Mosaicplasty for Treatment of Osteochondral Defects of the Ankle

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82.1 Introduction

An osteochondral ankle defect is a lesion involving talar articular cartilage and subchondral bone and mostly caused by a single or multiple traumatic events, leading to partial or complete detachment of the osteochondral fragment with or without osteonecrosis [1]. Many synonym terms are used, including osteochondral fracture, osteochondral lesion, osteochondritis dissecans (OCD), transchondral fracture, flake fracture, and intra-articular fracture. OCD defects are mainly located on the medial and lateral sides of the talar dome and less often centrally [2]. There exist many treatment possibilities, depending on the size and location of the osteochondral lesion, as well as the age of the patient and many other circumstances. One of these possibilities is mosaicplasty, which aims to replace the damaged hyaline cartilage and the underlying bone. This technique was originally developed for treating focal osteochondral lesions of the knee, by transferring multiple cylindrical osteochondral grafts from the less weight-bearing area of the knee to the defect on the weight-bearing surface, superimposing onto each other, thus allowing for 90–95 % coverage of the lesion. This technique was adapted to treating osteochondral defects in other joints, and mosaicplasty proved to be quite effective in the therapy of talar lesions.

82.2 Indications

Mosaicplasty as a treatment of osteochondral defects of the ankle is a relatively aggressive surgical procedure, since it requires the harvesting of a donor autologous osteochondral graft from a healthy knee joint and for medial side defects; a malleolar osteotomy is often required. For these reasons, indication of mosaicplasty is usually secondary, following a failed, less invasive, previous surgical treatment, such as debridement, curettage, or microfracture/drilling (bone marrow stimulation), etc. [3].

Before offering mosaicplasty, the size and location of the osteochondral lesion, blood supply of the talus, and associated pathologies must be identified using radiographs, CT scans, MRI, and/or bone scans. However, the final indication to perform mosaicplasty is based on the arthroscopic findings only after preparation of the lesion. The ideal indications for mosaicplasty include focal osteochondral lesion ≥10 mm in diameter, the location of the lesion on the medial or lateral dome, and detached osteochondral fragments, but otherwise normal articular surfaces of the ankle [4].

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Contraindications for this procedure are patients with ankle osteoarthritis and patients with pan-articular arthritis or cartilage thinning regardless of age or previous surgical history. Relative contraindications include patients over 50 years of age and patients who have had multiple previous surgeries (even though mosaicplasty is recommended as a second-line surgery).

82.3 Technique

The mosaicplasty technique for treatment of osteochondritis dissecans of the talus was reported by Hangody et al. in 1997 [5]. As a first step, an arthroscopic examination of the ankle joint is performed to check the intra-articular pathologies and other conditions. Standard anterolateral and anteromedial portals are recommended, but – in case of poor visualization – further additional portals can be added [2, 5]. If mosaicplasty has been decided, the surgery can be extended to an open procedure.

Considering the complex structure of the talocrural joint, the approach recommended is a mini-arthrotomy, combined with a medial malleolar osteotomy if the lesion is located on the medial talar dome, because it is of key importance that the grafts are placed perpendicularly to the articular surface (Fig. 82.1).

The cylindrical grafts are harvested from the less weight-bearing periphery (usually the medial femoral ridge) of the ipsilateral knee at the level of the patellofemoral joint; the lateral femoral ridge can serve as an additional harvest site. The quality of the hyaline cartilage of these grafts matches the requirements of the talar surfaces.

The surgical approach depends on the site of the lesion. In cases of medial osteochondral lesions of the talus, usually a medial malleolar osteotomy is required at the junction of the medial plafond, in order to ensure adequate exposure of the defect. Lateral lesions are most often located on the anterolateral surface of the talus, and since the lateral malleolus is in a relative retroposition, an osteotomy is usually not required; a vertical anterior lateral arthrotomy is sufficient (Fig. 82.2).

The foot is positioned in plantarflexion in order to achieve a perpendicular approach of the lesion. In cases of large lesions extended posteriorly, Gautier and Jakob recommend a lateral mal-

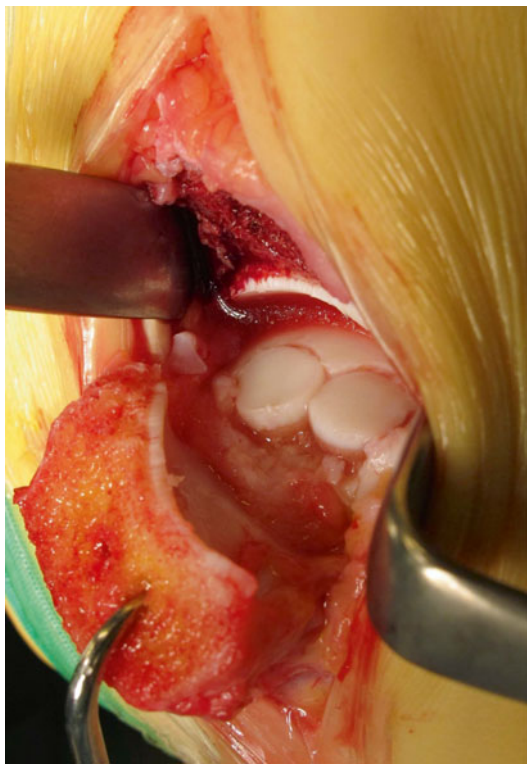

Fig. 82.1 Mosaicplasty on the medial talar dome – mini-arthrotomy approach, combined with a medial malleolar osteotomy

Fig. 82.2 Mosaicplasty on the lateral talar dome – no osteotomy is required for the surgical approach

leolar osteotomy, while Kish recommends exposure through an anterior fibular periosteal flap containing the origin of the anterior talofibular ligament and, if necessary, the calcaneofibular ligament. Then using a thick K-wire or a Steinmann pin tapped into the body of the talus (as a "joystick"), the talus can be drawn forward and rotated downward. In large, central defects, approach of the talus can be achieved by eversion of the ankle into a valgus position (if necessary, using a Steinmann pin as a joystick). The consequent twisting of soft tissues during surgery has not been shown to cause any negative postoperative side effect.

The following step is preparation of the recipient site. The lesion is exposed and after removal of the damaged cartilage, a sharp curette or abrader is used to refresh the bony surface until reaching the intact cartilage. Next, the graft sizes and number of grafts are measured using mosaicplasty instruments (Mosaicplasty™ Complete Instrumentation – Smith & Nephew Inc., Andover, MA) to be transferred to the recipient site. The drill guide is used to determine the diameter and locations of the intended drill holes. In the talus, the usual size of the drill holes is 6.5 and 4.5 mm in diameter. 8.5 mm diameter is recommended for defects not involving the convex dome area of the talus, while smaller sizes (3.5 mm in diameter) can be used to fill the remaining spaces between the implanted grafts. The depths of the defects are measured with the laser marks of the dilator.

The osteochondral grafts are then harvested from the peripheral, non-weight-bearing, medial upper part of the medial femur condyle of the ipsilateral knee. If necessary, the lateral supracondylar ridge can also be used to obtain additional graft through a mini-arthrotomy. By flexing the knee from 0° to 100°, three to four grafts can be harvested from each of the medial or lateral supracondylar ridges. Depending on the size of the lesion at the recipient site, the appropriate diameter tubular chisel is introduced with the harvesting tamp. The chisel is placed perpendicular to the articular surface and is driven by hammer to the appropriate depth (usually 15–20 mm). The taper design of the tubular chisel captures the graft. The chisel is then toggled – not rotated – causing the graft to break free. The chisel is then flipped upside down, and using a chisel guard, the graft is rejected from the cancellous bony side. All graft lengths should be recorded, and they should be stored in a saline solution until implantation. Grafts expand 0.1–0.2 mm in diameter after removal, which is a characteristic that adds to the press fit fixation of the grafts at the recipient site. After harvesting grafts, a suction drain is placed into the knee joint.

Following graft harvesting, implantation of the grafts are performed at the recipient site. The optimal position for the graft is found using the dilator, onto which we slide the universal drill guide, which has a sharp cutting edge. This is hammered in perpendicularly. The appropriate-sized drill bit is inserted and drilled to the proper depth (3–4 mm deeper than the selected graft). A conical dilator is used to enlarge the hole by 0.1–0.2 mm, which not only allows for easier graft insertion, but the dilation of the next hole also impacts the surrounding bone of the previously implanted grafts resulting in a secure press fit fixation. The osteochondral graft is then delivered to the recipient site by inserting the graft into the universal drill guide with the cartilage surface facing upward. The graft is then gently tapped into position. If the graft is proud, a tamp may be used to achieve congruency. The procedure of drilling, dilation, and delivery is repeated with each graft. Since the grafts superimpose onto each other, mosaicplasty allows for 90–95 % coverage of the defect (Fig. 82.3).

Finally, if an osteotomy was required, the medial malleolus is reduced back into position and the osteotomy is repaired with two malleolar screws. The ankle does not require drainage, and closure is of standard manner.

82.4 Complications

Analysis of clinical scores has shown good to excellent results in 93 % of talar mosaicplasties. Nevertheless, moderate and severe donor-site disturbances were present in 3 % of patients according to the Bandi score (evaluations were

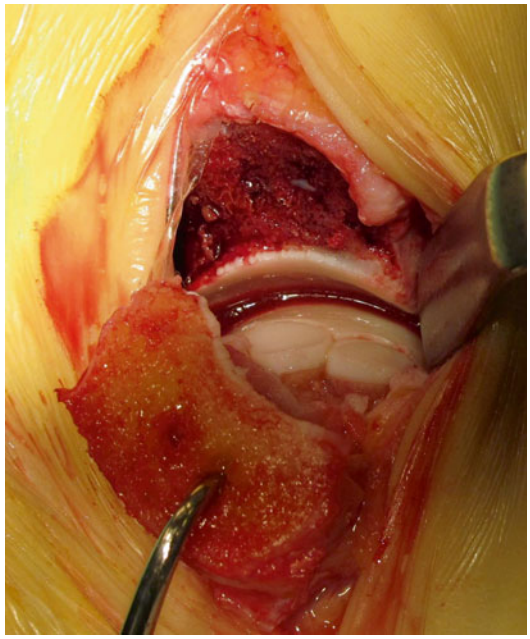

Fig. 82.3 Graft positioning during mosaicplasty – the surface of the graft is congruent with the surrounding cartilage

done in a 1–10-year interval) [6]. However, neither the number of osteochondral cylinders harvested, the total size of grafts harvested, nor the age of the patients has an effect on the donor-site morbidity; rather a higher body mass index of the patients resulted in poorer clinical outcomes [7]. Other complications include slight or severe degenerative changes at the recipient and/or donor sites and painful hemarthroses. In one case, Hangody reported limited range of motion of the ankle due to arthrofibrosis and three cases of incomplete incorporation of the graft on the follow-up MRI studies of over 80 patients who underwent talar mosaicplasty [4].

One of the technically demanding steps of mosaicplasty is the flush or congruent transplantation of the graft into the recipient site. Even if the graft is perpendicularly obtained from the medial or lateral femur condyle of the knee, it may not be completely congruent when transplanted into the medial or lateral dome of the talus. When contact pressures were measured in cadaver models, elevated grafts not only overloaded the cylindrical osteochondral plugs but also the surrounding area of the diseased talus; therefore, grafts should be placed congruent to the surrounding surface or slightly recessed when not possible [8].

General postoperative complications include deep infections and painful hemarthroses. Arthroscopic or open debridement may be necessary to resolve deep infections. Some cases of intra-articular hemorrhage also required arthroscopic or open debridement, but usually treatment by aspiration and cryotherapy is sufficient. Other general postoperative complications include thromboembolism. These general complications can be reduced by aseptic conditions, the administration of preoperative antibiotic prophylaxis, and postoperative thrombosis prophylaxis.

82.5 Results and Literature Overview

The treatment of cartilage and osteochondral defects of the ankle has gone through a significant development over the past two decades [2]. Osteochondral defects of the ankle comprise approximately 4 % of the total number of osteochondral defects [9]. These injuries often require surgical treatment, primarily debridement (removal of the fragment), curettage, and/or a bone marrow stimulation technique such as microfracture or Pridie drilling. If these primary techniques fail or if the lesion is larger or deeper in size, mosaicplasty may serve as a one-step operative osteochondral autograft transplantation procedure, aiming to promote a hyaline type of resurfacement of the defected area.

This technique was developed by Hangody et al. in 1992, originally for the treatment of osteochondral defects of the knee joint, and was first used to treat talar defects in 1993. Hangody et al. released a preliminary report in 1997, treating 11 patients with mosaicplasty, who suffered from osteochondritis dissecans of the talus. The average age of the patients was 25 years, and the average size of the defect was 1 cm^2, and the average number of grafts was 3. No graft loosening was observed, and they reported excellent

results based on clinical evaluation, radiography, follow-up arthroscopy, and biopsy [5].

In a more recent study involving two institutes with 121 patients, the researchers evaluated 21 years of clinical experience with autologous osteochondral mosaicplasty on the talus. One hundred and ten patients were followed for an average of 12 years (range, 1–20 years). The average age of patients was 21.8 years (range, 12–43), and the average size of the defect on the talus was 16.2 ± 10.1 mm^2. Except for two cases, all lesions were on the medial talar dome. The American Orthopaedic Foot and Ankle Society (AOFAS) scoring system was used to assess the patients, which increased from the preoperative value of 65 ± 3.1 points to 90.0 ± 8.3 points postoperatively (mean AOFAS improvement was 16 ± 8.1 points). The donor site had 90 % good results according to the Bandi score. One case of malunion and two cases of deep venous thrombosis occurred [10].

In another study group, similar results were reported, involving 2-year short-term outcomes of open mosaicplasty of large osteochondral lesions of the talus accessed via medial malleolar osteotomy in 32 patients. The mean age of the patients was 27.5 years (range, 20–47 years). Follow-up imaging of the patients included radiographs and MRI. The AOFAS score preoperatively was 59.12 ± 7.72 points and increased over the postoperative 2 years to 87.94 ± 3.55 points [11].

In 2011, Imhoff et al. evaluated the long-term results of osteochondral transplantations of the talus using clinical examinations and magnetic resonance imaging (MRI). They performed either mosaicplasty or Osteochondral Autograft Transfer System (OATS) transplantations in 26 cases. The average follow-up time of the study was 7 years (range, 53–124 months). The average body mass index (BMI) of the patients was 25. They observed an improvement in AOFAS score from 50 preoperatively to 78 points postoperatively and Tegner activity score improvement from 3.1 to 3.7, and pain intensity on the visual analog scale (VAS) decreased from 7.8 to 1.5. They also observed that patients with congruent or just slightly incongruent cartilage surfaces on the MRI had better AOFAS scores, but they found no other significant correlations between MRI findings and other criteria. They did however find a significant difference in patients who had osteochondral transplantation as a first procedure compared to those who had first a drilling and then OATS as a second procedure. The AOFAS, Tegner, and VAS clinical results were poorer in the group who had osteochondral transplantation as a second procedure [12].

In yet another study, authors evaluated the clinical and radiologic outcomes of ankles treated with mosaicplasty with poorer results. Although patients had a 92 % satisfaction rate of good to excellent and AOFAS score significantly increased from 45.9 to 80.2 points, while the VAS pain score decreased from 5.9 preoperatively to 3.9 following the operation, they reported significantly decreased sports activity levels, reduced ankle dorsiflexion, knee pain, recurrent lesions, and some degree of cartilage degeneration and discontinuity of the subchondral bone plate [13]. The study group however consisted of 21 patients, of which only 12 were available for the latest follow-up (mean, 72 months). They recommended the careful indication of mosaicplasty from the knee to the ankle joint.

Conclusion

In conclusion, the correct indication of mosaicplasty as a second surgery for osteochondral lesions of the talus, along with the careful selection of patients based on the size and location of the defect, patient age, and condition of the surrounding cartilage, offers a one-step, but two-incision, treatment technique providing hyaline resurfacement of the defects.

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