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Early Weight-Bearing After Percutaneous Reduction and Screw Fixation for Low-Energy Lisfranc Injury

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Abstract

Background: Anatomic restoration and postoperative rehabilitation of displaced fracture-dislocations of the tarsometatarsal junction of the foot are essential. Our objective was to report percutaneous reduction and screw fixation results in low-energy Lisfranc fracture dislocation injuries that were treated with early weight-bearing and rehabilitation.
Methods: We retrospectively evaluated patients with low-energy Lisfranc injuries who underwent surgery between May 2007 and April 2011. The study reviewed 22 patients (12 men and 10 women) with an average age of 36.2 years (range, 16-50 years) and an average follow-up of 33.2 months (range, 12-50 months). We report the mechanism of trauma; quality of reduction in the postoperative digital radiographs; subjective satisfaction; AOFAS score; time required to return to work, recreational activities, and low-impact sports; and complications. Postoperatively, all of the patients were instructed to be non-weight-bearing for 3 weeks, and the stitches were removed after 2 weeks. At the third postoperative week, the patients were encouraged to bear weight as tolerated.
Results: Quality of reduction was anatomic or near anatomic in 100% of cases. The subjective satisfaction reported by patients was very good, with complete satisfaction in 20 of them (90.9%). The AOFAS average was 94 points (range, 90-100 points). Average return to work was at 7 weeks (range, 6-9 weeks), recreational activities 7.2 weeks (range, 6-9 weeks), training for low-impact sports 7.6 weeks (range, 7-8 weeks), and symptom-free sport activities 12.4 weeks (range, 11-13 weeks).
Conclusion: In this selected group of patients with low-energy Lisfranc fracture dislocation, anatomic or near-anatomic reduction can be achieved with percutaneous reduction and screw fixation. Early weight-bearing is possible in these patients, and early return to regular activities and low-impact sport can be expected.
Level of Evidence: Level IV, retrospective case series.

Keywords: fracture, Lisfranc fracture dislocation, reduction, percutaneous, rehabilitation

Lisfranc fracture dislocation or tarsometatarsal joint complex injuries occur in 1 out of 55,000 persons each year in the United States, which accounts for approximately 0.2% of all fractures.[2,4] Males are 2 to 10 times more likely to sustain tarsometatarsal fracture dislocations, and the dislocations typically occur when patients are in their mid-30s.[9] Approximately 20% of the injuries are misdiagnosed or missed on the initial radiographic assessment.[2] A high index of suspicion is needed to accurately diagnose tarsometatarsal joint injury and to avoid the late sequelae of posttraumatic arthritis.

These injuries are often caused by both direct and indirect forces, ranging from high-energy trauma with severe midfoot disorganization to subtle subluxations from simple sprains.[9] Most injuries occur after high-energy trauma, such as motor vehicle accidents, industrial accidents, and falls from a height. Low-energy trauma accounts for approximately one-third of Lisfranc fracture dislocation injuries. Midfoot injuries that are sustained during athletic activities constitute a significant number of low-energy injuries.[16]

The goal of treatment for these injuries is anatomic reduction and secure fixation. However, there is controversy as to how anatomic reduction and secure fixation should be achieved.[9] Some physicians advocate percutaneous reduction and screw fixation whenever possible,[13,14] and

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other physicians perform open reduction and internal fixation in all cases.

After surgery, the rehabilitation program includes the foot being non-weight-bearing for 4 to 6 weeks followed by progressive weight-bearing as tolerated in a weight-bearing bivalved cast or removable boot.[8] Poor clinical results have been reported after Lisfranc fracture dislocation injuries; these results can be attributed to persistent pain and stiffness in the tarsometatarsal joints.[6] Despite early and adequate reduction, posttraumatic arthrosis is present in up to 50% of cases, which may be caused by the energy that is absorbed by the tissues and cartilage inside the joint. Furthermore, the intra-articular distribution of pressures may not be adequately restored, and the basic biomechanics of the tarsometatarsal joints may not be recovered.

In an effort to improve the clinical results of Lisfranc fracture dislocation injuries, our approach has been to use percutaneous reduction and fixation with screws to decrease the surgical trauma and to minimize the local damage to the capsule and dorsal ligaments. To optimize ligament healing, muscular recovery, and foot function, we then use aggressive postoperative management. At the third postoperative week, early weight-bearing is allowed, and the patients are rapidly progressed to full weight-bearing as tolerated.

The objective of this study was to present results of energy Lisfranc fracture dislocation injuries that were treated with percutaneous reduction, screw fixation, early weight-bearing, and rehabilitation.

Figure 1. Preoperative AP radiograph of a Lisfranc fracture dislocation. Note the lateral displacement of the base of the second metatarsal bone of the right foot.

Figure 2. Clinical view showing the immediate postoperative appearance. Note the minimal soft tissue disruption.

Methods

We performed a retrospective study of a consecutive series of patients with low-energy tarsometatarsal fracture dislocations that were treated by percutaneous reduction and screw fixation between May 2007 and April 2011. The study reviewed 22 patients (12 men and 10 women) with an average age of 36.2 years (range, 16-50 years). The patients were all operated on by the same surgeons. The average follow-up was 33.2 months (range, 12-50 months). The fracture dislocations occurred in low-energy activities, such as soccer, gymnastics, basketball, volleyball, and tennis. We included patients with ligamentous lesions and with marginal fractures that were associated with ligamentous lesions. We excluded Lisfranc fractures with comminution at the bases of the metatarsals. All of the patients signed informed consent forms, and approval was obtained from the local ethics committee.

Diagnosis was made from clinical examination and weight-bearing radiographs (Figure 1). Computed tomography evaluations were ordered when patients were unable to bear weight. Indications for surgery were more than 2 mm of widening (diastasis) between the first and second metatarsal bases and more than 1 mm of subluxation of a metatarsal base from its corresponding tarsal bone. Postoperatively, anatomic or near-anatomic reduction was defined as reduction within the previously mentioned limits.

All of the patients were operated on percutaneously (Figure 2) with cannulated 3.0 Synthes screws (Synthes Inc, Westchester, PA) for fixation. Fluoroscopy was used throughout the procedure to mark specific skin landmarks, including the medial cuneiform and the base of the first, second, and third metatarsal (Figure 3). Intraoperatively, we confirmed the instability of the compromised rays that were

Figure 3. Intraoperative identification of injured joints.

Figure 4. Intraoperative fluoroscopy with stress.

Figure 5. Percutaneous screw fixation of the second metatarsal base. Note the pointed tenaculum reducing the second metatarsal base against the medial cuneiform.

Figure 6. Final intraoperative view of Lisfranc fracture dislocation fixation.

determined from the preoperative radiographs (Figure 4). Reduction was achieved with pointed tenaculum clamps. Fixation was primarily performed with cannulated 3.0 screws in the following order (Figure 5): 1 screw was positioned from the medial cuneiform to the base of the second metatarsal, 1 screw was inserted from the base of the first metatarsal to the medial cuneiform, and 1 screw was inserted from the lateral cuneiform to the base of the third metatarsal (Figure 6). If the area was grossly unstable, double screw fixation was used for the medial column fixation. If the lateral rays did not reduce after the medial reduction, percutaneous K-wires were used to stabilize the lateral rays.

Postoperatively, all of the patients were instructed to remain non-weight-bearing for 3 weeks, and stitches were

Figure 7. Three-month postoperative weight-bearing radiographs.

removed after 2 weeks. At the third postoperative week, the patients were encouraged to bear weight as tolerated using a controlled ankle movement walker boot or a stiff soled shoe. At the sixth postoperative week, a regular shoe was used, but the shoe's stiffness was varied depending on the symptoms, such as with the use of a stiff insole.

Postoperative radiograph evaluations and clinical consultations were performed after 2 weeks, 6 weeks, 3 months, and 1 year. Ten patients had their radiographs taken but failed to return to the last follow-up visit; these patients were contacted by telephone. Outcomes were assessed by orthopedic residents who were blinded to the study. The quality of reduction was determined with postoperative digital radiographs; subjective satisfaction (Kenneth Johnson satisfaction score); AOFAS score; time required to return to full weight-bearing, work, recreational activities, and low-impact sports; and complications.

Results

In all of the patients, the postoperative radiographs showed anatomic or near-anatomic reduction (Figure 7). Medial and middle column fixation was performed on 5 patients. Fixation of only the first and second rays was performed in 6 patients, and fixation of only the second ray was performed on 11 patients

The patients reported very good subjective satisfaction, and 20 patients (90.9%) reported being completely satisfied. The average AOFAS score was 94 points (range, 90-100 points). The 2 unsatisfied patients had symptoms related to the screw fixation of the first ray. These patients achieved complete satisfaction after the screw was removed. All of the patients achieved full weight-bearing between the third and sixth postoperative weeks. The patients were weaned to a stiff-sole shoe after the 6-week follow-up visit.

The average time to return to work was 7 weeks (range, 6-9 weeks), the average time to return to recreational activities was 7.2 weeks (range, 6-9 weeks), the average time to resume training for low-impact sports was 7.6 weeks (weeks, 7-8 weeks), and the average time to engage in sport activities without symptoms was 12.4 weeks (range, 11-13 weeks). No patients reported wearing any type of orthotic device, and only 3 patients reported mild pain after resuming sports (Table 1).

Three patients reported hardware-related symptoms related to the first tarsometatarsal screw, which was removed at an average of 6 months. One patient developed transient paresthesia that was related to the intermediate branch of the superficial peroneal nerve. No other soft tissue complications were recorded. Anecdotally, 6 of the 10 patients with at least 36 months of follow-up were seen in our emergency department because of minor lower extremity trauma. These 6 patients had radiographs taken and were referred to us. However, no change in the tarsometatarsal alignment was detected, and no arthritic change was apparent.

Discussion

Anatomic reduction with stable internal fixation has become the standard treatment of tarsometatarsal fracture dislocations. Some authors favor percutaneous pinning whenever closed reduction is feasible under fluoroscopy. This technique is easy to perform and is less traumatic for the soft tissues. On the contrary, when open fixation is performed, soft tissues are more likely to sustain some damage. For this reason, there is controversy over how best to achieve anatomic reduction and stable internal fixation. Some physicians prefer open reduction and internal fixation in all cases, and other physicians advocate percutaneous reduction and screw fixation whenever possible. In a consecutive series of 42 patients with Lisfranc fracture dislocation who underwent percutaneous reduction and screw fixation, Perugia et al[11] reported an average AOFAS score of 81 points and no significant differences in the outcomes between anatomic and near-anatomic reductions. Richter et al[12] compared open and closed treatment of Lisfranc fracture dislocation and found no significant difference in

Table 1. Demographics and General Results.

Patient	Gender	Age	Injury Classification	Column Fixation	Postoperative Radiograph	AOFAS Score	Work Return, wk	Sport Reintegration, wk	Satisfaction	Follow-Up, mo
1	Male	16	Ligament lesion	2nd	Anatomic reduction	100	6	7	Yes	12
2	Male	29	Ligament lesion	1st, 2nd	Anatomic reduction	100	8	7	Yes	44
3	Female	28	Ligament lesion	1st, 2nd, 3rd	Anatomic reduction	100	6	8	Yes	28
4	Male	18	Marginal fracture	1st, 2nd, 3rd	Anatomic reduction	90	6	7	Yes	50
5	Female	36	Ligament lesion	1st, 2nd	Anatomic reduction	90	9	8	Yes	28
6	Female	38	Ligament lesion	2nd	Anatomic reduction	90	9	8	Yes	33
7	Male	48	Ligament lesion	2nd	Anatomic reduction	95	8	8	Yes	33
8	Male	47	Marginal fracture	2nd	Anatomic reduction	95	9	7	Yes	37
9	Male	36	Marginal fracture	2nd	Anatomic reduction	90	7	7	Yes	36
10	Female	28	Ligament lesion	1st, 2nd, 3rd	Anatomic reduction	90	6	7	Yes	44
11	Female	36	Ligament lesion	2nd	Anatomic reduction	95	6	8	Yes	45
12	Male	44	Ligament lesion	1st, 2nd	Anatomic reduction	95	7	7	Yes	34
13	Female	38	Marginal fracture	1st, 2nd, 3rd	Anatomic reduction	94	6	8	Yes	26
14	Female	44	Ligament lesion	2nd	Anatomic reduction	100	6	8	Yes	20
15	Male	33	Ligament lesion	1st, 2nd, 3rd	Anatomic reduction	95	7	8	Yes	15
16	Male	36	Ligament lesion	2nd	Anatomic reduction	95	7	8	Yes	19
17	Male	37	Ligament lesion	1st, 2nd	Anatomic reduction	95	6	8	Yes	33
18	Female	31	Ligament lesion	1st, 2nd	Anatomic reduction	95	6	8	No	36
19	Male	50	Ligament lesion	1st, 2nd	Anatomic reduction	95	6	7	Yes	41
20	Male	40	Ligament lesion	2nd	Anatomic reduction	90	7	8	Yes	48
21	Female	36	Ligament lesion	2nd	Anatomic reduction	100	6	8	Yes	41
22	Female	33	Ligament lesion	2nd	Anatomic reduction	100	7	7	No	33

the AOFAS score, gender, cause of the injury, or method of treatment. In a functional evaluation of a consecutive series of 11 patients with Lisfranc fracture dislocation who underwent open reduction and fixation, Teng et al[15] reported an average AOFAS score of 71 points, and a subjective evaluation of the patients showed a loss of joint motion in the involved feet compared with the uninjured feet.

To our knowledge, there are no reports in the literature for an early rehabilitation program after Lisfranc fracture dislocation surgery. The existing protocols emphasize non-weight-bearing for 4 to 6 weeks and weight-bearing as tolerated thereafter. In a prospective series of 5 patients who underwent open reduction and fixation, Brinsden et al[1] reported an average time to return to work of 6 months. The average time to return to activities has received little attention in the literature. In a study involving 19 athletes, Curtis et al[3] reported an average time to return to regular activities of 4.25 months. Similarly, Nunley and Vertullo[10] reported a retrospective study on 15 athletes with Lisfranc fracture dislocation and found that the return to regular activities for the entire cohort was fewer than 4 months.

In our series, all of the patients were allowed to bear weight as tolerated after the third postoperative week, and we did not detect any change in the postoperative radiograph evaluation at follow-up. The return to activities and low-impact sports, such as bicycling, progressive walking in the gym, and swimming, was achieved before 8 weeks. Our patients were likely able to return to regular activities so quickly because they only experienced low-energy trauma, and the percutaneous surgery had minimal impact on the soft tissues. When the Lisfranc fracture dislocation is secondary to low-energy trauma and the soft tissue injury is mild, a percutaneous reduction and screw fixation can be used. The amount of ligament disruption (eg, first cuneiform–second metatarsal, first cuneiform–second and third metatarsals, first cuneiform–second cuneiform ligaments)[5] likely allows for an early weight-bearing capacity when the medial and intermediate column stability is surgically restored. The early return to normal activities may provide a better restoration of joint and muscle activity in the lower leg, which can lead to a better and earlier return to function. We only removed screws in 3 patients, which may be attributed to our patients' predominantly engaging in low-impact sports and because only the first ray was fixed in 11 patients. Furthermore, half of our patients had fixation of only the second ray, which has little motion[7] and may have protected them from having hardware-related problems. Because the screws were not removed in a routine fashion, longer follow-up is needed and these patients may still present complications such as breakage or pain in the adjacent joints. Our short-term clinical and functional results may deteriorate over time.

In all low-energy closed Lisfranc fracture dislocations, we currently attempt to perform percutaneous reduction and fixation. We perform an open reduction when more than 2 mm of residual tarsometatarsal displacement or more than 15 degrees of persistent talo–first metatarsal angulation is present after the percutaneous reduction is attempted. When we perform percutaneous reduction and screw fixation, we encourage our patients to achieve full weight-bearing as soon as possible. We have achieved early return to regular activities and low-impact sports in all of our patients, and we believe that this rehabilitation protocol leads to improved functional results. For higher energy injuries or when a percutaneous reduction cannot be achieved, an open reduction and internal fixation is indicated. In these cases, we delay weight-bearing until the fourth to the sixth postoperative weeks.

The weaknesses of this study are its retrospective noncomparative design, the short follow-up time, and the postoperative radiological evaluation without a computed tomography scan. Our minimum follow-up of 12 months may not be critical, as we have not observed any deterioration of results in the initial patients. Our results may also be related to the low-energy injuries that the patients suffered. We consider weight-bearing radiographs to be sufficient for evaluating patients. Weight-bearing radiographs are the most commonly used method for diagnosing Lisfranc fracture dislocation injuries and are readily available in every medical center. An ongoing study with computed tomography scan evaluation is currently being performed.

In conclusion, in the selected group of patients with low-energy Lisfranc fracture dislocation, anatomic or near-anatomic reduction can be achieved with percutaneous reduction and screw fixation. Early weight-bearing is possible in these patients, and early return to regular activities and low-impact sport can be expected. This treatment protocol is an alternative to open reduction and internal fixation in this selected group of patients. An accelerated rehabilitation protocol may improve the final functional result.

Declaration of Conflicting Interests

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