The Journal of Foot & Ankle Surgery xxx (2015) 1–6

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Original Research

Short-Term Clinical Outcomes After First Metatarsal Head Resurfacing Hemiarthroplasty for Late Stage Hallux Rigidus

Gökhan Meriç, MD [1], Mehmet Erduran, MD [2], Aziz Atik, MD [1], Özkan Köse, MD [3], Ali Engin Ulusal, MD [4], Devrim Akseki, MD [5]

[1] *Surgeon, Department of Orthopaedics and Traumatology, Balikesir University Medical Faculty, Balikesir, Turkey*
[2] *Assistant Professor, Dokuz Eylul University Medical Faculty Department of Orthopaedics and Traumatology, Izmir, Turkey*
[3] *Assistant Professor, Antalya Education and Research Hospital, Orthopaedics and Traumatology Clinic, Antalya, Turkey*
[4] *Assistant Professor, Department of Orthopaedics and Traumatology, Balikesir University Medical Faculty, Balikesir, Turkey*
[5] *Professor, Department of Orthopaedics and Traumatology, Balikesir University Medical Faculty, Balikesir, Turkey*

ARTICLE INFO

Level of Clinical Evidence: 4

Keywords:
arthritis
arthroplasty
cartilage
implant
metatarsophalangeal joint resurfacing

ABSTRACT

The purpose of the present study was to evaluate the short-term results of metatarsal head resurfacing hemiarthroplasty in the treatment of advanced hallux rigidus. We reviewed 14 consecutive patients (5 males [35.71%], 9 females [64.29%]; mean age, 58.7 ± 7.4 years). These patients underwent first metatarsal head resurfacing hemiarthroplasty (HemiCAP®) for hallux rigidus from March 2010 to September 2012 at our institution. According to the Coughlin and Shurnas clinical and radiographic classification, 10 feet (71.43%) were classified as grade III and 4 (28.57%) as grade IV. We clinically rated all patients before surgery and at the final follow-up visit using the American Orthopaedic Foot and Ankle Society hallux metatarsophalangeal-interphalangeal scale, the visual analog scale for pain, and first metatarsophalangeal joint (MTPJ) range of motion. The mean follow-up duration was 24.2 ± 7.2 (range 12 to 36) months. The mean preoperative hallux metatarsophalangeal-interphalangeal scale score was 33.9 ± 9.8 (range 22 to 59), and it increased to 81.6 ± 10.1 (range 54 to 96; $p < .05$) postoperatively. The mean preoperative 10-cm visual analog scale for pain score was 8.4 ± 0.9 (range 7 to 10), which decreased to 1.21 ± 1.2 (range 0 to 5; $p < .05$) postoperatively. The mean preoperative MTPJ range of motion was 22.8° ± 7.7° (range 15° to 45°), which increased to 69.6° ± 11.8° (range 50° to 90°; $p < .05$) postoperatively. None of the 14 patients experienced component malalignment or loosening, infection, or neurovascular compromise during the follow-up period. One patient (7.14%) experienced postoperative pain and subsequently underwent first MTPJ arthrodesis. From the results of our investigation, first MTPJ arthroplasty is an effective treatment modality that can reduce pain and increase motion in the case of advanced hallux rigidus.

Hallux rigidus (HR) is a form of degenerative arthritis of the first metatarsophalangeal joint (MTPJ) characterized by pain, stiffness, difficulty in the push-off period of gait, and footwear discomfort owing to cartilage erosion or dorsal osteophyte formation over the joint. HR is often considered idiopathic or traumatic (intra-articular fractures, repetitive microtrauma) and will commonly develop because of metatarsus elevatus, a long first ray, pes planus, osteochondrosis dissecans, and inappropriate shoe wear (1–3).

Conservative and surgical treatment options have been reported in published studies (3–10). In the early stages of the disease, conservative treatment modalities, including foot orthotics, shoe modifications (rocker bottom), analgesic medications, intra-articular injections (corticosteroids, viscosupplementation), and activity modifications (e.g., avoiding kneeling), can be sufficient (4). However, as the disease progresses, simple joint debridement and/or cheilectomy could be required (5). In advanced stages, additional surgical procedures, including interposition arthroplasty, phalangeal or metatarsal decompression osteotomy, resection arthroplasty, arthrodesis, and partial or total MTPJ arthroplasty can be used (6–10).

Among all these different surgical techniques, arthrodesis has been shown to be very effective and safe, with acceptable complication rates and satisfactory outcomes for end-stage HR. This technique allows pushing off during gait and enables the hallux to fit in appropriate shoes. However, many patients demand a mobile and pain-free MTPJ (8,9). Thus, in accordance with the development of implant

Financial Disclosure: None reported.
Conflict of Interest: None reported.
Address correspondence to: Gökhan Meriç, MD, Department of Orthopedics and Traumatology, Balikesir University Medical Faculty, Balikesir University Medical Faculty, Balikesir 10010 Turkey.
E-mail address: drgokhanmeric@gmail.com (G. Meriç).

1067-2516/$ - see front matter © 2015 by the American College of Foot and Ankle Surgeons. All rights reserved.
http://dx.doi.org/10.1053/j.jfas.2014.10.016

Table 1
Demographic characteristics and clinical results (n = 14 feet in 14 patients)

Pt. No.	Age (y)	Sex	Side	Grade	ROM (°)		VAS Pain Score		AOFAS Hallux-First Ray Scale Score		Complications	Follow-Up (mo)
					Before	After	Before	After	Before	After		
1	59	Female	Right	3	15	50	8	0	27	58	None	36
2	53	Male	Right	3	15	55	7	0	33	79	None	36
3	55	Male	Right	4	15	90	8	3	31	96	None	28
4	52	Female	Left	4	20	70	10	2	22	82	None	27
5	67	Female	Left	3	30	90	9	1	47	92	None	12
6	58	Female	Right	3	25	80	9	1	29	83	None	26
7	75	Male	Left	4	20	80	9	0	29	82	None	23
8	56	Female	Left	3	25	75	8	1	34	81	None	21
9	56	Female	Right	3	20	85	8	1	34	88	None	18
10	54	Male	Left	3	25	90	9	0	40	89	None	20
11	59	Female	Left	4	20	75	8	1	31	79	None	19
12	54	Female	Right	3	20	75	8	1	33	86	None	15
13	61	Female	Right	3	45	90	7	1	59	94	None	27
14	63	Male	Right	3	25	50	10	5	26	54	Pain*	31

Abbreviations: AOFAS, American Orthopaedic Foot and Ankle Society; Pt. No., patient number; ROM, range of motion; VAS, visual analog scale.
* Pain at implant site required revision with first metatarsophalangeal joint fusion.

technology and equipment, metal arthroplasty of the first MTPJ has gained popularity.

The HemiCAP® resurfacing implant (Arthrosurface, Franklin, MA) was first introduced in 2005 (10). This implant design was determined by the anatomy and kinematics of the first MTPJ. The degenerative cartilage at the metatarsal head is removed, and the partial joint-simulating implant is placed. It has 2 components: a fixation component and an articular component that locks together to provide stable fixation. The fixation component is a titanium cancellous screw, and the articular component is composed of a cobalt-chromium-molybdenum alloy with a titanium plasma spray layer underside for bony ingrowth. This is designed in a form to fit the metatarsal head surface (10). The metatarsal head component size is available in 12- and 15-mm diameters (3). This system provides curvature offsets in all planes and can be directly visualized.

The purpose of the present prospective study was to evaluate the short-term (<5 years) results of HemiCAP® metatarsal head resurfacing hemiarthroplasty in the treatment of advanced HR.

Patients and Methods

First metatarsal head resurfacing hemiarthroplasty (HemiCAP®) was performed for symptomatic advanced HR from March 2010 to September 2012 at our institution. The present study was performed according to the Declaration of Helsinki, and our institutional review board approved the study. The "International Classification of Diseases, 10th revision" (World Health Organization, Geneva, Switzerland), was used for patient classification. All patients were informed about the surgical intervention and signed an informed constant form concerning the operative technique. Those patients diagnosed with advanced HR radiologically and by physical examination, aged >50 years, experiencing persistent first MTPJ pain, with limitations in daily activities, and failure of conservative treatment were included in our study. One of us (A.A.), who did not perform the surgery, examined all the patients. The patients' feet were graded using the Coughlin and Shurnas radiographic and clinical classification. Using this classification, 10 feet (71.43%) were classified as grade III (<10° dorsiflexion, with substantial joint space narrowing, possible subchondral cyst formation, and >25% joint involvement), and 4 (28.57%) as grade IV (same criteria as grade III but with pain in the half range of the motion) (3). Those patients with grade III and grade IV HR were included in the present study.

The exclusion criteria were previous surgical procedures in the same foot, an increased intermetatarsal angle or hallux valgus deformity (>15°), bilateral involvement, inflammatory arthritis, postinfectious arthritis, and a follow-up duration <12 months. We did not consider such patients in the present study to decrease the comorbid effects. Two of us (A.E.U., D.A.) reviewed all the patients' operation reports. MTPJ hemiarthroplasty were considered in the case of persistent pain, loss of MTPJ movement, and difficulty in performing daily activities, without axial plane deformity for patients >50 years old. The contraindications for hemiarthroplasty were joint infection, neuropathy, osteomyelitis, erosive systemic arthritis, inadequate bone stock, nickel allergy, previous cheilectomy, peripheral vascular disease, and unrealistic patient expectations. The demographic characteristics of the patients are listed in Table 1.

Surgical Technique

All surgeries were performed by one of us (G.M.), with the patient in the supine position and under spinal anesthesia, with tourniquet control at the ankle level. A

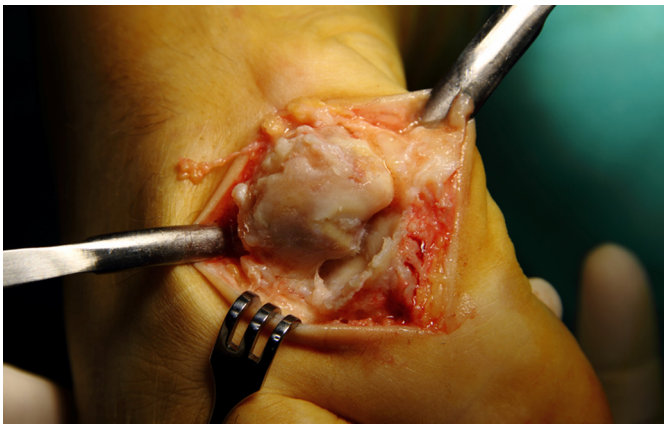

Fig. 1. The skin and capsule were opened longitudinally, and the metatarsal head was exposed. The metatarsal head, phalangeal osteophytes, and articular cartilage damage can be seen.

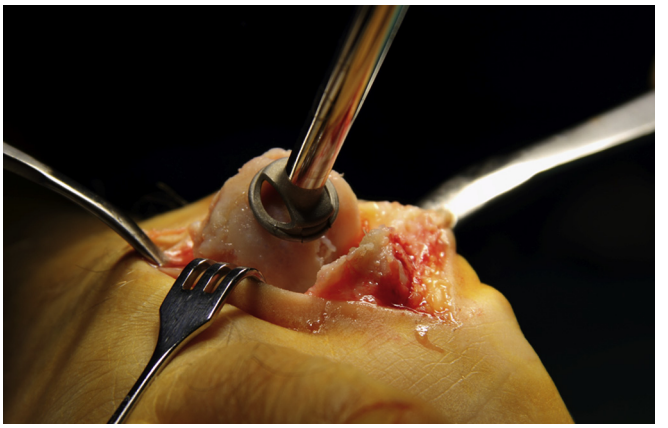

Fig. 2. A guidewire was placed parallel to the metatarsal bone and 1 to 2 mm plantar to the center of metatarsal head in the sagittal plane, in accordance with guidewire.

Fig. 3. *(A* and *B)* Position of the guidewire was checked using fluoroscopy in 2 planes.

dorsomedial approach was used, and the long extensor tendon of the hallux was retracted laterally. The first MTPJ capsule was opened longitudinally, and the first metatarsal head was exposed by plantar flexing the toe (Fig. 1). All fibrotic adhesions around the MTPJ were released until sufficient dorsiflexion (a minimum of 90° dorsiflexion) of the MTPJ was achieved. A guidewire was then placed parallel to the dorsal cortex of the shaft of the first metatarsal in a position 1 to 2 mm plantar to the center of metatarsal head in sagittal plane (Fig. 2). The range of first MTPJ dorsiflexion was then assessed intraoperatively to ensure that the sesamoids were not clicking at the interface of the metal implant and cartilage.

Complete release of the first MTPJ collateral ligaments and capsule was performed until the first metatarsal head central crista could articulate in a balanced fashion with the sesamoids. The position of the guidewire was checked using fluoroscopy in 2 planes (Fig. 3), and the size of the metatarsal component was determined by sizing trials. The cannulated contact probe was placed over the central guidewire to measure the size of the metatarsal head (Fig. 4). The probe could help depict the dorsal, plantar, medial, and lateral contact points of the metatarsal head to determine the appropriate implant size (Fig. 5).

The sizing card with the offset measurements was used to select the proper implant. Drilling and tapping over the guide pin was performed in 1- to 3-mm increments, depending on the tightness of the tapered post (stem) of the metatarsal head. After reaming, osteophytes and hypertrophic synovial tissues were debrided to avoid overresection of the metatarsal head. Dorsal osteophytes and periprosthetic bone remnants were removed to create a smooth metatarsal head without any residual degeneration. The proximal phalangeal aspect of the joint was debrided from all osteophytes and fibrosis. Next, the tapered post and properly sized articular component of the hemi-implant was placed.

An impactor was used to gently hammer the implant securely into the first metatarsal. The range of motion (ROM) of the MTPJ was checked for any impingement, loose bodies, and periarticular adhesions (Fig. 6). In all cases, a minimum 90° of dorsiflexion was achieved in the operating room. To reach a satisfactory ROM, any adhesions were released subperiosteally. The articulations between the sesamoids and the implant were assessed during dorsiflexion using an image intensifier. If the dorsiflexion of the first MTPJ was <90°, the flexor hallucis brevis tendon was released subperiosteally from the tendon's insertion. After ensuring satisfactory and smooth ROM of the first MTPJ, the tourniquet was deflated, hemostasis was settled, and the wound was closed in anatomic layers. We performed a biopsy of the metatarsal head cartilage to confirm the diagnosis. All histopathologic specimens were stained with hematoxylin-eosin and examined with 10× magnification (Fig. 7).

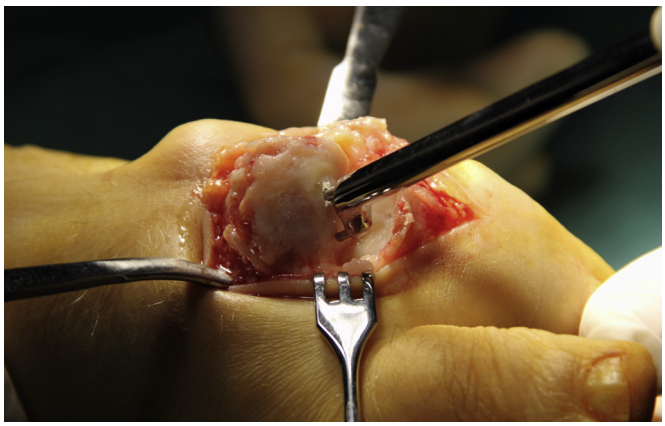

Fig. 4. The probe refers to dorsal, plantar, medial, and lateral contact points. At the plantar point, the sesamoid groove is used as the landmark to determine the implant size and place it.

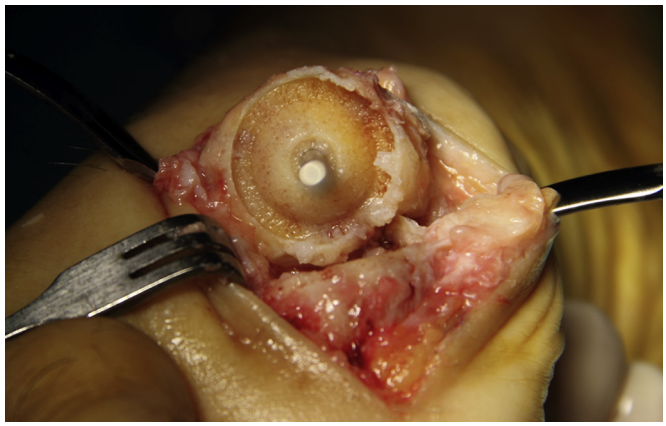

Fig. 5. Drilling and tapping over the guide pin was performed to 1 to 3 mm in depth, depending on the joint tightness.

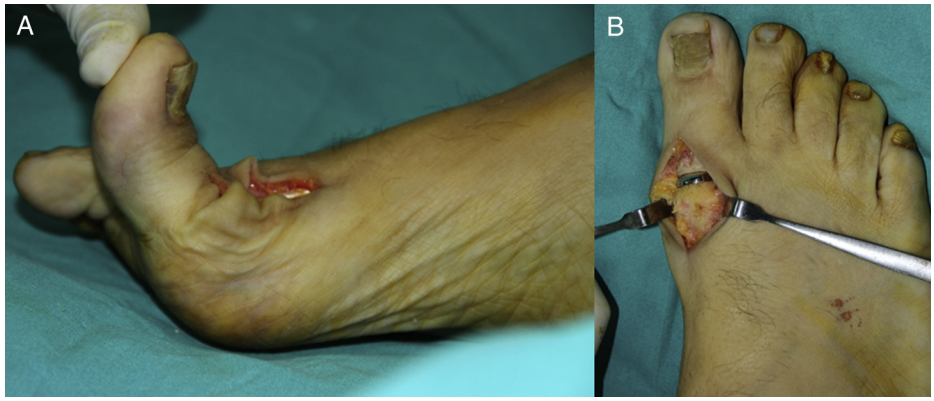

Fig. 6. *(A)* The range of motion of the metatarsophalangeal joint was checked after surgery for any impingement, adhesions, or restrictions. *(B)* The alignment of the implant can be seen.

Postoperative Rehabilitation

The immediate postoperative anteroposterior and lateral radiographs of all patients were obtained. The patients were allowed to bear weight fully on the operated foot using a below-the-knee immobilizing brace. Passive ROM exercises were started within the first 3 postoperative days, and the skin sutures were removed on the 12th postoperative day. The patients were allowed to wear normal shoes and ambulate freely after 4 weeks. Follow-up evaluations were performed in the 1st, 3rd, 6th, and 12th postoperative months.

Clinical and Radiologic Outcomes

We clinically rated all patients using the American Orthopaedic Foot and Ankle Society (AOFAS) hallux metatarsophalangeal-interphalangeal scale at their initial admission and at the final follow-up visit (11,12). A 10-cm visual analog scale (VAS) was used to quantify the pain of the first MTPJ preoperatively and at the final follow-up visit (13). The ROM of the MTPJ between the proximal phalanx and the first metatarsal shaft was measured with the foot and ankle in the neutral position using a goniometer at the last follow-up visit (14). All the measurements were recorded both preoperatively and postoperatively by the same observer (A.A.).

Standard weightbearing anteroposterior and lateral foot radiographs were used to evaluate any change in the component position or loosening during the follow-up period (Fig. 8). The potential complications included infection, stiffness, persistent plantar pain, neurologic problems, implant loosening, and loss of intraoperative ROM. All observed complications during the follow-up period were recorded by one of us (M.E.). The operation reports of the patients from the computerized database were reviewed by 2 surgeons (A.E.U., D.A.). In the case of implant failure (i.e., persistent pain, stiffness, infection, or other reasons), revision surgical options, such as arthrodesis or Keller resection arthroplasty, were considered after removing the implant.

Statistical Analyses

A descriptive analysis of the continuous and categorical data was performed using proportions, frequency distributions, the mean ± standard deviation, and ranges. In addition to standard descriptive statistics, the Wilcoxon signed rank test (nonparametric 2 related [paired] sample) was used to compare the preoperative and postoperative AOFAS and VAS scores and ROM. The statistical analyses were performed by 1 of us (O.K.), and statistical significance was defined at the 5% ($p \leq .05$) level.

Results

A total of 14 feet in 14 patients (no bilateral cases) that had met the inclusion criteria were included in the study. The patient demographic and clinical data are listed in Table 1. Of the 14 patients, 5 (35.71%) were male and 9 (64.29%) were female, with a mean age of 58.7 ± 7.4 (range 52 to 75) years. The mean follow-up duration was

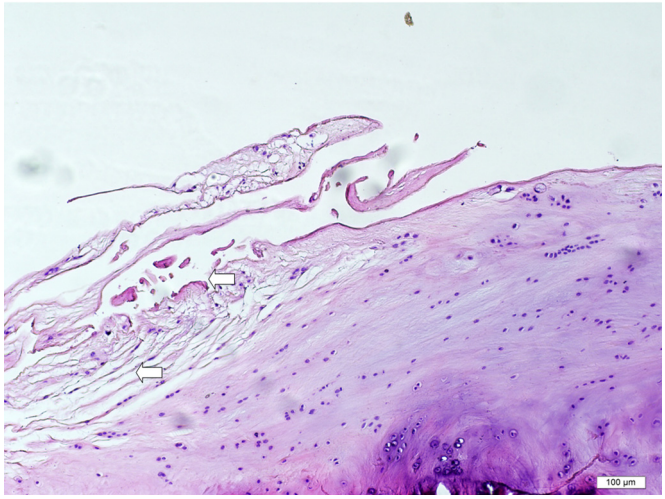

Fig. 7. Histopathologic slide of the first metatarsal head. Arrows show degeneration of the metatarsal head cartilage. (All histopathologic specimens were stained with hematoxylin-eosin and examined with 10× magnification.)

Fig. 8. *(A)* Anteroposterior and *(B)* lateral radiographic views after metatarsophalangeal joint hemiarthroplasty.

Table 2
Statistical comparison of outcomes (n = 14 feet in 14 patients)

Outcome Variable	Preoperative	Postoperative	*p* Value*
ROM (°)	22.8°± 7.7°	69.6° ± 11.8°	.0010
VAS pain score	8.4 ± 0.9	1.21 ± 1.2	.0009
AOFAS hallux-first ray scale score	33.9 ± 9.8	81.6 ± 10.1	.0010

Abbreviations: AOFAS, American Orthopaedic Foot and Ankle Society; ROM, range of motion; VAS, visual analog scale.
* Wilcoxon signed rank test.

24.2 ± 7.2 (range 12 to 36) months. The statistical results of the preoperative and postoperative values are listed in Table 2.

The mean preoperative AOFAS score was 33.9 ± 9.8 (range 22 to 59) points and had increased to 81.6 ± 10.1 (range 54 to 96) points at the final follow-up visit ($p < .0010$). The mean preoperative VAS score for pain was 8.4 ± 0.9 (range 7 to 10) cm and had decreased to 1.21 ± 1.2 (range 0 to 5) cm at the final follow-up visit ($p < .0009$). The mean preoperative first MTPJ ROM was 22.8° (range 15° to 45°) and had increased to 69.6° (range 50° to 90°) at the final follow-up visit ($p < .0010$). One patient's implant (7.14%) was removed, and arthrodesis of the first MTPJ was performed because of ongoing pain and immobility. This particular patient (patient 14 in Table 1) had the poorest AOFAS and VAS scores (54 and 5, respectively) at the final follow-up visit. Two more patients (14.29%; patients 1 and 2 in Table 1) also had low AOFAS scores and limited ROM; however, these patients refused any additional surgery. They had adequate pain relief with a sedentary lifestyle. None of the patients in the present study experienced a postoperative infection or neurovascular compromise.

Discussion

The results of the present study have demonstrated the short-term clinical outcomes of resurfacing hemiarthroplasty for the treatment of advanced stage HR. We observed statistically significant improvements in the AOFAS, VAS for pain, and ROM scores. Instrumentation was used to map the native joint surface and to precisely align the surface of the implant to the contour of the patient's articular surface. The implant must resurface the metatarsal head without modifying the sesamoid articulation. The resurfacing implant changes the radii of the evolving curvature of the first metatarsal, thereby allowing the proximal phalanx to glide with dorsal rollback.

Arthrodesis for late stage HR results in quite good outcomes. For years, it has been accepted as the reference standard treatment of advanced HR, despite the numerous complications that have been reported in association with arthrodesis, such as nonunion, metatarsalgia, prolonged recovery, limited shoe wear selection, hallux interphalangeal and tarsometatarsal joint degeneration, decreased stride length, and diminished ankle torque (2,3,8,9,15). Arthrodesis can provide a painless MTPJ without joint movement. However, in our study, we observed that hemiarthroplasty could reduce pain and increase patients' ROM.

The ideal implant for the treatment of HR must be stable enough to decrease pain and to preserve or increase the joint's ROM (16). Implant options such as silicone, ceramic, chrome-cobalt, and titanium have been used (10,15–20). Ceramic implants were introduced, with good functional outcomes (19). However, the long-term results showed a high prevalence of loosening and revision surgery (20), synovitis, granulomatous reactions, and metatarsalgia (21). Phalangeal hemiarthroplasty has also been used for the treatment of HR; however, implant loosening and plantar cutout (i.e., plantar dislocation of the implant due to asymmetric forces to both the first MTPJ and the foot) were common problems with this implant. Hemiarthroplasty addresses primarily the metatarsal side of the first MTPJ and was designed for patients who live actively, because the implant preserves much of the native joint and maintains the joint biomechanics. Moreover, the implant's dorsal flange is oriented to cover the dorsal aspect of the metatarsal head and to prevent subsequent osteophyte formation after implantation.

Several published reports have described increased ROM after hemiarthroplasty for the treatment of HR. Hasselman and Shields (10) reported the results for 25 MTPJ hemiarthroplasties with a mean follow-up period of 20 months. They observed that their patients' ROM had increased by a mean of 42° postoperatively. After their initial report, they followed up their patients further and reported an 87% survivorship after 5 years (22). Carpenter et al (23) also reported good results in their 30-patient study, showing a mean absolute improvement in the AOFAS score of 58.5 points, without any implant failure. Aslan et al (24) reported their early results using HemiCAP® resurfacing hemiarthroplasty in 27 toes and showed a mean AOFAS score improvement from 40.94 to 85.1 and a mean first MTPJ ROM improvement from 14.36° to 54.38°, with no failures. Erdil et al (25) reported their results after metatarsal head resurfacing hemiarthroplasty in 14 feet and reported that the mean first MTPJ ROM had improved significantly from a preoperative value of 22.2° ± 5.6° (range 10° to 28°) to a postoperative value of 56.3° ± 9.6°. The findings we observed in our patients were consistent with those cited in previously published studies (Table 3).

Although the results of the HemiCAP® procedure have generally been satisfactory, it is not immune to complications. Hasselman and Shields (10) reported 2 failures in 25 patients who were treated for

Table 3
Summary of previously published studies reporting clinical results of HemiCAP®*

Investigators	Patients (n)	Age (y)	Complications	Follow-Up (mo)	DROM (°)		VAS Pain Score		AOFAS Hallux-First Ray Scale Score	
					Before	After	Before	After	Before	After
Hasselman et al (10), 2008	25	51	Metallosis and infection in 1 patient each	20	23	65	NR	NR	82.1	96.1
Carpenter et al (23), 2010	30	62.8	None	27.3	30.84 (10 to 54)	89.31 (70 to 100)	NR	NR	30.84 (10 to 54)	89.31 (70, 100)
Aslan et al (24), 2012	25 (27 toes)	58	None	37.6 (30 to 43)	14.36	54.38	8.3	2.05	40.94 (25 to 63)	85.1 (54, 98)
Erdil et al (25), 2012	12 (14 toes)	63.5	None	19.5	22.2 (10 to 28)	56.3	NR	NR	Increased 26.2 points	
Kline et al (22), 2013	26 (30 toes)	51	4 Implants were revised in 3 y	60	28.0	66.3	NR	NR	51.5	94.1
Present study	14	58.7	Implant removal in 1 patient, who underwent arthrodesis for continued pain†	24.2	22.8 (15 to 45)	69.6 (50 to 90)	8.4	1.21	33.5 ± 9.8 (22 to 59)	83.7 ± 10.1 (54 to 96)

Abbreviations: AOFAS, American Orthopaedic Foot and Ankle Society; DROM, dorsiflexion range of motion; VAS, visual analog scale.
* Before and after refer to before and after surgery.
† Pain at implant site required revision with first metatarsophalangeal joint fusion.

high-grade HR using the HemiCAP® with a mean follow-up period of 20 months. Although one of the failures had resulted from infection, the other had resulted from metallosis. Hopson et al (26) also reported a case of implant failure; after removal of the implant, they used an osteochondral plug from the ipsilateral femoral condyle to press fit into the defect in the first metatarsal head. Stone et al (27) reported a case of late hematogenous infection of the first MTPJ 18 months after HemiCAP® implantation. They removed the implant and resected the osteomyelitic bone. One of our patients (patient 14) had persistent pain and joint stiffness; thus, we removed the implant and fused the first MTPJ. Although our first and second patients had poor functional results and limited ROM, they did not have any restrictions in their daily activity.

We believe that the precise source of pain must be localized during the preoperative planning. In advanced stages of HR, the sesamoid articulations have usually been spared, except in the most extreme cases. However, sesamoid arthrosis can cause MTPJ pain; thus, it is important to ensure accurate localization of the source of the pain. The toe sesamoids must be evaluated by direct palpation during dorsiflexion of the hallux. Any pain localized to the plantar aspect of the MTPJ, when palpating during dorsiflexion, can result from sesamoid arthritis. If the sesamoids are involved, the pain will continue even after hemiarthroplasty. This is not necessarily a contraindication to hemiarthroplasty; however, during surgery, the articular surface of the sesamoids must be debrided and sesamoidal contouring planned to avoid impingement. Alternatively, arthrodesis can be used.

The possible reasons for limited dorsiflexion of the first MTPJ after hemiarthroplasty include insufficient adhesion release, improper size of the implant selection, and inadequate postoperative rehabilitation. To prevent these problems, adequate first MTPJ soft tissue release and precise operative planning are very important. We believe that if dorsiflexion remains $<90^{\circ}$, the flexor hallucis brevis should be released subperiosteally from the tendon insertions and any MTPJ adhesions should be released.

The alignment of the implant is also very important. Any alignment problem involving the implant and first ray will likely result in asymmetric forces over the implant and can cause pain and erosion in the bone, resulting in implant failure. Also, we believe that appropriate implant size selection and early postoperative rehabilitation exercises are very important to achieve a satisfactory result. The surgical technique we have described in the present report has some advantages for the patients and surgeons. These include pain relief without restriction of joint motion, permitting dorsal roll back (excursion) of the phalanx on the resurfaced metatarsal head, a relatively short learning curve for most surgeons, preservation of the joint's mechanics, and preservation of a wide range of possible surgical options if needed.

We had some limitations that could threaten the validity of our conclusions. These included the lack of a control group and the short follow-up period. The control group for a resurfacing hemiarthroplasty study might be an arthrodesis group; however, we thought that arthrodesis should be reserved for a salvage procedure after hemiarthroplasty. Therefore, additional comparative investigations might consider other implant options than arthrodesis for the control group.

In conclusion, first MTPJ hemiarthroplasty is an alternative method when HR is too severe for cheilectomy and decompression. If the patient prefers a mobile joint, hemiarthroplasty could be a desirable alternative to arthrodesis. Hemiarthroplasty appears to be an effective treatment method that recovers both great toe function and first MTPJ motion, without affecting strength or stability. Short-term clinical satisfactory functional results and statistically significant improvements with high patient satisfaction rates can be obtained with the HemiCAP®. It seems to be an effective treatment method in the short term. Comparative studies of different surgical techniques with a longer follow-up period and involving more patients would be welcome to establish the effectiveness of the treatment methods for late-stage HR.

References

1. Yee G, Lau J. Current concepts review: hallux rigidus. Foot Ankle Int 29:637–646, 2008.
2. Coughlin MJ, Shurnas PS. Hallux rigidus: demographics, etiology, and radiographic assessment. Foot Ankle Int 24:731–743, 2003.
3. Coughlin MJ, Shurnas PS. Hallux rigidus: grading and long-term results of operative treatment. J Bone Joint Surg Am 85-A:2072–2088, 2003.
4. Shereff MJ, Baumhauer JF. Hallux rigidus and osteoarthrosis of the first metatarsophalangeal joint. J Bone Joint Surg Am 80:898–908, 1998.
5. Feldman RS, Hutter J, Lapow L, Pour B. Cheilectomy and hallux rigidus. J Foot Surg 22:170–274, 1983.
6. Lau JT, Daniels TR. Outcomes following cheilectomy and interpositional arthroplasty in hallux rigidus. Foot Ankle Int 22:462–470, 2001.
7. Citron N, Neil M. Dorsal wedge osteotomy of the proximal phalanx for hallux rigidus: long-term results. J Bone Joint Surg Br 69:835–837, 1987.
8. Coughlin MJ, Abdo RV. Arthrodesis of the first metatarsophalangeal joint with Vitallium plate fixation. Foot Ankle Int 15:18–28, 1994.
9. Keiserman LS, Sammarco VJ, Sammarco GJ. Surgical treatment of the hallux rigidus. Foot Ankle Clin 10:75–96, 2005.
10. Hasselman C, Shields N. Resurfacing of the first metatarsal head in the treatment of hallux rigidus. Tech Foot Ankle Surg 7:31–40, 2008.
11. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int 15:349–353, 1994.
12. Ibrahim T, Beiri A, Azzabi M, Best AJ, Taylor GJ, Menon DK. Reliability and validity of the subjective component of the American Orthopaedic Foot and Ankle Society clinical rating scales. J Foot Ankle Surg 46:65–74, 2007.
13. Lundeberg T, Lund I, Dahlin L, Borg E, Gustafsson C, Sandin L, Rosén A, Kowalski J, Eriksson SV. Reliability and responsiveness of three different pain assessments. J Rehabil Med 33:279–283, 2001.
14. Norkin CC, White DJ. Metatarsophalangeal Joint Measurement: Measurement of Joint Motion: A Guide to Goniometry, ed 4, edited by K Karter, FA Davis, Philadelphia, 2009.
15. Ettl V, Radke S, Gaertner M, Walther M. Arthrodesis in the treatment of hallux rigidus. Int Orthop 27:382–385, 2003.
16. Sullivan MR. Hallux rigidus: MTP implant arthroplasty. Foot Ankle Clin 14:33–42, 2009.
17. Brewster M, McArthur J, Mauffrey C, Lewis AC, Hull P, Ramos J. Moje first metatarsophalangeal replacement—a case series with functional outcomes using the AOFAS-HMI score. J Foot Ankle Surg 49:37–42, 2010.
18. Mann RA, Clanton TO. Hallux rigidus: treatment by cheilectomy. J Bone Joint Surg Am 70:400–406, 1988.
19. Arbuthnot JE, Cheung G, Balain B, Denehey T, Higgins G, Trevett MC. Replacement arthroplasty of the first metatarsophalangeal joint using a ceramic-coated endoprosthesis for the treatment of hallux rigidus. J Foot Ankle Surg 47: 500–504, 2008.
20. Nixon MF, Taylor GJS. Early failure of the Moje implant when used to treat hallux rigidus: the need for regular surveillance. Foot 18:1–6, 2008.
21. Rahman H, Fagg PS. Silicone granulomatous reactions after first metatarsophalangeal hemiarthroplasty. J Bone Joint Surg Br 75:637–639, 1993.
22. Kline AJ, Hasselman CT. Metatarsal head resurfacing for advanced hallux rigidus. Foot Ankle Int 34:716–725, 2013.
23. Carpenter B, Smith J, Motley T, Garrett A. Surgical treatment of hallux rigidus using a metatarsal head resurfacing implant: mid-term follow-up. J Foot Ankle Surg 49:321–325, 2010.
24. Aslan H, Citak M, Bas EG, Duman E, Aydin E, Ates Y. Early results of HemiCAP® resurfacing implant. Acta Orthop Traumatol Turc 46:17–21, 2012.
25. Erdil M, Bilsel K, Imren Y, Mutlu S, Guler O, Gurkan V, Elmadag NM, Tuncay I. Metatarsal head resurfacing hemiarthroplasty in the treatment of advanced stage hallux rigidus: outcomes in the short-term. Acta Orthop Traumatol Turc 46:281–285, 2012.
26. Hopson M, Stone PA, Paden M. First metatarsal head osteoarticular transfer system for salvage of a failed HemiCAP-implant: a case report. J Foot Ankle Surg 48: 483–487, 2009.
27. Stone PA, Barnes ES, Savage T, Paden M. Late hematogenous infection of first metatarsophalangeal joint replacement: a case presentation. J Foot Ankle Surg 49:489.e1–489.e4, 2010.