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A Prospective Comparison of Clinical, Radiographic, and Intraoperative Features of Hallux Rigidus: Long-Term Follow-Up and Analysis

Andrew D. Elliott, DPM, JD [1], Andrew J. Borgert, PhD [2], Thomas S. Roukis, DPM, PhD, FACFAS [3]

[1] *Gundersen Lutheran Medical Foundation, La Crosse, WI*
[2] *Department of Medical Research, Gundersen Health System, La Crosse, WI*
[3] *Orthopaedic Center, Gundersen Health System, La Crosse, WI*

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ABSTRACT

Forty-seven patients (50 feet) underwent surgical intervention for symptomatic hallux rigidus from February 1998 to April 1999. Thirty-eight patients (41 feet) returned at 1 year for a follow-up evaluation. Of these 38 patients, 20 (21 feet) returned for the 15-year follow-up evaluation. Subjective evaluations were performed using the modified American Orthopaedic Foot and Ankle Surgery hallux metatarsophalangeal-interphalangeal 100-point scale. Long-term postoperative objective physical examination and radiographic analysis were performed. These data were compared with the preoperative and short-term follow-up data. The subjective evaluation showed a statistically significant differing over the long term, with a mean increase of 27.6 points. The results of the physical examination and radiographic measurements were mixed. The long-term dorsal range of motion was not significant across surgery type. Radiographically, the procedure types resulted in similar changes, suggesting that neither joint preservation nor joint destructive procedures were more stable over time. Plantar transposition of the capital fragment, offsetting the longitudinal shortening of the first metatarsal, was not significant, confirming the short-term findings. For this patient population, the long-term results of surgical intervention for hallux rigidus, regardless of procedure type, provided subjective patient improvement but no statistically significant increase in first metatarsophalangeal joint function or dorsal range of motion.

To obtain long-term resolution of the symptoms associated with hallux rigidus, a commonly held belief is that the underlying primary biomechanical precipitating factors must be corrected (1–5). Over the years, abundant surgical stepwise algorithms have been proposed, and numerous surgical procedures have been devised purporting to do just that (1,3,6–13); however, no long-term studies, commonly defined as ≥10 years of follow-up, have been published that have prospectively followed up a cohort of patient surgically treated for symptomatic hallux rigidus.

The use of long-term prospective studies to evaluate the surgical outcomes of foot and ankle surgery is rare; however, their value cannot be understated. These types of studies provide clarity to both patients and surgeons. Patients are helped in that they will have a better understanding of what to expect over time (i.e., not just for 12 months after surgery but 12 years). Surgeons will have a better understanding of the tools at their disposal and can adjust their decision making accordingly. In a recently published, prospective, randomized study, Faber et al (14) compared the results of the Hohmann first metatarsal osteotomy against the modified Lapidus first metatarsal-cuneiform arthrodesis for the correction of 101 hallux valgus deformities at a mean follow-up period of 9.25 years. They found no difference in the clinical or radiographic outcomes regarding those with documented first ray hypermobility, thereby challenging the idea that arthrodesis of the first metatarsocuneiform joint is necessary in those hypermobile cases. The results of the study suggested that the presence of a hypermobile first ray does not need to be considered when selecting the surgical approach for correction of hallux valgus deformities. Thus, surgeons might not need to consider first ray hypermobility, as previous generations of surgeons had thought, and thus could select the less technically demanding osteotomy instead of arthrodesis. In isolation, these findings cannot be considered definitive, but this challenge to conventional wisdom would not have been possible without the results of the longer term >9-year follow-up period.

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Address correspondence to: Thomas S. Roukis, DPM, PhD, FACFAS, Department of Medical Research, Gundersen Health System, La Crosse, WI 54601-5467.
E-mail address: tsroukis@gundersenhealth.org (T.S. Roukis).

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In our previous studies (8,15), we initially presented the results of a prospective comparison of clinical, radiographic, and intraoperative features of 47 patients (50 feet) with symptomatic hallux rigidus. In those studies, the data collected were compared with historical controls from previously published studies. Those patients enrolled in our previous prospective studies had undergone surgical intervention in the form of either a joint salvage (e.g., cheilectomy or periarticular decompressive osteotomy) or joint destructive (e.g., implant arthroplasty) procedure (8). In a subsequent, short-term follow-up study of the same patient cohort, including 38 patients (41 feet), we presented the 1-year outcomes of those patients (15). The short-term data indicated that the results of surgical intervention in this cohort provided subjective patient improvement and satisfaction and a statistically significant, but functionally minimal, increase in first metatarsophalangeal joint dorsal range of motion. Also noted in the patients who had undergone periarticular decompression osteotomy was a lack of relevant plantar transposition of the capital fragment. The purpose of the present study was to report the long-term 15-year follow-up outcomes of these same patients.

Patients and Methods

All the patients who had been clinically diagnosed with symptomatic hallux rigidus and were scheduled for surgical intervention at the Gundersen Lutheran Medical Center (now Gundersen Health System) from February 1998 to April 1999 were prospectively evaluated. Symptomatic hallux rigidus was defined according to the now discontinued American College of Foot and Ankle Surgeons Preferred Practice Guidelines.

Only patients undergoing isolated first ray surgical procedures and with an intermetatarsal angle of $\leq 12^{\circ}$ were included in the original study. This intermetatarsal angle was chosen to eliminate the arthritic hallux valgus condition from inclusion within the patient population. Individuals with hallux rigidus resulting from systemic disease, neuromuscular disorders, trauma, or iatrogenic causes were also excluded. In the original study, 47 consecutive patients, representing 50 feet, had met the criteria for inclusion. Neither the patients nor the surgeries were randomized. At no point during the study were the surgeon or patients blinded in any fashion. For each patient, the senior author (T.S.R.) performed the preoperative, 1-year postoperative, and 15-year postoperative clinical assessments and physical examinations.

The radiographic system used to grade the degree of hallux rigidus was developed and implemented by 1 of us (T.S.R.) and consisted of a hybrid of the proposed systems from Kravitz et al (1), Drago et al (2), and Hanft et al (7) (Table 1). This classification system was the first system to be applied prospectively and included the clinical, radiographic, and intraoperative features of hallux rigidus. It is considered a methodologically robust classification system (16). It is simple to understand, easy to use, does not require special tools or training, and, when combined with the physical examination findings, is prognostic of the location and extent of osteoarthritis within the first metatarsophalangeal joint (8,15). The subjective clinical assessment included a modified version of the hallux metatarsophalangeal-interphalangeal scale advocated by the American Orthopaedic Foot and Ankle Society (AOFAS) (Table 2) (17). The modified scale allows 40 possible points for pain, 40 possible points for function, and 20 possible points for alignment/cosmesis. The total maximum score possible is 100 points.

A physical examination was conducted during the preoperative, short-term, and long-term assessments to determine the location of pain and hyperkeratotic lesion pattern. The non-weightbearing relaxed hanging position of the first metatarsophalangeal joint was obtained by bisecting the medial aspect of the shafts of both the first metatarsal and the proximal phalanx and manually determining the angle subtended by the intersection of these lines, as described by Hetherington et al (18). Assisted dorsiflexion of the first metatarsophalangeal joint was determined by exerting manual pressure on the proximal phalanx of the hallux in a dorsal direction using the same bisection lines. This measurement was obtained with the foot non-weightbearing and in a simulated weightbearing position, as described by McGlamry et al (19). Similarly, non-weightbearing-assisted plantarflexion of the first metatarsophalangeal joint was determined by exerting manual pressure on the proximal phalanx of the hallux in a plantar direction using the same bisection lines.

The radiographic measurements included the (1) metatarsal protrusion distance (MPD) (20,21); (2) angle of deviation of the second metatarsophalangeal joint (22); (3) lateral talar–first metatarsal angle (aka, Meary's angle) (21,23); (4) sagittal plane relationship between the first and second metatarsals (i.e., Seiberg index and the sagittal intermetatarsal 1-2 angle of Green) (23,24); and (5) sagittal plane relationship between the first metatarsal and hallux (i.e., hallux equinus angle) (25). The senior author (T.S.R.) performed all radiographic analyses.

The senior attending physician at our institution responsible for the patients' care (T.S.R.) preoperatively determined the specific surgical procedure selected during the study period (8,15). Specifically, joint preservation procedures consisted of either cheilectomy or periarticular decompression osteotomy (i.e., Austin-Youngswick, Watermann-Green, Weil decompression osteotomy, or telescoping Scarf osteotomy) (26–29). Joint destructive procedures consisted of either implant arthroplasty (i.e., Swanson total Silastic implant; Wright Medical Technologies, Inc., Arlington, TN; or BioPro resurfacing endoprosthesis; BioPro, Port Huron, MI) or first metatarsophalangeal joint arthrodesis.

Longitudinal outcome data were analyzed using linear mixed effects regression analysis with random intercepts. For all outcome variables, the regression model included surgery type (joint salvage or joint destructive), follow-up point (baseline, short-term, long-term), and the interaction between surgery type and follow-up point. An unstructured covariance model was used to describe the correlation between the measurements from the same subject over time. All subsequent pairwise contrasts

Table 1
Hybrid radiographic grading system for hallux rigidus

Grade	Description
I	Metatarsus primus elevatus with or without hallux equinus
	Periarticular subchondral sclerosis
	Minimal dorsal exostosis (first metatarsal head and base of proximal phalanx)
	Minimal flattening of first metatarsal head
II	Moderate dorsal exostosis (first metatarsal head and base of proximal phalanx)
	Moderate flattening of first metatarsal head
	Minimal joint space narrowing
	Lateral first metatarsal head erosion and/or joint flare/exostosis
	Sesamoid hypertrophy
	With or without subchondral cyst formation/loose body formation
III	Severe dorsal exostosis (first metatarsal head and base of proximal phalanx)
	Irregular joint space narrowing
	Traction enthesopathic sesamoid hypertrophy with immobilization-induced osteopenia
	Definite subchondral cyst formation and presence of loose bodies
IV	Excessive exostosis proliferation with trumpeting of first metatarsal head, base of proximal phalanx, and sesamoid apparatus
	Minimal/absent joint space
	Sesamoid fusion
	Hallux interphalangeal and/or first metatarsal–medial cuneiform joint osteoarthritic changes

Table 2
Modified American Orthopaedic Foot and Ankle Society hallux metatarsophalangeal-interphalangeal 100-point scale

Domain	Score
Pain (n = 40 points)	
None	40
Mild, occasional	30
Moderate, daily	20
Severe, almost always present	0
Function (n = 40 points)	
Activity limitations	
No limitations	10
No limitation of daily activities (e.g., employment responsibilities or recreational activities)	7
Limited daily and recreational activities	4
Severe limitation of daily and recreational activities	0
Footwear requirements	
No restrictions	10
Restricted to sneakers, wide shoes	5
Restricted to modified shoes	0
Range of motion	
Completely satisfied	10
Nonpainful, limited motion	5
Painful, restricted motion	0
Calluses	
None or present but not painful	5
Painful	0
Swelling	
None	5
Slight	3
Almost always present	0
Alignment/cosmesis (n = 20 points)	
Good, pleased	20
Fair	10
Poor, unhappy	0