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Original article

Outcomes of talar dome osteochondral defect repair using osteocartilaginous autografts: 37 cases of Mosaicplasty®

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ABSTRACT

Background: The indications of osteochondral autograft implantation using the Mosaicplasty® technique were only recently extended to osteochondral lesions of the talus (OLT), a site for which no medium- or long-term outcome data are available. Our objective here was to evaluate medium-term outcomes in case-series of patients who underwent Mosaicplasty® for OLT repair.
Hypothesis: Mosaicplasty® provides good medium-term outcomes with low morbidity when used for OLT repair.
Patients et methods: We retrospectively reviewed cases of Mosaicplasty® for OLT repair, performed in combination with malleolar osteotomy on the side of the OLT, at either of two centres, between 1997 and 2013. Pre-operative clinical data were collected from the medical records and all patients were re-evaluated. We studied 37 patients with a mean age of 33 years.
Results: Mean follow-up at re-evaluation was 76 months. Mean AOFAS score at re-evaluation was 83 (range, 9–100). A work-related cause to the OLT was associated with significantly poorer outcomes ($P = 0.01$). AOFAS values were significantly better in patients whose OLT size was 0.5 to 1 cm^2. The Ogilvie-Harris score at last follow-up was good or excellent in 78% of patients. No patient experienced morbidity related to the malleolar osteotomy. Persistent patellar syndrome was noted in 6 patients.
Discussion: In our case-series, Mosaicplasty® for OLT repair provided good medium-term outcomes in 78% of patients. Nevertheless, the donor-site morbidity should be borne in mind. Mosaicplasty® deserves to be viewed as a reference standard method for OLT repair.
Level of evidence: IV, retrospective study.

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1. Introduction

The treatment of osteochondral lesions of the talus (OLTs) constitutes a major surgical challenge, since the cartilage receives no blood supply and, therefore, has no potential for self-repair. The natural history of OLTs is the development of fibrous scar tissue with impaired mechanical properties compared to cartilage [1,2]. Palliative techniques involving defect debridement with or without an intervention to stimulate the bone marrow provide outcomes that are satisfactory in the short term but seem to deteriorate over time [3–5]. Mosaicplasty® is a cartilage repair technique that involves implanting osteochondral autografts. Available data indicate similar short-term outcomes compared to those of palliative techniques.

The objective of our study was to evaluate medium-term outcomes of patients who underwent Mosaicplasty® for OLT repair. Our working hypothesis was that Mosaicplasty® OLT repair was effective in the medium-term, with durable improvements and low morbidity rates.

2. Material and methods

2.1. Inclusion and exclusion criteria

We retrospectively included consecutive patients who underwent Mosaicplasty® in either of two centres, between 1997 and 2013. Mosaicplasty® was performed for one of two reasons: symptomatic and incapacitating OLT shown by imaging studies to be greater than 1 cm^2 in size and deep, reaching down to the subchondral bone, after failure of optimal conservative treatment for 3 months; or OLT less than 1 cm^2 in size after failure of arthroscopic surgery (debridement with or without subchondral bone

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Table 1
Pre-operative clinical data.

Sex	29 males, 8 females
Mean age at surgery (min-max)	33 years (17–49 years)
Body mass index, BMI (Kg/m^2)	
Mean (min–max)	27 (19–36)
25 < BMI < 30	40%
BMI > 30	24%
Cause	
Traumatic	31 cases (84%)
Non-traumatic	6 cases (16%)
Mean time to surgery (min–max) in months	29 (1–120)
Previous procedures	
Arthroscopic debridement	4
Removal of the detached fragment	3
Debridement and subchondral perforation	1

Table 2
Pre-operative radiological findings.

Type of lesion	
"F"	6
"O"	26
"G"	5
Location	
Medial side	26, including 14 postero-medial (38%)
Lateral side	11 (30%)
Signs of osteoarthritis (Van Dijk) [7]	
Stage 0 (normal)	34
Stage 1 (osteophytes)	3
Stage 2 (decreased joint-space height)	0
Stage 3 (complete or nearly complete joint-space obliteration)	0

stimulation by perforation or microfracture). Contra-indications to Mosaicplasty® were cartilage lesions caused by a tumour, an infection, or an inflammatory disease; age older than 50 years; and imaging study evidence of osteoarthritis (radiographic joint-space narrowing and/or mirror lesions by computed tomography [CT] arthrography or magnetic resonance imaging [MRI]). In patients with OLTs less than 1 cm^2 in diameter, the first-line treatment was arthroscopic debridement and subchondral perforation or microfracture (45 patients).

2.2. Patient groups

Tables 1 and 2 report the clinical and radiological pre-operative data for the study patients. The OLT was caused by a work-related injury in 30% of cases.

2.3. Operative technique

The same operative technique was used in all patients, with either the OATS transfer system (Arthrex Inc., Naples, FL, USA) or

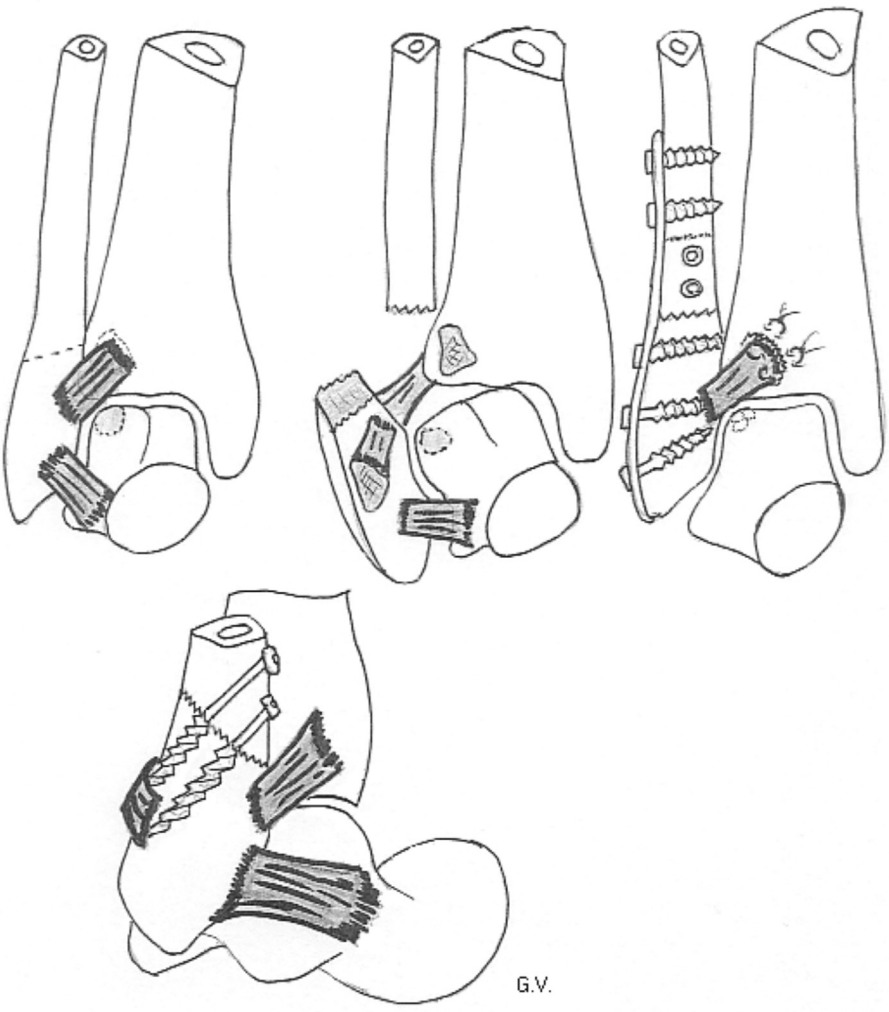

Fig. 1. Lateral transmalleolar approach [6].

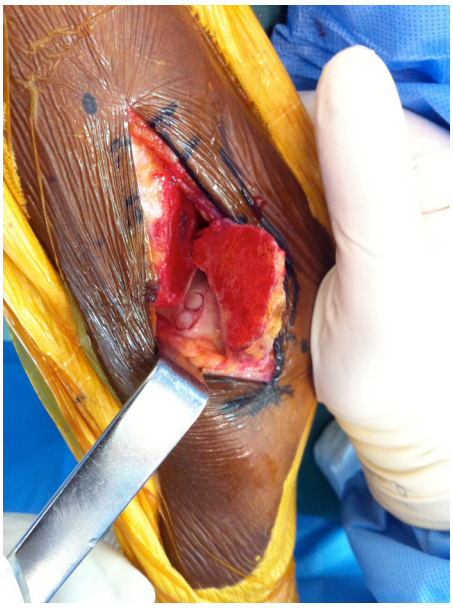

Fig. 2. Medial malleolar osteotomy allowing the implantation of two grafts.

the Acufex Mosaicplasty® system (Smith-Nephew Inc., Andover, MA, USA). A pneumatic tourniquet was used. Medial malleolar osteotomy was performed in patients with medial OLTs. When the OLT was located laterally, the surgical approach was through the lateral malleolus. The lateral malleolus was exposed, the fibular tendons protected, and the anterior and inferior tibio-fibular ligaments were identified and detached from the tibia with a bony disc from Chaput's tubercle; the disc with its ligaments was reattached using two anchors or a screw at the end of the procedure. A supra-ligamentous osteotomy of the lateral malleolus was then performed in an oblique plane directed downwards and posteriorly [6] (Fig. 1). After debridement and sizing of the lesion using the transplant tool, holes were drilled in the recipient zone, the diameter of each hole being 1 mm less than that of the planned graft, along a depth of 20 mm. The grafts were harvested via a para-patellar arthrotomy of the ipsilateral knee, at the level of the edge of the femoral trochlea, then press-fit into the drilled holes until they were flush with the healthy cartilage (Fig. 2).

Weight bearing was eliminated for 6 weeks after the procedure. Passive ankle mobilisation was started after 2 weeks.

The procedure was performed via the medial approach in 26 patients and the lateral approach in 11 patients. The donor site was the medial edge of the trochlea in 15 (40.5%) patients and the lateral edge in 22 (59.5%) patients. Mean OLT size was 0.85 cm^2 (range, 0.4–2.12 cm^2). Mean number of grafts used was 2.3 (range, 1–8) and mean graft diameter was 5.7 mm (range, 2.7–10 mm. An additional procedure was performed in 8 patients: cancellous bone grafting between the plugs in 1 patient, subchondral bone perforation in 2 patients, removal of a free intra-articular osteochondral fragment in 4 patients, and lateral ankle ligament reconstruction in 1 patient.

Table 4
Functional outcomes.

Score	At re-evaluation after 76 months (12–192 months)
AOFAS	83 points (9–100)
Ogilvie-Harris	
Excellent	21
Good	8
Fair	5
Poor	3

2.4. Data collection

The pre-operative data were collected from the medical records. We recorded gender, age and body mass index (BMI) on the day of surgery, whether a trauma or work-related injury led to the OLT, time to surgery, and previous treatments. The initial imaging studies were reviewed by an independent observer at each of the two study centres. OLTs were categorised using the FOG (fracture, osteonecrosis, geode) system [2]. Any lesions of osteoarthritis were evaluated using the radiological classification developed by Van Dijk [7] (Table 3).

The surgical report was examined to collect the intra-operative data: approach, OLT size, graft number and size, and concomitant procedures.

At re-evaluation, each patient was assessed by an independent examiner at each centre. Any immediate post-operative complications were recorded. The clinical and functional evaluation of the ankle relied on the American Orthopaedic Foot and Ankle Society (AOFAS) score and the Ogilvie-Harris score (Fig. 3 and Table 3) [8,9]. Patients were asked about knee complaints. Imaging studies were obtained, including antero-posterior and lateral radiographs of the ankle and either MRI or CT-arthrography.

The statistical analysis was performed using Statplus™ software (AnalystSoft, Alexandria, VA, USA). Data were described as mean and range. Student's *t* test for paired data was chosen to look for associations linking outcomes to BMI, age, pattern of OLT, and graft harvesting method. Values of $P \leq 0.05$ were considered significant.

3. Results

Mean follow-up at re-evaluation was 76 months (12–192 months). All included patients were re-evaluated. No immediate post-operative complications were recorded. Healing of the malleolar osteotomy was achieved consistently. Persistent knee pain was reported by 6 patients but showed no correlation with the harvesting site or number of grafts.

The mean final AOFAS score was 83 points (9–100) and the final Ogilvie-Harris score was good or excellent in 78.4% of patients (Table 4). In the subgroup followed-up for longer than 4 years,

Table 3
Ogilvie-Harris score [8].

	1-Poor	2-Fair	3-Good	4-Excellent
Pain	Pain	Pain	Mild	None
Swelling	Moderate/marked	Mild, everyday activities	Après efforts	None/minimal
Stiffness	Limited motion	Limited and painful	Mild	None/minimal
Limping	Marked (walking aid)	Moderate	Mild	None
Activity	Limited	Moderately decreased	Slightly decreased	No limitations

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
Limited daily and recreational activities, cane	4
Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace	0
Maximum walking distance, blocks	
Greater than 6	5
4-6	4
1-3	2
Less than 1	0
Walking surfaces	
No difficulty on any surface	5
Some difficulty on uneven terrain, stairs, inclines, ladders	3
Severe difficulty on uneven terrain, tairs,inclines,ladders	0
Gait abnormality	
None, slight	8
Obvious	4
Marked	0
Sagittal motion (flexion plus extension)	
Normal or mild restriction (30° or more)	8
Moderate restriction (15°-29°)	4
Severe restriction (less than 150)	0
Hindfoot motion (inversion plus eversion)	
Normal or mild restriction (75%-100% normal)	6
Moderate restriction (25%-74% normal)	3
Marked restriction (less than 25% normal)	0
Ankle-hindfoot stability (anteroposterior,varus-valgus)	
Stable	8
Definitely unstable	0
Alignment (10 points)	
Good, plantigrade foot, midfoot well aligned	15
Fair, plantigrade foot, some degree of midfoot malalignment observed, no symptoms	8
Poor, nonplantigrade foot, severe malalignment, symptoms	0
Total=	100

American Orthopaedic Foot and Ankle Society

Fig. 3. AOFAS scale [9].

mean follow-up was 119 months (48–192) and the proportion of patients with good or excellent outcomes was 81% (17/21). Patients with work-related OLTs had significantly lower functional scores ($P = 0.01$). In contrast, OLT size between 0.5 and 1 cm^2 was associated with significantly better functional outcomes (Table 5). The Ogilvy-Harris score was poor in 3 patients, who underwent tibio-talar arthrodesis 3, 7, and 11 years, respectively, after the Mosaicplasty® procedure.

Table 5
AOFAS score by body mass index, lesion type, and lesion size.

	AOFAS
BMI (kg/m^2)	
< 30	83.3 (9–100)
> 30	80.56 (57–100)
Age	
< 30	85 (56–100)
30–40	87 (57–100)
> 40	72.5 (9–100)
FOG	
F	83 (63–100)
O	83.2 (9–100)
G	79.4 (43–100)
Defect size (cm^2)	
< 0.5	75.21 (9–100)
0.5–1	90.30 (68–100)[a]
1–1.5	81.5 (50–100)
> 1.5	86 (69–100)

[a] Statistically significant difference.

Fig. 4. Computed tomography arthrography 12 months after surgery showing perfect incorporation of the graft with restoration of a smooth cartilage surface.

At re-evaluation, radiographs were obtained in all patients, MRI in 16 patients, and CT-arthrography in 4 patients. In the 20 patients with MRI or CT-arthrography data, the findings showed integration of the grafts (Fig. 4). At re-evaluation, 6 (16%) patients exhibited joint space narrowing, 73 to 132 months after the Mosaicplasty® procedure.

4. Discussion

Our results showed that Mosaicplasty® OLT repair was effective in 78.4% of cases after a mean follow-up of more than 6 years. Major strengths of our study are the inclusion of the largest sample size to date and the mean follow-up longer than 6 years. Nevertheless, the non-comparative retrospective design cannot demonstrate that Mosaicplasty® is superior over other OLT repair techniques. It is worth noting that none of our patients was lost to follow-up.

The first data on outcomes after Mosaicplasty® OLT repair were published in 1997 [10]. Since then, several studies [6,10–19] obtained good outcomes, with a patient satisfaction rate of 80% after 12 to 84 months. However, some of these studies were retrospective evaluations of small sample sizes with short follow-ups. In our study, medial or lateral malleolar osteotomy provided satisfactory exposure with no medium-term morbidity. The malleolar osteotomy approach therefore deserves preference, except in readily accessible lesions of the most anterior part of the talar dome, which are rare [20].

Outcomes were significantly better in the subgroup with OLTs measuring 0.5 to 1 cm^2, in keeping with earlier reports [12,16]. Therefore, Mosaicplasty® is a valid option even for the first-line treatment of lesions less than 1 cm^2 in size. Second-line Mosaicplasty® produces similar outcomes [12]. Neither age nor BMI significantly influenced the outcomes, suggesting that the indications of Mosaicplasty® may deserve extension to patients older than 50 years, provided they have no pre-operative evidence of osteoarthritis. Caution is in order regarding work-related OLTs, which are associated with poorer outcomes. Time to Mosaicplasty® was not associated with the outcomes [4]. The main limiting factor of Mosaicplasty® OLT repair is donor-site morbidity, whose frequency ranges across studies from 2% to 50%, without any influence of graft number or size or of patient age or weight [11,13,16,17,21,22].

Functional methods [23] and other techniques (Table 6) have been reported as treatments for OLTs. "Palliative" methods produce

Table 6
Outcomes of the various techniques identified by the literature review.

Type of treatment	Author, year	No. of cases	Mean FU	Excellent or good outcome	OA
Functional treatment	Tol, Foot Ankle Int, 2000 [23]	201	–	45%	–
	Verhagen, Foot Ankle int 2003 [4]	–	–	45%	–
Palliative techniques	Ferkel, Am J Sport Med, 2008 [3]	50	71 months	72%	34%
Debridement ± microfracture and/or subchondral perforation	Hunt, Arthroscopy 2003 [24]	37	66 months	46%	–
	Robinson, JBJS Am, 2003 [25]	65	3.5 years	52%	–
	Van Bergen, JBJS Am, 2013 [26]	50	12 years	78%	33%
	Flick, Foot Ankle, 1985 [27]	22	24 months	79%	33%
	Jarde, Rev Chir Orthop Reparatrice Appar Mot 2000 [28]	30	47 months	75%	23%
Mosaicplasty®	Our case-series	37	76 months	78%	16%
	Hangody, Foot Ankle Int, 1997 [10]	11	16 months	100%	–
	Hangody, Foot Ankle Int, 2001 [14]	36	4.2 years	94%	–
	Sammarco, Foot Ankle Int, 2002 [18]	12	25 months	100%	50%
	Al Shaikh, Foot Ankle Int, 2002 [19]	19	16 months	89%	–
	Baltzer, Arthroscopy 2005 [16]	23	12 months	73%	–
	Valderrabano et al., Am J Sport Med, 2009 [17]	20	72 months	92%	100%
ACI	Whittaker, JBJS, 2005 [29]	10	4 years	90%	–
	Thermann, Orthopade, 2008 [30]	9	4 years	100%	–
	Giannini, Am J Sport Med, 2008 [31]	46	36 months	80%	–
	Anders, International orthopaedics 2012 [32]	22	63.5 months	95%	–

good short-term outcomes (in about 80% of patients, comparable to those of Mosaicplasty® [27,33,34] with a simpler post-operative course and no donor-site morbidity [2,4,28,35]. However, the results deteriorate over time, with nearly 50% of patients having poor outcomes after more than 4 years [24,25] and 33% exhibiting signs of osteoarthritis after 5 to 12 years [3,26]. These results are consistent with the inability of palliative treatment to restore the cartilage. Palliative treatment should not be used as the first-line method unless the defect is small (< 1 cm^2) [36]. Our results demonstrate that second-line Mosaicplasty® after failed palliative treatment is effective. Thus, Mosaicplasty® is the only method that restores the mechanical properties of the talus [37]. Few data on allografting have been reported [38]. Allografting avoids donor-site morbidity but carried a potential risk of pathogenic virus transmission [38,39]. Autologous chondrocyte grafts [29–32], platelet-rich plasma, and composite grafts [40–42] seem promising but need to be evaluated in larger numbers of patients.

5. Conclusion

Mosaicplasty® is a reliable technique and the only means of obtaining durable improvements in patients with OLTs. At present, Mosaicplasty® can be viewed as the reference standard first-line treatment for OLTs measuring more than 1 cm^2 and as the second-line treatment for smaller OLTs. The non-negligible donor-site morbidity deserves note, however, and the development of composite grafts might constitute a solution.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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