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First Metatarsophalangeal Joint Fusion With Use of Crossed Kirschner Wires and Intramedullary Steinmann Pin

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ABSTRACT

Primary arthrodesis is a thoroughly studied treatment option for end-stage pathologic entities of the first metatarsophalangeal joint. It is a commonly accepted treatment of many pathologic conditions, including hallux rigidus, severe hallux valgus, hallux varus, and other conditions pertaining to the first ray. Numerous fixation techniques are available for this procedure. Fixation constructs range from simple crossing Kirschner wires to plate and screw fixation or, even, external fixation. We propose a simple and cost-effective fixation technique using an intramedullary Steinmann pin with crossing Kirschner wires. Similar fixation techniques have been described; however, minimal data are available regarding this type of fixation. We present a series of 64 first metatarsophalangeal joint fusion procedures performed on 60 patients using our technique. A retrospective review with attention to several clinical and radiographic parameters was performed. The mean follow-up time was 27 (range 6 to 56) months. This technique resulted in a fusion rate of 90.6% (58 of 64 procedures). Despite the use of a large intramedullary Steinmann pin across the interphalangeal joint (IPJ), only 6 of the 64 procedures (9%) resulted in hallux IPJ degeneration. Of these, only 3 (4.6%) were symptomatic and required therapeutic measures. This suggests that violation of the IPJ with this form of fixation contributes minimally to postoperative pathologic features and is a viable alternative to traditional Association for Osteosynthesis/Association for the Study of Internal Fixation techniques.

Arthrodesis of the first metatarsophalangeal joint (MPJ) has been a well-documented procedure for a variety of MPJ deformities. Since Clutton (1) introduced the procedure in 1894, multiple surgical techniques and fixation methods have been described in published reports. Some of these options include Kirschner wires, monofilament wires, Steinmann pins, biodegradable rods, staples, and plates and screws in multiple configurations. Gregory et al (2) reported success rates for first MPJ fusion ranging from 77% to 100%. The success rate varies depending on the technique and fixation method used to achieve fusion. Sussman et al (3) used Kirschner wires and monofilament wires for fixation and achieved a fusion rate of 92%. Bishay et al (4) reported a fusion rate of 100% using 2 crossed Kirschner wires in ambulatory adolescents with spastic cerebral palsy. Smith et al (5) used five 0.062-mm Kirschner wires and achieved a 97% arthrodesis rate. Mann and Oats (6) reported a fusion rate of 95% using two 3/32-in. threaded Steinmann pins crossing both the interphalangeal joint (IPJ) and the MPJ. Choudhary et al (7) used 2 compression staples and achieved fusion in 96.7% of their patients. Hyer et al (8) reported their results in 2012 after performing first MPJ fusions using 4 different plate and screw constructs. They showed a fusion rate of 95% using a static plate, 86% using a static plate with a lag screw, 92% using a locking plate, and 96% using a locking plate with a lag screw (8).

Some investigators have attributed their low success rates to IPJ complications. In 1963, Moynihan (9) achieved a fusion rate of 87% using a peg-in-socket technique but considered patients with postoperative pain in the IPJ a failure. Fitzgerald (10) reported on 10 patients with symptomatic hallux IPJ arthritis and attributed this to decreased mobility at the IPJ and malposition of the hallux. Gregory et al (2) reported that 4 of 32 feet had postoperative complications

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after treating IPJ arthritis. Mann and Thompson (11) reported that 65% of their rheumatoid patients showed radiographic changes at the IPJ after first MPJ arthrodesis.

Other investigators have reported that IPJ complications do not seem to be a major concern after arthrodesis. In 1980, Mann and Oates (6) found "significant deterioration by x-ray examination" at the IPJ after crossing the joint with two 3/32-in. Steinmann pins. In their case series, 25 of 41 patients (60%) displayed these radiographic changes; however, only 4 were symptomatic at the examination (6). They also stated that degenerative changes at the IPJ "do not seem to be of any real clinical significance" (6). In 1996, Bouche and Adad (12) noted IPJ symptoms "have not been a problem" in their small case series. Smith et al (5) reported 1 of 34 feet had a problem with IPJ arthritis postoperatively.

The primary purpose of our study was to present a user-friendly, cost-effective technique for fusing the first MPJ. We were also interested in determining the incidence of posttraumatic arthritis at the IPJ of the hallux and how this affected patients' long-term outcomes. We hypothesized that although posttraumatic arthritis was likely to develop at the IPJ, it would be clinically insignificant. We undertook a retrospective review of the medical records of patients who had undergone first MPJ fusion using our proposed technique. We also believe this type of surgical construct will be a more cost-effective and extremely stable option where access to more modern plates and screws might be unavailable, such as rural locations or developing countries.

Patients and Methods

From June 1999 to April 2005, the senior author (L.G.K.) performed 64 first MPJ fusions using a crossed Kirschner wire configuration with an intramedullary Steinmann pin, crossing both the IPJ and MPJ of the hallux. The patients were from the senior author's (L.G.K.) private clinic and had a previous diagnosis of hallux rigidus deformity or severe hallux valgus deformity (Figs. 1 and 2). All patients who underwent arthrodesis of the first MPJ with an intramedullary Steinmann pin and crossing Kirschner wire construct were included in the present study. The patient's medical records were retrospectively reviewed for the time to fusion clinically and radiographically and for development of symptoms of IPJ arthritis. In our study, no motion at the first MPJ fusion site and clinical evidence of a rigid construct equated to clinical fusion. In contrast, any movement at the fusion site was classified as nonunion. The interval to clinical fusion was determined by pain-free dorsiflexion/plantarflexion stress testing to the first MPJ. The degree of IPJ range of motion and pain was compared with those for the patient's contralateral, nonoperative side.

The radiographs were reviewed by the senior author and an associate author (L.G.K., R.P.) to evaluate for radiographic union and the presence of hallux IPJ osteoarthritis. Radiographic union was determined when complete consolidation of the joint on all 3 radiographic views was evident (i.e., no gaps at the fusion site and complete trabeculation patterns across the fusion site). The radiographs were reviewed preoperatively, postoperatively, and at the final follow-up examination for all patients. Any radiographs failing to meet these criteria were considered to show nonunion. The interval to radiographic union was the time required to achieve bony consolidation seen on radiographic examination. The development of IPJ arthritis was defined as asymmetric joint space narrowing, the loss of any obvious preoperatively normal subchondral plate, abnormal osteophyte formation, sclerosis at the IPJ surgical site, and/or improper joint alignment.

The procedure was performed on 47 (73.4%) females and 17 (26.6%) males. Two of the females had insulin-dependent diabetes. The average patient age was 63.9 (range 16 to 83) years. Nine patients had a social history that included tobacco smoking, with five active smokers and four previous smokers. The average follow-up time was 27 (range 6 to 56) months. The senior author (L.G.K.) performed all clinical and radiographic evaluations, and the resident physicians (L.B., S.T.C.) involved in the study were responsible for data collection and interpretation.

Operative Technique

All procedures were performed by the senior author (L.G.K.) with the patient under general anesthesia or intravenous sedation with local anesthesia. A pneumatic ankle tourniquet was used for hemostasis in all patients, except for one. All procedures were performed with the patient in the supine position. A standard dorsomedial incision over the first MPJ was used for surgical access. Careful dissection ensured preservation of the anatomic layers. The joint capsule around the first MPJ was exposed, and the extensor hallucis longus tendon was protected and retracted laterally. A lateral soft tissue release was not performed in any of the cases, even in the presence of severe hallux valgus deformity. A linear capsulotomy was used medial to the long extensor tendon to expose the metatarsal head and proximal phalanx base. Care was taken to minimize local capsular dissection and periosteal stripping. The articular surfaces and subchondral bone at the first MPJ were removed by manual curettage or planar resection or using a conical reamer system. Most cases were performed using planar resection. The sagittal plane position of the hallux was 2 to 3 mm off a simulated weightbearing surface (the back of a surgical basin). The hallux was also placed into a rectus (neutral) position in the frontal plane.

Fig. 1. Preoperative radiographic evaluation showing joint space narrowing and cystic changes in the first metatarsal head.

Primary fixation began with a 1/8-in. Steinmann pin passed through the base of the proximal phalanx across the hallux IPJ, exiting the tip of the hallux. The Steinmann pin was then returned back across the fusion site into the medullary canal of the first metatarsal. After confirmation of satisfactory hallux positioning and Steinmann pin placement using fluoroscopic examination, two 0.062-in. Kirschner wires were placed across the arthrodesis site in a crossed fashion. The first Kirschner wire was oriented from distally and medially to proximally and laterally. The second Kirschner wire was positioned opposite the first, oriented from proximally and medially to distally and laterally. These wires were then cut, bent, and buried into the bone (Fig. 3). Before closure, the fusion site was stressed in all planes and confirmed to be stable. The Steinmann pin was cut short, leaving approximately 4 to 5 mm protruding from the tip of the hallux. No bone graft was used for any of the procedures. The capsule and

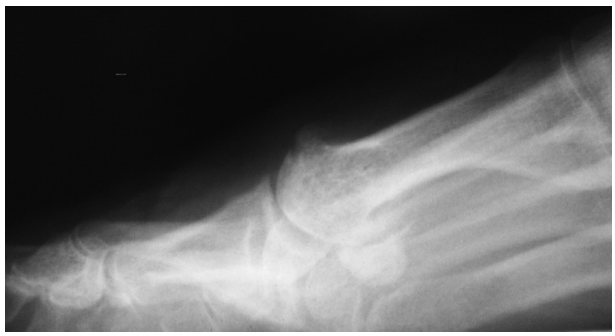

Fig. 2. Lateral view radiograph demonstrating dorsal spurring and joint space narrowing.