



## Autogenous Capsular Interpositional Arthroplasty Surgery for Painful Hallux Rigidus: Assessing Changes in Range of Motion and Postoperative Foot Health



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### ABSTRACT

The autogenous capsular interpositional arthroplasty procedure can be a motion-sparing alternative to arthrodesis for the treatment of recalcitrant hallux rigidus deformity. Previous studies have reported positive results; however, many had small samples or lacked comparable preoperative measures. The present study used a prospective cohort study to assess the benefit of this technique for increasing range of motion, and comparative data to assess the reduction of pain and improvements in perceived foot health status for a consecutively drawn sample of patients. Thirty-four patients (44 feet) reviewed using a long-arm goniometer at a mean of 3.75 years after surgery experienced a significant increase in dorsiflexion (preoperative mean  $11.09^\circ \pm 10.13^\circ$ ; postoperative mean  $26.64^\circ \pm 10.07^\circ$ ;  $p < .001$ ); plantar flexion remained unchanged. Additionally, 15 of 17 patients for whom the hallux abductus angle was initially greater than the normal range was within the normal range postoperatively. The postoperative patient perceptions of foot pain were significantly better than those from a comparable sample of patients presenting for a surgical opinion ( $t[69] = 6.80$ ), just as were the perceptions of foot function, foot health, and footwear comfort ( $p < .001$  for all). The postoperative perceptions of foot pain were comparable with the postoperative results from a range of previously published studies. These results have shown, with improvements in range of motion and reduction in pain, that autogenous capsular interpositional arthroplasty is a useful, motion-sparing technique in the treatment of painful hallux rigidus and should be considered for classification as a clinical practice guideline.

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Hallux rigidus is a common and often debilitating pedal complaint causing pain, restricted mobility, and reduced quality of life (1). The goals of surgical intervention for hallux rigidus are to relieve pain, increase dorsiflexion, maintain plantar flexion power, maintain stability of the first metatarsophalangeal (MTP) joint, concomitant with maintenance of the length of the first metatarsal and hallux, and prevent transfer metatarsalgia (2). Achieving all these parameters satisfactorily has been difficult.

The clinical practice guidelines associated with disorders of the first MTP joint have classified surgical treatment to include a range of

joint salvage and joint destructive procedures. Joint salvage procedures have included cheilectomy, metatarsal osteotomy, phalangeal osteotomy, and chondroplasty. Joint destructive procedures include resection arthroplasty, interpositional implant arthroplasty, total joint replacement, and arthrodesis (3). Because hallux rigidus is a progressive osteoarthritis, each procedure should be appropriately chosen to address the degree of arthrosis present (3). However, each procedure is not without its limitations and inherent complications.

For example, the traditional Keller procedure, originally advocated for hallux valgus correction, has been used for hallux rigidus correction of varying severity. This procedure, involving 50% resection of the proximal aspect of the proximal phalanx (4), is considered to have too many complications to make it a suitable procedure in modern foot surgery. Such complications have included transfer metatarsalgia, decreased hallucal strength, excessive shortening of the first ray, hallux malleus, and clawing of the interphalangeal (IP) joint (5,6).

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Although first MTP joint arthrodesis has been considered the reference standard in surgical management, it also has potential complications and limitations. Arthrodesis has been associated with failure of fixation, malposition, nonunion, shortening, and associated transfer metatarsalgia (7), increased stress to the IP joint, and limitations of footwear options for the patient (8). The reported rates of nonunion after arthrodesis have varied from 0% to 20%, with the time to union requiring as long as 5 months (9,10). Nonunion of the first MTP joint can result from inadequate joint resection or unstable fixation (11). In terms of malposition, when the toe is too close to the ground, pain can be experienced from pressure, with the potential for ulceration, or the fixation can break, leading to nonunion. Poor correction in the sagittal plane can also cause contracture of the hallux IP joint. Excessive dorsiflexion ( $>15^\circ$ ) can may lead to problems with shoes fitting owing to dorsal pain affecting the IP joint and nail (10). Varus malposition can also cause shoe irritation (11), and excessive valgus creates pressure against the second toe, resulting in a painful corn at the point of contact (10). When fixation is too prominent or too loose, pain can result, leading to the need for its removal. Wound dehiscence can result from pressure from excessive amounts of hardware, including plates, prominent screws, and wires (11).

Despite these potential complications, it has been accepted that first MTP joint arthrodesis is an excellent procedure, providing anatomic dissection for good visibility has been achieved, good apposition of bone with stable fixation has been achieved, and optimal alignment and position have been obtained (11). However, it might be preferred to retain the range of motion. Galli and Hyer (12) therefore have strongly advised, for active young and middle-age patients, selecting a treatment method that can minimize bony resection, provide symptomatic relief, and maintain or restore motion and strength.

Interposition of a soft tissue biologic spacer after thorough dorsal cheilectomy without resection of the proximal phalanx or with minimal resection (to a maximum of 25%; i.e., a modified Keller technique) has been reported as an alternative surgical strategy for addressing hallux rigidus (2,8,13–23). Different soft tissue spacers have been used, including the free gracilis tendon (15), a fascia lata graft (18), an allograft using human cadaver acellular regenerative tissue matrix (15,23), and, more recently, a cadaver meniscus allograft (21). Of these, a number of investigators (2,8,13,14,16,19,20,22) used the patient's own capsular tissue with or without extensor digitorum brevis tissue as a biologic spacer. Using a soft tissue biologic spacer, 4 of these reported a change in first MTP joint dorsiflexion, with an increase in all cases from preoperatively to postoperatively (2,8,13,14). Two studies (2,8) reported on a change in first MTP joint plantar flexion range of motion, again demonstrating an increase. One study (8) also reported the hallux abductus angle (HAA) (or hallux valgus angle) as an indicator of alignment, although it appears their measures were taken radiographically rather than clinically.

The use of autogenous soft tissue in the interpositional arthroplasty technique for end-stage hallux rigidus was the focus of a systematic review by Roukis (24). He concluded the research had demonstrated an improvement in patient outcomes and first MTP joint dorsiflexion, with few complications, including inconsequential

hallux malleus. Because only 2 studies met his rigorous inclusion criteria, it is apparent that additional research into the autogenous interpositional technique is required. Furthermore, descriptions of the methods used to assess first MTP joint range of motion in many studies cited earlier lacked detail (8,13,14,19,22). Just 3 reports used a goniometer to determine the range of motion (2,16,20); of these, 2 did not describe their technique when using the goniometer.

The primary aim of the present study, therefore, was to assess the effectiveness of autogenous capsular interpositional arthroplasty as a method of improving the range of motion of the first MTP joint in a prospective cohort study. A secondary aim was to assess the improvement in patients' perception of foot health, including their level of pain, using comparative data.

#### Patients and Methods

A prospective cohort study (pre- and post-test, no control group) of changes in the range of motion for 34 patients (44 feet) who had undergone autogenous capsular interpositional arthroplasty for hallux rigidus was performed. Both pre- and post-operative ranges of motion were measured using a long-arm goniometer and a standardized technique, thus, ensuring more reliable measures than clinical assessments obtained by visual estimation (25). These physical measures were supplemented at the follow-up visits by a patient self-assessment of various aspects of foot health using the validated Foot Health Satisfaction Questionnaire (FHSQ), administered by 1 of us (C.C.) combined with the physical measures. Again, this measure can be considered more reliable than previously used measures (26). In the absence of preoperative measures, the results from the FHSQ were compared with published results from an equivalent sample of patients with hallux rigidus who had presented for a surgical opinion, as a proxy control group, and with normative samples. They were compared also with the trends in patient and control group scores from other studies using the American Orthopaedic Foot and Ankle Society (AOFAS) hallux MTP-IP clinical rating system, focusing, in particular, on pain as the most comparable variable in the 2 sets of scales.

Of a total of 70 consecutive patients (92 feet) who had undergone an autogenous capsular interpositional arthroplasty procedure by a single surgeon (A.K.) from June 2006 to April 2008, 61 (87%) responded to a mailed request containing information about the study, sent from the surgeon's office, and were recruited for the present study at around 3 years postoperatively. These were patients who had presented with intolerable pain associated with hallux rigidus deformity and for whom conservative measures had failed to provide symptomatic relief. They were offered this procedure, along with any other options appropriate to their condition, which was determined by a combination of range of motion and radiographic and clinical examination criteria, as outlined by Coughlin and Shurnas (7) (Table 1). Of the 44 feet in the final cohort, 39 (89%) exhibited grade 2 (54.5%) or 3 (34.5%) first MTP joint changes according to this classification. Five feet (11%) exhibited grade 4 hallux rigidus. No patients exhibited grade 0 or 1 changes. Patient preference was also considered, and the patients had chosen this procedure instead of arthrodesis owing to its preservation of joint range of motion.

The patients were treated operatively at 1 of 3 private hospital facilities as a day case or overnight stay. At just  $>3$  years postoperatively, all 61 patients recruited for the study were asked by telephone to rate their general satisfaction with the procedure and its outcome using a 5-point scale, as currently experienced.

Of the initially recruited 61 patients, a final cohort of 34 patients (56% [49% of the original 70 patients treated]) was available at a mean of 3.75 (range 3.01 to 4.82) years postoperatively to undergo the final range of motion study and complete the FHSQ. Attrition resulted from both the interval to the follow-up point and patient accessibility, because many had spread over vast distances (rural, interstate, and overseas). The mean age of each patient group, whether in the final cohort or not, was 56 years at surgery. More critically, the 34 who participated in the full study did not differ from the remaining 36 of the full cohort of 70 patients with respect to their preoperative measures for either dorsiflexion or plantar flexion (dorsiflexion mean difference 0.02,  $t$  [90] = .10,  $p$  = .92; plantar flexion mean difference 1.4,  $t$  [89] = .66,  $p$  = .51). Thus, the sample available for the final range of motion study was representative of the original consecutively selected patient cohort. Furthermore, the satisfaction scores for the group measured at the follow-up point did not differ from those of the 27 patients

**Table 1**  
Classification of hallux rigidus according to Coughlin and Shurnas (7)

Grade	First MTP Joint Characteristics
0	DF of $40^\circ$ to $60^\circ$ (20% loss of normal motion), normal radiographic results, and no pain
1	DF of $30^\circ$ to $40^\circ$ , dorsal osteophytes, and minimal to no other joint changes
2	DF of $10^\circ$ to $30^\circ$ , mild flattening of the MTP joint, mild to moderate joint space narrowing, or sclerosis and osteophytes
3	DF of $<10^\circ$ , often $<10^\circ$ plantar flexion, severe radiographic changes with hypertrophied cysts or erosions or with irregular sesamoids, constant moderate to severe pain and pain at extremes of ROM
4	Stiff joint, radiographs showing loose bodies or osteochondral defects and pain throughout entire ROM

Abbreviations: DF, dorsiflexion; MTP, metatarsophalangeal; ROM, range of motion.

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