Indian Journal of Orthopaedics Surgery 2023;9(4):254–257

Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Orthopaedics Surgery

Journal homepage: https://www.ijos.co.in/

Case Report

# A novel technique for successful closed reduction of a lisfranc fracture-dislocation

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ARTICLE INFO

*Article history:*
Received 15-09-2023
Accepted 09-10-2023
Available online 07-12-2023

*Keywords:*
Foot & Ankle
Trauma
Lisfranc
Midfoot injury
Orthopaedic surgery

ABSTRACT

**Background:** The purpose of this study is to present a novel technique for the closed reduction of a divergent Lisfranc fracture-dislocation. Successful closed reduction of this injury limits the morbidity associated with soft tissue compromise that may otherwise delay definitive surgical fixation.

**Materials and Methods:** A combination of weighted axial traction/counter-traction with a two-stage manipulation of the medial/middle and middle/lateral columns of the mid- and forefoot was performed. A Kling was affixed to the hallux and second ray within closed loops, then mounted to an intravenous pole. Weight was then applied to the distal tibia. Axial traction-counter traction and manual plantar translation with medial to lateral compression were then combined until successful reduction of the first and second metatarsal was achieved. The third, fourth and fifth metatarsals were hyper-dorsiflexed and abducted with subsequent inline manual traction and lateral to medial compression over the base of the metatarsals. This was followed by plantarflexion and adduction to complete the reduction maneuver.

**Results**: A combination of weighted axial traction/counter-traction with two-stage manipulation of the medial/middle and middle/lateral columns of the mid- and forefoot was performed to successfully reduce a divergent Lisfranc fracture-dislocation. Successful closed reduction avoided the need for acute open reduction and mitigated the risk of soft tissue compromise, neurovascular complication, and compartment syndrome.

**Conclusion:** This novel technique for reduction permitted percutaneous internal fixation due to the satisfactory alignment obtained from the closed reduction maneuver. Early closed reduction obviates the need for acute open reduction and limits soft tissue morbidity. This permits orthopaedic surgeons to non-urgently manage Lisfranc fracture-dislocations with definitive surgical fixation that is amenable to either percutaneous techniques or open reduction and internal fixation.



## 1. Introduction

The Lisfranc injury is an eponym attributed to French gynecologist and field surgeon Jaques Lisfranc de Saint-Martin, who described an amputation through the tarsometatarsal (TMT) joint in 1815.[1] Lisfranc injuries encompass a broad spectrum of pathology, ranging from high to low energy mechanism. These can either be purely ligamentous, associated with fractures (metatarsals, cuneiforms or cuboid), or a combination of ligamentous and osseous pathology.[2–4] Indirect injuries can also occur with axial loading of a plantarflexed foot, resulting in bending and torsion of the tarsus.[5]

Fracture-dislocations are relatively uncommon. Lisfranc injuries have an annual incidence of 1 per 55,000 persons, accounting for approximately 0.2% of all fractures.[4] However, it is estimated that approximately 20-40% percent of these injuries go undiagnosed, often attributed to the subtle nature of the malalignment from ligamentous disruption.[6] Subsequent failure to accurately diagnose and

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https://doi.org/10.18231/j.ijos.2023.048

treat these injuries can lead to post-traumatic osteoarthritis, chronic pain and long-term disability.[2,3]

## 2. Lisfranc Anatomy

The Lisfranc joint complex is the articulation formed by the bases of the five metatarsals (M1-5), cuboid (Cu) and medial, middle (or intermediate) and lateral cuneiforms (C1, C2, C3). The Lisfranc joint complex is linked by ligamentous and capsular structures to connect the forefoot with the midfoot.[6]

The bases of the first, second and third metatarsals and the cuneiforms are trapezoidal in shape (narrower on the plantar aspect than the dorsal aspect). This forms a "Roman Arch", also known as the transverse arch, in the coronal plane with a plantar concavity. This arch confirs stability to the midfoot.[3] The second metatarsal is recessed between the first and third metatarsals and articulates minimally with the medial and middle cuneiform. The recessed second TMT creates a "Mortise" type joint, serving as the "Keystone" of the arch and midfoot complex.[3,4,6]

The Lisfranc ligamentous complex is comprised of dorsal, interosseous, and plantar tarsometatarsal ligaments. The base of the second to the fifth metatarsals are connected by transverse intermetatarsal ligaments. There is no intermetatarsal ligament between the base of the first and second metatarsals.[2,4,5] The traditional Lisfranc ligament is often described as the thick interosseous ligament spanning the medial aspect of the base of the second metatarsal to the medial cuneiform.[7] The Lisfranc ligament is the strongest of the cuneometatarsal interosseous ligaments and courses from the plantar surface of the lateral aspect of the medial cuneiform to the second metatarsal.[5] The dorsal ligaments are weaker than the plantar ligaments.

In the Tricolumn Theory, described by Sands & Grose,[8] the foot is divided into the medial, middle, and lateral columns that provide midfoot stability throughout the gait cycle. The medial column is formed by the first metatarsal, medial cuneiform, and navicular. The medial column affords stability to the midfoot, bearing the majority of the load during stance. The middle column is formed by the second and third metatarsals articulating with the middle and lateral cuneiforms. The middle column is the most rigid, allowing for push off. The lateral column is formed by the articulation of the fourth and fifth metatarsals with the cuboid and has the most inherent mobility of the three columns. This permits accommodation of the foot to navigate uneven terrain.[3,5,9]

## 3. Case Presentation

A 33-year-old male was sent to the emergency department, after being evaluated in the office, for attempted closed reduction of a foot injury he sustained 4 days prior. The patient reported that his right foot was "stepped on" and he fell awkwardly to the right side while intervening in an altercation. The patient was noted to have significant edema to the dorsum of the right foot with a prominent medial eminence of the first ray. His foot was neurovascularly intact; however, he had significant pain over the foot with visible deformity. Plain films and Computed-Tomography (CT) were performed. A diagnosis of divergent type Lisfranc fracture dislocation of the right foot was made (Figures 1 and 2). Closed reduction was performed in the emergency department (Figure 3).


**Figure 1:** Initial injury films in emergency department. AP (**A**), oblique (**B**) and lateral (**C**) radiographs of the right foot demonstrating a divergent type Lisfranc injury

## 4. Results

While the patient was under conscious sedation, a combination of weighted axial traction/counter-traction with a two-stage manipulation of the medial/middle and middle/lateral columns of the mid- and forefoot was performed to successfully reduce a divergent Lisfranc fracture-dislocation. Ten mililiters of 1% lidocaine without epinephrine was injected equally into the second and third tarsometatarsal joint spaces. A Kling was affixed to the

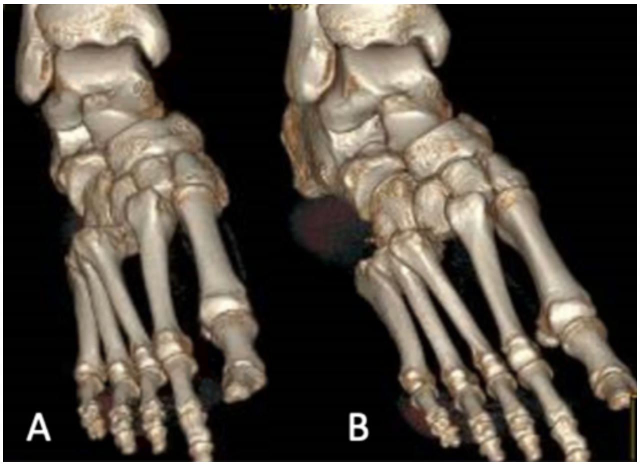


**Figure 2:** Pre-reduction CT-scan demonstrating lateral subluxation first MT base with respect to medial cuneiform, widening of the second TMT joint, lateral dislocation 3-5 MT bases

hallux and second toe within closed loops. The Kling was then mounted to an intravenous pole and the knee was extended with the ankle suspended. Approximately 10 pounds of weight was applied to the distal tibia. Axial traction-counter traction and manual plantar translation with medial to lateral compression were then combined until successful reduction of the first and second metatarsal was achieved. Attention was then turned to the third metatarsal and lateral column. With the ankle still suspended, the third to fifth metatarsals were hyper-dorsiflexed and abducted with subsequent inline manual traction. Lateral to medial compression was applied over the base of the metatarsals followed by plantarflexion and adduction of the third to fifth metatarsals (Figure 3). Reduction was achieved, and satisfactory alignment was confirmed using fluoroscopy. The patient's post-reduction neurovascularly exam remained intact.

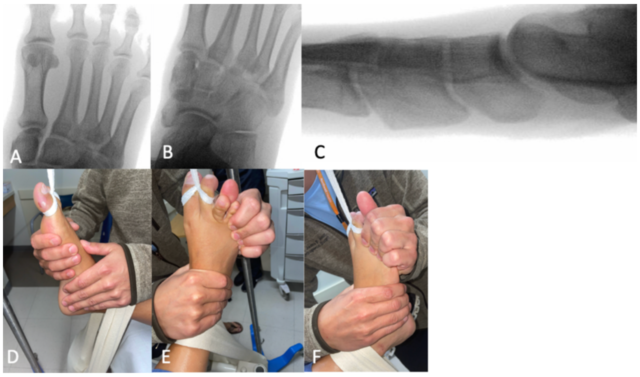


**Figure 3:** Post reduction fluoroscopic images in emergency department (**A-C**): Reduction technique: Axial traction with plantar translation (**D**): Hyper-dorsiflexion, abduction and traction; (**E**): lateral to medial compression (**F**)

A combination of weighted axial traction/counter-traction with two-stage manipulation of the medial/middle and middle/lateral columns of the mid- and forefoot was performed to successfully reduce a divergent Lisfranc fracture-dislocation. This avoided the need for acute open reduction and mitigated the risks of soft tissue compromise, neurovascular complications, or compartment syndrome.

The successful reduction permitted the patient to be brought to the operating room for percutaneous stabilization on an elective basis. The reduction eliminated the stress on the soft tissues, removing the urgent nature of reduction in the operating room due to risk of soft tissue compromise (tenting, blanching, wound creation). This provided surgical options of open reduction and internal fixation versus percutaneous screw placement.

A percutaneous screw was placed from the medial cuneiform to the base of the second metatarsal to stabilize the first to third tarsometatarsal joints. On stress examination, intercuneiform instability was noted. Then the medial and middle cuneiform were percutaneously stabilized (Figure 4).


**Figure 4:** Post-operative fluoroscopic images demonstrating C1-M2 & Intercuneiform stabilization (**A-B**) and 6 weeks follow up post-operative radiographs (**C-E**)

The patient has been followed without complication for 12 months. The patient is ambulating without assistive devices in running sneakers and performing light activity.

## 5. Discussion

Lisfranc injuries are complex, difficult to identify and frequently missed. Anatomic alignment and stable reduction are crucial for a successful outcome.

Multiple methods of Lisfranc reductions have been described. This includes a spectrum from direct to indirect as well as closed versus open techniques.[7,9–11] Methods utilizing finger traps to provide longitudinal distraction followed by percutaneous placement of Kirschner wires to stabilize the reduction or a Steinmann pin with Kling or Kerlix to manipulate the rays are described.[7]

A mal-reduced Lisfranc joint can lead to debilitating pain, forefoot instability, and accelerated post-traumatic arthritis. Our reduction technique for a Lisfranc dislocation reduction emphasizes axial traction through the second metatarsal, as the second metatarso-cuneiform articulation is the "keystone" of the Lisfranc joint. This "keystone" is imperative for anatomic reduction and stability since the second metatarsal is recessed between the medial and lateral cuneiform. Recreating the mortise-type configuration of the recessed second metatarsal should confer boney stability. However, this could be limited based upon the specific injury pattern. Subsequent areas of dislocation are then able to be manipulated with traditional reduction methods and techniques to restore fore- and midfoot alignment.

Our reduction technique has many advantages. Kling or Kerlix suspension of the foot with counterweights on the distal tibia permits the reduction to be completed by a sole-practitioner, with ample space for fluoroscopy or flat-plates in either the emergency department or the operating room. The reduction maneuver can be attempted in the emergency department with a local anesthetic block, or with sedation –depending on patient specific requirements and injury morphology. The closed nature of the reduction reduces soft tissue complications surrounding the operative site and permits early percutaneous fixation of the Lisfranc complex. However, there is concern of soft tissue injury to the skin of the first and second metatarsal with prolonged weighted-axial traction. This method is relatively safe, easily performed by a sole-practitioner and effective to reduce a divergent Lisfranc fracture-dislocation.

## 6. Conclusion

This reduction maneuver for a Lisfranc fracture-dislocation type injury is a non-invasive technique for successful closed reduction. Early closed reduction obviates the need for acute open reduction and limits soft tissue morbidity. This permits non-urgent definitive surgical fixation that is amenable to either percutaneous techniques or open reduction and internal fixation.

## 7. Source of Funding

None.

## 8. Conflict of Interest

None.

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**Cite this article:** Henry JP, Discala N, Rizzo SE, Bitterman AD. A novel technique for successful closed reduction of a lisfranc fracture-dislocation. *Indian J Orthop Surg* 2023;9(4):254-257.