



# Metatarsal head resurfacing hemiarthroplasty in the treatment of advanced stage hallux rigidus: outcomes in the short-term

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**Objective:** The aim of this study was to evaluate the short-term outcomes of metatarsal head metal resurfacing hemiarthroplasty in patients with advanced stage hallux rigidus.

**Methods:** The study included 14 feet (4 left, 10 right) of 12 patients (10 female, 2 male; mean age: 63±5; range: 55 to 71 years) who underwent metatarsal head metal resurfacing hemiarthroplasty (HemiCAP®) between 2007 and 2010. Additionally, capsular release and periarticular osteophyte debridement were performed. Staging was made according to Coughlin and Shurnas' clinical and radiological grading system. Hallux valgus and intermetatarsal angles were measured using pre and postoperative standing AP and lateral foot views. Clinical assessment was made with first metatarsophalangeal joint range of motion, the AOFAS (American Orthopaedic Foot and Ankle Society) hallux metatarsophalangeal-interphalangeal scale and satisfaction level.

**Results:** Mean follow up was 19.5 (range: 14 to 26) months. Two patients had bilateral involvement. According to Coughlin and Shurnas' clinical and radiological grading system, nine feet were Stage 3 and five feet were Stage 4. According to the AOFAS scale, results of eight feet (57.1%) were excellent, four feet (28.6%) were good and two feet (14.3%) were moderate. Mean total AOFAS score increased by 26.2 points postoperatively (p<0.05). Mean range of motion of the first metatarsophalangeal joint improved significantly from a preoperative 22.2±5.6 (range: 10 to 28) degrees to a postoperative 56.3±9.6 degrees (p<0.05). Mean hallux valgus angle decreased from a preoperative 14.3 (range: 9 to 17) degrees to a postoperative 11.1 (range: 4 to 13) degrees and the mean intermetatarsal angle increased from a preoperative 10.5 (range: 8 to 14) degrees to a postoperative 10.8 (range: 8 to 15) degrees. Patient satisfaction levels were very good in 10 feet (71.4%), good in 3 (21.4%), and moderate in one (7.2%). Complications included metatarsalgia aggravated by long walks in one patient and hypoesthesia of the great toe in three patients. Push-off power of the great toes was measured as 4/5 in three cases, and 5/5 in others.

**Conclusion:** Metatarsal head metal resurfacing hemiarthroplasty provides high patient satisfaction level and good functional outcome in the short-term, in the surgical treatment of advanced stage hallux rigidus refractory to conservative treatment options.

**Key words:** Arthroplasty; hallux rigidus; metatarsophalangeal joint; surgery.

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Hallux rigidus (HR) is a progressive degenerative joint disease accompanied with 1st metatarsophalangeal (MTP) joint pain, movement restriction, and osteophyte formation.<sup>[1,2]</sup> This pathology was first described by Davies-Colley in 1887.<sup>[3]</sup> The first MTP joint is the most common site of foot arthritis. The etiology is not clear, although trauma, a long 1st metatarsal and inappropriate shoes are commonly cited. Coughlin and Shurnas classified HR according to joint range of motion, clinical findings, and radiological findings.<sup>[4]</sup> Several surgical options have been described for HR in the literature. Conservative treatment with plantar release, cheilectomy and decompression osteotomies are performed for the early stages whereas resection interposition arthroplasty, hemiarthroplasty with 1st metatarsal or proximal phalangeal basis resurfacing, total joint arthroplasty and arthrodesis are options for advanced HR.<sup>[5-10]</sup> Age, activity level, patient expectations and severity of arthrosis are instructive in choosing the best treatment option.<sup>[7]</sup> Although arthrodesis with its high success rates is considered the best option for advanced HR, there are some disadvantages such as difficulty in shoe wear, long healing period, and progression of arthritic changes in the other joints in the foot. Resection interposition arthroplasty is recommended only for sedentary, elderly and low functional capacity patients who refused arthrodesis because of the disadvantages of postoperative 1st ray instability, shortness and transfer metatarsalgia.<sup>[8]</sup> Joint motion, stability, and deformity correction and preservation of metatarsal length can be achieved by implant arthroplasty in advanced HR patients who did not benefit from conservative treatment. In proximal phalangeal basis resurfacing hemiarthroplasty, pain may persist due to arthrosis in the metatarsal head.<sup>[9]</sup> Several complications such as subluxation and silicon synovitis can be seen in total joint arthroplasty.<sup>[9]</sup> Recently, good outcomes with low complication rates have been reported in metatarsal head metal resurfacing hemiarthroplasty.<sup>[10,11]</sup>



**Fig. 1.** HemiCAP® prosthesis with contoured articular surface and cone-shaped titanium screw components.

In our study, we evaluated the functional outcomes of metatarsal head metal resurfacing hemiarthroplasty in the short-term for Grade 3 and 4 HR patients who refused arthrodesis and were treated conservatively.

## Patients and methods

Metatarsal head metal resurfacing hemiarthroplasty was performed on 14 feet of 12 patients (10 female, 2 male; mean age: 63±5 years; range: 55 to 71 years) with advanced HR by two surgeons in two centers between 2007 and 2010. Capsular release and osteophyte debridement were also performed. Mean follow-up was 19.5 (range: 14 to 26) months. Bilateral involvement was seen in 2 patients. According to the Coughlin and Shurnas<sup>[4]</sup> clinical and radiographic classification, 9 feet were classified as Grade 3 and 5 feet Grade 4.

Detailed information on surgical interventions was provided and an informed consent form concerning the radiographic technique was signed by all patients.

HemiCAP® (Arthrosurface Inc., Franklin, MA, USA) resurfacing arthroplasty is a joint replacement system with joint and fixation devices (Fig. 1). The HemiCAP® is a 'contoured articular prosthetic' incorporating an articular resurfacing cobalt-chrome component and a titanium cancellous taper post component that mate together via a taper interlock to make a rigid fixation to the metatarsal head.

Under tourniquet control, we reached the joint via a dorsal approach by retracting laterally the extensor tendon. Adhesions around the sesamoid region were released. A guide wire was placed parallel to the metatarsal shaft 1-2 mm plantar sagittally (Fig. 2). Drilling and tapping over the guide pin for was performed for the taper post. Measuring the depth, the taper post was applied (Fig. 3). We attached the implant 1 mm deeper to the joint surface. Next, we reamed the surface over the guide pin for fixation of the resurfacing implant. Confirmation of appropriate depth was achieved using



**Fig. 2.** Placement of the guide wire parallel to the metatarsal shaft. [Color figure can be viewed in the online issue, which is available at [www.aott.org.tr](http://www.aott.org.tr)]

trial caps and it was observed that the implant was not located above the existing articular cartilage (Fig. 4).

Osteophyte resection on the dorsal aspect of the 1st metatarsal and proximal phalanx was performed. Joint debridement and irrigation was done and a smooth-contoured metatarsal head was obtained. In order to achieve a good articulation between the sesamoids and the implant, the plantar aspect of metatarsal head and sesamoidal crista were debrided and reshaped. HemiCAP® was applied to the implant bed and slightly impacted. Checking for the range of motion, irrigation was performed. After releasing the tourniquet, we repaired the joint capsule. An elastic bandage was applied after closing the wound. Drains were not applied in any patients.

The operated limb was elevated and an ice pad was applied on the wound postoperatively. Stitches were removed on the 15th postoperative day and partial weight-bearing was allowed using a walking boot. Patients were allowed to wear shoes as tolerated depending on wound healing. Passive ROM exercises were begun in the early postoperative period and active ROM exercises were begun following stitch removal. Patients began full weight-bearing near the end of the 1st postoperative month.

Hallux valgus angle and intermetatarsal angle were measured on pre and postoperative weight-bearing AP and lateral radiographs. Clinical outcomes were evaluated according to 1st MTP range of motion and the AOFAS (American Orthopaedic Foot and Ankle Society) hallux metatarsophalangeal-interphalangeal scale.<sup>[12]</sup> The

**Fig. 3.** Placement of the fixation screw. [Color figure can be viewed in the online issue, which is available at [www.aott.org.tr](http://www.aott.org.tr)]

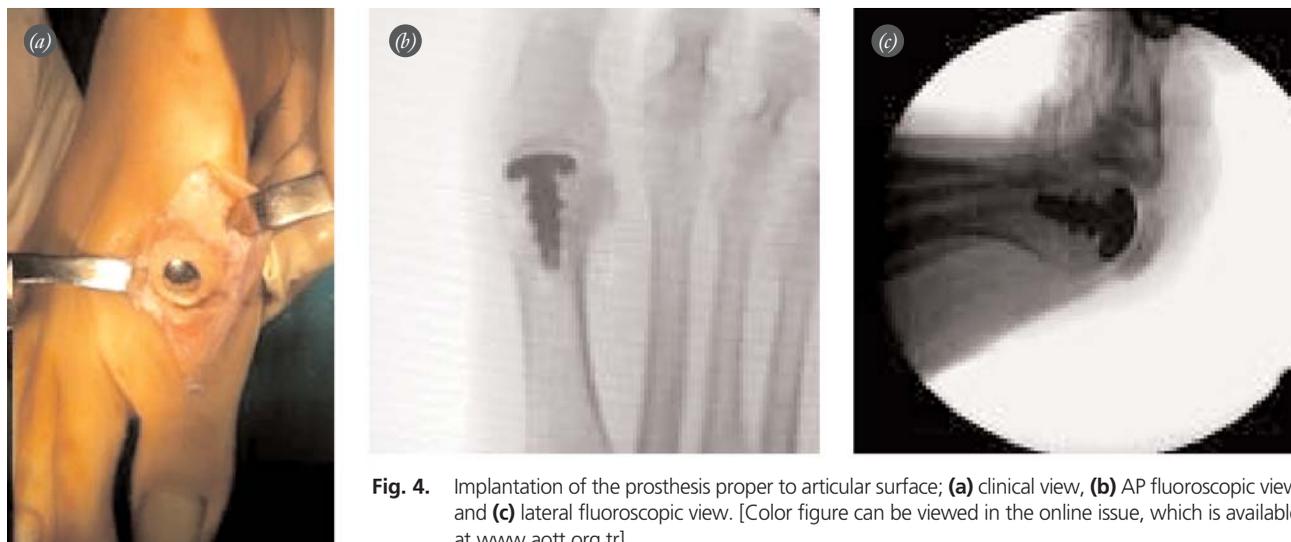


scale consists of 100 points; 45 points for function, 40 for pain points, and 15 evaluating the anatomical structure of the joint. Scores of 90 and above were excellent results, 80 to 89 points good, 70 to 79 points moderate, and under 70 bad. Additionally, patients' subjective satisfaction level was asked individually.

Statistical analysis was performed using the SPSS program. Data analysis was performed with paired t-test and Wilcoxon signed-rank test. P values less than 0.05 were considered significant.

## Results

Excellent results were achieved in 8 feet (57.1%), good results in 4 feet (28.6%) and moderate results in 2 feet (14.3%) according to the AOFAS score at the final follow-up. There was a mean improvement of 26.2 points according to the AOFAS score ( $p < 0.05$ ). First MTP joint ROM was restricted in all patients. ROM of the 1st MTP joint improved from a preoperative  $22.2 \pm 5.6$  (range: 10 to 28) degrees to a postoperative  $56.3 \pm 9.6$  (range: 40 to 65) degrees ( $p < 0.05$ ). One patient com-



**Fig. 4.** Implantation of the prosthesis proper to articular surface; **(a)** clinical view, **(b)** AP fluoroscopic view and **(c)** lateral fluoroscopic view. [Color figure can be viewed in the online issue, which is available at [www.aott.org.tr](http://www.aott.org.tr)].

plained of metatarsalgia after long walks and 3 patients complained of hypoesthesia in the first toe. Pushing power of the first toe was 4/5 in 3 feet and 5/5 in 11 feet. Preoperative mean hallux valgus angle was 14.3 (range: 9 to 17) degrees and mean intermetatarsal angle was 10.5 (range: 8 to 14) degrees. Postoperative mean hallux valgus angle was 11.1 (range: 4 to 13) degrees and mean intermetatarsal angle was 10.8 (range: 8 to 15) degrees. At the end of the follow-up period, patient satisfaction rates were 71.4% for 10 feet, 21.4% for 3 feet and 7.2% for one foot. There were no complications during or after operation. No infection, avascular necrosis of implant failure was detected in any patient.

## Discussion

Hallux rigidus is a degenerative joint arthritis with restricted movements of the first toe, stiffness, and pain on the 1st MTP joint.<sup>[1,2]</sup> This entity is the second most common pathology of the first ray of the foot after hallux valgus and has a 3% incidence in the adult population. Reported predictor factors were a long 1st metatarsal, flat metatarsal head, dorsiflexion of the first metatarsal, long and narrow foot, pes planus, excessive pronation of the foot and inappropriate shoe wear although etiopathogenesis is not clear.<sup>[13]</sup> Trauma, osteochondritis dissecans and infection may play a role in the degenerative period. Osteophytes can cause restriction of movement and pain by stretching the digital nerves.<sup>[1,13]</sup> HR is most common in females between the ages of 55 and 69. The main physical findings are pain in the lift-off phase of gait, MTP swelling, and restriction of dorsiflexion. X-ray examination with weight-bearing AP and lateral radiographs are useful in observing the narrowing of joint space, dorsal osteophyte formation, sesamoidal involvement, and flattening of the metatarsal head. Correct classification according to clinical and radiological findings is important in choosing the appropriate treatment option.

Oral non-steroid anti-inflammatory drugs, activity restriction, shoe wear modification and intra-articular steroid injection are the main conservative treatment options. Grade 0 patients who do not benefit from conservative treatment can be treated with plantar release, synovectomy and joint debridement. Decompression osteotomy, in addition to soft tissue procedures, may be performed for Grade 1 and 2 patients who have a long dorsiflexed 1st metatarsal.<sup>[2]</sup> Cheilectomy with resection of 25 to 33% of the dorsal metatarsal head and proximal phalangeal osteophytes is a suitable option for Grade 1 to 3 patients who suffer from shoe wear difficulties due to dorsal osteophyte and mechanical problems. Inadequate bone resection causes proceeding pain in

cheilectomy whereas bone resection of more than 1/3 of the articular surface causes instability and subluxation.<sup>[14]</sup> Moreover, proceeding postoperative arthritic pain may cause patient dissatisfaction.

Resection interposition arthroplasty is the resection of the 1st MTP articular surface and interposing soft tissue such as periosteum, capsule, and tendon or the interposing of biodegradable material. During proximal phalangeal resection a defect may appear on the insertion site of the flexor hallucis brevis tendon which plays a role in stabilization. This can result in cock-up deformity of the big toe and weakness in the push-off phase of gait. Moreover, because of other postoperative problems including a shortening of the 1st ray, valgus deformity of the MTP joint and transfer metatarsalgia, it is currently accepted only as a salvage procedure for elderly, low functional capacity and late stage arthritic patients who refuse arthrodesis.<sup>[14]</sup> In a comparative study of 19 cheilectomy patients, Lau and Daniels reported poor results, weakness of toes (72.7%) and an increased rate of transfer metatarsalgia after interposition arthroplasty.<sup>[15]</sup>

Despite being a salvage procedure for most joint diseases, arthrodesis is accepted as a standard treatment for Grade 3 and 4 HR cases. While all treatment methods have an approximately 80% success rate, an adequate bone stock, good vascularization, rigid stabilization and patient compliance are crucial for the success of the surgery. This technique sacrifices ROM for pain relief and carries potential problems such as nonunion, transfer metatarsalgia, osteoarthritis in adjacent joints, shoe wear difficulties and permanent activity restrictions. Arthrodesis can be preferred in cases of severe degenerative arthritis, instability due to abortive surgeries of the 1st MTP joint and recurrent hallux valgus deformity.

Good outcomes were reported in the short-term follow-up for old generation endoprosthetic replacement techniques with resurfacing of the proximal phalangeal and total joint arthroplasty with metal or silicone implants. In the long-term follow-up, complications such as implant related soft tissue reaction, joint stiffness, subluxation, silicone synovitis and osteolysis were reported and caused implant failure and poor functional results.<sup>[9,14]</sup>

HemiCAP® prosthesis can be used in the treatment of full-thickness chondral and osteochondral lesions in large joints, such as the shoulder, hip and knee with high success rates. Technological developments enable these metal implants to resurface the metatarsal head and become an alternative treatment method for HR. Metatarsal head resurfacing arthroplasty is an individually based treatment method in severe HR with minimal bone resection and resurfacing using a 4th generation

implant. This treatment method allows the surgeon to preserve MTP joint motion and metatarsal length, avoid causing changes in the articular contour or weakness in intrinsic muscles and apply joint decompression as well as eases the application of salvage procedures in revision surgery. HemiCAP® prosthesis can be a good choice for physically active patients with Grade 2 to 4 HR wanting to preserve MTP joint motion.<sup>[10]</sup> Inadequate bone stock, neuropathic changes of foot, metal sensitivity, osteomyelitis and chronic infection are the contraindications for this method.<sup>[10]</sup>

The choice of arthrodesis or arthroplasty in the treatment of severe HR is controversial. Arthrodesis is more commonly accepted as an appropriate treatment choice by most authors because of the resultant formation of osteophytes, narrowing of the joint, restricted joint motion and soft tissue contracture around the joint. Although higher patient satisfaction rates have been reported in arthrodesis than arthroplasty, better functional results were achieved following arthroplasty due to the development of new generation implants. In an analysis of 3,049 cases in 47 studies of 1st MTP joint arthroplasty, Cook et al. reported patient satisfaction rates of 85 to 95% over a mean 61.5 months of follow-up.<sup>[16]</sup> Raikin et al., in their comparative study of arthroplasty and arthrodesis, reported that most failures occurred in the first 2 years following surgery.<sup>[17]</sup> On the other hand, Carpenter et al. reported good functional results in 32 patients with metatarsal head resurfacing with a mean follow-up of 27.3 months and no patients needing a revision.<sup>[11]</sup> Hasselman and Shields<sup>[10]</sup> reported only 2 failures in more than 100 patients with a mean follow-up of 30 months for the treatment of high-grade HR with HemiCAP® prosthesis. They also reported high patient satisfaction rates and good functional outcomes in all 25 patients who were included in the study with a mean 20 months of follow-up.

In our study, we obtained significant improvements in the AOFAS scale and joint motion with metatarsal head resurfacing for the treatment of high-grade HR with metatarsal head resurfacing arthroplasty. Limitations of our study included the lack of a control group and short follow-up period. Long-term functional outcomes of comparative studies of different surgical techniques with larger case series with similar qualifications are required.

In conclusion, short-term good functional results and high patient satisfaction rates can be obtained with metatarsal head resurfacing arthroplasty with HemiCAP® prosthesis in cases of severe HR that does not benefit from conservative treatment. Arthrodesis

should be used only as a salvage procedure in the treatment of high-grade HR, as in other joints of musculoskeletal system.

**Conflicts of Interest:** No conflicts declared.

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