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Original Research

Long-Term Results of Hemiarthroplasty Compared With Arthrodesis for Osteoarthritis of the First Metatarsophalangeal Joint

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ABSTRACT

If operative treatment is opted for grade 3 and 4 osteoarthritis of the first metatarsophalangeal joint, arthrodesis is considered the standard of care. However, if preservation of joint mobility is preferred, implant arthroplasty could be favored. Previous studies have suggested hemiarthroplasty might result in less pain, better function, and greater patient satisfaction compared with arthrodesis. However, these studies only evaluated short-term results (range 2.2 to 6.6 years). The aim of our study was to determine whether patients treated with hemiarthroplasty would show better postoperative outcomes compared with those treated with arthrodesis after ≥5 years after surgery. The American Orthopaedic Foot and Ankle Society hallux metatarsophalangeal interphalangeal (AOFAS-HMI) scale score was used as the primary outcome measure. Secondary outcomes addressed satisfaction rates, patient procedure recommendation, and number of unplanned repeat surgical procedures. We also addressed the influence of the procedures on daily activities (work and sports), the influence of smoking on the postoperative results, and the costs for both procedures. A total of 47 primary arthrodeses and 31 hemiarthroplasties performed between January 2005 and December 2011 were evaluated. After a mean follow-up period of 8.3 (range 5 to 11.8) years, the mean AOFAS-HMI scale score after arthrodesis and hemiarthroplasty was 72.8 ± 14.5 and 89.7 ± 6.6, respectively ($p = .001$). The patients were significantly more pleased after hemiarthroplasty ($p < .001$), and this procedure was recommended more often ($p < .001$). The number of unplanned repeat surgical procedures did not differ between the 2 groups. Patients resumed sports activities significantly sooner after hemiarthroplasty ($p = .002$). The overall costs were similar for both procedures. Our results have shown more favorable postoperative outcomes for hemiarthroplasty compared with arthrodesis as operative treatment of osteoarthritis of the first metatarsophalangeal joint after a mean follow-up period of 8.3 years.

Osteoarthritis of the first metatarsophalangeal (MTP-1) joint is characterized by pain and reduced dorsiflexion. Radiographically, the characteristic formation of osteophytes on the dorsal aspect of the joint and progressive joint space narrowing will be present (1). Dorsiflexion in the MTP-1 joint leads to painful impingement and, therefore, limits the gait. Coughlin and Shurnas proposed a classification system for osteoarthritis of the MTP-1 joint in 1999 based on the range of motion and the radiologic and physical examination findings (2).

Nonoperative treatment options include nonsteroidal antiinflammatory drugs, intraarticular infiltration with corticosteroids, physical therapy, and footwear modifications (3,4). If nonoperative treatment is not efficacious, operative treatment can be considered. Arthrodesis of the MTP-1 joint is the most commonly performed procedure for late-stage osteoarthritis (5). If preservation of joint mobility is preferred, resection or implant arthroplasty can considered.

The preferred option for operative treatment is still being debated in the most recent studies. Multiple studies supporting fusion as the preferred procedure have reported better postoperative scores, greater patient satisfaction rates, fewer complications, and better outcomes after gait analysis (6–9). Total joint replacement initially showed favorable results, with a high level of patient satisfaction and preserved range of motion. However, multiple studies have shown increased failure rates after longer follow-up. Because of these relatively poor results, total MTP-1 joint arthroplasty is not recommended (6,10–13). Hemiarthroplasty has become more popular as an alternative to total joint replacement. A multicenter review showed no differences in

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subjective outcomes after arthrodesis or hemi-joint replacement (14). Recent studies by Voskuijl and Onstenk (15) and Simons et al (16) showed similar short-term results after arthrodesis and hemijoint replacement with greater satisfaction rates and the absence of severe postoperative pain after hemiarthroplasty. Hemijoint replacement with the BiopPro® First MPJ (BioPro Inc., Port Huron, MI) implant was associated with high survival rates, ranging from 76% to 96% (8,16–18). However, most of these studies only discussed the short-term results (15,16,19,20).

The aim of our study was to determine whether patients treated with hemiarthroplasty showed better postoperative outcomes than those treated with arthrodesis after a follow-up period of ≥5 years.

Patients and Methods

A cohort of 102 patients who had undergone surgery for osteoarthritis of the MTP-1 joint between January 2005 and December 2011 (including 67 arthrodeses and 47 hemiarthroplasty procedures) were invited to participate in our study. The patients were informed that a questionnaire would be administered and that both feet would be clinically and radiographically examined. Sixty-seven patients (65.7%) responded and were included in our study. Of the 66 patients, 39 underwent 47 arthrodeses using different fixation techniques (e.g., Kirschner wires, plates, staples, and lag screws) and 27 underwent 31 hemiarthroplasties using the BioPro® First MPJ (BioPro Inc.) implant. Both procedures were performed for stage 3 or 4 osteoarthritis according to the Coughlin and Shurnas classification. The postoperative protocol after arthrodesis included 6 to 8 weeks of cast immobilization, with full weightbearing as tolerated after 1 week. After hemiarthroplasty, a stiff-soled shoe for 2 weeks with passive range of motion exercises of the MTP-1 joint as soon as possible was recommended, and physical therapy was advised for postoperative weeks 2 to 8 for these patients. A physical treatment guideline is available for hemiarthroplasty of the MTP-1 joint (19).

The American Orthopaedic Foot and Ankle Society hallux metatarsophalangeal interphalangeal (AOFAS-HMI) scale score (21,22) was used as the primary outcome measure for our study. It includes scores for pain, function, and alignment. The maximum score is 100 points after hemiarthroplasty and 90 points after arthrodesis, with 10 points excluded owing to loss of MTP-1 joint motion. To make the scores comparable for both procedures, we analyzed the AOFAS-HMI scale scores as a percentage of the maximum score. We assessed pain, activity limitations, and footwear requirements by questionnaire, joint stability and joint motion clinically, and alignment radiographically. We defined good alignment of the MTP-1 joint as dorsiflexion ≤30° and valgus of ≤15°.

The secondary outcomes were satisfaction rates, patient recommendation for the performed procedure, and the number of unplanned repeat surgical procedures. Satisfaction rates were measured using a 5-point Likert-scale (1, very satisfied; 2, satisfied; 3, equal; 4, unsatisfied; 5, very unsatisfied) and the procedure recommendation using a 3-point Likert-scale (1, yes; 2, maybe; 3, never). We furthermore addressed the influence of the procedures on daily activities, the influence of smoking and diabetes mellitus on the postoperative results, and the total costs of the procedure. Work and sports activities, smoking behavior, and medical history (e.g., diabetes mellitus) were assessed by questionnaire. To determine the influence of smoking, the postoperative results of active smokers, exsmokers, and nonsmokers were compared. The total costs for each procedure were calculated as the sum of the costs for the performed surgical procedure, repeat procedures, hospitalization time, outpatient clinic visits, radiographs, physical therapy, footwear requirements, and work interruption. The duration of hospitalization, the number of outpatient clinic visits, and the number of radiographs were extracted from the patients' medical records. The hospital's finance department was queried for the costs of the performed surgical procedure (initial and repeat procedures). Local physiotherapists were queried for their prices for a single session of physical therapy, with the average prices used in the calculation of the total costs. The costs of footwear adjustments by a local podiatrist were used for the total costs calculation. The average income in the Netherlands for 2017 was included in the calculations.

Statistical Analysis

The scores of the AOFAS-HMI scale, patient satisfaction rates, recommendation for the performed procedure, and time until resumption of daily activities were analyzed as continuous variables. The independent sample Student *t* test was used to evaluate the differences between these outcomes for both procedures. To determine the influence of smoking on the total AOFAS-HMI scale score, the mean AOFAS-HMI scale score of the smoking and exsmoking group were compared with the mean AOFAS-HMI scale score of the nonsmoking group. A χ^2 test was used to compare the number of unplanned repeat surgical procedures. Differences with $p < .05$ were considered statistically significant.

Results

A total of 47 arthrodeses and 31 hemiarthroplasties in 40 and 27 patients, respectively, were evaluated (Table 1). The mean interval after surgery until evaluation did not differ significantly between the 2 treatment groups ($p = .052$; Table 2).

The mean postoperative AOFAS-HMI scale score was 72.8 ± 14.5 after arthrodesis and 89.7 ± 6.6 after hemiarthroplasty ($p = .001$) Less pain ($p < .001$) was reported after hemiarthroplasty. No differences in function ($p = .148$) or alignment ($p = .514$) were seen between the 2 groups. All patients in hemiarthroplasty group had a preoperative range of motion <20°, equal to stage 3 and 4 of the Coughlin and Shurnas classification. Postoperatively, all hemiarthroplasties resulted in a restored range of motion (range 30° to 74° for 28; >75° for 1), except for 2 patients, who scored less satisfaction. Patients were significantly more pleased after hemiarthroplasty ($p < .001$). Also, this procedure was recommended significantly more often ($p \leq .001$).

Of the 39 patients who underwent arthrodesis, 25 underwent surgery for hardware removal postoperatively. However, this was considered standard treatment rather than unplanned repeat surgery. Unplanned repeat surgery was performed in 4 patients after arthrodesis because of nonunion and in 3 patients after hemiarthroplasty for loosening of the prosthesis in 1 and limited range of motion in 2. The number of unplanned repeat surgical procedures did not differ significantly between the 2 treatment groups ($p = .547$).

No association was found between smoking and the postoperative results (Table 3). Because of the small number of patients with diabetes mellitus (n = 4), no analysis would have been considered meaningful.

All the patients resumed their work, and the average time until resumption did not differ significantly between the 2 groups ($p = .202$). After hemiarthroplasty, patients with sedentary employment returned to work significantly more quickly than did patients with employment requiring mobility ($p = .004$). Patients returned to sports a mean of 6.7 ± 4.6 weeks after hemiarthroplasty compared with a mean of 11.7 ± 5.1 weeks after arthrodesis ($p = .002$). Arthrodesis affected 15 of 21 patients (71.4%) active in sports. Of these 15 patients, 7 stopped their activity, 7 exercised less frequently, and 1 switched to another sport. Hemiarthroplasty affected 3 of 17 patients (17.6%) active in sports. Of these 3 patients, 2 stopped their activity and 1 exercised less frequently (Table 4).

The procedure costs for arthrodesis were, globally, 50% less than those for hemiarthroplasty. However, the additional costs for both procedures included the costs for repeat surgery, footwear modifications, and postoperative physical therapy. In our study, 21 of the 39 patients (53.8%) who had undergone arthrodesis required footwear modifications (13 [33%] required orthotics and 8 [21%] required orthopedic shoes or a brace). In contrast, 5 of the 27 patients (18.5%) who had undergone hemiarthroplasty required footwear modification

Table 1
Patient characteristics

Demographic Data	Arthrodesis (n = 47 Procedures)	Hemiarthroplasty (n = 31 Procedures)
Patients (n)	39	27
Male sex (n)	8 (21)	10 (37)
Age (y)		
Mean	62.3 ± 7.7	58.3 ± 6.9
Range	47 to 78	36 to 67
Operated side (n)		
Right side	13 (33)	7 (26)
Left side	18 (46)	16 (59)
Bilateral	8 (21)	4 (15)

Data in parentheses are percentages.