Background: Intramedullary screw fixation of fractures of the proximal fifth metatarsal bone may not be satisfactory in comminuted fractures or when the lateral metatarsal bowing has to be restored. We report our experience with plate fixation in these circumstances.

Methods: Between June 1, 2009, and January 31, 2013, 13 patients who had comminuted fracture or nonunion of fracture of the proximal fifth metatarsal bone underwent plate fixation. Study patients were followed up for a mean of 500 days (range, 51–1238 days). Their medical records and radiographs were retrospectively reviewed for demographic and operative data and radiologic evidence of fracture healing. At their most recent follow-up, patients were evaluated for pain levels with a visual analog scale, for foot function with the Foot and Ankle Disability Index, and for quality of life with the 12-Item Short-Form Health Survey.

Results: Fracture union was evident in 12 patients after a mean of 56.8 days (range, 30–92 days). There was only one major complication of sural nerve neuroma and reflex sympathetic dystrophy. Four patients required reoperation for plate removal. Plate fixation of proximal fifth metatarsal comminuted fractures is associated with high union rates, relief of pain, and patient satisfaction. However, plate removal for various reasons was required in approximately one-third of the study patients. This high revision rate might be avoided by better selection of patients and meticulous intraoperative identification and preservation of the sural nerve.

Conclusions: We recommend reserving plate fixation for proximal fifth metatarsal fractures for cases of laterally bowed fifth metatarsal or comminuted fractures. (J Am Podiatr Med Assoc 105(5): 389-394, 2015)
can prove challenging when considering the small fragments to fixate. For these specific indications, foot and ankle surgeons at Tel Aviv Sourasky Medical Center (Tel Aviv, Israel) advocate the use of plate fixation.

Plate fixation of fractures of the proximal fifth metatarsal has never been described in the orthopedic literature. We present a series of 13 cases of proximal metaphyseal fractures of the fifth metatarsal that were treated with open reduction and internal fixation using a Compact Foot set (Synthes Inc, West Chester, Pennsylvania) and 1.5- or 2-mm plate and screws.

Methods

Patients

After obtaining institutional ethical board approval to conduct this study, we reviewed the electronic medical records of 13 patients who underwent plate fixation for proximal fifth metatarsal fractures. All of the procedures were performed by two senior, fellowship-trained, foot and ankle orthopedic surgeons (S.E. and R.K.) between June 1, 2009, and January 31, 2013. The patients’ demographic and operative information was obtained by manually reviewing their files. Data on age, sex, fracture details (type and side), operative data (operation date, time from fracture to surgery, type of fixation, and hardware), and operative outcomes (time to fracture union, nonunion, or malunion; postoperative complications; and revision surgery for any cause) were collected for all of the patients. Preoperative radiographs were reviewed to ascertain the fracture type, and postoperative radiographs were reviewed to ascertain the type of fixation that had been used. Finally, signs of fracture union on postoperative radiographs were recorded.

A telephone survey was conducted to complete and verify the demographic and operative data. All of the patients who sustained a proximal fifth metatarsal fracture and underwent plate fixation surgery were eligible for study inclusion. The sole exclusion criterion was the inability to understand the items on the questionnaires for any reason. Suitable patients who consented to participate in the survey were asked to respond to questionnaires on quality of life, pain, foot function, and symptoms. Those questionnaires included a visual analog scale (VAS) for pain (scale 0–10), the 12-Item Short-Form Health Survey (SF-12) for quality-of-life assessment,7 and the Foot and Ankle Disability Index (FADI).8

Outcome Measures

The primary outcome measure was time to fracture healing. Secondary outcomes were the rate of revision surgery, postoperative complications, pain levels, foot function, and quality of life.

Operative Technique

General anesthesia was used in all of the patients. The patients were placed supine on the operating table with a sandbag under the involved hip and table tilted to expose the lateral aspect of the foot. A thigh tourniquet was used. A 4- to 5-cm incision was made, beginning 2 cm proximal to the fifth metatarsal tuberosity and extending distally along the metatarsal shaft. Care was taken to avoid the sural nerve branches by approaching the metatarsal inferior to the peroneus brevis tendon through the abductor digiti quinti aponeurosis. Reduction was achieved with a bone reduction clamp, and the position was held with a temporary Kirschner wire. When the indication for surgery was fracture nonunion, the bone edges were prepared with drilling and debridement. A bone graft was harvested from the ipsilateral calcaneus and was placed at the fracture site in cases

Figure 1. Anteroposterior radiograph of an acute fifth metatarsal fracture after intramedullary screw fixation. This case illustrates the poor accommodation of the straight screw to the laterally curved fifth metatarsal and the screw distortion that followed.
of nonunion with sclerotic fracture edges. Fixation involved application of a 1.5-mm plate for a tuberosity fracture and a 2-mm plate for a metaphyseal/diaphyseal fracture (Compact Foot set) (Fig. 2). When indicated, we used 5-mm bone anchors (FASTIN; Depuy Synthes, West Chester, Pennsylvania) for a combination of tuberosity avulsion and intra-articular displaced fractures.

Postoperative Management

Immediately after surgery, the foot was placed in a posterior splint for 14 days, at which point the splint and sutures were removed. The patient was then put in a below-the-knee cast for another month, followed by a walking boot for another month.

Patients were kept nonweightbearing for the first 6 postoperative weeks but were encouraged to

Figure 2. A, Preoperative radiograph demonstrating nonunion of fracture of the proximal fifth metatarsal. B and C, Radiographs at postoperative days 1 (B) and 45 (C). D, Radiograph demonstrating fracture union 8 months after plate removal.
move their ankle to full ranges of motion. At 6 weeks, a progressive weightbearing protocol and a physical therapy protocol consisting of gait, balance, and proprioceptive training with full weight-bearing were initiated. Standard anteroposterior, lateral, and oblique radiographs were obtained at each follow-up clinic visit.

Results

Patient Demographic Data

Thirteen patients underwent plate fixation for proximal fifth metatarsal fracture and met the inclusion criteria during the study period. Their mean age at the time of surgery was 32.4 years (range, 14–63.4 years), and the group comprised seven men and six women. The mean follow-up time was 500 days (range, 51–1238 days). The primary proximal fifth metatarsal fracture was of traumatic origin in all of the patients but one, in whom it was the result of a stress fracture due to pes cavus.

There were two major operative indications, other than the patient with a stress fracture. One was nonunion of the proximal fifth metatarsal fracture (seven patients). Nonunion was defined as no clinical or radiographic signs of fracture union 6 months after the primary insult. In one patient, it was decided to perform the surgery 3 months after the fracture had been sustained because there were no signs of fracture healing and its radiographic appearance indicated that it was not likely to heal with conservative measures alone. The other operative indication was a comminuted fracture of the proximal fifth metatarsal (five patients). It was an isolated injury in four patients, and the fifth patient had multiple fractures in the foot, including nondisplaced fractures of the base of the second and third metatarsals and of the lateral and medial cuneiform bones, which were not operatively fixed.

Operative Outcomes

There were radiographic signs of fracture healing in 12 of the 13 study patients (92%). The mean time to signs of radiographic fracture healing was 56.8 days (range, 30–92 days). One patient did not show radiographic signs of fracture healing and apparently required another operation, although it was evident intraoperatively that the fracture had actually healed. His plate was subsequently removed, and a calcaneal bone graft was applied to the fracture site. Signs of radiographic union appeared 53 days after the reoperation.

Four of the 13 patients (31%) had another surgery for hardware removal, and the mean time to this procedure was 415 days (range, 213–724 days). Revision surgery was not dependent upon indication for surgery. One patient developed a neuroma of the surgical scar and eventually required removal of the hardware and resection and burial of the sural nerve. These measures did not improve his pain, and he was subsequently diagnosed as having complex regional pain syndrome. One patient underwent another operation owing to tenderness around the hardware and sural nerve sensory loss; she reported improvement in pain and sensation after the hardware had been removed. Another patient, who had additional tarsal and metatarsal fractures, developed an abnormal gait pattern, and it could not be determined whether the hardware we had placed or the other fractures were responsible. We removed the hardware when the fracture had completely healed, but we could not evaluate the subsequent effect on gait because he was lost to follow-up. To date, none of the patients have had a refracture or a postoperative infection.

Foot Function and Quality-of-Life Questionnaires

Eleven of the 13 patients were contacted by telephone or while visiting the clinic, and they all responded to the questionnaires (the VAS pain score, the FADI, the SF-12, and the quality-of-life measurement). The group’s mean VAS score was 3 (range, 0–10), mean FADI score was 79.9 (range, 35–100), mean SF-12 mental component summary score was 51.7 (range, 26–69), and mean SF-12 physical component summary score was 46.1 (range, 31–57). One patient reported disabling knee pain unrelated to the fifth metatarsal fracture, which might account for the discrepancy between her poor SF-12 scores and good VAS and FADI scores.

Discussion

Fractures of the fifth metatarsals compose 70% of all metatarsal fractures, 80% of which are proximal fractures. Since first being described in 1902 by Sir Robert Jones, it became evident that some of these fracture patterns have relatively poor healing capacity. Several studies reported poor results when treating proximal fifth metatarsal fractures with conservative measures. One cohort study reported that casting achieved union in only 72%
of the patients in a mean of 21.2 weeks,\textsuperscript{11} and another report showed a 50\% union rate at 12 weeks.\textsuperscript{12} The main complication of casting is nonunion, but there are other sequelae that need to be considered, such as refracture, joint stiffness, and muscular atrophy.\textsuperscript{3,13}

Operative indications for fixation of proximal fifth metatarsal fractures are a matter of debate. Den Hartog\textsuperscript{2} summarized the current orthopedic literature and arrived at the recommendation that acute fractures in athletes and other high-demand individuals should be fixed operatively because this subpopulation shows higher rates of nonunion.\textsuperscript{14} Delayed union and stress fractures in nonathletes are also an indication for surgery. Furthermore, an informed patient who prefers surgery to the risk of nonunion should also be considered for the operation.

This study is the first to report the results of plate fixation for proximal fifth metatarsal fractures. We chose to use this novel fixation technique because of its potential advantages, mostly its superiority in the ability to achieve anatomical fracture reduction in comminuted fractures. According to Arbeitsgemeinschaft für Osteosynthesefragen (AO) principles, anatomical reduction is invaluable when fixing an intra-articular fracture and might decrease the risk of arthritis in the future. Anatomical reduction and stable plate fixation can hypothetically improve the chances of fracture healing owing to the decrease in the micromotion between the fragments. The plate can be contoured to the shape of the fifth metatarsal, in contrast to intramedullary fixation, and thus accommodate for its lateral bowing and prevent the medial cortex violation reported with an intramedullary screw.\textsuperscript{5,6} Medial cortex violation might be the etiology for postoperative fracture refracture, a common complication of intramedullary screw fixation.\textsuperscript{4} One of the potential disadvantages of plating over standard intramedullary fixation is stripping the bone of its periosteum, thus jeopardizing the proximal fifth metatarsal’s already tenuous vascular supply.

The present findings suggest that plate fixation is a safe and efficient technique for yielding good union rates and avoiding complications. Twelve of the 13 patients (92\%) achieved fracture union in a mean of 56.8 days. There was only one major complication of neurona formation and complex regional pain syndrome and one minor complication of sural nerve sensory loss. Four of the 13 patients (31\%) required reoperation for plate removal.

The study participants reported relatively high pain levels (3 on the VAS scale) and a moderate foot function score (79.9 on the FADI). Their mean SF-12 quality-of-life measures were 51.7 for the mental component and 46.1 for the physical component. The literature search yielded one report on SF-12 quality-of-life measures after screw fixation for a proximal fifth metatarsal fracture: the reported results were better than ours (54.6 and 58.4 on the SF-12 physical and mental component summaries, respectively).\textsuperscript{15} However, the latter study was performed solely on athletes and not on people in the general population, who composed our study group.

The most commonly reported operative fixation method is intramedullary screw fixation, and it is considered the standard of operative care for proximal fifth metatarsal fractures. Clapper et al\textsuperscript{11} reported a 100\% union rate with this technique. Mologne et al\textsuperscript{16} performed a clinical trial that demonstrated superiority of this fixation method over conservative treatment, both in terms of return to sports and in pain control. Several studies have shown that this technique has a rapid time to union (ie, 4.5–7.6 weeks).\textsuperscript{17} However, most of the available studies had been performed on athletes. A more recent study by DeVries et al\textsuperscript{18} on a nonathlete population showed longer union times, which were more comparable with those observed in the plating technique (ie, radiographic union at 11.7 weeks for titanium screws and 13.4 weeks for stainless steel screws). In addition, plate fixation was not associated with common postoperative complications after screw fixation, such as delayed union, nonunion, and refracture.\textsuperscript{10} Sural nerve injury, a common complication of screw fixation, occurred in two of the 13 patients in our cohort as well.

Plating of the fifth metatarsal is associated with several adverse effects, the most common of which is sural nerve injury, which occurred in two of 13 patients. This is a common complication in all lateral foot operations, and especially in fixation of the fifth metatarsal. In a cadaver study, Donley et al\textsuperscript{20} demonstrated the proximity of the intramedullary screw insertion site to the sural nerve branch (2–3 mm). Four of the present patients (31\%) needed plate removal due to sural nerve injury or local irritation. This is a relatively high number compared with recent reports of a reoperation rate of approximately 10\%.\textsuperscript{18}

We believe that plate fixation can be best used for proximal, intra-articular, displaced, and multifragmentary (3–4 parts) fractures. Achieving anatomical reduction and stable fixation of these patterns of fracture is challenging using the traditional intramedullary screws or intrafragmentery Kirschner
wire fixation. Plate fixation, similar to all surgical techniques, demands good patient selection and is best suitable for compliant, physically active patients with no secondary gain issues.

We are aware that the retrospective nature of this study is a limitation. It is also a relatively small case series with no control group. In a sample as small as ours, the mean scores can be skewed by one patient. This was the case with one patient who had poor outcomes in all parameters for reasons that were not directly related to the operative procedure. In addition, functional scores are an imperfect tool to measure the effect of an operative procedure. This was illustrated by a patient who had low SF-12 scores that were also not attributed to her operative procedure.

Conclusions

This study is the first to report the outcomes of plate fixation for proximal fifth metatarsal fractures. Plate fixation is a simple operative technique that provides anatomical fracture reduction. The primary results showed good fracture union rates and times to union that are comparable with standard techniques. Sural nerve injury is the most common complication associated with this technique. Notably, complications that are commonly associated with other operative techniques, such as infection and refracture, did not occur with plate fixation. The reoperation rate in this group was 31%, which is substantially higher than the rates for other techniques. We recommend preserving plate fixation for proximal fifth metatarsal fractures for cases of laterally bowed fifth metatarsal or comminuted fractures.

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References