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Early Screw Fixation Versus Casting in the Treatment of Acute Jones Fractures

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Background: There is considerable variability in the literature concerning the optimal treatment of acute Jones fractures.

Hypothesis: Early surgical fixation of acute Jones fractures will result in shorter times to union and return to athletics compared with cast treatment.

Study Design: Randomized controlled clinical trial; Level of evidence, 1.

Methods: Eighteen patients were randomized to cast treatment, and 19 patients were randomized to screw fixation. Success of treatment and the times to union and return to sports were calculated for each patient.

Results: Mean follow-up was 25.3 months (range, 15-42 months). Eight of 18 (44%) in the cast group were considered treatment failures: 5 nonunions, 1 delayed union, and 2 refractures. One of 19 patients in the surgery group was considered a treatment failure. For the surgery group, the median times to union and return to sports were 7.5 and 8.0 weeks, respectively. For the cast group, the median times were 14.5 and 15.0 weeks, respectively. The Mann-Whitney test showed a statistically significant difference between the groups in both parameters, with $P < .001$.

Conclusion: There is a high incidence (44%) of failure after cast treatment of acute Jones fractures. Early screw fixation results in quicker times to union and return to sports compared with cast treatment.

Keywords: fifth metatarsal fracture; Jones fracture; internal fixation; intramedullary screw fixation

Fractures of the proximal fifth metatarsal, at the junction of the diaphysis and metaphysis without extension distal to the fourth-fifth intermetatarsal articulation, present a difficult treatment dilemma in the active patient. Sir Robert Jones originally described the fracture in 1902 when he reported 4 cases, including his own that he sustained while dancing.¹¹ In 1927, Carp noted the difficulty in achieving union of proximal fifth metatarsal fractures.³ A review of the literature reveals considerable variability in the results obtained with nonoperative treatment of Jones fractures. Although some have reported excellent results,^{1,12,22,27} most authors have reported difficulty in achieving union with nonsurgical treatment.^{4,5,8,13,14,26} In 1984, Torg et al achieved a 93% healing rate with treatment of acute Jones fractures in a nonweightbearing cast

for 8 weeks.²² After their study, recommended treatment for this problem fracture has included nonweightbearing cast immobilization for up to 8 weeks. Even with nonweightbearing cast treatment, treatment failure is reported in up to 50%,⁸ and long periods of treatment are needed to achieve union. Clapper et al reported a 28% nonunion rate despite 8 weeks of treatment in a nonweightbearing cast. In addition, the mean time to union in the group successfully treated was 21.2 weeks.⁴

In 1984, Torg et al classified the Jones fracture into 3 types.²² The acute fracture was defined as a fracture line with sharp margins and no widening, no intramedullary sclerosis, and minimal cortical hypertrophy. Most important was the absence of intramedullary sclerosis. They did point out, however, that patients with acute fractures may have had pain or discomfort in the area before the fracture. The distinguishing features that defined the delayed union were a previous fracture, a widened fracture line with adjacent radiolucency, and evidence of intramedullary sclerosis. The features that defined the nonunion were a history of repetitive trauma, a wide fracture line with periosteal new bone, and complete obliteration of the medullary canal at the fracture site by sclerotic bone.

Nonsurgical treatment of acute Jones fractures has many potential adverse effects, including the deleterious

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effect of prolonged immobilization on the soft tissue structures about the ankle, disuse osteoporosis of the lower extremity, and the negative self-image associated with prolonged treatment in a cast. Specific to the military, active duty members are prevented from shipboard duty or overseas deployment while in a cast. In addition, the Jones fracture is susceptible to reinjury^{14,26} and often is a source of chronic pain despite prolonged cast immobilization. Many people are intolerant of protracted immobilization and, thus, are noncompliant with the nonweightbearing recommendations.

In recent years, surgical management of the acute Jones fracture has been advocated.^{2,6,10,13,15-19,23,25} The clinical studies following intramedullary screw fixation^{6,13,16,18,23,25} have reported excellent results, with shortened clinical and radiographic union time as compared to the historical cast immobilization. However, most authors have recommended this treatment only for competitive athletes. Portland et al recently recommended intramedullary screw fixation for acute Jones fractures in nonathletes as well as in athletes.¹⁸ To our knowledge, there has never been a prospective, randomized study comparing nonsurgical and surgical treatment of acute Jones fractures.

The purpose of this study was to prospectively evaluate a randomized trial of cast immobilization versus early intramedullary screw fixation in the treatment of acute Jones fractures in active patients, irrespective of the level of athletic participation.

MATERIALS AND METHODS

A prospective, randomized study was initiated to compare cast treatment to early surgical intervention in the treatment of acute Jones fractures. Before initiating the study, a power analysis was performed. The analysis was based on variability drawn from the literature on the time to clinical union with casting versus surgery of acute Jones fractures. Using α of .05, a power of .90, and a difference of 3 weeks to union as clinically significant between groups, we determined that we would need 20 patients per study arm.

Inclusion criteria for the study were an acute Jones fracture (Figure 1); an isolated, closed fracture; skeletal maturity; and, if present, prodromal symptoms for less than 2 weeks. An acute Jones fracture was defined according to the classification of Torg et al,²² that is, a fracture line with sharp margins without widening, absence of intramedullary sclerosis, and minimal or no cortical hypertrophy or evidence of periosteal changes due to chronic stress. Exclusion criteria were tuberosity avulsion fractures, fifth metatarsal shaft fractures, a prior fracture, prodromal symptoms for more than 2 weeks, and a nonunion or delayed union as defined by the radiographic criteria described by Torg et al.²² Our study proposal was approved by our clinical investigation department and our local institutional review board before initiation.

During a 30-month period of patient enrollment, there were 54 patients diagnosed with Jones fractures. Seventeen patients were excluded, including 5 with delayed unions, 4 with refractures, and 1 pediatric patient.



Figure 1. Acute Jones fracture with a sharp fracture line and the absence of periosteal thickening or intramedullary sclerosis.

Seven patients refused to participate in the study, leaving 37 patients as cohorts of the study. Thirty-six of the patients were active duty military personnel, 1 of whom was a US marine in recruit basic training. One patient was a spouse of an active duty military member. Patients who were not part of the study were treated with cast immobilization according to the nonoperative protocol. After obtaining appropriate consent, patients were randomized into 1 of 2 groups: (1) cast immobilization or (2) intramedullary screw fixation. Randomization was performed using a random-number generator. The patients selected a sealed envelope that contained their assigned treatment group.

Patients randomized to the cast group were treated in a nonweightbearing short leg cast for 8 weeks, followed by a walking cast or hard-sole shoe until clinical union. Clinical union was defined as a nontender fracture site, the absence of pain with ambulation, and radiographic evidence of fracture healing. Radiographic union was defined as the presence of new bone formation with bridging trabeculae across the fracture site. Patients were allowed to return to sports participation after clinical union of the fracture. Treatment failure was defined as a symptomatic



Figure 2. Fracture union with an intramedullary 4.5-mm malleolar screw.

fracture present on radiograph at 26 weeks after the initial injury.

Patients randomized to the surgical group had a percutaneous 4.5-mm AO malleolar screw (Synthes, Paoli, Pa) placed into the intramedullary canal of the fifth metatarsal with the aid of fluoroscopy. We used the technique for screw placement as previously described by DeLee et al.⁶ Special attention was used to ensure that all screw threads were distal to the fracture site. Bone graft was not used in any of the cases. All surgeries were done on an outpatient basis. All surgeries were performed or supervised by at least one of the authors. Postoperatively, patients were immobilized in a nonweightbearing bulky Jones splint for 2 weeks, followed by weightbearing as tolerated in a hard-sole shoe until clinical union. Like the cast group, sports were allowed when the patient had a clinical union (Figure 2). Treatment failure was again defined as a symptomatic fracture present on radiograph 26 weeks after the original injury.

All patients were followed up in the clinic at monthly intervals for 6 months and then at 1 year and 2 years after the initial injury. Patients were evaluated with a subjective questionnaire, physical examination, and radiographs of the affected foot. Data were collected and calculated for

TABLE 1
Mechanisms of Injury

Mechanism	Patients
Falling off stairs/curb	12
Basketball	11
Running	8
Football	2
Volleyball	1
Softball	1
Soccer	1
Karate	1

each patient with respect to (1) time to clinical union, (2) time returning to running and jumping sports, and (3) complications, including delayed union, nonunion, refracture, and any morbidity associated with treatment.

Statistical Analysis

We used descriptive statistics to calculate mean and median values, SDs, 95% confidence intervals, and the 25% to 75% quartile range. Because of the relatively small sample size and possible deviations from normality, we used median values instead of means in our statistical analyses. We used the Mann-Whitney test to compare the 2 groups with respect to the time to union and the time returning to sports participation.

RESULTS

The 37 patients who participated in the study included 35 male patients and 2 female patients. At the time of injury, all subjects were involved in recreational athletics that required running and jumping. In addition, the 36 active duty military subjects were required to participate in an aerobic conditioning and strength training program 3 days per week as directed by their respective commands. The mean age was 25.6 years (range, 18-58 years). The mean follow-up was 25.3 months (range, 15-42 months). The mechanism of injury for each of the 37 patients in the study is listed in Table 1. All patients reported an acute injury during an athletic event or after falling down a flight of stairs or off of a curb.

Cast Group

Eighteen patients were randomized into the cast group. Two of these 18 patients (11%) reported prodromal symptoms in the area of the fifth metatarsal for 10 to 14 days before the fracture. All 18 patients were available for follow-up. The mean time in a cast was 11.0 weeks (range, 8.0-17.0 weeks; SD, 2.74; 95% confidence interval, 9.9-12.4; median, 10.5; lower and upper quartile range, 9.0-12.0), and the mean time in a hard-sole shoe after casting was 3.7 weeks (range, 0-19 weeks; SD, 4.85; 95% confidence interval, 1.3-6.1; median, 4.0; lower and upper quartile



Figure 3. Symptomatic fifth metatarsal nonunion in a 22-year-old patient at 9 months from initial treatment. Note the sclerosis at the fracture site and obliteration of the intramedullary canal with sclerotic new bone formation.

range, 0.0-4.0). Eight of the 18 patients, or 44%, had treatment failures. Five patients (28%) developed nonunions (Figure 3), 1 patient developed a delayed union that required 68 weeks before clinical and radiographic union (Figure 4), and 2 patients (11%) developed refractures within the first year after the original injury. For the 10 patients with treatment successes, the mean time to clinical union was 14.5 weeks (range, 8-22 weeks; SD, 4.7; 95% confidence interval, 11.5-17.5). The median time to clinical union was 14.5 weeks (lower and upper quartile range, 10.5-18.5). The mean time returning to running and jumping sports for these 10 patients was 15.6 weeks (range, 10-22 weeks; SD, 3.9; 95% confidence interval, 13.1-18.1). The median time returning to sports was 15.0 weeks (lower and upper quartile range, 12.5-18.5). Return to running and jumping sports was delayed in 2 patients owing to ankle stiffness. These 2 patients required therapy to regain full ankle motion.

Of the 8 patients with treatment failures, 5 (28%) developed nonunions and 2 (11%) sustained a refracture at 8 and 12 months after the original fracture, respectively. Three of the patients with nonunions opted for surgery and underwent 4.5-mm screw fixation without bone graft. All 3 patients went on to heal their fractures uneventfully.



Figure 4. Symptomatic fifth metatarsal delayed union at 20 weeks from initial treatment. Note the widened fracture line and sclerosis at the fracture site.

Two patients with nonunions did not want surgery and were discharged from military service. At the time of follow-up, both still complained of pain and an inability to run. However, both were gainfully employed. Both patients who sustained refractures were offered surgery. One underwent screw fixation and healed uneventfully. The other declined surgery and was treated successfully with cast immobilization.

Surgical Group

Nineteen patients were randomized into the surgical group. One patient (5.3%) reported prodromal symptoms for 2 weeks before the fracture. The mean time from injury to surgery was 9.4 days (range, 1-22 days; SD, 6.0; 95% confidence interval, 6.9-12.8; median, 10.0; lower and upper quartile range, 4.0-15.0). All 19 patients were available for follow-up, and all had clinical and radiographic union at follow-up. One patient (5.3%) had treatment failure. He developed a nonunion and required a bone graft and repeat fixation to achieve union. For the other 18 patients, the mean time to clinical union was 6.9 weeks (range, 4-11 weeks; SD, 2.3; 95% confidence interval, 5.8-8.0). The median time to clinical union was 7.5 weeks (lower and upper quartile range, 5.0-8.0). The mean time

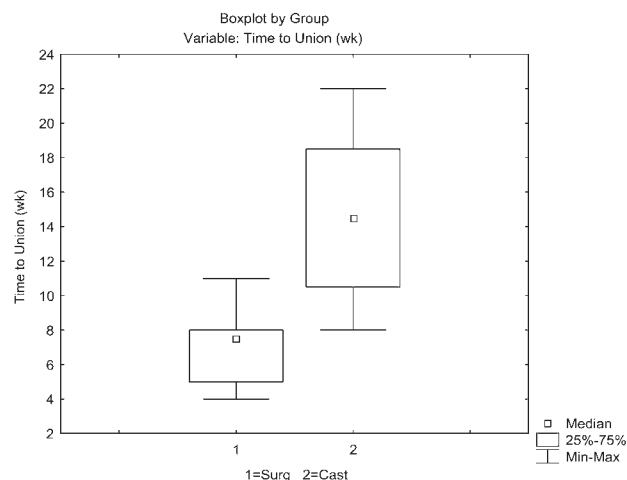


Figure 5. Time to union with median values, 25% to 75% quartile range, and minimum and maximum values. Using the Mann-Whitney test for nonparametric data, the results show a statistically significant difference, with $P < .001$.

returning to running and jumping sports was 7.9 weeks (range, 4-11 weeks; SD, 2.20; 95% confidence interval, 6.8-9.0). The median time returning to sports was 8.0 weeks (lower and upper quartile range, 6.0-10.0). Six patients (32%) had mild discomfort from the screw head. Three patients (16%), including the one with treatment failure, had the screw removed. We did not observe any changes on radiographs at the calcaneocuboid joint in any of the patients who complained of pain from the screw head. However, in 2 patients, the screw was removed for suspected screw head impingement on the cuboid. In both of these patients, the pain at the base of the fifth metatarsal resolved after screw removal. The other 3 patients had only mild discomfort and did not desire screw removal. The screw head discomfort did not prevent patients from resuming regular activities or from participating in all sports. There was 1 case of a postoperative superficial wound infection that was resolved with oral antibiotics. There were no cases of screw breakage or nerve injury.

Statistical Analysis

As previously mentioned, to avoid statistical errors due to potential deviations in normality of the data, we used median values to compare the 2 groups with respect to the time to clinical union and the time returning to running and jumping sports. The median time to clinical union was 7.5 weeks for the surgery group and 14.5 weeks for the cast group. The Mann-Whitney test showed a statistically significant difference between the 2 groups, with $P < .001$ (Figure 5). The median time returning to running and jumping sports was 8.0 weeks for the surgery group and 15.0 weeks for the cast group; the Mann-Whitney test also showed a statistically significant difference between the 2 groups, with $P < .001$ (Figure 6).

A post hoc power analysis of our data using an α of .05 revealed a power of greater than .99.

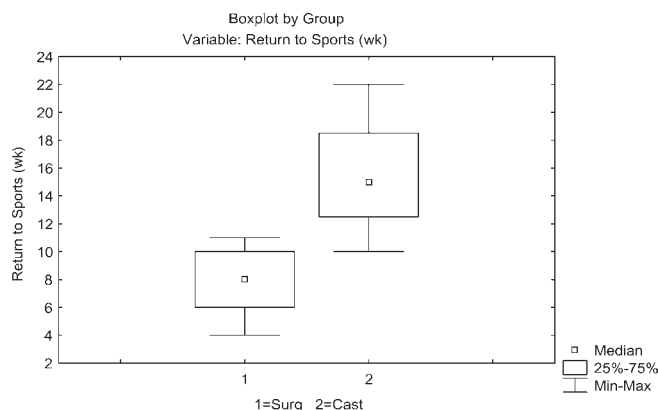


Figure 6. Time returning to sports participation. Graph displays the median values, the 25% to 75% quartile range, and the minimum and maximum values for both groups. Using the Mann-Whitney test for nonparametric data, the results show a statistically significant difference, with $P < .001$.

DISCUSSION

The purpose of this study was to determine whether early screw fixation or casting is most effective in the treatment of acute Jones fractures. In our study, early screw fixation resulted in clinical union at a mean of 7.6 weeks earlier than with cast treatment. In addition, the surgically treated patients returned to sports at a mean of 7.7 weeks earlier than did the patients who were casted. Early screw fixation resulted in satisfactory results in 18 of 19 patients (95%), whereas nonoperative treatment resulted in a nonunion, delayed union, or refracture in 8 of 18 patients (44%). Our results are consistent with previous studies that have documented a high incidence of treatment failure with nonoperative treatment.^{3-5,8,13,14,26}

Until recently,^{18,25} early surgical fixation of Jones fractures has only been recommended in competitive athletes.^{2,6,8,10,13,14,16,23} To our knowledge, our study is the first randomized, prospective study comparing treatments for acute Jones fractures. In addition, our inclusion criteria did not include the level of athletic participation. Our patient population was an active duty military population. They were unique because they were precluded from performing their respective jobs aboard ships or in the field while in a cast. For the 10 patients in whom casting was successful, the mean time in a cast was 11.0 weeks. For those in critical positions aboard a naval ship, they had to be reassigned during treatment. Early surgical treatment allowed our patients to remain with their units/ships during treatment. Given the results of our study, we have begun to offer surgical fixation to all military patients with Jones fractures.

In defining our inclusion criteria for the study, we elected to use the original radiographic criteria of Torg et al to define an acute fracture. Torg et al reported that patients with acute fractures may have had prodromal pain or discomfort before the fracture.²² In our study, we included 3 patients who reported prodromal pain for 2 weeks or less.

Two of the patients were randomized to the nonoperative group, and 1 patient was randomized to the surgical group. One of the 2 patients randomized to the nonsurgical group had treatment failure. Although the authors all agreed that the radiographs in these 3 patients did not meet the criteria for a delayed union, we acknowledge the injuries in these patients may have represented early stress fractures and may have been best treated surgically as recommended by DeLee et al.⁶

It has been reported that the poor blood supply to the base of the fifth metatarsal is, in part, responsible for the high incidence of delayed union and nonunion results after Jones fractures. Cadaveric studies have shown that the blood supply to the proximal fifth metatarsal is from a small nutrient artery that penetrates the bone at its medial aspect at the junction of the proximal and middle thirds.^{20,21} Fractures through this relatively hypovascular zone can potentially disrupt this single nutrient vessel, leading to poor healing.

Although our surgical results are encouraging, potential morbidity exists. Screw head discomfort, seen in 6 of the 19 patients (32%) in our study and in 3 of 10 patients (30%) in the study of DeLee et al,⁶ appears to be the most common problem. This discomfort did not prevent patients from participating in all sports. The use of a countersink before screw insertion can potentially decrease this problem. We also had 1 patient whose fracture failed to heal despite early surgical fixation. It is difficult to determine why this patient's initial treatment failed. The most plausible explanation is that he was allowed to return to activities too early and before fracture healing. In fact, he was allowed to deploy on a 6-month cruise aboard a naval ship 2 months postoperatively. Other potential problems include pain under the fifth metatarsal head, presumably secondary to an alteration in the metatarsal stiffness⁶; refracture^{9,24}; plastic deformation or breakage of the screw^{9,14}; and sural nerve injury.⁷ Potential technical errors during screw fixation include extension of the fracture during screw insertion, screw threads crossing the fracture site, and penetration of the diaphyseal cortex by the screw. Technical errors can lead to treatment failure.

CONCLUSION

To summarize, there is a high incidence, 8 of 18 (44%) in this study, of nonunion, delayed union, and refractures after the nonoperative treatment of acute Jones fractures. Long periods of immobilization and nonweightbearing are required for eventual union. Early intramedullary screw fixation with a 4.5-mm malleolar screw is a safe and effective treatment for acute Jones fractures. Early surgical treatment results in a shorter time to clinical union and allows patients to return to sports and activities of daily living faster than with cast treatment.

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