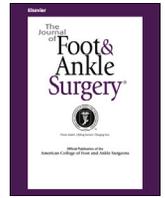




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## Immediate Weightbearing After First Metatarsophalangeal Joint Arthrodesis With Screw and Locking Plate Fixation: A Short-Term Review



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## ABSTRACT

Historically, the postoperative protocol for patients undergoing first metatarsophalangeal joint arthrodesis has included 6 weeks of non-weightbearing, followed by protected weightbearing in a below-the-knee cast boot or postoperative shoe. This prolonged period of non-weightbearing predisposes the patient to disuse atrophy, osteopenia, deep vein thrombosis risk, and, overall, a prolonged time to recovery. The present study reports a retrospective review of a patient cohort that underwent first metatarsophalangeal joint fusion with immediate full weightbearing postoperatively. Thirty consecutive first metatarsophalangeal joint arthrodeses were performed during the study period. Five patients were excluded secondary to insufficient postoperative follow-up data or a lack of adequate radiographic evaluation at regular postoperative intervals. Conical reamers were used for joint preparation. Internal fixation, consisting of a single cannulated interfragmentary compression screw and a dorsal locking plate, was used in all patients. The results showed that patients achieved clinical healing at an average of 5.92 weeks and showed radiographic fusion at an average of 6.83 weeks. The patients in the present study had an overall union rate of 96%. Complications included 1 nonunion, 1 superficial wound infection, 1 wound dehiscence, 1 case of symptomatic hardware, and 2 patients with symptomatic hallux interphalangeal joint arthralgia. The mean visual analog pain score preoperatively was 6.64 (range 4 to 8) and postoperatively was 0.6 (range 0 to 4). In conclusion, we found that immediate full weightbearing after first metatarsophalangeal joint fusion in the context of interfragmentary compression and locked plating techniques is a safe, predictable postoperative protocol that allows for a successful fusion interval and an early return to regular activity.

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First metatarsophalangeal joint (MTPJ) arthrodesis is a well-established and well-documented procedure that allows for treatment of numerous first ray maladies, including degenerative joint disease associated with trauma, end-stage hallux rigidus, severe hallux abductovalgus, geriatric hallux abductovalgus, hallux varus, septic MTPJ, and rheumatoid arthritis (1,2). Although numerous reports have directed various postoperative protocols, the historical regimen has included 6 weeks of non-weightbearing for the operative extremity (1–15). Well-documented risks, however, are associated with extended periods of immobilization, including disuse muscular and

osseous atrophy, fall risk, an extended time to rehabilitation, and the risk of deep vein thrombosis (5). These risks have made the procedure traditionally more difficult for patients and surgeons to accept.

The first MTPJ fusion rates with immediate weightbearing reported in preceding studies were consistent with previous studies in which patients were kept non-weightbearing for a specified number of weeks by the provider (1,2,4–7,11–15). Dayton and McCall (2) reported a 100% fusion rate after allowing their patients to immediately bear full weight on their heel or lateral foot in a surgical shoe. Taylor et al (4) allowed their patient cohort to be fully weightbearing immediately postoperatively in a surgical shoe, with a 96% union rate. Storts and Camasta (16) evaluated union after first MTPJ arthrodesis with immediate propulsive weightbearing in a surgical shoe with buried Kirschner wire fixation versus crossing screw fixation. No statistically significant difference was found between buried Kirschner wire fixation (97.9% union rate) and crossing screw fixation (95.9%)

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with immediate weightbearing in a surgical shoe (16). Lampe et al (6) found that early weightbearing resulted in a fusion rate equal to that for those kept non-weightbearing for 4 weeks.

The construct of internal fixation has also varied widely in reported studies, ranging from Kirschner wires to locking plates with crossed or parallel screws (1–15). In 2008, Berlet et al (1) noted that rigid internal fixation is essential for arthrodesis to help increase the rate of bony union and maintain the desired position. They also noted a lack of consensus in the reported data regarding the optimal technique for joint preparation, positioning, or type of fixation (1). Hyer et al (17) studied static plating with and without lag screw fixation and locked plating with and without lag screw fixation and found no difference in union after first MTPJ arthrodesis. Our technique used conical reamers and joint fenestration for preparation, with a subsequent interfragmentary screw and dorsal locking plate providing stable internal fixation.

The purpose of the present retrospective study was to evaluate the interval to clinical and radiographic fusion of patients who had undergone first MTPJ arthrodesis with a single cannulated interfragmentary screw and dorsal locking plate and subsequent immediate full weightbearing postoperatively.

#### Patients and Methods

The medical and radiographic records were reviewed for 30 consecutive patients who had undergone first MTPJ arthrodesis from December 2009 to February 2012. Given the retrospective nature and nonspecific data collected, the present study was exempt from institutional review board approval. All procedures were performed by the senior author (M.D.S.) for a variety of great toe maladies, including hallux abductovalgus, hallux rigidus, severe hallux abductovalgus with concomitant hallux rigidus, and rheumatoid arthritis. All patients who had undergone first MTPJ fusion within the study period were selected for inclusion in the cohort. Patients with <8 weeks of follow-up data or no postoperative radiographs from weeks 2 to 12 after surgery available were excluded from the cohort, as were patients who had undergone simultaneous procedures that required a non-weightbearing status. The initial review of the data identified 30 patients who had undergone first MTPJ arthrodesis. After applying our exclusion criteria, 25 patients with 25 fusions remained for inclusion into our study.

The following data were obtained from each patient's medical record: age, sex, body mass index, preoperative and postoperative visual analog scale (VAS) scores, time to clinical fusion, time to radiographic fusion, need for revision surgery, postoperative complications, delayed union, nonunion, tobacco use, disability, adjunct procedures, the need for hardware removal, and the type of internal fixation construct used. We used the Wilcoxon signed ranks test to compare the preoperative and postoperative VAS pain scores. Statistical significance was defined at the 5% ( $p \leq .05$ ) level. The analyses were performed by 1 author (K.W.A.).

#### Surgical Technique

A dorsomedial incision was made just medial to the extensor hallucis longus tendon. Standard dissection and MTPJ capsulotomy were performed. Joint preparation consisted of placing a guidewire longitudinally down the intramedullary canal of both the first metatarsal and the proximal phalanx, followed by contouring using cup and cone reamers. The corresponding articular surfaces were then fenestrated using a 2.0-mm drill bit. The hallux was then positioned in a slightly abducted and dorsiflexed position to maintain a rectus alignment. Stable rigid internal fixation was provided in all cases using a 3.0-mm cannulated interfragmentary screw, followed by a dorsally placed locking plate. The screw was directed from distally and medially to proximally and laterally. All plates were low-profile first MTPJ fusion plates designed with slight abduction and dorsiflexion to accommodate proper hallux positioning during first MTPJ fusion. However, the plates were contoured according to surgeon preference for the position desired. Eccentric drilling through the plate was used to aid the screw in further compression across the fusion site before proximal locked screw placement. Standard layered closure was then performed, and a dry sterile dressing was applied. The patient was placed into a stiff-soled surgical shoe. The sutures were removed at 2 weeks postoperatively.

All patients were allowed to immediately bear full weight postoperatively. No instructions were given to the patients to alter their gait (i.e., walk on the lateral aspect of their foot or heel). The patients were scheduled for follow-up clinical and radiographic examinations at 2, 6, 10, and 14 weeks postoperatively. Patients undergoing simultaneous hammertoe correction were seen at 2, 4, 7, 10, and 14 weeks for examination with radiographs, because they had their pins removed at the 4-week mark.

All procedures and postoperative clinical examinations were performed by the senior author (M.D.S.). All radiographs were independently examined by 2 authors (M.D.S., K.W.A.). Delayed union was defined as partial union occurring >16 weeks postoperatively. Nonunion was defined as lacking fusion >6 months postoperatively. Any delayed or nonunion was further evaluated by computed tomography for confirmation and further treatment planning, if indicated. Radiographically, union was determined by visualizing bony trabeculation crossing the fusion site on  $\geq 2$  views of weightbearing foot radiographs. Clinically, union was determined by the absence of pain and motion with manipulation of the fusion site.

#### Results

The records of 30 consecutive patients who had undergone first MTPJ arthrodesis from December 2009 to February 2012 were reviewed. Five patients were excluded because <8 weeks of follow-up data available (4 patients) and/or the lack of radiographs between postoperative weeks 2 and 12 (1 patient only had postoperative films taken at 2 weeks and 6 months). After applying our exclusion criteria, 25 patients and 25 fusions remained. The mean patient age was 60.04 (range 45 to 77) years, and 6 males (24%) and 19 females (75%) were included. The average body mass index was 27.6 (range 21.9 to 36.4) kg/m<sup>2</sup>. Six (24%) of the 25 patients were active tobacco users at surgery. Four patients were on disability. Five patients had undergone simultaneous procedures (Table 1). Nineteen patients received bone marrow aspirate from the calcaneus to their fusion site. The preoperative diagnoses consisted of hallux rigidus (20 of 25), hallux abductovalgus (1 of 25), and hallux abductovalgus with hallux rigidus (4 of 25; Table 2).

The complications are summarized in Table 3. One patient developed a superficial wound infection, which had resolved after 1 week of oral antibiotics alone. One patient developed partial wound dehiscence, which had completely healed by 6 weeks postoperatively. One patient developed painful prominent hardware, which was removed at 6 months postoperatively, and subsequently experienced complete resolution of symptoms with hardware removal. Two patients developed mild hallux interphalangeal joint arthralgia >1 year

**Table 1**

Summary of adjunct procedures performed in patients undergoing first metatarsophalangeal joint arthrodesis (N = 25)

Additional Procedure	n (%)
Weil osteotomy	5 (20)
Duvries condylectomy	4 (16)
Pan metatarsal head resection	1 (4)
Taylor's bunionectomy	1 (4)
Extensor digitorum longus lengthening	1 (4)

**Table 2**

Primary diagnoses for study population (N = 25)

Diagnosis	n (%)
Hallux rigidus	20 (80)
Hallux abductovalgus with hallux rigidus	4 (16)
Hallux abductovalgus	1 (4)

**Table 3**

Summary of postoperative complications observed in postoperative period (N = 25)

Complication	n (%)
Hallux interphalangeal joint arthralgia	2 (8)
Superficial wound infection	1 (4)
Partial wound dehiscence	1 (4)
Painful hardware	1 (4)
Nonunion	1 (4)



Fig. 1. Typical preoperative anteroposterior and lateral radiographs for patients undergoing first metatarsophalangeal joint arthrodesis.

postoperatively, neither of whom have required further intervention to date. One patient had a symptomatic nonunion secondary to failure of the internal fixation and an acute neuropathic Charcot event.

The mean follow-up period was 29.92 (range 8 to 64) weeks. The mean time to clinical fusion was 5.92 (range 4 to 8) weeks. The mean time to radiographic union was 6.83 (range 4 to 14) weeks. The overall union rate was 96%. The VAS score was obtained preoperatively and postoperatively for all patients. The mean preoperative VAS score was 6.64 (range 4 to 8). The mean postoperative VAS score was 0.6 (range 0 to 4). The difference in the pre- and postoperative VAS scores was statistically significant ( $p < .001$ ).

## Discussion

First MTPJ arthrodesis is a well-established procedure for the treatment of first MTPJ disorders. Many different fixation techniques have been reported, ranging from crossed screws, parallel screws, staples, external fixation, an isolated dorsal plate, a dorsal plate with screw fixation, and cerclage wire (1–16). Figs. 1 and 2 show our typical preoperative and postoperative anteroposterior and lateral radiographs for patients undergoing first MTPJ arthrodesis. Patients who have

undergone first MTPJ arthrodesis historically have shown predictable results, with fusion rates typically  $>90\%$  (1,2,4,6–8,11–14,16–18). Additionally, satisfaction scores have been shown to be high postoperatively (7,12–14,19). DeSandis et al (19) found that patients had improved ability to perform daily activities and little to no functional limitations after first MTPJ arthrodesis. The mean preoperative VAS score for the patients in our cohort was 6.64, which had decreased to a mean of 0.6 postoperatively, a statistically significant difference ( $p < .001$ ). The improvement we found is similar to that reported by other studies (11–14,19). Historically, the postoperative protocol for patients undergoing first MTPJ fusion has included 6 weeks of non-weightbearing, followed by several weeks of further protected weightbearing. This prolonged period of non-weightbearing, followed by protected weightbearing, predisposes the patient to disuse atrophy, osteopenia, the risk of deep vein thrombosis, and, overall, a prolonged time to recovery. Immediate full weightbearing postoperatively might prevent the detrimental sequelae of cast immobilization (1).

The results of the present retrospective study are consistent with those from previous similar reports (1,2,4–7,11–15). In 2004, Yu and Gorby (3) stated that weightbearing is the most detrimental influence

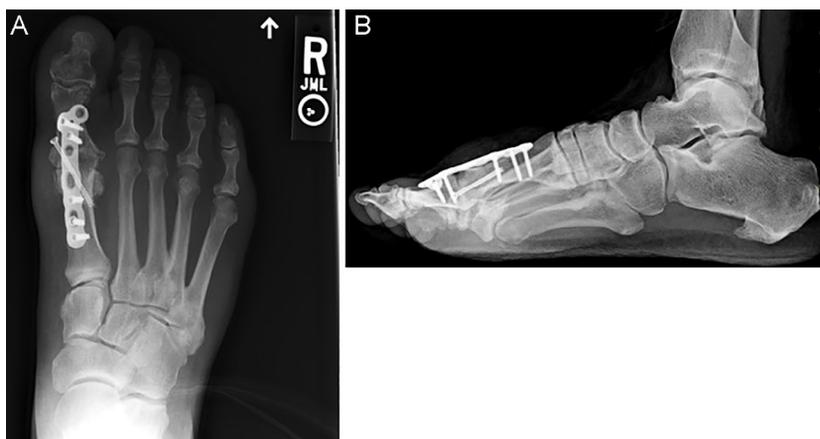


Fig. 2. Typical postoperative anteroposterior and lateral radiographs showing first metatarsophalangeal joint arthrodesis with screw and dorsal locking plate fixation.

on the bone healing process and that early excessive weightbearing and ambulation promote bone healing complications, such as delayed union, nonunion, and pseudoarthrosis. With the advent of new locking plating technology combined with traditional AO fixation principles, we believe that patients can predictably maintain full weightbearing status throughout the postoperative period (1,2,4,5,11,13). Berlet et al (1) found that with rigid internal fixation, they had an overall fusion rate of 91.1% and that full immediate postoperative weightbearing did not affect the fusion rate of either fixation group (crossed screws versus dorsal plate). The published data also have reported >90% MTPJ fusion rates with various joint preparation techniques (1,2,4,6–8,11–14,18). Mahadevan et al (18) examined 200 first MTPJ arthrodesis procedures with joint preparations ranging from a flat-on-flat configuration to the use of a rongeur or conical reamers. No statistically significant difference was observed among the techniques; however, a greater union rate was seen with low velocity preparation, which consisted of a rongeur, a rongeur and bur, and conical reamers (18). In our case series, we maintained a fusion rate of 96%, consistent with that reported in a systematic review of first MTPJ arthrodesis with mixed weightbearing protocols (8).

The apprehension of impending nonunion and what we know from the basic science of bone healing are what have historically driven surgeons to protect patients from weightbearing immediately after first MTPJ arthrodesis. Lampe et al (6) performed a randomized study of 61 patients, with 32 patients allowed to bear weight in a short-leg walking cast 2 to 4 days after surgery and 29 kept non-weightbearing postoperatively for 4 weeks. They reported 4 nonunions in each group, with only 2 of those 8 nonunions remaining symptomatic. They showed that early full weightbearing resulted in the same rate of union as that with delayed weightbearing (6). In a 2011 systematic review, Roukis (8) studied nonunion rates after first MTPJ arthrodesis in 2818 cases with mixed postoperative weightbearing protocols. The review showed an overall incidence of nonunion of 5.4%, revealing that the historical incidence of 10% nonunion is inaccurate. Furthermore, the review showed a symptomatic nonunion frequency of 32.7% for first MTPJ nonunions and a symptomatic nonunion rate of 1.8% for all first MTPJ arthrodesis procedures (8). Hope et al (15) reported it was not mandatory to refuse a nonunion of the first MTPJ, as their study showed that hardware removal with debridement alone was a reasonable option to offer patients. Berlet et al (1) and Storts and Camasta (16) concluded that immediate postoperative weightbearing did not compromise the clinical results. In our case series, 1 patient developed nonunion, which was symptomatic. This patient was the only diabetic patient in our patient population and the only patient who had experienced an acute Charcot event 2 weeks postoperatively. This ultimately led to failure of the internal fixation and subsequent nonunion. These results are again consistent with the reported data (8).

Complications consisted of postoperative wound infection, acute Charcot osteoarthropathy with subsequent nonunion, partial wound dehiscence, painful hardware, and hallux interphalangeal joint arthralgia. Only 1 patient required revision surgery. This patient was also the only diabetic patient in our series and had developed an acute Charcot event requiring further surgical stabilization. The postoperative wound infection resolved with oral antibiotics and that patient did not require subsequent surgery. One patient underwent hardware removal at 6 months postoperatively secondary to painful prominence, and the symptoms resolved with hardware removal. The partial wound dehiscence had completely healed at the 6-week follow-up appointment. At the last follow-up examination, the 2 patients with mild hallux interphalangeal joint arthralgia had not required any treatment. Our complication rate is similar to those reported in previous studies (1,5,8,11,14).

The limitations of our study included a relatively small number of patients, although a single surgeon (M.D.S.) performed all procedures.

In theory, this would indicate that all procedures were performed with the same surgical technique, which can reduce intersurgeon variation for surgical outcomes. We also included consecutive patients in the cohort, and all exclusions were secondary to the lack of proper follow-up data. Patients were not selectively excluded because of comorbidities or postoperative complications, which would have given false results. All fusion sites were permanently fixated with rigid internal fixation consisting of a cannulated 3.0-mm compression screw and a dorsal locking plate. The purpose of our study was not to evaluate the healing potential with various methods of internal fixation but, rather, to show that immediate full weightbearing postoperatively results in fusion rates similar to those traditionally reported for this procedure. We also had a relatively short follow-up period, with an average of 29.92 weeks. Because we were not studying patient satisfaction, we did not believe the short follow-up period was detrimental to our study, because it was sufficient to show clinical and radiographic healing of the fusion site, which was the focus of our study. We also did not objectively collect data on patient satisfaction after first MTPJ arthrodesis with immediate full weightbearing after surgery, because ours was a retrospective review. This should be a continued focus of future studies.

In conclusion, the results of the present study suggest that patients undergoing first MTPJ arthrodesis with locked internal fixation can predictably begin full weightbearing immediately after surgery in a postoperative surgical shoe and maintain fusion rates that are equal to, or better than, those previously reported. The fusion and complication rates for our patients in the present study are also consistent with those reported in previous studies. Our results can further guide clinical decision-making regarding an early weightbearing regimen after first MTPJ arthrodesis and add to the body of evidence contrasting the historical stature of prolonged offloading.

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