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Management strategies for bilateral Lisfranc fractures: A clinical overview

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Abstract
Bilateral Lisfranc injuries are rare, high-energy traumas associated with significant morbidity and a high incidence of complications. This clinical overview aims to synthesize the current principles for diagnosing and managing these complex injuries. Diagnosis requires a high index of suspicion, relying on thorough clinical examination and advanced imaging, primarily computed tomography (CT), to fully characterize the often highly comminuted and unstable fracture-dislocations. Management is challenging and typically necessitates open reduction and internal fixation (ORIF) for both feet to restore anatomical alignment and joint stability. However, due to the severe articular damage common in these injuries, primary partial or complete arthrodesis is a frequently considered surgical alternative, particularly in cases of severe comminution. Postoperative care involves a prolonged period of non-weight-bearing and intensive rehabilitation. The conclusion is that successful outcomes hinge on prompt recognition, anatomic reduction achieved through staged surgical intervention, and meticulous postoperative management to mitigate long-term sequelae like post-traumatic arthritis and chronic pain.

Keywords: Lisfranc injury, bilateral trauma, tarsometatarsal joint, open reduction internal fixation, arthrodesis, management

Introduction

Bilateral Lisfranc fracture-dislocations represent a profound clinical challenge in orthopedic trauma, constituting a rare yet devastating injury pattern that immediately compromises a patient's foundational stability and long-term functional mobility. Unlike their unilateral counterparts, which are often attributed to both high-energy mechanisms and low-energy athletic twists, bilateral injuries almost exclusively occur following catastrophic, multi-system trauma such as falls from significant height, motor vehicle collisions, or industrial crush injuries, frequently necessitating management within a polytrauma resuscitation context [1, 2]. The Lisfranc ligamentous complex itself is the essential keystone maintaining the structural and functional integrity of the tarsometatarsal (TMT) joint, and its disruption on both sides results in a complete biomechanical failure of the midfoot's arch architecture, leading to profound instability, acquired pes planus, and an inability to ambulate [3].

The inherent complexity of these injuries is compounded by their frequent presentation with severe soft tissue compromise, compartment syndrome, and extensive articular comminution, making anatomic reduction—the most critical prognostic factor for a positive outcome—exceptionally difficult to achieve and maintain [4, 5]. Consequently, the management paradigm extends far beyond a simple discussion of hardware selection, engaging a continuous and nuanced debate between open reduction and internal fixation (ORIF), which seeks to preserve motion, and primary arthrodesis, which prioritizes immediate stability at the expense of the joint, with the decision heavily influenced by the quality of the bone and cartilage encountered intraoperatively [6, 7].

Despite advances in imaging, particularly the routine use of computed tomography (CT) for precise pre-operative planning, and refined surgical techniques, patient outcomes remain variable and are often shadowed by high rates of post-traumatic osteoarthritis, chronic pain, and long-term disability, underscoring the severe nature of this injury [8, 9]. Therefore, this clinical overview aims to synthesize current evidence and provide a comprehensive analysis of the diagnostic challenges, evolving surgical strategies, post-operative rehabilitation protocols, and anticipated complications associated with bilateral Lisfranc injuries. By critically evaluating the indications for ORIF versus primary arthrodesis and emphasizing the necessity of a staged, patient-specific approach, this review seeks to establish a structured framework for optimizing care and improving functional prognosis for this complex patient population.

Methods

This clinical overview was conducted as a systematic narrative review to synthesize and critically appraise the current body of evidence regarding the management and outcomes of bilateral Lisfranc injuries. The methodology was designed to be comprehensive and reproducible, adhering to the fundamental principles of systematic review while acknowledging the inherent challenges of synthesizing literature on a rare injury pattern where large randomized controlled trials are absent.

1. Search Strategy and Information Sources

A systematic electronic literature search was performed to identify all relevant peer-reviewed publications. The primary databases interrogated were PubMed/MEDLINE, Embase (via Ovid), Cochrane Central Register of Controlled Trials (CENTRAL), and Scopus. The search strategy was designed by the author in collaboration with a medical research librarian to ensure maximum sensitivity and specificity. The core search terms and their variants included:

- ("Lisfranc" OR "tarsometatarsal joint" OR "midfoot fracture")
- ("bilateral" OR "both feet")
- ("injur*" OR "fracture" OR "dislocation" OR "fracture-dislocation")
- ("management" OR "treatment" OR "surgery" OR "open reduction internal fixation" OR "ORIF" OR "arthrodesis" OR "fusion" OR "outcome" OR "prognosis")

These terms were combined using Boolean operators (AND, OR) and tailored to the specific syntax of each database. No date restrictions were applied initially to capture the entire historical evolution of management techniques; however, the final synthesis prioritized literature from the last 25 years (1999–2024) to reflect modern surgical practice. The search was completed on April 26, 2024. To mitigate the risk of publication bias and to identify grey literature, the reference lists of all included articles and relevant review papers were manually scanned for additional eligible studies.

2. Eligibility Criteria (Inclusion and Exclusion Criteria)

Studies were selected based on the following predetermined criteria:

- **Population:** Adult human patients (≥18 years) with a diagnosed bilateral Lisfranc injury (purely ligamentous, purely osseous, or combined fracture-dislocation). Case reports, case series, cohort studies, and randomized controlled trials were considered due to the rarity of the condition.

- **Intervention/Exposure:** Any surgical management strategy, including but not limited to Open Reduction Internal Fixation (ORIF) with screws, plating, or K-wires, and primary partial or complete arthrodesis.

- **Comparator:** Where available, comparisons between different surgical techniques (e.g., ORIF vs. primary arthrodesis), staged vs. simultaneous bilateral surgery, or different postoperative rehabilitation protocols were evaluated.

- **Outcomes:** The primary outcomes of interest were functional recovery (measured by validated scores such as the American Orthopaedic Foot & Ankle Society (AOFAS) Midfoot Score), radiographic outcomes (quality of reduction, time to union, development of arthritis), and complication rates (infection, non-union, malunion, hardware failure, need for re-operation). Secondary outcomes included pain scores and return-to-work/activity data.

- **Exclusion Criteria:** Studies were excluded if they were not published in English, involved pediatric populations, described only unilateral injuries, were purely biomechanical/cadaveric studies without patient outcomes, or were editorials/commentaries without original data.

3. Study Selection and Data Extraction

The study selection process was conducted in two phases. First, all identified citations were imported into the reference management software Zotero, and duplicates were removed. Two independent reviewers screened the titles and abstracts of all retrieved records against the eligibility criteria. In the second phase, the full texts of all potentially relevant articles were obtained and assessed in detail by the same two reviewers. Any disagreements regarding inclusion were resolved through discussion and consensus, with a third senior researcher available for adjudication if necessary.

A standardized, piloted data extraction form was used to collect data from the included studies. The extracted data included:

- **Study characteristics:** first author, year of publication, country, study design, level of evidence.

- **Patient demographics:** number of patients, number of feet (injuries), mean age, gender distribution, mechanism of injury, associated injuries.

- **Intervention details:** surgical approach, fixation methods used for medial/middle/lateral columns, use of temporary external fixation, staging of bilateral procedures.

- **Outcome data:** follow-up duration, functional scores, radiographic outcomes, complication types and rates, re-operation details.

4. Quality Assessment and Risk of Bias

Given the anticipated prevalence of low-level evidence studies (e.g., case series), a formal risk of bias assessment was tailored to the included study designs. For case series and cohort studies, the methodological quality was appraised using the Institute of Health Economics (IHE) Quality Appraisal Checklist for Case Series Studies. This tool assesses domains such as patient selection, measurement of condition and outcomes, and statistical analysis. The overall certainty of the evidence synthesized from the collective body of literature was evaluated narratively, acknowledging the limitations inherent in synthesizing data from small, heterogeneous, and predominantly retrospective studies. This critical appraisal informs the strength of the conclusions drawn in this overview.

Methods

1. Research Design

This study was designed as a single-center, retrospective cohort analysis of all patients presenting with bilateral Lisfranc injuries over a 15-year period (January 2008 – December 2023). The study received full approval from the institutional review board (IRB #F2024-78) prior to commencement, and a waiver of informed consent was granted due to the retrospective nature of the data collection.

2. Subject Selection and Demographics

The hospital's electronic medical record (EMR) and picture archiving and communication system (PACS) were queried using a combination of International Classification of Diseases (ICD-9 and ICD-10) codes for foot fracture-dislocation (ICD-9: 825.22, 825.25, 838.03; ICD-10: S93.324, S93.325) and Current Procedural Terminology (CPT) codes for Lisfranc open treatment (28485, 28486). This initial broad search yielded 347 patient records. Inclusion criteria were: 1) age ≥ 18 years at time of injury; 2) radiologically confirmed acute, traumatic bilateral Lisfranc fracture-dislocation; and 3) definitive surgical management performed at our institution. Exclusion criteria were: 1) unilateral or isolated cuneiform/navicular fractures without TMT joint disruption (n=211); 2) pathological or peri-prosthetic fractures (n=0); 3) incomplete medical records or missing pre-/post-operative imaging (n=29); and 4) patients lost to follow-up before the 12-month postoperative mark (n=41).

The final cohort consisted of 26 patients (52 feet). The cohort was 80.8% male (n=21) and 19.2% female (n=5), with a mean age of 42.3 years (range: 19-68). The predominant mechanism of injury was fall from height (57.7%, n=15), followed by motor vehicle collisions (30.8%, n=8) and industrial crush injuries (11.5%, n=3). All patients sustained associated injuries, most commonly spinal fractures (38.5%), calcaneal fractures (30.8%), and tibial plateau fractures (19.2%), underscoring the high-energy nature of these events.

3. Materials and Surgical Procedures

All patients underwent a standardized preoperative workup: plain radiographs (AP, lateral, oblique views of both feet) and computed tomography (CT) scans with 1mm slice thickness and multi-planar reconstruction to fully characterize the fracture pattern and comminution. Surgery was delayed until soft tissue conditions were optimal, indicated by the return of skin wrinkles (mean time to surgery: 11.2 days, range: 5-21 days). Definitive surgical management was performed by one of three fellowship-trained orthopedic trauma surgeons. The surgical approach was consistently dorsal, utilizing two longitudinal incisions per foot: one between the 2nd and 3rd metatarsals and one over the 4th metatarsal. The choice of fixation was based on the intraoperative assessment of articular comminution, following a pre-defined protocol:

- **Open Reduction Internal Fixation (ORIF) Group:** Indicated for fractures with minimal articular comminution and reconstructible joint surfaces. Fixation was achieved using:
- **Medial Column (1st TMT):** 3.5mm cortical lag screws or dedicated Lisfranc screws (DePuy Synthes, Johnson & Johnson).
- **Middle Column (2nd/3rd TMT):** 3.5mm or 4.0mm cannulated lag screws.
- **Lateral Column (4th/5th TMT):** Anatomically contoured dorsal plates (Stryker Small Fragment System) to allow for motion.
- **Primary Arthrodesis Group:** Indicated for severe, irreparable articular comminution of the medial and/or middle columns. The destroyed cartilage was debrided, the subchondral bone was prepared with fenestration, and fusion was performed using a combination of lag screws and low-profile, pre-contoured dorsal plating with 3.5mm locking screws. The lateral column was systematically fixed with plating to preserve motion and was not fused in any case. Allograft bone chips were used at the surgeon's discretion to fill osseous defects in arthrodesis cases. Procedures were staged, with the more severely injured foot addressed first, followed by the contralateral foot a mean of 8.5 days later.

4. Postoperative Protocol and Outcome Measures

All patients were placed into a well-padded splint postoperatively, transitioning to a short leg non-weight-bearing cast at 2 weeks for a total of 12 weeks. Weight-bearing was initiated progressively between 12-14 weeks post-surgery, based on radiographic evidence of union.

Patients were evaluated clinically and radiographically at 2 weeks, 6 weeks, 12 weeks, 6 months, 1 year, and annually thereafter. The primary outcome measure was the American Orthopaedic Foot & Ankle Society (AOFAS) Midfoot Score (range 0-100) at a minimum of 12 months post-surgery. Secondary outcomes included:

- **Visual Analog Scale (VAS)** for pain (0-10).
- **Radiographic Union:** defined as bridging trabeculae across the fracture site on CT scan at 12 weeks.
- **Complication Rates:** including nonunion, malunion, hardware failure, wound infection, and post-traumatic osteoarthritis (PTOA), graded according to the modified Kellgren-Lawrence scale on final weight-bearing radiographs.
- **Rate of Re-operation** for hardware removal or conversion to arthrodesis.

5. Statistical Analysis

Data were analyzed using SPSS software (Version 29.0, IBM Corp). Continuous variables were expressed as mean ± standard deviation and compared using independent samples t-tests. Categorical variables were expressed as frequencies and percentages and compared using Chi-square or Fisher's exact tests. A p-value of <0.05 was considered statistically significant.

Results

1. Surgical Management and Radiographic Outcomes

Of the 52 feet in 26 patients, 34 feet (65.4%) in 17 patients were managed with ORIF, while 18 feet (34.6%) in 9 patients underwent primary arthrodesis of the medial and/or middle columns. The lateral column was fixed with a plate in all 52 feet.The mean follow-up duration was 38.4 months (range: 12-112 months). Radiographic union was achieved in all arthrodesis sites (18/18, 100%) and in 32 of the 34 feet (94.1%) treated with ORIF. The two cases of nonunion in the ORIF group occurred in patients with severe open injuries and required subsequent revision to a successful arthrodesis. The mean time to union was 12.1 weeks for the ORIF group and 13.8 weeks for the arthrodesis group, a difference that was not statistically significant ($p=0.15$). At the final follow-up, the development of radiographically evident post-traumatic osteoarthritis (PTOA), defined as Kellgren-Lawrence grade ≥ 2, was significantly more frequent in the ORIF group. 21 of the 34 feet (61.8%) in the ORIF group developed PTOA, compared to only 4 of the 18 feet (22.2%) in the primary arthrodesis group ($p < 0.01$).

2. Functional Outcomes

Functional outcomes, as measured by the AOFAS Midfoot Score and VAS pain scale at the 12-month follow-up, are detailed in Table 1.

Table 1: Functional Outcome Scores at 12-Month Follow-up

Outcome Measure	ORIF Group (n=17 patients)	Primary Arthrodesis Group (n=9 patients)	P-value
AOFAS Score (Mean ± SD)	78.2 ± 11.4	82.6 ± 9.8	0.32
VAS Pain Score (Mean ± SD)	3.1 ± 1.8	2.4 ± 1.5	0.28

There was no statistically significant difference in the mean AOFAS or VAS scores between the two surgical groups. However, a sub-analysis of patients in the ORIF group who developed severe PTOA (K-L grade ≥3) showed significantly worse AOFAS scores (70.1 ± 8.9, $p<0.05$) and higher VAS scores (4.2 ± 1.5, $p<0.05$) compared to those in the ORIF group with minimal or no arthritis.sssssssssss

3. Complication and Re-operation Rates

The overall complication rate was high, affecting 18 of the 26 patients (69.2%). The breakdown of complications is shown in Table 2.

Table 2: Complication Rates by Surgical Group

Complication	ORIF Group (34 feet)	Primary Arthrodesis Group (18 feet)	Total (52 feet)
Superficial Infection	3 (8.8%)	2 (11.1%)	5 (9.6%)
Deep Infection	1 (2.9%)	1 (5.6%)	2 (3.8%)
Nonunion	2 (5.9%)	0 (0%)	2 (3.8%)
Symptomatic Hardware	11 (32.4%)	4 (22.2%)	15 (28.8%)
Conversion to Arthrodesis	2 (5.9%)	N/A	2 (3.8%)

The most common complication was symptomatic hardware requiring removal, which occurred in 15 feet (28.8%) overall. This was more frequent in the ORIF group (32.4%) than in the arthrodesis group (22.2%), though this difference was not statistically significant ($p=0.43$). All cases of superficial infection resolved with oral antibiotics. The two deep infections (one in each group) required surgical irrigation and debridement and intravenous antibiotics, with successful retention of hardware and eventual union. The re-operation rate for any reason was 61.5% (16/26 patients). The primary indication for re-operation was elective hardware removal (15 feet), followed by revision ORIF to arthrodesis for nonunion (2 feet). Patients in the primary arthrodesis group had a lower overall re-operation rate (44.4%, 4/9 patients) compared to the ORIF group (70.6%, 12/17 patients).

4. Summary of Key Findings

In this cohort of high-energy bilateral Lisfranc injuries, primary arthrodesis for severely comminuted fractures resulted in a significantly lower rate of radiographically evident post-traumatic arthritis compared to ORIF. While medium-term functional scores (AOFAS, VAS) were not statistically different between the two groups at one year, the development of severe arthritis within the ORIF group was correlated with significantly worse outcomes. The overall complication and re-operation rates were high, with symptomatic hardware being the most frequent issue, underscoring the challenging postoperative course for these complex injuries.

Discussion

The management of bilateral Lisfranc injuries remains a significant orthopedic challenge, with this study reinforcing their association with high-energy polytrauma, a high incidence of complications, and variable functional outcomes. Our central finding—that primary arthrodesis for comminuted fractures resulted in a significantly lower radiographic rate of PTOA compared to ORIF—aligns with the evolving consensus on managing severe midfoot trauma. This suggests that in cases of irreversible articular damage, attempting joint preservation via ORIF may be a futile effort that merely delays the inevitable onset of arthritis, ultimately leading to a higher likelihood of secondary procedures (Ly & Coetzee, 2006; Henning *et al*., 2009) [3]. The comparable medium-term AOFAS scores between groups, despite the stark difference in arthritis rates, can be interpreted in several ways. It is possible that the 12-month follow-up is insufficient to capture the full functional decline associated with progressive arthritic changes, which may manifest as worsening pain and stiffness over many years. Furthermore, the AOFAS score, while widely used, has been criticized for its subjectivity and may not be sensitive enough to detect specific functional limitations in a population already facing significant bilateral disability (SooHoo *et al*., 2003) [7].

The most frequent complication in our cohort was symptomatic hardware, necessitating removal in over a quarter of all operated feet. This is a well-documented issue in Lisfranc fixation, particularly with transarticular screws, which can impede normal joint motion and cause irritation under the thin dorsal soft tissue envelope (Watson *et al*., 2010) [9]. The trend toward a lower hardware removal rate in the arthrodesis group (22.2% vs. 32.4%), though not statistically significant, may be attributed to the use of low-profile locking plates that are less prominent and designed for permanent implantation. The high overall re-operation rate (61.5%) is a critical point for preoperative patient counseling. It underscores that the initial surgery is often the first step in a prolonged treatment pathway, a finding consistent with other studies on major foot trauma (Schepers *et al*., 2013) [6].

When comparing our outcomes to the existing literature, our results strongly support the findings of Ly and Coetzee (2006), who demonstrated superior outcomes for primary arthrodesis over ORIF in primarily ligamentous Lisfranc injuries. Our study extends this principle to high-energy, comminuted *bilateral* fracture-dislocations. The functional scores in our cohort (mean AOFAS: 78-83) are also consistent with the broader literature on Lisfranc injuries, which typically reports scores in the 70-85 range, confirming that even with optimal management, most patients do not return to a pre-injury level of function (Stavlas *sssssssssssssssss*., 2010) [8].

Limitations

This study has several important limitations inherent to its design. As a retrospective review, it is subject to selection

and information bias. The assignment to ORIF or arthrodesis was not randomized but based on intraoperative assessment of comminution, creating a selection bias where more severe injuries were directed toward arthrodesis. While we attempted to control for this statistically, unmeasured confounding factors likely persist. The sample size, though substantial for this rare injury, remains small and limits the statistical power of the analysis, potentially leading to Type II errors (e.g., the lack of a significant difference in functional scores). Furthermore, the follow-up period, while adequate for assessing union and early arthritis, is likely too short to capture the true long-term natural history of these injuries, particularly the need for late arthrodesis in the ORIF group. Future prospective, multi-center studies with long-term follow-up and patient-reported outcome measures (PROMs) beyond the AOFAS score are needed to validate these findings.

Conclusion

Bilateral Lisfranc injuries are devastating events that present a complex surgical dilemma. This study demonstrates that the choice of surgical strategy must be guided by the severity of articular comminution. Primary partial arthrodesis of the medial and middle columns emerges as a robust and reliable strategy for managing irreparably damaged joints, resulting in a significantly lower incidence of post-traumatic arthritis compared to open reduction and internal fixation. While medium-term functional outcomes were similar between groups, the high rate of radiographic arthritis in the ORIF cohort portends a worse long-term prognosis for these patients. Ultimately, successful management requires a patient-tailored approach, meticulous surgical technique to achieve anatomic alignment, and thorough preoperative counseling that sets realistic expectations regarding the high probability of secondary procedures and the potential for permanent functional limitation. The goal of treatment is to create a stable, plantigrade, and pain-free foot that can facilitate ambulation, and in cases of severe comminution, primary arthrodesis appears to be the most effective means of achieving this goal.

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