Functional and MRI Outcomes After Arthroscopic Microfracture for Treatment of Osteochondral Lesions of the Distal Tibial Plafond

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Background: Osteochondral lesions of the distal tibial plafond are uncommon compared with talar lesions. The objective of this study was to assess functional and magnetic resonance imaging (MRI) outcomes following microfracture for tibial osteochondral lesions.

Methods: Thirty-one tibial osteochondral lesions in thirty-one ankles underwent arthroscopic microfracture. The Foot and Ankle Outcome Score (FAOS) and Short Form-12 (SF-12) general health questionnaire were used to obtain patient-reported functional outcome scores preoperatively and postoperatively. MRI scans were assessed postoperatively with use of the Magnetic Resonance Observation of Cartilage Repair Tissue (MOCART) score for twenty-three ankles.

Results: The average age was thirty-seven years (range, fifteen to sixty-eight years), and the average lesion area was 38 mm² (range, 7.1 to 113 mm²). Twelve ankles had a kissing lesion on the opposing surface of the talus, and two ankles had a concomitant osteochondral lesion elsewhere on the talus. FAOS and SF-12 scores were significantly improved (p < 0.01) at the time of follow-up, at an average of forty-four months. The average postoperative MOCART score was 69.4 (range, 10 to 95), with a lower score in the ankles with kissing lesions (62.8) than in the ankles with an isolated lesion (73.6). Increasing age negatively impacted improvement in SF-12 (p < 0.01) and MOCART (p = 0.04) scores. Increasing lesion area was negatively correlated with MOCART scores (p = 0.04) but was not associated with FAOS or SF-12 scores. Lesion location and the presence of kissing lesions showed no association with functional or MRI outcomes.

Conclusions: Arthroscopic microfracture provided functional improvements, but the optimal treatment strategy for tibial osteochondral lesions remains unclear. The repair tissue assessed on MRI was inferior to normal hyaline cartilage. The MRI outcomes appeared to deteriorate with increasing lesion area, and both functional and MRI outcomes appeared to deteriorate with increasing age.

Level of Evidence: Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

Osteochondral lesions of the distal tibial plafond are rare—far less common than osteochondral lesions of the talus1-4. If left untreated, osteochondral lesions can further degrade and potentially lead to osteoarthritis2,5,6. However, the treatment guidelines and prognostic indicators that have been established for the talus have not been established for tibial osteochondral lesions, probably because of their infrequent occurrence. Arthroscopic microfracture is a common first-line treatment for talar osteochondral lesions, but there are few case series in which its outcomes have been investigated in the tibial plafond1-4. It has been suggested that tibial osteochondral lesions may not repair as favorably as those in the talus, but the current authors...
are not aware of any data describing the morphological quality of repair tissue on postoperative magnetic resonance imaging (MRI) after microfracture of tibial osteochondral lesions. Further understanding of the prognostic factors and lesion characteristics that affect the functional and radiographic outcomes of arthroscopic microfracture may help to determine surgical treatment guidelines and to more accurately manage patient expectations.

The purpose of this study was to report functional and MRI outcomes of arthroscopic microfracture for osteochondral lesions of the distal tibial plafond. Our hypothesis was that arthroscopic microfracture would provide improved functional outcomes with infill of fibrocartilage repair tissue as seen on MRI. Second, we hypothesized that large lesions and lesions associated with another osteochondral lesion on the opposite surface of the talar dome would result in poorer outcomes.

Materials and Methods
This retrospective study was approved by our institutional review board. Using our foot and ankle database, we identified forty-one distal tibial osteochondral lesions in forty-one ankles that had been treated with arthroscopic microfracture from April 2006 to December 2011. The senior surgeon (J.G.K.) provided all surgical treatment and postoperative care. Ten of the forty-one ankles were excluded because they had been followed for less than twenty-four months. Thirty-one ankles with a tibial osteochondral lesion were eligible for analysis. Fourteen of these ankles also had a talar osteochondral lesion, which was opposite to the tibial osteochondral lesion (a kissing lesion) in twelve and elsewhere on the talar dome in two.

Clinical Evaluation
Conservative treatment had been tried without success before surgical treatment was recommended. The conservative treatment consisted of non-weight-bearing immobilization in a controlled ankle movement (CAM) boot for three to four weeks followed by the performance of dorsiflexion and plantar flexion exercises and progression of weight-bearing by 10% each day for the next four weeks. Conservative therapy was considered to have failed if symptoms had not decreased or had worsened. Preoperative care was the same for all patients and entailed recording a complete history, a detailed physical examination, standard weight-bearing radiographs, and MRI (Fig. 1). The presence of anteromedial...
and/or anterolateral impingement was assessed during the physical examination and on preoperative MRI. Clinical and functional outcomes were assessed with use of the Foot and Ankle Outcome Score (FAOS) and Short Form-12 (SF-12) general health questionnaire at the last office visit before surgery and at each follow-up visit. A previously described nine-zone anatomic grid scheme was used to define the lesion location1 (Fig. 2). The lesion size was determined on preoperative MRI by the senior radiologist (T.W.D.) and intraoperatively by the senior surgeon (J.G.K.) using a ruled probe (Smith & Nephew, London, United Kingdom).

**Surgical Technique**

Standard anteromedial and anterolateral portals were used for arthroscopic access, and microfracture was performed as previously described7. Noninvasive distraction was employed. Debridement of impingement areas, synovectomy, and loose-body removal were performed as needed. The edges of the osteochondral lesion were resected with use of a spinal curet and smoothed with a 2.9-mm resector. The curet was also used to remove any cystic lining. Microfracture was performed within the crater. The subchondral plate was breached to a depth of 4 mm, with 3 to 4 mm between each microfracture, until bleeding was visualized (Figs. 3 and 4). Kissing...
lesions and concomitant talar osteochondral lesions underwent microfracture, at the time of the tibial microfracture, with use of the same technique. Two ankles, both of which had a kissing lesion, underwent additional antegrade transmalleolar drilling of the tibial lesion. Four ankles, two of which also had a kissing lesion, underwent concomitant lateral ligament repair. One ankle was treated for a concomitant non-kissing talar lesion with autologous osteochondral transplantation.

**Postoperative Treatment**

Postoperative care was standardized for all patients. A short leg splint was applied after surgery and worn for fourteen days, after which it was removed and the patient wore a CAM boot for the following four weeks. Patients were instructed to perform plantar flexion and dorsiflexion exercises twice daily for ten minutes each time. They began to bear 10% of their body weight four weeks postoperatively and increased weight-bearing by 10% daily until full weight-bearing was reached six weeks after surgery. Patients were enrolled in formal physical therapy at this point with a focus on balance and joint proprioception. Beginning at ten weeks postoperatively, the focus of rehabilitation was shifted to strengthening and sports-specific exercises.

**MRI Assessment**

The senior musculoskeletal radiologist (T.W.D.) reviewed all images and evaluated articular cartilage morphology using fast-spin-echo proton density sequences with and without fat saturation and inversion recovery sequences (Fig. 1). MRI studies were obtained with a 3-T clinical imaging system (GE Healthcare, Milwaukee, Wisconsin).

Tibial articular cartilage was assessed with the modified Magnetic Resonance Observation of Cartilage Repair Tissue (MOCART) scoring system for twenty-three (74%) of the thirty-one ankles. MRI was not scored with the MOCART system for two patients because of susceptibility artifact from prior implants, and MRI was not acquired for six because of restrictions imposed by their insurance providers.

**Statistical Analysis**

Paired t tests were used to compare preoperative and postoperative patient-reported outcome scores (FAOS and SF-12). Spearman rank correlations were performed to assess associations between independent variables (patient demographics, clinical data, lesion size, functional outcomes, and MOCART scores). Wilcoxon rank sum tests were used to compare outcome scores between patients who had undergone only osteochondral lesion microfracture and those who had also undergone concomitant procedures. A value of \( p \leq 0.05 \) was considered significant.

**Source of Funding**

No external funding was used for this study.

**Results**

**Patient Demographics**

The cohort included seventeen right ankles (55%) and fourteen left ankles (45%). The average duration of follow-up was forty-four months (range, twenty-four to seventy-two months). Anteromedial or anterolateral impingement was seen arthroscopically in twenty ankles (65%). One ankle underwent subsequent autologous osteochondral transplantation for a talar lesion. Another ankle had had previous debridement, but not microfracture, of an osteochondral lesion at another institution. Patient demographic and lesion data are summarized in Table I.

The average lesion area was 38 mm\(^2\) (range, 7.1 to 113 mm\(^2\)). The frequency of the osteochondral lesions in each tibial grid location (Fig. 2) is provided in Table II. Lesions were most commonly located in the centromedial (23%) and anterolateral (19%) regions of the tibial plafond.

**Functional Outcomes**

The average FAOS pain score improved from 50.5 (range, 17 to 75) of 100 points preoperatively to 74.2 (range, 47 to 92) postoperatively (\( p < 0.01 \)). The average SF-12 score improved
Lesion location and lesion area were not significantly associated with the preoperative-to-postoperative change in either functional outcome score (p > 0.05). There was no significant difference in functional outcome between kissing lesions and isolated tibial lesions (p > 0.05). For the patients who underwent concomitant lateral ligament repair or autologous osteochondral transplantation, the average FAOS score improved from 47.8 (range, 22 to 68) preoperatively to 71.8 (range, 54 to 84) postoperatively. The average SF-12 score in this subset improved from 31.2 (range, 3 to 52) preoperatively to 55.2 (range, 32 to 81) postoperatively. There was no significant difference in functional outcome between this subset of patients and the remainder of the cohort (p > 0.05), but the sample size was small. Postoperative complications included one subchondral cyst, one superficial peroneal nerve dysesthesia, and one deep vein thrombosis.

**MRI Outcomes**

The average MOCART score, which was obtained for twenty-three (74%) of the thirty-one ankles, was 69.4 (range, 10 to 95) of 100 points (Table III). Increasing age was negatively correlated with the MOCART score (r = −0.43; p = 0.04). There was no significant difference in MOCART scores between the sexes (p > 0.05). Kissing lesions had lower average MOCART scores than isolated lesions (average, 62.8 and 73.6, respectively). Increasing lesion area was associated with lower MOCART scores (r = 0.50; p < 0.01).

**Discussion**

There is scant literature regarding surgical treatment of tibial osteochondral lesions, and treatment guidelines have not been established. Tibial osteochondral lesions have been observed in as few as twenty-three (2.6%) of 880 ankle arthroscopies. In fact, only one tibial osteochondral lesion is reported for every fourteen to twenty osteochondral lesions of the talus. This infrequency may be due to the fact that the articular cartilage of the distal tibial plafond is both thicker and stiffer than that of the talus. The concave contour of the distal tibial plafond may decrease exposure to stress compared with that experienced by the talar dome. Cases with a concomitant osteochondral lesion on the opposing surface of the talar dome are rarer than isolated tibial osteochondral lesions. These kissing lesions seem to be even more rare than non-kissing tibial and talar lesions. Cuttica et al. and Elias et al. reported only one true kissing lesion in each of their series. As a result, very little data regarding treatment of these lesions are available.

Surgical treatments, including debridement, curettage, transmalleolar drilling, abrasion arthroplasty, and arthroscopic microfracture, have been reported but only in studies with low levels of evidence. Several case reports have been published, but we are aware of only three case series in which tibial osteochondral lesions have been reported and only two series in which the outcomes of arthroscopic microfracture for those lesions have been specifically reported. Elias et al. reported the frequency of osteochondral lesions in each of nine locations from 38.7 (range, 3 to 57) of 100 points preoperatively to 59.5 (range, 16 to 89) postoperatively (p < 0.01). Functional outcome data are summarized in Table III.

Age was negatively correlated with the preoperative-to-postoperative change in the SF-12 score (r = −0.50; p < 0.01). The result of analogous testing for the change in the FAOS score was not significant (p > 0.05). There was no significant difference in either outcome score between the sexes (p > 0.05).

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. (%) of Patients</th>
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<tbody>
<tr>
<td>Degree of defect infill</td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>12 (52)</td>
</tr>
<tr>
<td>Hypertrophy</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Incomplete</td>
<td></td>
</tr>
<tr>
<td>&gt;50% of adjacent cartilage</td>
<td>4 (17)</td>
</tr>
<tr>
<td>&lt;50% of adjacent cartilage</td>
<td>3 (13)</td>
</tr>
<tr>
<td>Subchondral bone exposed</td>
<td>4 (17)</td>
</tr>
<tr>
<td>Integration to border zone</td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>13 (57)</td>
</tr>
<tr>
<td>Incomplete</td>
<td></td>
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<tr>
<td>Demarcating border visible</td>
<td>5 (22)</td>
</tr>
<tr>
<td>Defect visible</td>
<td></td>
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<tr>
<td>&lt;50% of length of repair tissue</td>
<td>2 (9)</td>
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<tr>
<td>&gt;50% of length of repair tissue</td>
<td>3 (13)</td>
</tr>
<tr>
<td>Surface of repair tissue</td>
<td></td>
</tr>
<tr>
<td>Surface intact</td>
<td>12 (52)</td>
</tr>
<tr>
<td>Surface damaged</td>
<td></td>
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<tr>
<td>&lt;50% of repair tissue depth</td>
<td>4 (17)</td>
</tr>
<tr>
<td>&gt;50% of repair tissue depth or total degeneration</td>
<td>7 (30)</td>
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<tr>
<td>Structure of the repair tissue</td>
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<tr>
<td>Homogeneous</td>
<td>18 (78)</td>
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<tr>
<td>Inhomogeneous</td>
<td>5 (22)</td>
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<tr>
<td>Signal (proton density) intensity of repair tissue</td>
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<td>Isointense</td>
<td>20 (87)</td>
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<tr>
<td>Moderately hyperintense</td>
<td>3 (13)</td>
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<tr>
<td>Markedly hyperintense</td>
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<tr>
<td>Subchondral lamina</td>
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<td>Intact</td>
<td>15 (65)</td>
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<tr>
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<td>8 (35)</td>
</tr>
<tr>
<td>Subchondral bone</td>
<td></td>
</tr>
<tr>
<td>Intact</td>
<td>8 (35)</td>
</tr>
<tr>
<td>Not intact (edema or subchondral cyst)</td>
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<td>Adhesions</td>
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</tr>
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</tr>
<tr>
<td>Yes</td>
<td>5 (22)</td>
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</table>
on the tibial plafond as seen on MRI. They found no relationship between lesion location and size, and all patients had pain at the time of the MRI. No treatment outcomes were reported. We did not find any significant difference in lesion size, functional outcome, or MOCART score among the lesion locations. However, the number of lesions in each location may have been too small for us to detect a difference. Cuttica et al. reported American Orthopaedic Foot & Ankle Society (AOFAS) ankle-hindfoot scores after microfracture for tibial osteochondral lesions in eleven patients. Four patients also had a lesion on the talus, but only one had a true kissing lesion. The authors found an improvement in the average AOFAS score from 35.2 before microfracture to 50.4 following the procedure, and four patients had a poor outcome (<40 points). The clinical outcomes were found to be similar between the patients with an isolated tibial lesion and those with both tibial and talus lesions.

In what we believe is the largest previously published series, Mologne and Ferkel reported on seventeen tibial osteochondral lesions, six of which were associated with a talar osteochondral lesion. In their study, the median AOFAS scores significantly increased from 52 preoperatively to 87 postoperatively; there was no difference between patients with an isolated tibial lesion and those with a concomitant talar lesion. All patients were treated with excision, curettage, and abrasion arthroplasty. However, five patients were also treated with transmalleolar drilling, two cystic lesions were treated with iliac bone-grafting, and only two were treated with microfracture. Thus, because of the paucity of evidence in the literature, the prognostic factors and lesion characteristics that affect clinical outcomes of arthroscopic microfracture for osteochondral lesions of the distal tibial plafond are unknown. Our findings agree with those of Cuttica et al. and Mologne and Ferkel in that we noted no significant difference in functional improvements between patients with a concomitant talar osteochondral lesion and those with an isolated tibial osteochondral lesion. The mean improvement in both functional scores was greater in the patients with an isolated tibial lesion, but this difference was not significant. Also, the correlation between lesion area and improvement in either functional outcome score was not significant. The lack of significance may be due to a small kissing-lesion sample size and because the lesions included in the study were relatively small (mean, 38 mm²).

The results of our study confirm the improvements in functional outcome reported by Cuttica et al. and Mologne and Ferkel. However, we used the FAOS as a measure of outcome, which cannot necessarily be directly compared with the AOFAS ankle-hindfoot scoring system. The lack of correlation between lesion size and functional outcome was also in agreement with the findings of Mologne and Ferkel.

Although we found that arthroscopic microfracture for tibial osteochondral lesions improved function (Table III), we noted less improvement with higher patient age. In comparison, Choi et al. found no difference among six age groups with regard to VAS (visual analog scale) pain ratings or AOFAS scores after microfracture for osteochondral lesions of the talus. However, the preoperative duration of symptoms was longer in the older group. Although we found less improvement in the SF-12 scores for older patients, the same cannot be said of the FAOS scores. The FAOS has been validated for multiple foot and ankle conditions with comparison with the SF-36 and SF-12. In the more recent study, the FAOS demonstrated moderate correlation with the physical-health-related SF-12 domains. On the basis of our results, the FAOS may be less sensitive than the SF-12. Other scoring systems may have demonstrated more responsiveness, but the FAOS has been previously validated, and the lack of significance may be attributable to the small cohort size. The FAOS was utilized in this study because it was sensitive when used to evaluate hindfoot outcomes in previous studies. For this reason, FAOS and SF-12 scores are used at the time of follow-up as the standard of care at our institution.

The MOCART score has been previously utilized to assess talar repair cartilage and has never been applied to tibial osteochondral lesions, to our knowledge. Our results indicate, in agreement with those of prior MOCART scoring of the talus, that the fibrocartilage repair tissue formed after microfracture may be compromised compared with normal hyaline cartilage. As is the case in the talus, it is unclear whether distal tibial repair cartilage will withstand the high pressures on the ankle joint over time. Like the SF-12 scores, the MOCART scores were negatively correlated with increasing age, which may suggest that repair tissue is of decreased quality in older patients. MOCART scores were negatively correlated with increasing lesion area. This finding more closely reflects prior findings in talar osteochondral lesions and may suggest that lesion size plays a role in repair. The lack of reports on tibial osteochondral lesions in the literature limits understanding of the effect of lesion area on repair and patient-reported outcomes. MOCART scores were lower in the presence of a kissing lesion but the difference was not significant. This may again be due to small sample size and because the MRI was performed at an average of sixteen months postoperatively. Proteoglycan depletion, chondrocyte death, and collagen type-I deposition occur a year after repair. Degeneration may then occur in the months following the first year after surgery. Thus, studies with long-term MRI follow-up could more effectively measure the relationship between lesion characteristics and clinical variables and repair-tissue integrity.

Cuttica et al. found that postoperative bone marrow edema was seen on MRI of all patients with a “poor” outcome. Subchondral bone marrow edema was present in fifteen (65%) of twenty-three ankles in our cohort. While the MOCART score was not significantly associated with the change in functional scores, the prevalence of subchondral edema may indicate poor-quality repair tissue that allows synovial fluid influx into the subchondral bone.

On the basis of our data, kissing lesions may be more common than previously reported. It is not yet known whether concomitant talar lesions have an impact on outcome or if different treatment guidelines should be established for
isolated distal tibial osteochondral lesions. Centromedial lesions were common in our study (23%) and in the study by Elias et al. (21%). In contrast, Elias et al. found the second most common lesions to be posteromedial (16%) whereas we found the second most common lesions to be anteromedial (19%). Cuttica et al. showed anterolateral and anterocentral zones to be most commonly affected. Lesion location appears to be variable, as proposed by Cuttica et al., and early data suggest that there is no correlation between location and outcome.

Limitations of the present study include its retrospective design, the fact that several different surgical procedures were used, the lack of a control or comparable treatment group, a wide range of patient ages, a wide range of lesion sizes, and the lack of MOCART scores for eight (26%) of the ankles. While there was a wide range of lesion sizes, many lesions had cystic or bone-void components. Even small lesions of this nature required deep curettage and were more similar to the larger lesions than area measurements indicate. Comparisons in a series of patients ranging in age from fifteen to sixty-eight years may not be valid, but the age range was similar in a previous study, and inclusion of these patients allowed us to determine the association between increasing age and functional outcome and to include enough patients to demonstrate significant functional improvements.

Including patients who underwent transmalleolar drilling and lateral ligament reconstruction introduced confounding variables to our study, but these procedures are often indicated in conjunction with microfracture and have been reported in previous case series. Patients who underwent concomitant procedures in our study demonstrated average functional outcome scores that were comparable with those in the total cohort. Ankles with concomitant anterior impingement were included for similar reasons. These ankles underwent simple removal of scar tissue and areas of osseous impingement, which are known to occur in ankles with osteochondral lesions. Although the impingement in these patients was not, in itself, severe enough to indicate surgery, impingement areas were resected to improve access and because they could be easily addressed at the time of surgery. Resection of impingement areas did not change the postoperative treatment course or duration of recovery and was unlikely to affect the overall clinical result. Furthermore, MOCART scoring allowed assessment of articular cartilage in isolation from concomitant pathological conditions.

Additional limitations include a small number of ankles in total and of ankles with kissing lesions, which limited statistical power.

The results of our study should be interpreted in light of the above limitations. However, despite these limitations, this case series is the largest in the literature and presents early evidence regarding the lesion characteristics and patient demographics that may or may not affect functional and MRI outcomes after microfracture of tibial osteochondral lesions.

In conclusion, arthroscopic microfracture provided good midterm functional results, but the optimal treatment strategy for these lesions remains unclear. The repair tissue assessed on MRI was inferior to normal hyaline cartilage, and both functional and MRI outcomes may deteriorate with increasing age. MRI outcomes also seem to deteriorate with increasing lesion area. The effect of lesion size, kissing lesions, and other prognostic factors has yet to be established. Whether microfracture in the tibia provides functional and MRI outcomes comparable with those in the talus remains to be determined.

References


