Novel Metal Implantation Technique for Osteochondral Defects of the Medial Talar Dome

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Abstract: The optimal treatment for large osteochondral defects of the talus or secondary treatment after failed primary surgical treatment is yet to be determined. A metal implant with a diameter of 15 mm has been developed for treatment of these lesions of the medial talar dome. The approach by means of a medial malleolar osteotomy and the implantation technique are outlined. The surgical technique is safe and reproducible, and short-term clinical results are promising.

Key Words: osteochondral defect, talus, metal implant, medial malleolar osteotomy, treatment

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HISTORICAL PERSPECTIVE

In the 18th century, Monro¹ was the first to report the presence of cartilaginous bodies. In 1888, König² used the term osteochondritis dissecans to describe loose bodies in the knee joint and suggested that these were the result of spontaneous necrosis. It was not until 1922 that the first report on osteochondritis dissecans in the ankle was published.³ Since then, several etiologies for these lesions have been suggested. Trauma is known to be the most important etiologic factor⁴; however, ischemia and idiopathic osteochondral ankle lesions do occur.⁵ The most common location of osteochondral defects (ODs) is in the knee, followed by the talar dome.⁶ In 62% of osteochondral talar defects, the defect is located on the medial talar dome.⁷ These medial defects are generally deep and cup-shaped.⁸ An OD may sometimes heal and stabilize, but often progresses to a cystic lesion causing deep ankle pain on weight bearing, prolonged swelling, diminished range of motion, and synovitis.⁹,¹⁰

Arthroscopic debridement and bone marrow stimulation is considered the primary treatment and yields 85% success.¹⁰ In case of failure of the primary treatment, current secondary treatment options include osteochondral autograft transfer system, autogenous cancellous bone graft, and autologous chondrocyte implantation.¹¹–¹⁴ In a systematic review, the mean success rates of these secondary treatment strategies were reported to be 87%, 61%, and 76%, respectively.¹⁰ However, these techniques are associated with donor-site morbidity or involve 2-stage surgery.¹⁵–¹⁷

For treatment of large lesions of the medial talar dome or for secondary treatment after failed primary treatment, a contoured articular inlay implant (HemiCAP, Arthrosurface Inc., Franklin, MA) with a diameter of 15 mm has been devel-oped.¹⁸ Its goals are to offer relief from pain, return to activity, and prevent degeneration/further cyst formation. There are 2 components: a cobalt-chromium articular component and a titanium screw. Fifteen articular component offset sizes are available, based on the surface geometry of the medial talar dome. The offset sizes have been found appropriate for a variety of talus specimens in a cadaveric study.¹⁸ In our institution, the implant has been in clinical use since October 2007.¹⁹

INDICATIONS AND CONTRAINDICATIONS

Our main indication is a large OD of the medial talar dome (anterior-posterior or medial-lateral diameter >12 mm on computed tomography) in patients with persistent complaints more than 1 year after primary surgical treatment. Contra-indications are as follows: age < 18 years, OD size > 20 mm, ankle osteoarthritis²⁰ grade II or III, concomitant ankle pathology (tibial OD, instability, fracture < 6 mo old, tendonitis), diabetes mellitus, advanced osteoporosis, infection, and a known allergy to the implant material.

PREOPERATIVE PLANNING

Computed tomography is made preoperatively to determine the size, location, shape, and degree of displacement of osteochondral fragments. The scanning protocol involves “ultrahigh resolution” axial slices with an increment of 0.3 mm and a thickness of 0.6 mm. Multiplanar coronal and sagittal reconstructions are 1 mm.⁶

SURGICAL TECHNIQUE

The procedure is carried out under general or spinal anesthesia. The patient is placed in the supine position with a tourniquet applied around the upper leg and a rolled-up apron underneath the lateral malleolus to facilitate elevation of the foot and improve exposure of the talus. A curved skin incision of approximately 7 cm is made over the medial malleolus. The anterior skin is mobilized using a scalpel and pincer, and a sharp hook is placed to retract the skin. A Holmann retractor is placed over the distal tibia. A small anterior arthrotomy exposes the anteromedial talar dome. The level of this anterior superior border of the talar dome will later in the procedure act as a guide to identify the level of the posterior ankle joint. Next, the tibialis posterior tendon sheath is incised. After placement of this Holmann retractor posterior to the medial malleolus, the posterior capsule of the ankle joint can be visualized and incised. The posterior intersection between the medial malleolus and tibial plafond is identified using an arthroscopic hook. The surgeon carefully inserts the 5-mm tip of the hook in the posterior medial joint space by sliding along the posterior aspect of the distal tibia at the intersection with the medial malleolus, and gently pulls in an oblique craniomedial direction (Fig. 1). This maneuver identifies the posterior part of the intersection between the tibial plafond and medial malleolus. The periosteum at the level of the intended osteotomy is marked with a surgical knife, sterile marker pen, or osteotome. Next, the

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hook is placed in the anteromedial tibial notch and pulled in an oblique craniomedial direction, identifying the anterior part of the intersection. The anterior intersection is marked, and this is connected to the posterior intersection as a reference guide to the osteotomy. Before creating the osteotomy, 2 screw holes are predrilled and tapped in the medial malleolus, using a cannulated drill. An oscillating saw is placed on the incised periosteum and directed at the marked intersection of the tibia plafond and medial malleolus. The osteotomy is created up to approximately 2 mm above the articular cartilage, whereas 2 Hohmann retractors protect the adjacent soft tissue. The optimal angle for the osteotomy was determined to be at a mean angle of 30 degrees relative to the long tibial axis.21 The osteotomy is completed with the use of an osteotome. This way, the surgeon controls the osteotomy of the articular part and minimizes the risk of damaging the talar cartilage. After the osteotomy has been completed, the surgeon manually retracts and everts the medial malleolus using gauze. Optionally, the distal part is temporarily transfixed by drilling a large-diameter K-wire into the talus through one of the predrilled holes. Exposure of the talar dome is improved by forced eversion of the heel. The fibula is hereby used as a fulcrum (take care not to use too much force), and the talus is tilted.

The necrotic fragment of the defect can now be identified and debrided. Using a drill guide, a guide pin is placed into the center of the defect, perpendicular to the curvature of the medial talar dome (Fig. 2). The guide pin ensures that a perpendicular direction is maintained throughout the procedure. The fixed fixation component of the metal implant is inserted after drilling a pilot hole. A contact probe is used to determine the radius of curvature in the sagittal and coronal planes to allow for a precise fit of the articular component to the existing articular surface (Fig. 3). A matching reamer prepares the site for placement of the articular component. The reamer is a cannulated instrument with a diameter of 15 mm used over the guide pin. A sizing trial with corresponding offsets allows for final verification of proper fit (Fig. 4). The selected articular component is oriented into the correct planes and is placed on the screw. It is impacted with a gentle hammer-stroke on an instrument with a plastic tip, thereby engaging the taper interlock (Fig. 5). After the confirmation of slightly recessed implant edges, the osteotomy is reduced. Initially, large-diameter K-wires are placed through the predrilled screw holes to confirm correct alignment. A Weber bone clamp can be placed for initial compression (Fig. 6). Placement of the proximal leg of the Weber clamp is facilitated by creating a small hole in the

FIGURE 1. Medial intraoperative view of a right ankle. An arthroscopic hook is inserted in the posterior intersection between tibial plafond and medial malleolus to identify the intersection between medial malleolus and tibial plafond for the purpose of the medial malleolar osteotomy.

FIGURE 2. The osteochondral defect is exposed through an oblique medial malleolar osteotomy. A K-wire can be inserted into the talus through one of the predrilled holes to hold the medial malleolus in place (*). A guide pin is placed into the center of the defect, perpendicular to the curvature of the medial talar dome by means of an aiming device.

FIGURE 3. After the insertion of a screw, a contact probe is used to determine the radius of curvature in the sagittal and coronal planes to allow for a precise fit of the articular component to the existing articular surface.

FIGURE 4. After determination of the appropriate offset sizes, a trial articular component (arrow) is placed.
RESULTS

We published the first clinical case report with an excellent outcome after a follow-up of 2 years.22 We performed a prospective case series of 15 patients with a clinical follow-up of 1 year.22 All patients had failed prior surgical treatment of a large defect of the medial talar dome. Various outcome measures were recorded prospectively, including numeric rating scales (NRS) of pain at rest, climbing stairs, and running, American Orthopaedic Foot and Ankle Society (AOFAS) Ankle and Hindfoot clinical rating System, Foot and Ankle Outcome Score (FAOS), and Short Form 36 (SF-36).

After 1-year follow-up, the NRS pain at rest improved from 2.5 ± 2.3 preoperatively to 0.9 ± 1.2 at 1 year (P = 0.021). NRS pain during walking improved from 6.3 ± 1.2 preoperatively to 2.1 ± 1.9 at 1 year (P < 0.001). NRS pain during running improved from 9.2 ± 1.2 preoperatively to 3.8 ± 3.2 at 1 year (P < 0.001). Five patients did not fill out the NRS during running at 1 year because they did not or could not run. NRS pain during stair climbing improved from 6.1 ± 1.4 preoperatively to 2.1 ± 1.9 at 1 year (P < 0.001). All patients improved by at least 1 point on the NRS at final follow-up.

The median AOFAS improved from 69 (range, 42 to 75) preoperatively to 87 (range, 58 to 100) at 1 year (P = 0.001). The FAOS “pain” component improved from a mean of 56.6 ± 13.4 preoperatively to 73.6 ± 22.1 at 1-year follow-up (P = 0.001). The “function” component improved from 64.2 ± 13.0 preoperatively to 82.8 ± 15.7 at 1 year (P < 0.001). The “sports” component improved from 29.1 ± 19.6 preoperatively to 48.3 ± 31.7 at 1 year (P = 0.005). The “quality of life” component improved from 17.3 ± 13.9 preoperatively to 46.3 ± 26.2 at 1 year (P < 0.001). The “symptoms” component did not significantly change from 53.6 ± 20.7 preoperatively to 56.3 ± 18.5 at 1 year (P = 0.63).

The SF-36 physical component scale improved from 36.9 ± 8.0 preoperatively to 45.1 ± 10.1 at 1 year (P = 0.008). The final physical component scale was less than that of the normal population.23 The mental component scale did not significantly change from 56.6 ± 5.6 preoperatively to 52.7 ± 5.8 at 1 year (P = 0.099). The final mental component scale was higher than that of the normal population.23

There were 4 minor complications that resolved within the study period. Three patients reported an area of numbness about the scar, which resolved within the postoperative year. Another patient had a superficial wound infection, which was effectively treated by oral antibiotics. On radiographs there were no signs of prosthetic loosening or degenerative changes at 1-year follow-up (Fig. 7). The medial malleolar osteotomy healed in all cases.

COMPlications

The surgical approach is an important part of the implantation technique because the accuracy of implantation of this device strongly depends on the approach and quality of exposure. If the osteotomy is created too medially, that is, in the articular facet of the malleolus, exposure of the talar dome may be insufficient for adequate treatment. Furthermore, a small distal fragment may be prone to fracture when fixed at the end of the procedure. Conversely, if the osteotomy is created too laterally, it will exit in the tibial plafond. This is undesirable because the medial tibial plafond directly articulates with the medial talar dome,18,24 and damage to this weight-bearing area might lead to secondary osteoarthritis.25 We therefore routinely use a probe to determine the intersection of the tibial plafond and the articular facet of the medial malleolus when performing the osteotomy.

The surface of the prosthetic device should be placed slightly recessed relative to the surrounding surface of the talar cartilage because talar cartilage deforms during weight bearing, whereas the implant does not. Wan et al26 measured a peak cartilage deformation of 34.5% ± 7.3% under full body weight in persons with a medial talar dome cartilage thickness of 1.42 ± 0.31 mm. We therefore aim at an implantation level of 0.5 mm below the adjacent cartilage. This implantation level was found appropriate in a previous cadaveric study.18 When the prosthetic device is correctly implanted, excessive contact pressures of the implant on the tibial plafond are avoided.18

POSTOPERATIVE MANAGEMENT

The postoperative management consists of a plaster cast for 1 week, after which full range of motion is ensured. A functional non–weight-bearing brace (Walker) or a detachable plaster cast can be applied for another 5 weeks. During this period non–weight-bearing sagittal range-of-motion exercises are allowed, that is, 15 minutes twice daily. After these 6 weeks,
radiographs of the operated ankle are obtained to confirm consolidation of the malleolar osteotomy. Subsequently, physical therapy is subscribed to assist in functional recovery and extend to full weight bearing in approximately 1 month.

**POSSIBLE CONCERNS, FUTURE OF THE TECHNIQUE**

The metallic implantation technique appears to be a promising treatment option for ODs of the medial talar dome after failed primary treatment. Although the clinical and radiologic results of 1-year follow-up are encouraging, more patients and longer follow-up are clearly needed to draw any firm conclusions and determine whether the results hold up over time. The development of similar contoured implant for the treatment of secondary lateral defects seems to be the next step.

**REFERENCES**


