Autologous Matrix-Induced Chondrogenesis for Osteochondral Lesions of the Talus

A Clinical and Radiological 2- to 8-Year Follow-up Study

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Background: Autologous matrix-induced chondrogenesis (AMIC) has become an interesting treatment option for osteochondral lesions of the talus (OLTs) with promising clinical short- to midterm results.

Purpose: To investigate the clinical and radiological outcome of the AMIC procedure for OLTs, extending the follow-up to 8 years.

Study Design: Case series; Level of evidence, 4.

Methods: Thirty-three patients (mean age, 35.1 years; body mass index, 26.8) with osteochondral lesions of the medial talar dome were retrospectively evaluated after open AMIC repair at a mean follow-up of 4.7 years (range, 2.3-8.0 years). Patients requiring additional surgical procedures were excluded. All OLTs (mean size, 0.9 cm^2; range, 0.4-2.3 cm^2) were approached through a medial malleolar osteotomy, and 28 patients received subchondral autologous bone grafting. Data analysis included the visual analog scale for pain, the American Orthopaedic Foot and Ankle Society score for ankle function, the Tegner score for sports activity, and the MOCART (magnetic resonance observation of cartilage repair tissue) scoring system for repair cartilage and subchondral bone evaluation.

Results: Mean $\pm$ SD visual analog scale score improved significantly from 6.4 $\pm$ 1.9 preoperatively to 1.4 $\pm$ 2.0 at latest follow-up ($P < .001$). The mean American Orthopaedic Foot and Ankle Society score was 93.0 $\pm$ 7.5 (range, 75-100). The Tegner score improved significantly from 3.5 $\pm$ 1.8 preoperatively to 5.2 $\pm$ 1.7 at latest follow-up ($P < .001$), and 79% returned to their previous sports levels. The MOCART score averaged 60.6 $\pm$ 21.2 (range, 0-100). Complete filling of the defect was seen in 88% of cases, but 52% showed hypertrophy of the cartilage layer. All but 1 patient showed persistent subchondral bone edema. The patient's age and body mass index, the size of the osteochondral lesion, and the MOCART score did not show significant correlation with the clinical outcome. There were no cases of revision surgery for failed AMIC. Fifty-eight percent underwent reoperation, mainly for symptomatic hardware after malleolar osteotomy.

Conclusion: AMIC for osteochondral talar lesions led to significant pain reduction, recovery of ankle function, and successful return to sport. The MOCART score did not correlate with the good clinical results; the interpretation of postoperative imaging remains therefore challenging.

Keywords: osteochondral lesion; talus; AMIC; MOCART; collagen I/III matrix

An osteochondral lesion of the talus (OLT) is defined by a circumscribed defect of the talar articular cartilage and its underlying subchondral bone. When compared with osteochondral lesions of other joints, OLTs are more often caused by a single or multiple traumatic events.[14,17,28,29] Preceding trauma is documented in 93% to 98% of lateral lesions and 61% to 70% of medial talar lesions.[19,53] For nontraumatic lesions, other etiological factors have been proposed, such as ischemia and genetics.[16,27,56]

Different treatment modalities have also been described, such as microfracture,[7,18,44,50] osteochondral autograft[20,30,31] or allograft[1,25,40] transplantation, and matrix-induced chondrocyte implantation.[3,15,23] Microfracture is a simple, minimally invasive method that leads to recruitment of chondrogenic cells from the bone marrow, which results in the formation of fibrocartilage but does not achieve restoration of the subchondral osseous defect. By contrast, the key benefit of osteochondral autograft transplantation is that the osteochondral lesion is filled with a cylinder of hyaline cartilage and subchondral bone

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in a single-step procedure. However, a concerning rate of postoperative knee pain attributed to donor site morbidity has been reported with this technique.[37,48] Osteochondral allograft transplantation avoids the donor-site morbidity, but its use is restricted because of limited graft availability and high costs. Furthermore, most OLTs are located on the medial or lateral edge of the talar dome, which makes a matching and stable anchorage of the osteochondral graft to the talar surface challenging. Matrix-induced chondrocyte implantation can be combined with subchondral autologous bone grafting, and it causes minimal donor site morbidity; however, it is expensive and requires a second surgical procedure to implant the harvested and cultured chondrocytes.[23] Overall, none of these treatment modalities has shown significantly better clinical results when compared with the others.[12]

First described in 2005,[6] autologous matrix-induced chondrogenesis (AMIC) has become an interesting treatment option for OLTs. This technique involves microfracture of the subchondral bone and application of a collagen type I/III bilayer matrix, which stabilizes and protects the released chondrogenic cells. Subchondral defects are filled with autologous cancellous bone before the application of the matrix. This technique overcomes the drawbacks of the other osteochondral repair and reconstruction procedures, since it is a cost-effective single-step procedure that is easily applicable and avoids donor site morbidity.

OLTs are often sequelae of chronic ankle instability, which needs to be addressed with additional interventions, such as lateral ligament repair or reconstruction or corrective calcaneal osteotomy, to regain stability and correct the axis of the hindfoot.[10,21,35] These interventions are associated with a prolonged healing process and more restricted rehabilitation program. Some studies performed such interventions in combination with AMIC in up to 83% of the cases, which may have influenced the final results.[49,55] Therefore, only isolated AMIC procedures, without additional surgical interventions, were included in the present study. Overall, promising clinical results have been reported with the use of the AMIC procedure for OLTs.[33,41,45,49,54,55] However, most previous studies comprised either a short-term follow-up or a small number of study participants.

Cross-sectional imaging studies, especially magnetic resonance imaging (MRI)[22,52] and computed tomography arthrography,[43] have become the diagnostic tools of choice for preoperative planning and postoperative evaluation of osteochondral lesions. The significance of findings of postoperative imaging of patients treated with cartilage repair technique for OLTs is still unclear.[32,34] The MOCART (magnetic resonance observation of cartilage repair tissue) score was introduced in 1994 for morphological evaluation of cartilage repair tissue in the knee.[36] Since then, few studies have implemented the MOCART score to evaluate AMIC-repaired OLTs.[33,45,49] The reliability of this score is nevertheless still controversial.[2,13]

The purpose of this retrospective study was to evaluate the clinical and radiological results after open AMIC-repaired osteochondral talar lesions via medial malleolar osteotomy among consecutively treated patients after a follow-up of 2 to 8 years.

METHODS

Participants

The study was approved by the local research ethics committee (BASEC No. 2017-00439). All patients received oral and written information and signed written informed consent.

The charts of 86 consecutive patients who underwent AMIC of the talus in our institution between October 2009 and August 2015 were reviewed. All sizes of OLTs were included. Exclusion criteria were follow-up <2 years, prior surgery on the affected ankle, associated injuries or deformities that required additional surgical procedures, or another relevant trauma to the affected ankle after the AMIC procedure. Furthermore, all lateral OLTs were excluded to keep the study group as homogeneous as possible (Figure 1).

Surgical Technique

An open approach via a medial malleolar osteotomy was used in all cases to achieve adequate exposure of the OLT. The unstable overlying cartilage and necrotic subchondral bone were removed with a curette. Microfracture was performed by drilling multiple holes into the OLT with a 1.2-mm K-wire (Depuy Synthes). Subchondral defects or cysts were filled with autologous cancellous bone that was harvested from the osteotomy site of the medial malleolus. A collagen I/III bilayer matrix (Chondro-Gide; Geistlich Pharma AG) was adjusted to the shape of the OLT and rinsed with water. The moistening of the matrix led to a slight expansion, which had been considered during cutting of the matrix. The matrix was then placed into the lesion and fixed with fibrin glue (Tissucol; Baxter), the porous side facing the bone (Figure 2). The stable position of the membrane was checked by moving the ankle joint several times throughout the full range of ankle plantar flexion and dorsal extension. The malleolar osteotomy was fixed with two 3.5-cm malleolar screws.

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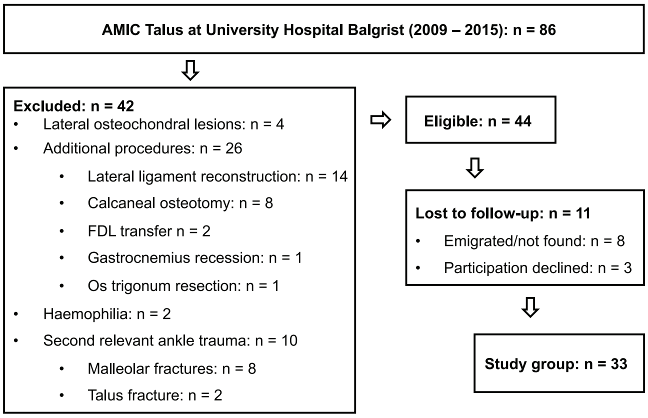

Figure 1. Flow diagram showing patient enrollment and recruitment. AMIC, autologous matrix-induced chondrogenesis; FDL, flexor digitorum longus.

Postoperative Rehabilitation

All patients in this study were kept nonweightbearing for 6 weeks, followed by progression to full weightbearing as tolerated. Passive range of motion exercises were started 2 days after surgery, after the first change of dressing. The patients were scheduled for a clinical and radiological follow-up in the outpatient clinic 6 weeks after the surgery. Low-impact sports were allowed after 12 weeks. The patients were free to return to contact sports after 6 months.

Patient Data

Between August 2017 and March 2018, 33 of 44 eligible patients could be retrospectively evaluated after a mean follow-up of 4.7 years (range, 2.3-8.0 years). The study group consisted of 19 males and 14 females with a mean age of 35.1 years (range, 13-75 years) and a mean ± SD body mass index of 26.8 ± 4.3 kg/m^2 at the time of surgery. For 28 of 33 patients (85%), a subchondral defect was filled with autologous cancellous bone that was harvested from the osteotomy site at the medial malleolus.

Clinical evaluation consisted of a visual analog scale (VAS; 0-10 points) for pain assessment, the American Orthopaedic Foot and Ankle Society (AOFAS; 0-100 points) score for ankle function, and the Tegner score (0-10 points) for sports activity. The clinical outcome at follow-up was graded as excellent (90-100 points), good (80-89), fair (70-79), and poor (<70).[42] All patients rated their satisfaction based on a modified Coughlin scale[9] (very satisfied, satisfied, partially satisfied, dissatisfied) and indicated if they would undergo the same procedure again.

To evaluate a possible deterioration in clinical outcome over time, patients with a follow-up of 2 to 5 years were compared with patients with a follow-up >5 years. Further subgroup analysis was performed to investigate the significance of subchondral bone grafting (yes vs no) and OLT size (<1.5 vs ≥1.5 cm^2).

All AMIC-treated osteochondral lesions were evaluated on current MRI scans performed on the same day when the study participants had the appointment for the clinical follow-up. The MOCART (0-100 points) scoring system[36] was used to assess the quality of the repair cartilage and the subchondral bone. Osteochondral lesion size measurement was conducted on preoperative MRI scans by determining the maximum diameter of the lesion in the sagittal and coronal images and calculating the surface area (A) with the ellipse formula: $A = ab\pi$ = coronal length × sagittal length × 0.79.[7] All scans were performed with a 3-T MRI scanner with a foot and ankle coil (Siemens Trio). The MRI acquisition protocol consisted of proton density–weighted turbo spin echo fat-suppressed Dixon sequences in coronal, sagittal, and axial planes.

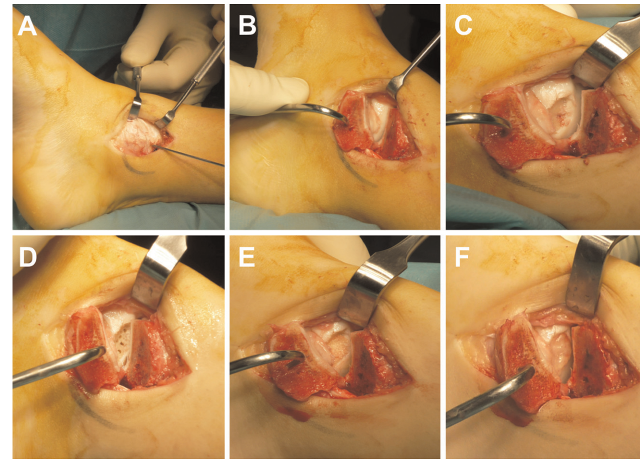

Figure 2. Surgical technique: (A) K-wire placed under fluoroscopy to guide (B) the malleolar osteotomy, (C) debridement of the unstable cartilage, (D) microfracture of the osteochondral lesion, (E) filling of the subchondral defect with autologous cancellous bone, and (F) application of the collagen membrane with fibrin glue fixation.

Statistical Analysis

Qualitative variables were described by absolute and relative frequencies of their categories. Distributions of numeric variables were summarized by means, SDs, and extreme values. Changes over time were tested by 2-sided exact Wilcoxon signed rank tests at the 5% level. Association between 2 numeric or ordinal variables was investigated by showing scatterplots with robust regression lines. The strength of association was indicated by Spearman rank correlations with exploratory P values obtained by approximate permutation tests. All P values of association tests were evaluated at a smaller level of 5% divided by the number of association tests to account for multiple testing (simple Bonferroni correction). The primary endpoint was the reduction of pain (preoperative pain vs pain at last follow-up) based on the VAS. Statistical analysis was performed by an independent statistician using R (v 3.3.2; R Foundation for Statistical Computing) with package “coin” for exact rank tests and package MASS for robust linear regression.

TABLE 1
Subgroup Analyses[a]

	VAS Reduction	AOFAS	Δ Tegner to Preinjury	Δ Tegner to Presurgery
Follow-up, y				
2-5 (n = 17)	–4.8	93.5	–1.0	1.4
>5 (n = 16)	–5.3	92.5	–0.9	1.9
P value	0.6	0.8	0.7	0.4
Subchondral bone grafting				
Yes (n = 28)	–5.0	95.4	–1.0	1.9
No (n = 5)	–4.8	92.6	–0.8	0.6
P value	0.8	0.6	0.6	0.6
OLT size, cm^2				
<1.5 (n = 29)	–4.9	92.8	–0.9	1.5
≥1.5 (n = 4)	–6.0	95.0	–1.3	2.8
P value	0.5	0.7	0.3	0.2

[a]AOFAS, American Orthopaedic Foot and Ankle Society; OLT, osteochondral lesion of the talus; VAS, visual analog scale.

RESULTS

Clinical Outcome

The clinical results of 33 patients after AMIC-repaired OLTs at a mean follow-up of 4.7 years (range, 2.3-8.0 years) can be considered good to excellent, with a significant VAS improvement from 6.4 ± 1.9 points (range, 2-9 points) preoperatively to 1.4 ± 2.0 points (range, 0-7 points) at the final follow-up ($P < .001$). With a mean AOFAS score of 93.0 ± 7.5 points (range, 75-100 points), 25 patients (76%) scored excellent, 6 (18%) good, and 2 (6%) fair. The sports level based on the Tegner score improved significantly from 3.5 ± 1.8 points (range, 0-9 points) to 5.2 ± 1.7 points (range, 2-9 points; $P < .001$), and 26 patients (79%) achieved their previous sports activity level before the onset of symptoms. Only 1 patient had to change his prior profession owing to persistent ankle pain but was very satisfied at the final follow-up (AOFAS, 100; VAS, 0). In total, 21 patients (64%) were very satisfied, 10 satisfied (30%), and 2 unsatisfied (6%) with the postoperative course, and 31 (94%) stated that they would undergo the AMIC procedure again.

No early postoperative complications occurred, such as wound infection or deep vein thrombosis. There was 1 case of delayed union (6 months) that did not result in reoperation. In total, reoperation was performed in 19 cases (58%), mainly because of disturbing malleolar screws (n = 14, 42%), with additional ankle arthroscopy in 5 of these cases. Another 4 ankle arthroscopies (12%) were performed without hardware removal because of restricted range of motion or impingement. One patient (3%) needed additional gastrocnemius recession (Strayer procedure).

Subgroup Analyses

No significant differences for VAS reduction, ankle function (AOFAS score), and sports activity (Tegner) could be detected between the respective subgroups (Table 1).

Radiological Outcome

The mean preoperative size of the osteochondral lesion was 0.9 ± 0.5 cm^2 (range, 0.4-2.3 cm^2). The MOCART score averaged 60.6 ± 21.2 points (range, 0-100 points) (Figure 3). The subcategory results of the MOCART score are shown in Table 2.

Prognostic Factors

Table 3 presents correlations of the patients' preoperative age, body mass index (BMI), and size of osteochondral lesion with the clinical results. No significant correlations could be detected. There was only a tendency toward a higher BMI resulting in a poorer AOFAS score. Moreover, the MRI findings based on the MOCART score did not correlate with the clinical outcome.

DISCUSSION

The most important finding of this study is that AMIC for osteochondral lesions of the talus led to significant pain reduction, good ankle function, and high return to sports after a mean follow-up of 4.7 years.

Since OLTs are often already symptomatic among young and athletic patients, there is a need for long-term clinical results after AMIC repair. Gottschalk et al[24] reported clinical improvement from 1- to 5-year follow-up, yet no studies examined the clinical outcomes beyond 5 years. In the present study, subgroup analysis revealed a slightly lower mean AOFAS score for patients with follow-up >5 years versus 2 to 5 years (92.5 vs 93.5 points). However, a greater VAS score reduction could be achieved in the subgroup with follow-up >5 years (–5.3 vs −4.8 points), which may indicate that this subgroup had poorer preoperative ankle function, which might have negatively influenced the clinical outcome. A prospective study of a larger cohort is needed to correctly interpret these

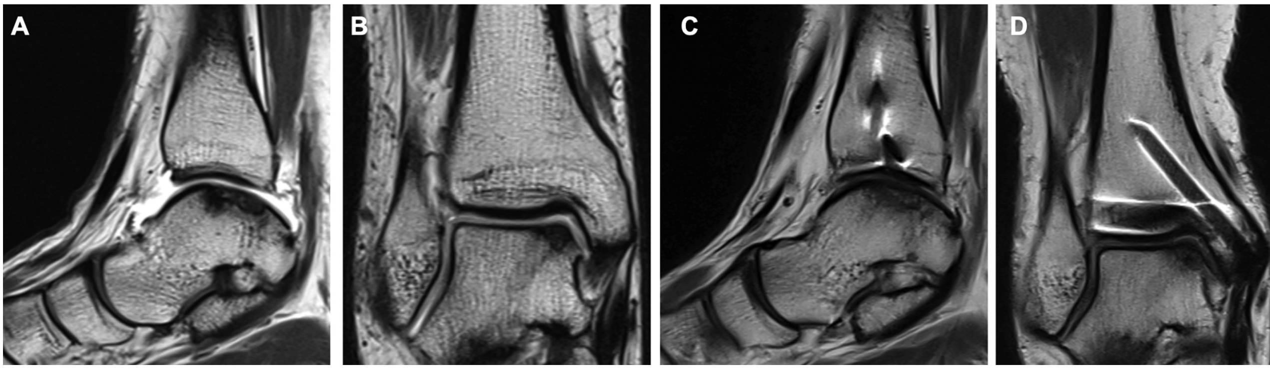

Figure 3. (A, B) Magnetic resonance imaging evaluation of an 18-year-old patient with a large osteochondral lesion on the medial talar dome. (C, D) After 8.0 years, the patient was still very satisfied with the postoperative course (American Orthopaedic Foot and Ankle Society, 100; visual analog scale, 0), although the scans showed a moderate result with persistent subchondral bone changes (MOCART [magnetic resonance observation of cartilage repair tissue] score, 70).

results and draw the conclusions on the long-term efficacy of the AMIC procedure for OLTs.

The present clinical results are better than those of previous midterm AMIC studies.[33,49,54] A possible reason for these superior results may be the quite small OLT size of 0.9 cm^2, which may also be a major point of criticism of this study. Walther[54] evaluated 20 cases with a lesion size >2 cm^2 after a minimum of 3 years and reported a mean AOFAS score of 82 points. Kubosch et al[33] reviewed 17 cases with a mean OLT size of 2.4 cm^2 and noted significant pain reduction (VAS, 7.8-2.4) and a mean AOFAS score of 83 points at a mean follow-up of 3.3 years. However, there is little evidence that the size of AMIC-treated OLTs has a negative impact on the clinical results. Kubosch et al found a significant correlation between lesion size and postoperative pain as well as significantly lower values of AOFAS score for lesions >3 cm^2. In the present study, we could not detect such a correlation between OLT size and clinical outcome. Another reason for inferior results in some studies may be the inclusion of patients who received additional surgical interventions.[49,55] Valderrabano et al[49] prospectively followed 26 patients with AMIC-treated OLTs, for whom they had performed additional surgical interventions for chronic instability in 81% of the cases. A significant clinical improvement (AOFAS, 60-89 points) could be shown after a follow-up of 2.6 years. We included only patients who received isolated AMIC for osteochondral talar lesions, without any further surgical interventions, to avoid this possible bias.

Microfracture is still considered the gold standard for OLTs up to 1.5 cm^2.[12] However, a main disadvantage of microfracture is that only the chondral surface is restored, not the subchondral bone defect. van Dijk et al[51] proposed that pain in OLTs is not caused by the cartilage lesion itself but arises from the highly innervated subchondral bone underneath. However, it could not be proven that subchondral cysts are associated with worse clinical outcomes.[26,31] Autologous cancellous bone from the osteotomy site was used to fill these subchondral cysts in most of the cases. Still, all but 1 patient in our study showed persistent irregularities in the subchondral bone in the final follow-up MRI scans. Moreover, subgroup analysis did not show any significant difference between patients who received subchondral bone grafting and those who did not. The clinical results after microfracture in previous studies are inferior to the ones in the present study. Chuckpaiwong et al[8] treated 105 cases of similar OLT size (8.8 cm^2) with microfracture, in which the AOFAS score improved from 41 to 68 points after a mean follow-up of 2.6 years. Likewise, Ferkel et al[18] reported on 50 cases with microfractured OLTs, with an AOFAS score of 83 points after a mean follow-up of 5.9 years (range, 2-13 years). They did not give any information about the OLT sizes in their study. van Bergen et al[50] evaluated 50 cases with a lesion size of 0.9 cm^2 after a mean 12-year follow-up, with a median AOFAS score of 88. A recent study[5] retrospectively compared microfracture (n = 16) with arthroscopic AMIC (n = 16). Both groups showed significant clinical improvement. The results of the AMIC group were not significantly better; however, data on the OLT size in both groups are lacking.[5]

All cases of AMIC in this study were performed in an open manner with a malleolar osteotomy, facilitating the exposure of the osteochondral lesion. The high reoperation rate, mainly attributed to symptomatic hardware or scar tissue impingement, made us reconsider the necessity of the malleolar osteotomy. With a more thorough pre- and intraoperative evaluation of the OLT location, the osteotomy can now be avoided in most cases. AMIC was also recently introduced as an arthroscopic procedure, which may be an interesting option to reduce the approach-related morbidity[4,5,46]; however, precise fitting and stable fixation of the Chondro-Gide matrix to the defect via an arthroscopic approach is challenging. Usuelli et al[45] prospectively evaluated the first 20 cases of arthroscopic AMIC and found a significant reduction in VAS score (8.1 to 2.5 points) and improvement of AOFAS score (57 to 86 points) at the 2-year follow-up. They had no complications but 1 reoperation for impingement. The results are comparable with or even slightly worse than our results with an open approach.

TABLE 2
MOCART Score[a]

Subcategory (Points)	Patients, n (%)
Filling of the defect	
Complete (20)	12 (36)
Hypertrophy (15)	17 (52)
Incomplete	
>50% (10)	2 (6)
<50% (5)	0 (0)
Subchondral bone exposed (0)	2 (6)
Integration to border zone	
Complete (15)	19 (58)
Incomplete	
Split (10)	12 (36)
<50% of length (5)	1 (3)
>50% of length (0)	1 (3)
Surface of the repair tissue	
Intact (10)	17 (52)
Damaged <50% of depth (5)	7 (21)
Damaged >50% of depth (0)	9 (27)
Structure of the repair tissue	
Homogeneous (5)	22 (67)
Inhomogeneous (0)	11 (33)
Signal intensity of the repair tissue	
Normal (30)	10 (30)
Slight areas of signal alteration (15)	14 (42)
Large areas of signal alteration (0)	9 (27)
Subchondral lamina	
Intact (5)	9 (24)
Not intact (0)	28 (76)
Subchondral bone	
Intact (5)	1 (3)
Not intact (0)	32 (97)
Adhesions	
No (5)	26 (79)
Yes (0)	7 (21)
Effusion	
No (5)	27 (82)
Yes (0)	6 (18)

[a]MOCART, magnetic resonance observation of cartilage repair tissue.

TABLE 3
Correlation Between Demographic and MRI Findings With the Clinical Results[a]

	VAS Reduction		AOFAS	
	Rank Correlation	*P* Value	Rank Correlation	*P* Value
Age	–0.26	.14	0.19	.28
BMI	–0.06	.73	–0.35	.05
OLT size	0.21	.25	–0.21	.25
MOCART	–0.21	.24	0.18	.32

[a]AOFAS, American Orthopaedic Foot and Ankle Society; BMI, body mass index; MOCART, magnetic resonance observation of cartilage repair tissue; MRI, magnetic resonance imaging; OLT, osteochondral lesion of the talus; VAS, visual analog scale.

The return to sports after OLT repair procedures varies in the literature.[38,44,48] Schuman et al[44] showed an improvement in the Tegner score from 2.6 to 5.7 points after arthroscopic debridement and drilling of 38 OLTs at a follow-up of 2 to 11 years. Paul et al[38] analyzed data from 131 patients after osteochondral autograft transplantation for OLTs and found reduced sports activity at a mean follow-up of 5 years (Tegner score, 5.0 points) as compared with the year before surgery (5.9 points). The authors attributed the lower Tegner scores to the safety behavior of the patients to reduce the risk of another trauma to the ankle. Both studies did not display any information about the OLT sizes. Wiewiorski et al[55] followed 60 patients after AMIC for a mean 3.9 years and could not show a significant improvement in sports activity (Tegner score, 3.3 to 3.4 points). Once again, the high rate of additional interventions (83%) may have influenced the results. In contrast, 79% of the patients in the present study fully returned to the previous sports activity level and showed a significant improvement of the Tegner score (3.5 to 5.2 points). Likewise, we could show a high rate of return to work at 97%.

Previous radiological results after AMIC for osteochondral talar lesions have been only moderate, as revealed by mean MOCART scores up to 62 points,[33,45,49] comparable with our results. However, the overall MOCART score did not correlate with the clinical outcome parameters in our study. The reliability for postoperative MRI evaluation of OLTs remains questionable. For the majority of MRI parameters, limited or no correlation has been shown.[2,22] Gatlin et al[22] found moderate sensitivity (71%) and specificity (74%) for 3.0-T MRI to detect chondral lesions of the talus. Lee et al[34] investigated OLTs after autologous chondrocyte implantation and compared the postoperative MOCART score with 1-year postoperative arthroscopy findings as the gold standard. They detected good reliability in only 2 of the 5 studied categories. Kubosch et al[33] were able to show a correlation between the postoperative MOCART score and the clinical results after AMIC of OLTs; however, their analysis included a 3-dimensional evaluation. Albano et al[2] recently showed that the MOCART score is not sufficiently reproducible to analyze OLTs.

Certain demographic factors were shown to negatively affect the clinical outcome of OLTs after microfracture.[8,57] Chuckpaiwong et al[8] could show that increasing age and BMI were both significantly correlated with poor results. In accordance with our results, most studies about AMIC-treated OLTs could not show any significant influence of these demographical factors.[11,24,47] D'Ambrosi et al[11] performed arthroscopic AMIC in 31 OLTs and did not find any age-related differences. However, the preoperative and final functional results were inferior in the subgroup aged >33 years, which may indicate that the preoperative ankle status is a negatively influencing factor. However, Kubosch et al[33] found a significantly poorer clinical outcome for patients with a BMI >30 kg/m^2. Patients with a higher BMI showed a weak trend toward worse clinical results in the present study.

Limitations of the present study are mainly due to the retrospective design lacking a control group and preoperative functional scores, which made an objective evaluation of the improvement of ankle function impossible. However, with 94% showing good to excellent results in the AOFAS score, a substantial improvement can be assumed. Given the long follow-up period, only 75% of the study group could be evaluated, which might have introduced a selection bias. Furthermore, we are aware that the AOFAS score has not been validated for OLTs and is even no longer recommended by the AOFAS.[39] We still applied the score for better comparison with previous AMIC studies.

CONCLUSION

Our study shows that the AMIC procedure for OLTs leads to a significant reduction of pain, recovery of ankle function, and successful return to sports after a follow-up of 2 to 8 years. The moderate MRI findings did not correlate with the good clinical results. Thus, the interpretation of postoperative imaging after AMIC-treated osteochondral talar lesions remains challenging. The low complication and revision rate make AMIC a safe and efficacious technique to treat OLTs.

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