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Treatment and Hardware Removal after Lisfranc Injury: A Narrative Review

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Abstract

Lisfranc injuries can be difficult injuries to identify and treat, while also being the subject of significant debate on proper surgical management. A narrative literature review was performed using Pubmed and Google Scholar databases to identify recent studies evaluating open reduction internal fixation vs primary arthrodesis for Lisfranc injuries to further elucidate optimal surgical management. Additional focus was placed removal of hardware after ORIF to identify the need for routine hardware removal as an additional surgery may guide surgeon decision-making. This review showed inconclusive data on the superiority of ORIF vs arthrodesis, as multiple conflicting results exist, though established that functional results are similar between these options. Though both are generally accepted treatment options, there are no well-designed randomized controlled trials directly comparing the two. Retention of hardware after ORIF has been shown to be tolerated, though there is a significant risk of the need for unplanned removal due to pain and hardware breakage.

Keywords

Lisfranc, Fixation Type, Hardware Removal, Hardware Retention

1. Lisfranc Injuries

The Lisfranc joint complex is composed of articulations between the tarsometatarsal, intermetatarsal and intertarsal joints, while being supported by ligamentous structures to provide support to the transverse arch of the midfoot [1]. Lisfranc injuries are defined by disruption of the articulation between the medial cuneiform and the medial base of the second metatarsal, where the oblique interosseous ligament, also known as the Lisfranc ligament, serves as the strongest

support [2] [3]. Lisfranc injuries consist of a wide range of injuries from purely ligamentous sprains to fracture-dislocation injuries with significant soft tissue injury [4] [5]. They represent about 0.2% of all fractures with an estimated incidence of 1/55,000 in the U.S. annually, though can be a challenge with regard to diagnosis and treatment [6]. Despite how common these injuries may be, up to 20% of Lisfranc injuries are missed at initial assessment [7]. Delayed diagnosis is associated with significant morbidity as patients may have an increased risk of developing midfoot instability, arch collapse, post-traumatic arthritis, deformities, and chronic pain [8] [9]. Therefore, practitioners must have a high suspicion for Lisfranc injuries when a patient presents with midfoot pain and should have a low threshold in ordering additional diagnostic tests.

2. Diagnosis

A thorough history and physical exam are important in assessing Lisfranc injuries. These injuries most commonly occur with low-energy trauma, representing approximately 55%, though regularly occur via high-energy trauma as well [4] [10] [11]. The most common mechanism of injury is a rotational force with an axial load on a hyperplantarflexed foot in low-energy trauma and direct crush injury in high-energy trauma. Low-energy mechanisms may include falls or sporting activities, whereas high-energy activities are commonly motor vehicle collisions or fall from significant heights [11]. High-energy trauma often leads to an easier diagnosis secondary to the direct nature of the trauma, compared to the indirect trauma seen in low-energy trauma [12]. The provider must have high suspicion in low energy trauma patients with midfoot pain, particularly if they present with difficulty weight bearing. Physical examination may reveal plantar edema or ecchymosis and tenderness to palpation at the midfoot [4] [13]. Standard 3 view radiographs of the foot are recommended initially to assess for bony injuries, such as the "fleck sign" from an avulsion of the Lisfranc ligament [1]. When a Lisfranc injury is in the differential diagnosis based on the mechanism and physical exam, weight-bearing radiographs are typically the first additional diagnostic imaging ordered, as non-weight missed up to 40% of these injuries [14]. The next diagnostic test would be computed tomography (CT) or magnetic resonance imaging (MRI). A CT scan may be utilized when a subtle fracture is suspected on radiographs as it will show subtle bony injuries and comminution across the Lisfranc joint, which can prove especially useful when determining operative management [15]. When radiographs are negative and a purely ligamentous injury at the Lisfranc joint is suspected, an MRI should be ordered. Raikain *et al.* found that MRI correctly identified 90% of ligamentous Lisfranc injuries when compared to intraoperative findings [16]. CT or MRI may also be obtained when patients are unable to participate in weight-bearing radiographs. A final option when all imaging is negative is stress maneuvers under anesthesia, though this is very rare and would likely be a last resort in patients who are unable to receive advanced imaging. In a cadaveric study by Coss *et al.*,

abduction stress maneuvers were been found to be superior to weight-bearing radiographs in purely ligamentous Lisfranc injuries [17].

3. Treatment

Non-operative management is typically reserved for Lisfranc sprains or non-displaced intra-articular fractures that are proven to be stable with weight-bearing [18]. Nonoperative management involves boot or cast immobilization with serial radiographs with the patient kept non-weight bearing for 4 - 8 weeks [19].

Surgical management is required for all unstable Lisfranc injuries as the prognosis and progression of post-traumatic osteoarthritis following a Lisfranc injury is highly dependent on an anatomic reduction. Traditional operative management is open reduction internal fixation (ORIF), though there has been increasing debate on the use of primary arthrodesis for these injuries. ORIF may be performed via trans-articular screws, dorsal plating, or a combination of the two [20]. Trans-articular screws may cause further damage to the articular surface, which is avoided by joint-spanning dorsal plates [4]. Both methods have been shown to have similar stability with weight bearing in biomechanical studies though Kirzner *et al.* showed improved functional outcome scoring and improved anatomic reduction in patients treated with dorsal plating compared to trans-articular screws [21] [22]. In patients with a tenuous soft tissue envelope, dorsal plating may be avoided due to a wider surgical exposure.

Arthrodesis was reserved as a salvage procedure for patients with failed ORIF or who developed post-traumatic OA, though, over the past decade, primary arthrodesis has been increasingly used as an initial treatment option [9] [23]. In injuries with significant articular damage, primary arthrodesis can be used to prevent future surgery for post-traumatic osteoarthritis [24]. Primary arthrodesis serves as a particularly good option for highly comminuted, unstable injuries due to bone loss and high reoperation rates with ORIF [25] [26] [27]. Arthrodesis also avoids additional surgeries for removal of hardware, which is often seen in ORIF.

There have been multiple studies comparing ORIF with primary arthrodesis with mixed results. Henning *et al.* found no difference in short form 36 (SF-36) and short musculoskeletal functional analysis (SMFA) outcome scores between primary arthrodesis and ORIF at any time interval up to 24 months [28]. Smith *et al.*, in their systematic review and meta-analysis, did not find any difference in patient-reported outcomes between ORIF and primary arthrodesis, though ORIF had a higher rate of revision and persistent pain compared to arthrodesis [29]. Magill *et al.*, in their systematic review and meta-analysis, found that primary arthrodesis is potentially associated with better pain and functional outcomes with a decreased rate of revision surgery, as well [30]. In contrast, Budda *et al.* found that when excluding routine hardware removal in ORIF, there was no difference in reoperation rates between ORIF and primary arthrodesis [31]. Ly *et al.*

found 92% of Lisfranc injuries treated with arthrodesis returned to pre-injury level of function, compared to 65% in the ORIF group [32], though this study only included 41 patients. Each of these studies was not able to adequately conclude that one method was superior to the other, but ORIF had consistently higher re-operation rates, though it is unclear how clinically significant this is in terms of patient outcome.

A newer, less studied, alternative treatment option to avoid the complications associated with ORIF and arthrodesis is the use of bioabsorbable screws. The most common bioabsorbable screws available now are composed of polylactic acid (PLA), which is weaker in comparison to steel screws, though are sufficient for Lisfranc fixation while patients are kept non-weight bearing [33] [34]. Ahmad *et al.* found that bioabsorbable screw fixation had comparable foot and ankle ability measure (FAAM) scores and radiographic outcomes as steel screw fixation in unstable Lisfranc injuries, with the added benefit of no need for hardware removal [35]. This method has not been adequately studied, particularly with long-term efficacy, to recommend its routine use in the care of these injuries.

4. Hardware Removal after ORIF

The management of hardware following Lisfranc ORIF is an area of ongoing debate. Traditionally, Lisfranc ORIF protocols called for routine hardware removal performed 3 - 4 months post-operatively [28] [36]. The primary purpose for removal of hardware after Lisfranc ORIF is to restore midfoot mobility and preoperative function, with additional benefits of prevention of painful hardware, broken hardware with weight-bearing, and more complicated potential future surgeries for post-traumatic OA [37]. Rhodes *et al.* conducted a systematic review comparing functional outcomes and complications between patients with routine hardware removal and retention of hardware via 28 studies, 10 studies on hardware retention and 18 on routine hardware removal. There was no significant difference between functional outcome scoring though 62.5% of patients in the retention group had unplanned hardware removal. The most common reasons for unplanned hardware removal were pain and broken hardware, though 68% of these procedures had no stated reason for removal [38]. This shows that hardware is still commonly removed, even if it was not planned pre-operatively. The disadvantages of routine hardware removal, aside from typical risks of an additional surgery, include a significantly increased risk for deep peroneal nerve injury. Brown *et al.* found that the rate of nerve injury after primary ORIF was 11% compared to 23% after hardware removal [39] [40] [41], likely due to scar formation from previous instrumentation. Ly *et al.*, in their study, demonstrated that patients who had routine hardware removal after Lisfranc ORIF had post-operative complications of increased deformity, loss of reduction, and degenerative joint disease [32]. Removal of hardware prior to sufficient healing may contribute to these high rates of reduction loss [35]. In

contrast, VenPalt *et al.* conducted a retrospective review evaluating radiographic outcomes in patients who underwent Lisfranc ORIF without routine hardware removal by assessing radiographs at 2 weeks, 6 weeks, 3 months, 6 months, and 12 months post-operatively. In 61 patients, they found over 80% of their patients had adequate reduction at final follow-up and concluded that retaining hardware was well tolerated [42]. Conflicting data on the routine removal of hardware make individual patient factors all the more important. For patients that are highly active and would benefit from increased midfoot mobility such as athletes, routine removal of hardware would be advised. However, for most patients, loss of TMTJ motion in the midfoot was not shown to affect patient functional outcomes, suggesting there is no added benefit to increased mobility seen with hardware removal [32] [42].

To date, there are no well-designed randomized control trials comparing outcomes after routine hardware removal and retention of hardware after Lisfranc injury. However, available literature does suggest that retention of hardware after Lisfranc fixation can be well tolerated, though patients often require removal for painful hardware or broken hardware. The authors suggest retention of hardware unless the patient is symptomatic.

5. Conclusion

In conclusion, Lisfranc injuries are difficult to effectively manage, depending on the involvement of bony and ligamentous structures. Prompt diagnosis and treatment are crucial in salvaging motion and function of the midfoot. There is significant controversy regarding the optimal surgical fixation method, which includes ORIF, primary arthrodesis, or bioabsorbable screw fixation. Though there are conflicting data on which is superior, ORIF and primary arthrodesis consistently have similar results in function and are accepted as reasonable fixation methods. Arthrodesis may be considered for comminuted fractures and patients who are not optimal surgical candidates to prevent an additional procedure for hardware removal, which is a common complication in ORIF. When anatomic reduction can be obtained, ORIF is a viable option. There is no consensus on the necessity of routine hardware removal in patients treated with ORIF, though similar function levels with retention suggest routine removal is not needed. Patients with retained hardware must be counseled about the high risk of unplanned removal, typically secondary to painful or broken hardware. Future randomized control trials directly comparing the arthrodesis and ORIF would hopefully further elucidate if there is a superior fixation method. Ultimately, these injuries can be safely treated with ORIF or arthrodesis and the decision should be made based on fracture pattern, surgeon preference, and patient factors until further evidence is available.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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