

Osteochondral Lesions of the Talus: Randomized Controlled Trial Comparing Chondroplasty, Microfracture, and Osteochondral Autograft Transplantation

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Purpose: The purpose of this study was to compare outcomes of chondroplasty versus microfracture versus osteochondral autologous transplantation (OAT) in patients with osteochondral lesions of the talus (OLT). **Methods:** After prospective sample size analysis, patients with symptomatic, recalcitrant Ferkel class 2b, 3, and 4 OLT were randomized to chondroplasty, microfracture, or OAT treatment groups. Outcomes were measured with use of the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale (AHS), the Subjective Assessment Numeric Evaluation (SANE) rating, Numeric Pain Intensity (NPI), and magnetic resonance imaging (MRI). **Results:** Eleven patients had chondroplasty, 10 ankles (9 patients) had microfracture, and 12 patients had OAT. Mean time to follow-up was 53 months (range, 24 to 119 months). AHS scores showed no differences at 12 and 24 months, and SANE ratings showed no differences at final follow-up. NPI was significantly lower ($P < .001$) in chondroplasty and microfracture cases as compared with OAT at 24 hours postoperatively. Pearson's correlation analysis demonstrated an inverse relation between microfracture and OAT groups in that better outcome was associated with smaller lesions, compared with the chondroplasty group, which revealed mixed results with no particular trend. MRI revealed incomplete fill and edema after chondroplasty or microfracture and chondral gaps after OAT. **Conclusion:** Our results demonstrate no difference between chondroplasty, microfracture, and OAT with regard to AHS and SANE ratings in patients with OLT. However, NPI at 24 hours postoperatively was significantly lower in patients who had chondroplasty and microfracture. **Level of Evidence:** Level I, Therapeutic study, high-quality randomized controlled trial with no statistically significant differences but narrow confidence interval. **Key Words:** Ankle—Arthroscopy—Talus—Microfracture—Chondroplasty—Osteochondral.

Osteochondral lesions of the talus (OLT) have been variously described and may include transchondral, osteochondral, flake, or talar dome fractures and osteochondritis dissecans as a result of

trauma, vascular compromise, genetic, endocrine, or morphologic abnormalities or idiopathic phenomena.¹⁻⁵ The exact incidence of this condition is unknown and may be higher than has been reported.⁶⁻⁹

Treatment options include nonsurgical and surgical approaches according to the severity and location of the lesion. However, a systematic review of 14 OLT publications¹⁰ demonstrated successful nonsurgical treatment in only 45% of cases.

When nonsurgical management is ineffective, surgery is often recommended.¹¹⁻¹⁵ Historically, surgeries were performed with the use of conventional open techniques. Now, surgical treatment of patients with OLT, consisting of chondroplasty, microfracture, and osteochondral autologous transplantation (OAT) techniques, may be performed

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TABLE 1. *Ferkel Classification of Osteochondral Lesions of the Talus*

Ferkel Classification	Description
1	Cystic lesion with intact walls
2a	Cystic lesion communicating with the talar dome
2b	Full-thickness lesion with an overlaid fragment
3	Lesion without fragment displacement
4	Free loose fragment

arthroscopically.¹⁶⁻²⁷ However, controversy continues because no surgical guidelines have been generally agreed upon for this clinically challenging problem. Furthermore, evidence-based level 1 investigations that could provide useful information are lacking. To our knowledge, these available treatment options have not been prospectively compared in this ideal manner.

The purpose of this study was to compare outcomes of chondroplasty, microfracture, and OAT in patients with OLT. We tested the null hypothesis: No difference in treatment outcomes will be seen.

METHODS

Included in this investigation were patients with Ferkel class 2b, 3, and 4 OLT (Table 1)⁶ with symptoms of ankle pain or limitation of function despite a minimum of 6 months of nonsurgical management. Only primary cases with no previous surgical treatment for OLT were included. All lesions were confirmed by magnetic resonance imaging (MRI) and arthroscopy. Excluded were patients with lesions smaller than 1 cm² in diameter, bipolar (“kissing”) lesions, and diffuse arthritic changes, as well as those with associated ankle disease (e.g., ankle fracture). For technical reasons, patients with far posterior or central lesions not readily amenable to arthroscopic management were excluded, thus limiting subjects to those with anterior and lateral lesions. All defects in the 3 groups were carefully measured with the use of a marked probe. An inherent limitation of this means of documentation is the possible slight error that may occur during measurement.

Patients were randomized according to operating surgeon, such that an individual surgeon was assigned to a particular surgical technique (chondroplasty, microfracture, or OAT). This method of randomization was selected to allow each surgeon to perform the technique in which he or she specializes with the goal

of achieving the “best possible outcomes” for each procedure.

Outcomes were measured with the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale (AHS) (Table 2).²⁸ The AHS score (primary outcome measure, range 0 to 100) was determined preoperatively and at 12 and 24 months postoperatively. Additional outcome measures were the Single Assessment Numeric Evaluation (SANE) rating, range 0 to 100,²⁹ which was performed preoperatively and at final follow-up; the Numeric Pain Intensity (NPI rating, range 1 to 10),³⁰ which was determined 24 hours postoperatively; and MRI evaluation, which was performed 12 months postoperatively. MRI (Signa LX; General Electric Systems, Milwaukee, WI) was performed with an ankle coil, and views were analyzed by an independent radiologist who was blinded to the purpose of the study. MRIs of patients with chondroplasty and microfracture were analyzed for fill, edema, and osteonecrosis, and MRIs for patients with OAT were analyzed for edema, osteonecrosis, graft lysis, graft subsidence, and graft chondral and bone integration.³¹⁻³³

Surgical Techniques

Chondroplasty was performed arthroscopically via anteromedial and anterolateral portals. Loose chondral or osteochondral fragments were excised, and a mechanical shaver (Dyonics Power Shaver System; Smith & Nephew, Andover, MA) was used to trim damaged cartilage with the goal of creating a stable, smooth articular surface. Microfracture was performed with a microfracture awl (Linvatec, Largo, FL), as described by Steadman et al.²⁶ Unstable chondral fragments were excised with an arthroscopic shaver or handheld curette, subchondral bone was debrided of the calcific layer, and multiple perforations perpendicular to the joint surface were placed 3 to 4 mm apart to a depth that allowed observation of fat droplets and blood from the perforations when arthroscopic irrigation fluid pump pressure was lowered.

OAT was performed with the mosaicplasty autogenous osteochondral grafting system (Smith & Nephew, Andover, MA). Unstable chondral fragments were removed with an arthroscopic shaver or handheld curette; this was followed by measurement of the lesions with sizers of variable diameters. A total of 1 to 3 osteochondral plugs were then harvested (from the periphery of the lateral femoral condyle or the trochlear notch of the ipsilateral knee) and

TABLE 2. AOFAS Ankle-Hindfoot Scale (100 points)

Pain (40 points)	None	40
	Mild, occasional	30
	Moderate, daily	20
	Severe, almost always present	0
Function (50 points)		
	Activity limitations, support requirement	
	No limitations, no support	10
	No limitation of daily activities, limitation of recreational activities, no support	7
Maximum walking distance, blocks	Limited daily and recreational activities, cane	4
	Severe limitations of daily and recreational activities, walker, crutches, wheelchair, brace	0
	Greater than 6	5
	4-6	4
Walking surfaces	1-3	2
	Less than 1	0
	No difficulty on any surface	5
	Some difficulty on uneven terrain, stairs, inclines, ladders	3
Gait abnormality	Severe difficulty on uneven terrain, stairs, inclines, ladders	0
	None, slight	8
	Obvious	4
	Marked	0
Sagittal motion (flexion plus extension)	Normal or mild restriction ($\geq 30^\circ$)	8
	Moderate restriction (15° - 29°)	4
	Severe restriction ($< 15^\circ$)	0
	Normal or mild restriction (75% to 100% normal)	6
Hindfoot motion (inversion plus eversion)	Moderate restriction (25% to 74% normal)	3
	Marked restriction (less than 25% normal)	0
	Stable	8
	Definitely unstable	0
Ankle-hindfoot stability (anteroposterior, varus-valgus)	Good, plantigrade foot, ankle-hindfoot well aligned	10
	Fair, plantigrade foot, some degree of ankle-hindfoot malalignment observed, no symptoms	5
	Poor, nonplantigrade foot, severe malalignment, symptoms	0
Alignment (10 points)		

were transplanted to the lesion in a particular position, such that the articular surfaces were level with the adjacent talar dome.

Postoperatively, all ankles were immobilized in a brace for 7 days; this immobilization was followed by unrestricted, active range of ankle motion, non-weight bearing for 8 weeks, and no sports or impact activity for 6 months.

Statistical Methods

Sample size analysis was prospectively performed. On the basis of pilot data, we estimated AOFAS standard deviation of 3.2 and SANE standard deviation of 3.0. By assuming that the minimum clinically significant difference between treatment group scores was 5, we determined with the use of iterative methods that a minimum of 10 samples would be necessary for each treatment group with decisional criteria of α equals 5% and β error equals 20%.

The Kolmogorov-Smirnov test ($P > .1$) and

Barlett's test ($P > .1$) were used to verify normal distribution and the homogeneity of variances of the scales used (AOFAS and SANE).

Statistical analysis of data obtained was performed with (1) an analysis of variance (ANOVA) 1-way test and post hoc Tukey's test to evaluate differences between treatment group scores, (2) *t* test to evaluate differences between scores within treatment groups over time, and (3) Pearson's correlation to determine whether lesion size is related to treatment outcomes in the 3 groups that were being tested.

RESULTS

A total of 33 ankles in 32 patients were included. Mean time to follow-up was 53 months (range, 24 to 119 months). Eleven patients had chondroplasty, 10 ankles in 9 patients had microfracture, and 12 patients had OAT. Demographic details are described in Table 3.

TABLE 3. Patient Demographics and OLT Data

Demographics	Treatment Group		
	Chondroplasty	Microfracture	OAT
Sex	6 male : 5 female	6 male : 3 female (1 case with bilateral involvement)	8 male : 4 female
Age, years	32 (19–45)	24 (17–28)	27.8 (21–53)
Lesion location	7 Lateral 4 Medial	7 Lateral 3 Medial	8 Lateral 4 Medial
Mean lesion size, range	4 cm ² (1–6)	4.5 cm ² (1.5–8)	3.7 cm ² (1.2–5)
Lesion Ferkel class	3 - IIb 4 - III 4 - IV	2 - IIb 3 - III 5 - IV	4 - III 8 - IV

Abbreviations: OLT, osteochondral lesion of the talus; OAT, osteochondral autologous transplantation.

AHS (Table 4) showed statistically significant improvement in all treatment groups from preoperative status to outcomes 12 months postoperatively ($P < .001$), as well as continued statistically significant improvement in the OAT group from 12 months to 24 months postoperatively ($P = .03$). No differences were noted between chondroplasty, microfracture, and OAT AHS scores preoperatively or at 12 or 24 months postoperatively.

SANE ratings (Table 5) showed statistically significant improvement in all treatment groups from preoperative status to outcomes 12 months postoperatively ($P < .001$). No differences were noted between chondroplasty, microfracture, and OAT SANE values preoperatively or at 24 months postoperatively.

NPI ratings (Table 6) were significantly lower ($P < .001$) in chondroplasty and microfracture groups as compared with the OAT group at 24 hours postoper-

atively. No differences were noted between chondroplasty and microfracture groups.

Analysis with Pearson's correlation demonstrated only a minor relationship between lesion size and outcomes at 12 and 24 months in all treatment groups tested.

MRI views were not available in 4 of 11 patients with chondroplasty because of financial constraints. Among the 7 chondroplasty cases with MRI views, incomplete fill and edema were noted in all, and osteonecrosis was not observed. MRI views were also unavailable in 2 of 10 microfracture cases because of financial constraints. The remaining 8 cases with MRI were observed to have incomplete fill and decreased edema, and osteonecrosis was not observed (Figs 1 and 2).

MRI views obtained from all OAT cases generally demonstrated minimal edema; absence of graft necro-

TABLE 4. American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scores (AHS) and Statistical Data

Treatment Group	Mean AOFAS Score			Student <i>t</i> Test			Correlation (<i>r</i>) (defect size v AHS)	
	Preop	12 mo	24 mo	Preop v 12 mo	Preop v 24 mo	12 v 24 mo	12 mo	24 mo
Chondroplasty	36.8	78.2	82.7	$P < .001$	$P < .001$	$P = .20$	$r = -.57$	$r = .07$
Osteochondral autologous transplantation (OAT)	31.1	81.4	85.4	$P < .001$	$P < .001$	$P = .03$	$r = -.92$	$r = -.89$
Microfracture	33.8	82.2	83.8	$P < .001$	$P < .001$	$P = .38$	$r = -.92$	$r = -.92$
Post hoc Tukey Test Between Treatment Groups								
				Preop		12 mo		24 mo
Chondroplasty v OAT				$P = .066$		$P = .194$		$P = .159$
Chondroplasty v microfracture				$P = .121$		$P = .064$		$P = .735$
OAT v microfracture				$P = .978$		$P = .0785$		$P = .536$

TABLE 5. Subjective Assessment Numeric Evaluation (SANE) Scores and Statistical Data

Treatment Group	SANE		Student <i>t</i> Test
	Preop	24 mo	Preop <i>v</i> 24 mo
Chondroplasty	38	78	<i>P</i> < .001
Microfracture	36	80	<i>P</i> < .001
Osteochondral autologous transplantation (OAT)	35	82	<i>P</i> < .001
ANOVA test (<i>P</i> values)	0.15	0.39	—
	Post hoc Tukey Test Between Treatment Groups		
	Preop	24 mo	
Chondroplasty <i>v</i> OAT	<i>P</i> = .363	<i>P</i> = .126	
Chondroplasty <i>v</i> microfracture	<i>P</i> = .625	<i>P</i> = .777	
OAT <i>v</i> microfracture	<i>P</i> = .917	<i>P</i> = .422	

Abbreviation: ANOVA, analysis of variance.

sis, lysis and subsidence; full bony integration; and incomplete chondral integration (gaps).

Complications

A review of cases in the 3 treatment groups demonstrated the presence of pain of unknown cause at various intervals after surgery. No other complication of significant value was observed.

In the chondroplasty group, 1 patient had persistent ankle pain 9 months postoperatively. Revision arthroscopic chondroplasty and arthroscopic synovectomy were performed. Final outcomes were poor because of persistent pain 24 months postoperatively.

In the microfracture group, 2 cases (in the single patient with bilateral disease) had poor outcomes because of persistent pain 24 months postoperatively. The patient declined additional surgical treatment.

In the OAT group, 2 patients had pain and stiffness at 8 months and 22 months postoperatively, respectively. Both had arthroscopic debridement for anterior fibrous impingement. One of these 2 patients had a poor outcome because of persistent pain and stiffness 24 months postoperatively. No harvest site complications were observed.

DISCUSSION

Our results demonstrate no difference between chondroplasty, microfracture, and OAT with regard to the primary outcome measure (AHS) and with regard

to SANE ratings. However, NPI was significantly lower 24 hours postoperatively in patients with chondroplasty and microfracture as compared with patients who had OAT.

Van Dijk et al.¹⁰ reported 22% unsatisfactory results of chondroplasty in patients with OLT. This can be compared with 9% poor results (reoperation and persistent pain) in our investigation. Van Dijk et al.¹⁰ also reported 14% unsatisfactory results of microfracture in patients with OLT. This can be compared with 20% poor results (persistent pain) in our investigation. Lee et al.³⁴ demonstrated 11% unsatisfactory results of OAT in patients with OLT. This can be compared with 17% poor results (reoperation and persistent pain) in our investigation.

In a similar investigation by Schuman et al.,³⁵ who performed arthroscopic curettage and drilling, 19% of 38 patients demonstrated unsatisfactory results for a variety of reasons, including persistence of pain, swelling, and locking. On the other hand, in a series of patients with OAT who were treated by Baltzer et al.,³⁶ 10% demonstrated persistent pain at 2 years' follow-up.

Other variables analyzed, such as defect size, demonstrated that the microfracture group registered the biggest size with a mean of 4.5 cm² compared with

TABLE 6. Numeric Pain Intensity Scores and Statistical Data

Patient	Numeric Pain Intensity Scores		
	Chondroplasty	Osteochondral Autologous Transplantation (OAT)	Microfracture
1	3	4	3
2	2	5	2
3	4	5	4
4	3	6	3
5	5	5	4
6	4	7	4
7	3	6	5
8	3	4	3
9	2	5	4
10	4	5	2
11	3	6	—
12	—	5	—
Mean Score	3.3	5.25	3.4
	Post hoc Tukey Test Between Treatment Groups		
Chondroplasty <i>v</i> OAT			<i>P</i> < .001
Chondroplasty <i>v</i> microfracture			<i>P</i> = .76
OAT <i>v</i> microfracture			<i>P</i> < .001

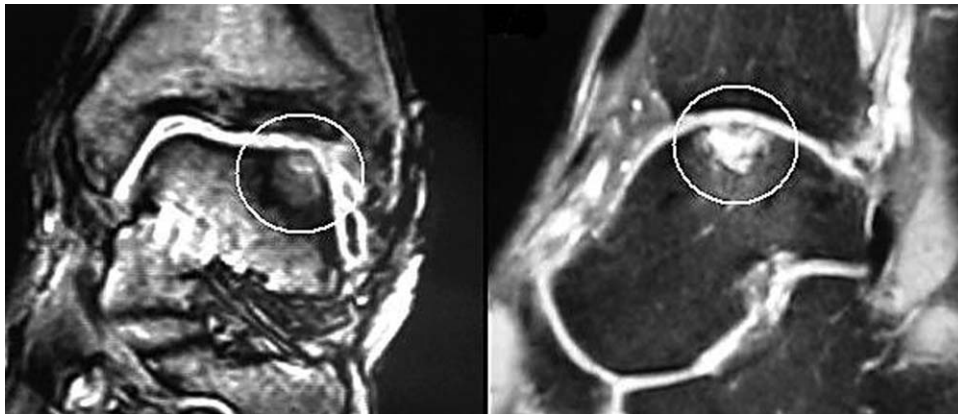


FIGURE 1. Anteroposterior and lateral preoperative images of a medial osteochondral lesion of the talus. The fragment remains undisplaced, demonstrating significant subchondral edema.

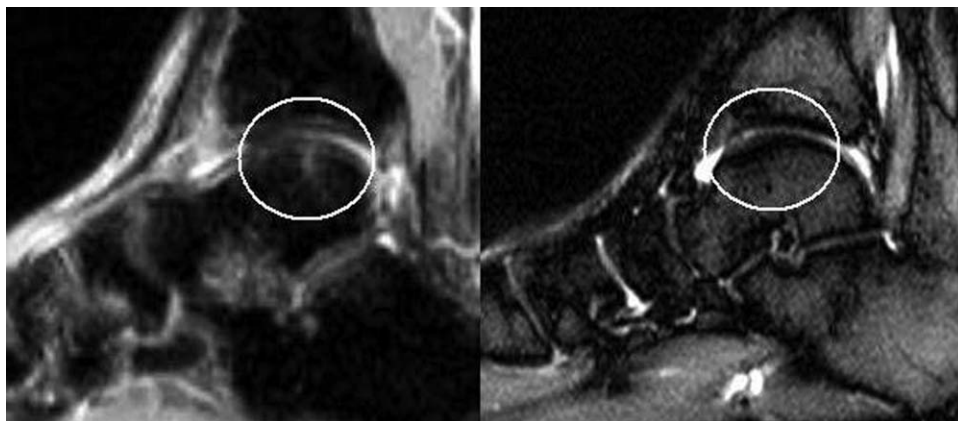
chondroplasty and OAT, which had mean diameters of 4 cm² and 3.7 cm², respectively. However, this difference in size was not statistically significant ($P > .05$). Further investigation with Pearson's correlation analysis revealed the minor relationship between defect size and outcome when lesions were examined, regardless of the treatment applied at 12 ($r = -.68$) and 24 months ($r = -.62$) after surgery. On the other hand, when analyzed according to treatment, the microfracture ($r = -.92$) and OAT ($r = -.89$) groups both demonstrated an inverse relationship, with smaller defects producing better AHS scores at 12 and 24 months compared with lesions with bigger diameter. In the same manner, for the OAT group, defects transplanted with fewer bone plugs demonstrated better outcomes than lesions with multiple plugs. For the chondroplasty group ($r = .07$), mixed results with no observable trend were attained. Our finding is consistent with that reported by Baltzer et al.,³⁶ in which better outcomes in terms of pain reduction and functional improvement were attained in patients with smaller-diameter defects who were treated with OAT.

On the basis of clinical data obtained during this investigation, we recommend that chondroplasty or microfracture should be used as first-line surgical treatment for patients with OLT. We make this recommendation on the basis of our finding of increased postoperative pain documented in patients with OAT, as well as the more extensive nature of this procedure when compared with chondroplasty and microfracture, which are relatively simpler. Although no graft harvest or knee surgery complications were noted, increased pain may be related to surgery on the ipsilateral knee. However, additional investigation to assess the contribution of surgical knee pain to postoperative pain was not undertaken, making this one of the limitations of this study.

With regard to MRI, Becher et al.³⁷ described "cartilage" at 24 months' follow-up in 30 cases of OLT post microfracture, and Assenmacher et al.¹⁶ described "stable osteointegration" at 9.3 months' mean follow-up in 9 cases of OLT post OAT.

In our investigation, limitations with regard to MRI data were apparent because (1) outcome measures

FIGURE 2. Postoperative images after microfracture surgery. At 12 months, subchondral edema remains with minimal effusion. Image at 24 months demonstrates better fill with minimal subchondral edema.



were subjective, (2) 3 different imaging centers were involved, and (3) 2 patients with chondroplasty and 2 with microfracture did not participate in postoperative MRI evaluation. Despite this limitation, we also base our recommendation of chondroplasty or microfracture as first-line surgical treatment for patients with OLT on the MRI data, specifically, the chondral gaps noted in patients with OAT. This finding was previously reported,¹⁶ and the long-term clinical significance of these gaps is unknown.

Our study has additional limitations. The method of randomization might be considered a “pseudo-randomized approach”³⁸ and may introduce study bias. In addition, inclusion of 3 different operating surgeons may introduce performance bias, and differences between treatment groups with regard to patient sex and age and lesion size and Ferkel class (Table 3) may introduce selection bias. We also emphasize that our investigation reflects only findings related to arthroscopically accessible lesions, which therefore excluded the analysis of far posterior and some medial talar dome lesions.

Our study also has strengths: Transfer bias is limited in that all patients were available for final follow-up, and reporting bias is limited because the AHS is a validated outcome measure.

Future research should include improved randomization methods, longer-term follow-up of a greater number of patients, blinded or double-blinded outcome assessment, quantitative MRI evaluation, and consideration of other treatment methods, such as autologous chondrocyte implantation, which is steadily gaining wide acceptance among surgeons. In addition, it is very important for future investigators to determine which method of treatment is most suitable for posterior and medial lesions because very few studies have dealt with this particular issue.

CONCLUSIONS

Our hypothesis is supported. On the basis of AHS and SANE ratings, no difference can be seen between chondroplasty, microfracture, or OAT for patients with OLT.

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