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Foot Ankle Int 2004 25: 256
DOI: 10.1177/107110070402500411

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What is This?
Arthrodesis of the Toe Joints With an Intramedullary Cannulated Screw for Correction of Hammertoe Deformity

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ABSTRACT

Twenty-four patients (37 feet, 51 toes) affected by hammertoe deformity of the lesser toes and treated surgically by arthrodesis of the proximal interphalangeal joint, stabilized with an intramedullary titanium cannulated screw, were reviewed 1–4 years after the operation. At follow-up, the arthrodesis was fused in 48 toes; three toes showed an asymptomatic radiographic nonunion, and in one of them the screw was broken. In seven toes, the cannulated screw was removed because of persistent pain at the tip of the toe where the head of the screw was located. In one case only, there was a late infection, with toe malalignment. All the patients were able to use street shoes 2 weeks after surgery. The average AOFAS score at follow-up was 86.54 points. Compared to the conventional temporary stabilization with an intramedullary Kirschner wire, the stabilization with a cannulated screw decreases the risk of infection, of radiographic nonunion, and of mallet toe deformity.

Key Words: Cannulated Screw; Digital Arthrodesis; Hammertoe; Hammertoe Deformity; Lesser Toe Deformities; Proximal Interphalangeal Joint Arthrodesis

INTRODUCTION

Hammertoe deformity due to flexion of the proximal interphalangeal (PIP) joint of the toes is one of the most common foot deformities. The metatarsophalangeal (MTP) joint is usually hyperextended, while the distal interphalangeal (DIP) joint may be extended or in a neutral position.

The second toe is most frequently affected, but the other small toes may also be involved. Patients with this deformity often complain of significant pain and they seek treatment of the deformed toe. When conservative treatment fails, many surgical options can be proposed, but the ideal technique has not yet been found.1,5–8,11,12,16,19 In the present study, 51 PIP joint fusions with an intramedullary cannulated screw fixation for the treatment of hammertoe deformity were reviewed in 24 patients with 37 affected feet. To the best of our knowledge, this technique of internal fixation in arthrodesis of the smaller toe joint has never been previously described.

MATERIALS AND METHODS

One hundred forty-four patients affected by a hammertoe deformity of the smaller toes were surgically treated by a PIP joint arthrodesis from 1998 to 2001 at the Department of Orthopaedic Surgery of the University of Rome “Tor Vergata.” The authors proposed stabilizing the arthrodesis with an intramedullary cannulated screw to all patients, but only 24 patients (37 feet, 51 toes) accepted this type of operation. All five authors were involved in this surgical treatment. In the remaining 120 patients, the arthrodesis was stabilized with a Kirschner wire, which was removed 4 weeks after the operation. Of the 24 patients, six were male and 18 were female. Both feet were affected in 13 patients, whereas the hammertoe deformity was unilateral in 11. A total of 51 toes were operated on: 37 second toes, eight third toes, and six fourth toes. The hammertoe deformity was associated with hallux valgus in 14 feet, whereas the hammertoe deformity was unilateral in 11. The age of the patients at the time of operation ranged from 16 to 72 years, with an average of 48 years. Before surgery, all patients reported significant
pain at the deformed toe, with limitation of recreational and/or daily activities. In all cases, the contracture of the PIP joint was either partially reducible or unreducible. Nine patients needed special shoes to ambulate.

All the operations were performed using either an ankle block for anesthesia and a tourniquet at the level of the ankle for hemostasis or a toe block with a rubber loop for hemostasis. The ankle block was used in patients with multiple toe deformity and in those who had simultaneous correction of the hallux deformity.

The PIP joint of the affected toe was exposed by a transverse incision, the middle phalanx was denuded of the articular cartilage, and the head of the proximal phalanx was resected. The bones were then transfixed with a thin wire, some of which was left protruding from the tip of the toe. The wire was positioned as a guide into the diaphyseal medullary canal with the aid of an image intensifier, and internal fixation of the end-to-end digital arthrodesis with a 3.0-mm titanium cannulated screw was performed. The screw length was selected using the indicator, which is an integral part of the titanium cannulated screw instrumentation. Hallux valgus deformity was corrected at the same time in 10 feet by the Keller or chevron osteotomy.

Both mallet deformities of the hallux were surgically treated by interphalangeal arthrodesis stabilized with a cannulated screw. In 11 toes, in which we observed an evident elevation of the operated toe at the end of the surgical procedure, we performed a lengthening of the extensor digitorum longus of the affected toe.

All the patients who had hammertoe correction as the only surgical procedure started to walk on crutches immediately after surgery with heel weightbearing. Full weightbearing without crutches was awarded at an average of 4 days after surgery. All these patients were able to walk with street shoes 2 weeks after surgery. The patients who had an associated surgical procedure for correction of hallux deformity started to walk 24 hours after surgery with heel weightbearing, and 2 weeks after surgery, they were allowed to have full weightbearing. This group of patients were able to walk with street shoes an average of 1 month after surgery.

The mean length of follow-up was 2.6 years (range, 1–4 years). At follow-up, all the patients had both a physical and a radiographic examination; from a clinical point of view, the patients were evaluated according to the Clinical Rating System for lesser toes of the American Orthopaedic Foot and Ankle Society (AOFAS) (100 points total). From a radiographic point of view, we evaluated the presence of the PIP joint fusion and the toe alignment. Radiographic alignment was considered good when a 0°–10° medial-lateral or dorsal-plantar angulation was present and poor when the axial deviation of the toe was greater than 20°.

**RESULTS**

Five patients (seven toes) had a reoperation to remove the cannulated screw at an average of 10 months after surgery. The operation was performed with a digit block anesthesia. In one case, the titanium cannulated screw had been improperly applied with the thread corresponding to the site of arthrodesis, and it broke at the junction between the smooth and the threaded part. Only the smooth part of the screw was removed (Fig. 1). In another case, the screw was removed because of a late infection which healed after screw removal, but a toe malalignment developed. In the remaining five toes, the screw was removed because of persistent pain at the tip of the toe caused by the head of the screw. In all cases, pain was relieved after screw removal (Fig. 2).

On the basis of the AOFAS System, in our group of patients the score at follow-up ranged from 70 to 90, with an average of 86.54 points.

Nineteen patients had no pain at follow-up (Fig. 3), whereas five had occasional mild pain in the operated toe. Seven patients reported limitation of recreational activities. Five patients required an insert in their shoes for a symptomatic callus under the head of the second and the third metatarsus, but all these patients had had an associated surgical correction for hallux valgus. In two cases, we had performed a chevron procedure for correction of hallux valgus deformity; in three cases, we performed a Keller procedure. Two patients presented an instability of the MTP joint. Only one patient had a malalignment of the operated toe.

Twenty patients were defined as unqualifiedly satisfied with the treatment, whereas four were described as satisfied with reservation; however, all patients who were followed up considered their hammertoe surgery successful in eliminating their chief complaint. Of the four patients who were satisfied with reservations, in two cases we had corrected only one hammertoe deformity, whereas in the other two we had also performed the correction of an associated hallux valgus, one by a chevron and the other one by a Keller procedure. The reasons for satisfaction with reservations were in one case a toe malalignment which developed after a postsurgical infection, in one case incomplete pain relief (presence of occasional mild pain in the operated toe), and in two cases the presence of a toe which was too straight.

At follow-up, a radiographic fusion of the PIP joint appeared in all toes but three in which a nonunion resulted. In one case, a joint infection developed, while in another case the screw broke.
In the seven toes in which the screw had been removed, the DIP joint showed narrowing of the joint space but no arthodesis. At physical examination, the DIP joint was very stiff and no mallet toe deformity had developed. None of these patients had pain in the operated toe or expressed dissatisfaction concerning stiffness of the PIP and DIP joints.

DISCUSSION

Hammertoe deformity is a frequent and very troublesome foot deformity which develops insidiously with increasing age. The peak incidence ranges between the 4th and the 7th decades of life, and frequently the deformity is associated with hallux valgus.

PIP joint arthrodesis, first described by Higgs in 1931,8 represents the gold standard of treatment of the deformity. The simplest way of fusing the PIP joint is to remove the joint cartilage of the middle phalanx, combined with partial proximal phalangeal condylar resection to straighten the toe and to hold together the bony surfaces until they fuse with a Kirschner wire, some of which is left protruding from the tip of the toe.18 This surgical technique presents several disadvantages:
Fig. 2: A, Postoperative radiograph of a 63-year-old patient affected by hammertoe deformity of the third toe treated by arthrodesis of the PIP joint stabilized with a cannulated screw. B, X-rays taken 4 years after surgery showed a fusion of the PIP joint in the right position. The screw had been removed 1 year after surgery.

1) the Kirschner wire should not be removed for 4 weeks until the joint fuses; 2) it often becomes loose after a couple of weeks; 3) it can slide off easily during wound medication; 4) it can cause severe pain if the affected toe is stubbed; 5) it is difficult to protect, and often it is necessary to use a Zimmer plate for protection; and 6) the patient is not allowed to quickly resume wearing street shoes.

Our technique of internal fixation of the PIP joint with an intramedullary cannulated screw eliminates all the above-mentioned problems; moreover, all our patients with isolated hammertoe deformities were able to walk with street shoes 2 weeks after surgery.

Another significant problem with the classic operation is the high risk of infection reported by several authors. In 1987, Reese et al. reported as much as 18% of pin-tract infections in 156 digital arthrodeses fixed by Kirschner wires. In our group of patients (51 digits), we observed only one infection of the third digit which was resolved after removal of the cannulated screw and 20 days of antibiotic therapy.

The average incidence of nonunion following PIP joint arthrodesis, fixed by an intramedullary Kirschner wire, is about 20%. In our cases, radiographic signs of nonunion were present only in three toes (6%), but in two of them there was an evident cause: screw breakage and infection. However, in all cases in which a nonunion was present, we observed a fibrous union of the PIP joint that was sufficiently strong to maintain the correction. Coughlin et al. reported the same rate of satisfaction in patients with bone fusion of the PIP joint versus patients with fibrous union. Although from a clinical point of view there seems to be no significant difference between bone fusion and fibrous union of the PIP joint, we believe that bone fusion certainly avoids the risk of a painful recurrence of the deformity. Moreover, to the best of our knowledge, no very long-term follow-up studies have been published on the outcome of fibrous union of the PIP joint following surgical correction of a hammertoe deformity.

Malalignment and incomplete pain relief are the major factors associated with an unsuccessful result, which is reported by many authors at a rate of 5–50%. In our subjects, clinical and radiographic alignment of the toes was rated as good in all cases but one, and incomplete pain relief was reported only in five toes (10%). We considered a toe to have a good radiographic alignment when the axis of the proximal and the middle phalanges in a medial-lateral and dorsal-plantar plane measured less than 10°.
Fig. 3: A and B, Radiographs taken at 3 years after surgery of a 25-year-old patient successfully treated by arthrodesis of the hallux and the PIP joint of the second and third toes. The patient was pain free, although the screws were still present.

Several authors have reported a mallet toe deformity of the DIP joint, ranging from 8% to 44%. We never observed a mallet toe deformity in our patients. In most of the operated toes the screw was still present without any complaint, but even in the five patients (seven toes) in whom the screw had been removed, we observed a good alignment of the DIP joint because the joint was very stiff, probably because of a fibrous union. Further studies will be necessary to evaluate the late outcome of this joint in those cases in which the screw was removed. Lehman and Smith reported, in the reasons for satisfaction with reservations and for dissatisfaction, the presence of a toe that was too straight or that did not touch the ground in seven and in four cases, respectively. In our group of patients, at follow-up only two patients expressed satisfaction with reservations because of the presence of a toe that was too straight. We never observed an elevation of the tip of the operated toe which did not touch the ground. We attributed the absence of this complication in our series to the lengthening of the extensor digitorum longus, performed in all cases in which an evident elevation of the operated toe was present at the end of the surgical procedure. No patient was dissatisfied on account of stiffness of the DIP joint.

Seven screws had been removed because of pain at the tip of the toe caused by the head of the screw. We believe that a new screw either with a very low head profile or without a head could resolve this problem. In one case, we observed a breakage of the screw 4 months after the operation. In our vision, this complication was the consequence of an improper application of the screw because the thread of the screw corresponded to the site of arthrodesis.

In conclusion, we think that PIP joint arthrodesis with an intramedullary cannulated screw fixation for hammertoe deformity correction is a new technique that provides a stable fixation of the deformity, with a high success rate at an average of 2.6 years after surgery. Although this surgical procedure sacrifices the DIP joint to treat the PIP joint, it significantly reduces the risk of residual toe angulation, the risk of a mallet toe deformity, and the risk of nonunion of the PIP joint, and, finally, reduces postoperative shoe restrictions. The disadvantages of this technique are the risk of a second operation related to persistent pain at the tip of the toe, caused by the head of the screw, and the breakage of the screw. Long-term follow-up studies will be necessary to know the final outcome of the DIP joint in the cases reoperated for removal of the screw.
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