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Staged management of open Lisfranc injury

Experience from 14 patients

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Abstract

There are still controversies on the management and outcome of open Lisfranc injury in available studies. This study evaluates the staged management of Lisfranc injury and its complications.

Patients who received a staged strategy for open Lisfranc injury were reviewed.

One patient with degloving injury suffered from partial skin and hallux necrosis which was treated by debridement, hallux amputation, definitive internal fixation, and local flap transfer on the 12th day after first stage management. A definitive internal fixation and simultaneous skin graft or flap coverage were performed in another 3 patients with soft tissue defects. Other patients without soft tissue problems underwent a second stage of definitive internal fixation. Bone union was observed on the 12.5th week after definitive surgery. The median AOFAS midfoot score at the last follow-up was 74.4 ± 8.7, while the average VAS score was 2.2 ± 1.8. The average return-to-work time was 8th months postoperatively in 9 patients. Flap necrosis, infection, implant failure, nonunion, and osteomyelitis were not observed during the follow-up. Two patients received Lisfranc arthrodesis for persistent pain due to posttraumatic arthritis.

In the management of open Lisfranc injury, surgeons must consider soft tissue condition. Staged strategy is a rational protocol for this severe injury. Temporary K-wire fixation after early radical debridement and realignment will facilitate the definitive internal fixation until soft tissue condition improves, which also can decrease the soft tissue complication.

Abbreviations: VAS = visual analog scale, VSD = vacuum sealing drainage.

Keywords: definitive fixation, K-wire fixation, open Lisfranc injury, soft tissue complication, staged management

1. Introduction

Lisfranc injury comprises only 0.2% of all injuries, but the incidence of open injury is unknown. A complex combination of soft tissue and bony injury may occur with tarsal and metatarsal fracture–dislocation, resulting in an unstable foot and other complications. Lisfranc complex is always involved and the clinical outcome may be compromised. Thus, posttraumatic arthritis has a high prevalence and usually requires a second salvage arthrodesis.

Since Lisfranc fracture–dislocations may cause painful malunion and impaired function if overlooked or treated improperly, early diagnosis and proper management is of great importance. It is generally accepted that displaced or unstable Lisfranc injuries should be treated with anatomic reduction and stable fixation to achieve good outcomes and avoid deleterious sequelae.[1] However, for high energy foot and ankle trauma, early open reduction and internal fixation will cause catastrophic consequences, especially the soft tissue complications, sometimes requiring a salvage amputation. In the treatment of Pilon fracture, staged management has been proved to significantly decrease the soft tissue complications and improve the prognosis.[2–4] Similarly, this protocol is also feasible for open Lisfranc injury.

In this retrospective study, the radiographic and clinical outcome as well as complications of open Lisfranc injuries were investigated, aiming to evaluate the therapeutic efficacy of the staged protocol for this severe injury.

2. Methods

2.1. Patient data

This study has been approved by the Ethics Committee of Shanghai Sixth People's Hospital. A retrospective study was carried out in the patients who received staged management of open Lisfranc injuries between 2009 and 2013. Patients with fractures of talus and calcaneum, history of foot ankle surgery and open injuries without fractures/dislocations were excluded from this study. A total of 18 patients including 13 males and 5 females with an average age of 42.2 years (range: 21–67 years) were recruited into this study. Eleven (61.1%) patients suffered from a motor-vehicle accident, while others (38.9%) had work-related crushing injury. The left side injury was found in 10 cases (55.6%) and right side injury in 8 (44.4%). A complete clinical evaluation of the patient was carried out with special attention to the foot injury. The condition of the skin, the extent of bone and soft tissue injury, contamination and a neurovascular condition of the foot were assessed. All patients had anteroposterior, oblique, and lateral radiographs of the affected foot, which showed the instability of midfoot: entire midfoot dislocation without fracture in 5 cases (27.8%) and displaced fractures of

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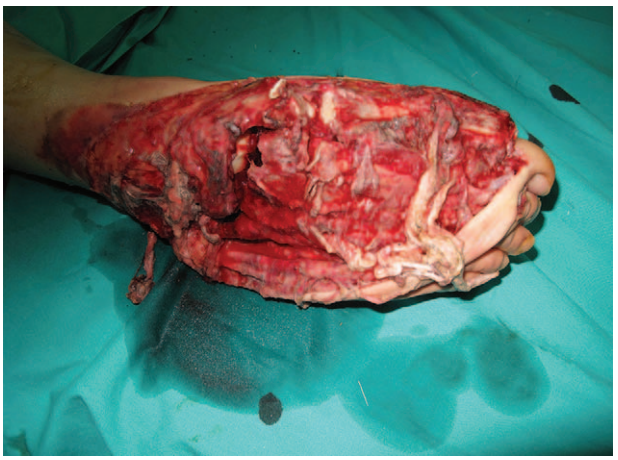

Figure 1. A 47-year-old female suffered from a traffic accident with dorsal skin degloved and hallux avulsion. The wound was severely contaminated.

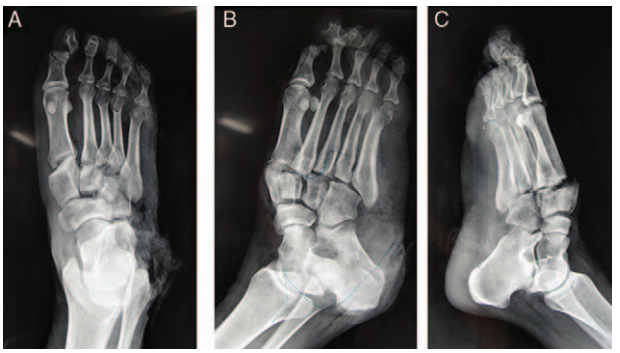

Figure 2. Preoperative X-rays displayed the dislocation of Lisfranc complex with forefoot fracture. (A) AP view, (B) oblique view, (C) lateral view.

midfoot in remaining cases. Stress radiographs and CT were not done in these patients in emergency. According to Chiodo and Myerson's 3-column classification system,[5] all the injuries in this study were classified as 3-column injury, and 4 (22.2%) patients had concomitant medial or lateral column shortening. In 8 (44.4%) cases, the injury involved the Lisfranc complex, including intercuneiform joint and cuneonavicular joint. Other foot injuries involving the metatarsal shafts, metatarsophalangeal joints, and phalanges were found in 6 patients (33.3%), 1 of which (5.6%) had concomitant avulsion of the hallux. Three (16.7%) had skin or soft tissue defects and 1 patient (5.6%) suffered a dorsal skin degloving injury (Figs. 1 and 2). According to the Gustilo–Anderson classification, the injuries were all classified as type III, including 12 patients (66.7%) with type IIIA injury, 5 patients (27.7%) with type IIIB injury, and 1 patient with type IIIC injury (5.6%) (Table 1).

2.2. Surgical technique

All patients were treated primarily in our institution within 8 hours after injury for the first stage debridement and temporary fixation. Three surgeons were involved in their treatment at both stages.

At first stage, operations were performed under spinal anesthesia in a supine position. After a radical debridement, the wound was copiously irrigated with saline solution. Then, the fractures and dislocations were identified and reduced via the wound or with a joy-stick technique. The reduction was performed always from medial to lateral column, but for complex injuries involving the intercuneiform joint or cuneonavicular joint, these joints were first reduced and stabilized. The K-wires stabilization was applied as follows: for patients with Lisfranc joint fracture–dislocation, bridging fixation was done via the axial K-wires for metatarsocuneiform or metatarsocuboid joint; for patients with a Lisfranc ligament injury, a 1.5-mm K-wire was inserted from medial cuneiform to the base of 2nd metatarsal; for patients with Lisfranc complex injury, a transverse wire was used for the fixation of intercuneiform joint. For patients with medial or lateral column shortening, a mini-fixator was used for the restoration of the length of midfoot. After temporary fixation and fluoroscopic imaging of reduction, the wound was radically irrigated again and then closed as far as possible.

The degloved skin was stabbed and grafted in situ for the patient with degloving injury (Fig. 3). For patients with soft tissue defect or degloving injury, a vacuum sealing drainage (VSD) system was used for temporary wound coverage.

Antibiotics were used for 3 days after first stage management. The VSD system was applied for 7 days, and then removed for

Table 1

General information and outcome of patients receiving follow up.

Age, y	Sex	Complex involved	G-A type	Second stage, d	AOFAS	VAS	RTW	Complication
21	M	√	IIIA	7	71	3	√	Posttraumatic arthritis
67	M		IIIA	5	74	2		
38	M		IIIA	8	89	0	√	
44	F		IIIA	6	84	0	√	
36	M	√	IIIB	7	71	2	√	
28	M	√	IIIB	10	69	4	√	Posttraumatic arthritis
54	M		IIIA	8	79	2		
60	M		IIIA	9	72	2		Posttraumatic arthritis
37	F		IIIA	6	82	1	√	
25	M	√	IIIA	10	56	6	√	Posttraumatic arthritis (arthrodesis)
45	F		IIIA	8	76	2	√	
52	M		IIIA	6	81	1		
47	F	√	IIIC	12	76	1		First stage of hallux necrosis, skin necrosis; posttraumatic arthritis
39	M	√	IIIB	15	62	5	√	Posttraumatic arthritis (arthrodesis)

G-A = Gustilo–Anderson, RTW = return-to-work, VAS = visual analog scale.

Figure 3. First stage debridement, realignment, and K-wires fixation. The degloved skin was grafted in situ.

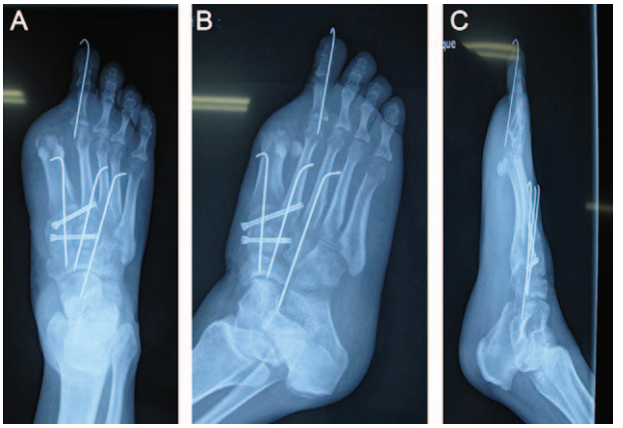

Figure 5. X-ray after the second stage definitive fixation. Two K-wires were replaced by 2 cannulated screws for stable fixation, and other wires were preserved because of the poor soft tissue condition. The hallux was amputated because of avascularity. (A) AP view, (B) oblique view, (C) lateral view.

evaluation of soft tissues condition. Subsequently, the postoperative X-ray image was checked (Fig. 4). After soft tissue condition improved, the second stage of operation was considered. We defined improved soft tissue condition as: reduced swelling; reduced wound exudation; no redness and swelling around wound; approximately same skin temperature compared to the contralateral foot.

To avoid the recurrence of column shortening, all the fixators were retained. The K-wires for lateral column fixation were also preserved for 6 weeks. For patients with dislocation, we replaced the K-wires with the 4.3-mm cannulated screws (Newdeal, Lyon, France) percutaneously depending on the soft tissue condition. For patients with metatarsal fractures, a definitive minifragment plate fixation (Synthes, Paoli, PA) was performed after evaluation of the soft tissue condition. If needed, a limited incision was created. An intraoperative fluoroscopy was performed to confirm the reduction and fixation. The simultaneous soft tissue coverage by local flap transfer or skin graft was performed for patients suffering from degloving injury or soft tissue defect. The flap donor site was covered by skin graft.

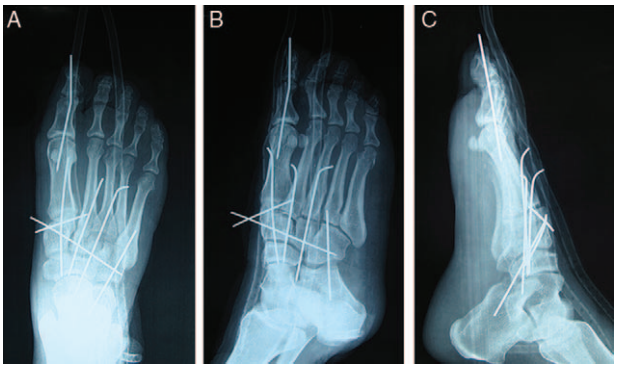

Figure 4. Postoperative X-ray after first stage operation displayed the acceptable alignment of the midfoot. One K-wire was inserted from the medial cuneiform to the base of 2nd metatarsal, and another K-wire was applied for the stabilization of intercuneiform joint. (A) AP view, (B) oblique view, (C) lateral view.

2.3. Postoperative management and follow-up

All patients received antibiotic therapy till the third day after the second stage operation. All the feet were immobilized for 2 weeks with a short leg cast. After removal of the cast, patients were encouraged to begin range of motion exercises of the foot and ankle. At the 6th week of follow-up, the K-wires and fixator were removed in the out-patient clinic, and partial weight-bearing was recommended with a walking boot and arch support for an additional 6 weeks, then gradually progressed to full weight bearing. All patients received comprehensive physiotherapy and gait training in the out-patient clinic.

For clinical outcome measurements at follow-up, current complaints, return-to-work (RTW) and complications were documented. The pain was evaluated by visual analog scale (VAS) system (range: 0–10). The overall function was evaluated with the AOFAS midfoot score system (range: 0–100).

Postoperative radiographic outcomes were assessed at AP, oblique, and lateral views. Any loss of reduction or incongruence of the joint surfaces and manifestations of posttraumatic arthritis was noted.

3. Results

The first stage emergency operation was performed at an average of 3.4 hours (range: 1–8 h) after initial trauma. After the first stage operation, no infection occurred. The average time interval between 2 stages was 9 days (range: 5–15 days). The definitive fixation and flap coverage or skin graft were performed in 3 patients with soft tissue defect on the 7th, 10th, and 15th day after the first stage operation. The patient with degloved skin suffered from hallux necrosis as a consequence of avulsion injury, and therefore we undertook a hallux amputation at the second stage operation (Fig. 5). Furthermore, partial skin necrosis was also seen in this patient, and we performed a local transfer flap coverage on the 12th day postoperatively.

Four patients were lost to follow-up within 3 months. The remaining 14 patients were followed up for a median period of 48 months (range: 36–60 months). Solid union was achieved in the 12.5th week (range: 10–16 weeks) after the second surgery. Flap necrosis, infection, nonunion, malunion, implant failure, loss of reduction, or osteomyelitis were not observed during the follow-up (Figs. 6 and 7). Six patients had radiographic manifestations

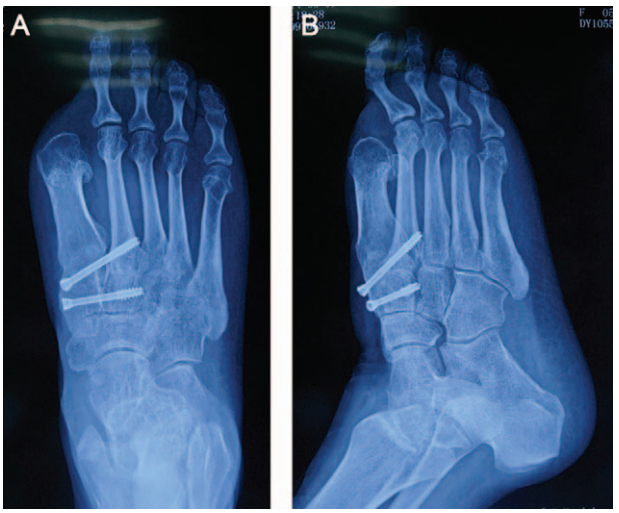

Figure 6. X-ray of the foot at 4 years after surgery showed the anatomic restoration of midfoot alignment. (A) AP view, (B) oblique view.

Figure 7. The photograph of the foot at 4 years after surgery displayed the acceptable appearance with the flap.

of arthritis, but only 2 of them underwent Lisfranc arthrodesis due to persistent pain secondary to posttraumatic arthritis. The median AOFAS midfoot score at the final follow-up was 74.4 ± 8.7 (range: 56–89), while the average VAS score was 2.2 ± 1.8 (range: 0–6). Nine patients were back to work at a median time of 8 months (range: 4–12 months) (Table 1).

4. Discussion

The severity and pattern of injury are important determinants for the outcome of open Lisfranc injuries. Generally, the final outcome mainly depends on the soft tissue injury and the management quality. Therefore, an early and appropriate wound management with realignment for fracture–dislocation is crucial to limit the complications. In our study, the first stage operation was performed in an average of 3.4 hours after injury. The limited soft tissue complication rate reflects our timely management.

Open Lisfranc injury is always caused by high energy trauma, leading to multiple fractures. Dubois-Ferriere et al[6] investigated the clinical outcome of tarsometatarsal joint complex injuries. Overall, the outcome was acceptable, however, posttraumatic arthritis still occurred in several patients. In our study, all patients suffered from a 3-column injury due to the high-energy trauma, and 6 developed radiographic manifestations of posttraumatic arthritis. Despite of this, only 2 of them, who underwent a complex injury initially, finally were subjected to a salvage midfoot arthrodesis. In the presence of well-planned staged management, most of the patients only had mild residual pain and limited function. At the final follow-up, the average AOFAS midfoot score was 74.4, and the median VAS score was 2.2. Moreover, most of young patients returned to work.

First stage internal fixation for high energy trauma of the foot and ankle may lead to a disaster because of the poor soft tissue condition unless simultaneous soft tissue coverage could be performed. Sanli et al[7] reported a case of primary internal fixation with soft tissue coverage for open Lisfranc injury, achieving favorable outcome, and suggested that this technique was feasible for this type of injury. On account of this, a staged protocol for open Lisfranc injury may be more applicable and reliable, which may minimize the soft tissue complication and improve the final clinical outcome. By virtue of this protocol, wound-related complications were not found after the definitive operation in our study. Moreover, The high amputation rate after Gustilo–Anderson type IIIC injury, uncontrollable deep sepsis or massive injury by high energy trauma has been reported.[8] Even though the injury of one Gustilo–Anderson type IIIC patient in our series was very severe, the foot was preserved with an acceptable function, which may be mainly attributed to the well-designed management.

The main purpose of first stage surgery is to stabilize the soft tissue and bony structures, however, the second stage definitive reconstruction is more challenging. Some procedures still remain controversy, especially for the ligamentous injuries. Some current studies suggested that for the ligamentous injuries or severe fracture–dislocation cases, a primary arthrodesis might be taken as the first option for better clinical outcome.[9–11] However, other clinical studies or meta-analysis concluded that no significance in functional outcome was found between these 2 procedures.[12,13] Schepers et al[14] even reported that ORIF may achieve better outcome in both low- and high-energy Lisfranc injuries. And Coetzee and Ly[15] also emphasized that primary tarosometatarsal arthrodesis should not be applied in all ligamentous injuries, especially for the hyper-plantar flexion injuries. Furthermore, the early degeneration of adjacent joint is another issue for a primary arthrodesis. So, we still prefer a primary ORIF even in ligamentous injuries. For lateral column injury or nutcracker fracture of cuboid, if reconstructable, ORIF should be taken the priority to maximally preserve the range of motion.[16]

For open Lisfranc injuries, the implants for fixation still remain debates at both stages. In this study, K-wires were used for temporary fixation. The advantages of K-wire fixation in case of open injury are that it avoids further soft tissue devitalization with an easy technique and facilitation for postoperative wound care and VSD application. Pin tract infection and loss of reduction are the major problems, which did not occur in our series. Nithyananth et al[17] also reported an acceptable outcome after the treatment of open Lisfranc injury with definitive K-wire fixation without further displacement so that they recommended the K-wires for the mainstream fixation of open Lisfranc injury. Mini fixator is also an alternative for Lisfranc stabilization.[18,19] Taking pin track infection into consideration,[20,21] we preferred to apply it only for the restoration of the length of shortening deformity.

In the second stage definitive fixation, trans-articular screw is often applied for rigid fixation of medial and mid column.[22,23]

Trans-articular screw can be implanted percutaneously, and patients with serious soft tissue injury may benefit from this minimal invasive technique. However, concern has been raised regarding further articular cartilage damage during the introduction of screws.[24] Currently, bridging plate fixation is more often used in internal fixation for Lisfranc injury.[25,26] In our study, for patients with metatarsal shaft or base fracture, screw fixation may cause implant failure. Therefore, bridging plate was applied in these patients for rigid stabilization of fracture–dislocation without injury to the articular surface, and implant failure and loss of reduction were not found postoperatively. Soft tissue management is a challenge for open Lisfranc injury. For degloving injury or soft tissue defect, VSD is preferred in the first stage management because of its facilitation of the growth of new capillaries and granulation tissues. A simultaneous flap transfer or skin graft at second stage will ensure the healing of soft tissue and coverage of implants. No soft tissue complications occurred after the second operation in our series.

This retrospective study still has some limitations. First, the sample size of this study was small, which may cause bias. Second, we did not perform comparative analysis and our evaluation is not comprehensive. All these will be improved in the future study.

In conclusion, staged management is applicable for open Lisfranc injury. This may achieve optimal outcomes through anatomic midfoot reconstruction and prevention of wound-related complications.

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