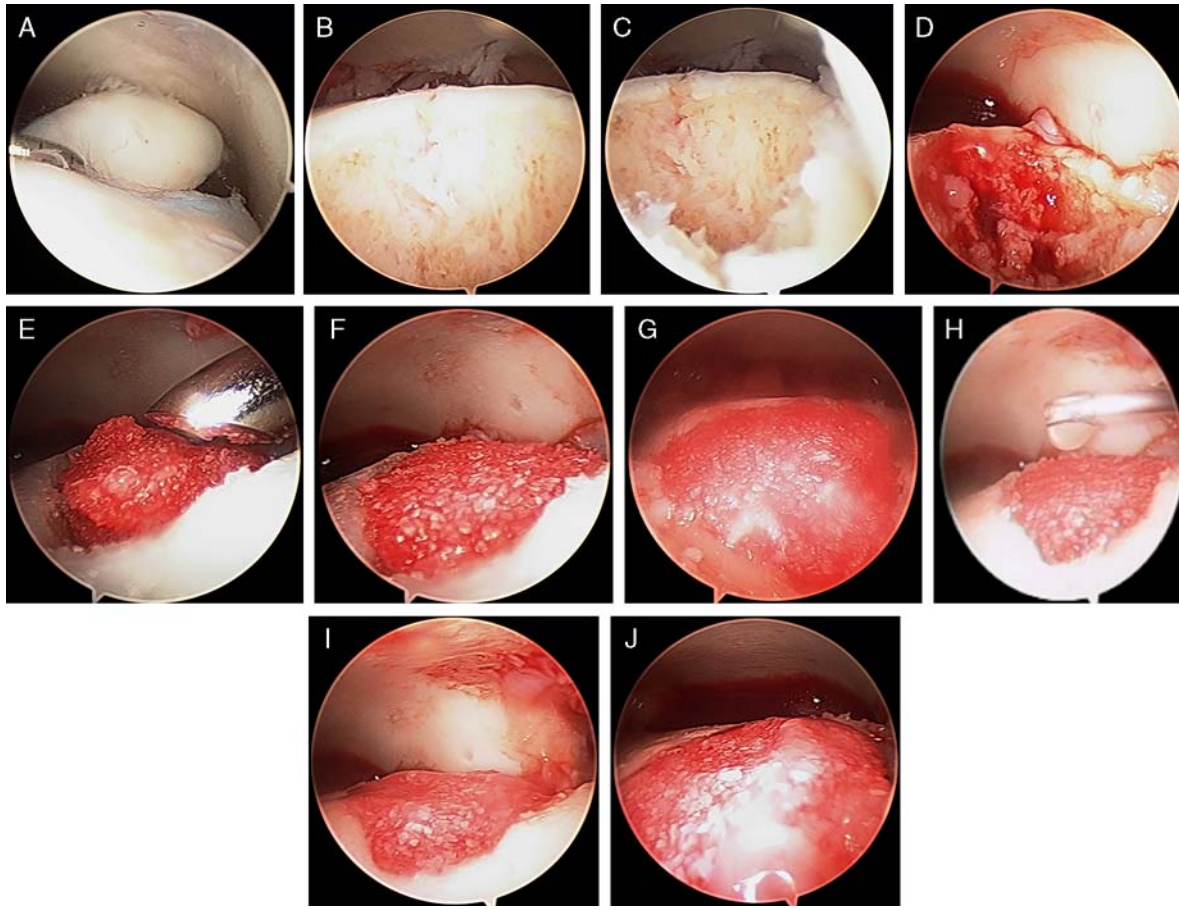

FIGURE 4. A, Arthroscopic image of displaced medial talar dome osteochondral lesion, same as the patient in Figures 2 and 3. B, Osteochondral lesions (OCL) after debridement, note vertical edges created. C, OCL after debridement. D, OCL after marrow stimulation with good bleeding response. E, Injection of micronized allograft cartilage matrix in OCL defect. F and G, After application and contouring of micronized allograft cartilage matrix. H, Application of fibrin adhesive. I and J, Visualization of OCL after fibrin sealant is applied and allowed to set.

TABLE 1. Patient Information and Results

Patient Number	Age	Location	Size (mm^2)	Ferkel Grade	Cystic	Months From Surgery	Revision (No. Previous Surgeries)	Result
1	32	MTD	63	F	No	8	No	Excellent
2	37	LTD	42	F	No	7	Yes	Excellent
3	74	MTD	169	E	Yes	12	No	Excellent
4	36	LTD	110	F	No	12	Yes (2)	Excellent
5	50	LTD	96	D	No	13	No	Excellent
6	23	MTD	190	E	Yes	13	Yes (1)	Good
7	18	LTD	112	E	No	15	No	Excellent
8	49	MTD	121	F	Yes	13	Yes (1)	Excellent
9	61	MTD	285	D	No	15	No	Good

LTD, lateral talar dome; MTD, medial talar dome.

structures. In the author's experience, the majority of OCLs can be addressed through anterior portals.

Next, routine debridement of the disrupted articular cartilage and unstable subchondral bone is performed with a combination of a shaver and curettes. Vertical edges are created at the periphery of lesion, which will allow the surrounding cartilage to better shoulder the load compared with beveled edges (Figs. 4A–C). Marrow stimulation can be performed using various techniques and the method employed is the surgeon's choice (Fig. 4D). Irrespective of the technique used, several principles should be followed. The marrow stimulation should be performed in the periphery of the lesion then moved centrally. The holes created should be small and perpendicular to the surface of the lesion. They should be close to each other without fracturing the interconnecting bone bridges. Over aggressive microfracture may disrupt the subchondral architecture and may lead to osteophyte formation at the base of the lesion. A key point to remember is the goal of the marrow stimulation is simply to gain access to the mesenchymal stem cells. The tourniquet is deflated at this point to confirm adequate bleeding from the marrow stimulation sites.

Next, all arthroscopic fluid is aspirated from the joint and the defect is dried with multiple pledgets. This step is important as a wet environment makes application of the micronized allograft cartilage matrix very difficult.

The micronized allograft cartilage matrix is mixed with an autologous blood solution in the mixing syringe. The mixture is delivered into the lesion using a Tuohy delivery needle (Figs. 4E–G). The lesion should be filled to 1 mm beneath the articular surface and a small elevator can be used to further contour the mixture in the defect. A thin layer of fibrin sealant is then applied through a dual lumen applicator tip to the surface of the lesion. Excessive application of the fibrin sealant should be avoided as this can make the area too proud. The fibrin sealant is allowed to set for 5 minutes and the ankle should not be manipulated during this time (Figs. 4I, J). After this time period the ankle can be taken through a range of motion to confirm adherence of the micronized allograft cartilage matrix. The wounds are closed with a 3-0 nonabsorbable suture and a standard bulky splint is applied. Video 1 (Supplemental Digital Content 1, http://links.lww.com/TFAS/A44) displays the described technique in a patient who had a cystic-type lesion and a previously performed standard arthroscopic debridement and microfracture. She is asymptomatic at 13 months after the revision procedure.

RESULTS

To date the author has performed this technique in 9 patients. The average age was 42 years and ranged from 18 to 61 years. There were 5 male and 4 female patients. The average size of the lesions was 132 mm^2 and ranged from 42 mm^2 to 285 mm^2. Five occurred about the medial talar dome and 4 laterally. There were 3 Ferkel arthroscopic grade D lesions, 3 grade E lesions, and 3 grade F lesions. Four of the 9 patients underwent revision surgeries who had previously undergone at least 1 previous surgery to address their OCL. The average follow-up was 12 months and ranged from 7 to 15 months. At the most recent follow-up appointments 7 of 9 patients reported doing excellent with no functional limitations. Two patients reported good results but had occasional pain; however, neither required further surgical intervention. All patients state that they were happy with the results and would undergo the procedure again (Table 1).

On examination of the data, many of the lesions would have historically been treated with procedures other than arthroscopic debridement with marrow stimulation. Many of the lesions were cystic in nature and revision surgeries were performed. Both of these circumstances have been shown to have poor results.[17,19,22] In the set of patients treated, even in these situations have good short-term results. The 2 patients who had some degree of residual pain both had large lesions (190 and 285 mm^2). One of these was revision surgery on a cystic lesion.

COMPLICATIONS

Complications are very infrequent and would be similar to standard ankle arthroscopy procedures. To date no complications have been encountered in the author's experience.

POSTOPERATIVE MANAGEMENT

The patient remained strictly non–weight-bearing for 6 weeks. They remain in the postoperative splint for 1 week, followed by a cast for 2 weeks, and then a boot for the final 3 weeks. Hip exercises and quad sets are started immediately and active range of motion of the ankle is encouraged at 3 weeks. At 6 weeks the patient begins weight-bearing as tolerated in a walking boot and can transition to a lace-up ankle brace and tennis shoe when comfortable. Formal ankle rehabilitation is started, and low-impact activities such as swimming and biking are allowed at this time. At 3 months the patient can progress to high-impact activity. I recommend wearing the brace for 1 year during athletic activity.

FUTURE OF THE TECHNIQUE

The technique described offers a cost-effective and safe arthroscopic surgery, which takes advantage and potentially enhances accepted arthroscopic marrow stimulation procedures. The early results of this procedure appear promising,

including in cystic lesions, lesions >150 mm^2, and revision cases that would traditionally be treated with more extensive surgeries. Longer term follow-up and larger set of patients are needed to determine the durability of this procedure.

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CME QUESTIONS

1. Microfracture with marrow stimulation as a treatment for talar osteochondral lesions has been shown to be successful in approximately what percentage of patients:

   A. 3-8%
   B. 12-20%
   C. 35-50%
   D. 65-85%

2. With the technique of arthroscopic debridement, marrow stimulation, and application of micronized allograft cartilage matrix for the treatment of osteochondral lesions of the tibial plafond, which is not an important principle to adhere to:

   A. Marrow stimulation holes should be large
   B. Maintaining a dry environment during application of the micronized allograft cartilage matrix
   C. Creating vertical borders at the periphery of the osteochondral lesion
   D. Marrow stimulation holes should be perpendicular to the surface of the lesion

3. What is the primary tissue type formed after standard microfracture procedures?

   A. Micronized autograft cartilage matrix
   B. Micronized allograft cartilage matrix
   C. Demineralized bone matrix
   D. Particulated juvenile cartilage

4. Berndt and Harty in their original paper describing osteochondral lesions of the talus elicited a history of trauma in what percentage of patients:

   A. Type 1 collagen
   B. Type 2 collagen
   C. Fibrocartilage
   D. None of the above

5. Studies have shown that debridement with marrow stimulation for the treatment of osteochondral lesions are more likely to be poor in which situations:

   A. Lesions $>150mm^2$
   B. Revision surgery
   C. Cystic lesions
   D. All of the above

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Your completion of this activity includes evaluating it. Please respond to the following questions below.

Please rate these activities (1 — minimally, 5 — completely)	1 2 3 4 5
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Please rate your ability to achieve the following objectives, both before this activity and after it: 1 (minimally) to 5 (completely)

	Pre 1 2 3 4 5	Post 1 2 3 4 5
Assess the advantages of micronized allograft cartilage matrix in the treatment of osteochondral lesions of the talus.	O O O O O	O O O O O
Apply the technique of arthroscopic debridement, marrow stimulation, and application of micronized allograft cartilage matrix in the treatment of osteochondral lesions of the talus.	O O O O O	O O O O O
Evaluate situations in which standard debridement and marrow stimulation techniques may lead to poor results in the treatment of osteochondral lesions.	O O O O O	O O O O O

How many of your patients are likely to be impacted by what you learned from this activity?
O <20% O 20-40% O 40-60% O 60-80% O >80%

Do you expect that these activities will help you improve your skill or judgment within the next 6 months? (1 — definitely will not change, 5 — definitely will change)	1 2 3 4 5
	O O O O O

How will you apply what you learned from these activities (mark all that apply):

In diagnosing patients O	In making treatment decisions O
In monitoring patients O	As a foundation to learn more O
In educating students and colleagues O	In educating patients and their caregivers O
As part of a quality or performance improvement project O	To confirm current practice O
For maintenance of board certification O	For maintenance of licensure O

Please list at least one strategy you learned from this activity that you will apply in practice:

_____

How committed are you to applying these activities to your practice in the ways you indicated above? (1 — minimally, 5 — completely)	1 2 3 4 5
	O O O O O

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