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Direct Axial Impact Causing Lisfranc Fracture: Case Study and Literature Review

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Abstract: Lisfranc fractures are uncommon injuries accounting for only 0.2% of all fractures. The joint complex acquires stability through its osseous arrangement and ligamentous attachments. The strong interosseous Lisfranc ligament, that attaches between the medial cuneiform and base of the second metatarsal, is the strongest stabilizer of the joint. The case of our 29-year-old patient elaborates the severity of disability that can be encountered. After suffering a direct axial load to his forefoot, the patient was left with severe pain and instability of his foot. Radiographs and computed tomography (CT) confirmed comminution of the second metatarsal base where the Lisfranc's ligament wound insert. The patient was brought in to the operating room (OR) for fixation with a good surgical outcome and decrease in pain in only a few weeks.

Key words: Lisfranc, tarsometatarsal joint (TMTJ), open reduction internal fixation (ORIF), arthrodesis

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Lisfranc injuries refer to a variety of injuries involving the tarsometatarsal joint (TMT) complex. They can include closed or open fractures, dislocations, and sprains (1). Fracture-dislocations of the Lisfranc joint are uncommon, accounting for only 0.2% of all fractures and it is estimated that between 20-30% are missed at time of initial presentation (1, 2). Even with accurate diagnosis and early treatment, Lisfranc injuries can result in chronic disability with prolonged pain (3). Open reduction and internal fixation (ORIF) plus or minus partial primary arthrodesis has been the treatment of choice for Lisfranc fracture dislocations. Myerson et al. showed the poor outcomes commonly associated with purely conservative treatment thus leading away from this modality in favor of surgical fixation (3, 4).The Lisfranc joint complex is comprised of the five metatarsals and their articulations with the three cuneiforms and cuboid. The bony anatomy is often described as an archway with the second metatarsal joint being the "keystone" or stabilizing component. Having a fracture in this keystone location can cause gross morbidity and instability as well as compromise of the Lisfranc ligament. A 2001 study by Solan et al. looked to test the hypothesis that the Lisfranc and plantar ligaments were stronger and stiffer than the dorsal ligaments and that the Lisfranc ligament was stronger and stiffer than the plantar ligaments. Twenty pairs of cadaveric feet were obtained and the second and third metatarsal along with the first cuneiform were dissected. Using a servo-hydraulic testing apparatus which applied a load along the longitudinal axis of the ligament fibers, the tensile strength for each ligament was tested. The ligaments' strengths were defined as the peak load on the force-versus-deformation plot. They found that the mean strength of the dorsal ligaments was 170 +/- 93 N, the Lisfranc ligament was 449 +/- 58 N and the plantar ligaments were 305 +/- 38 N. Their findings coincide with prior statements that the dorsal TMT ligaments are indeed weaker than the plantar TMT ligaments and that the interosseous Lisfranc ligament was the strongest of the three (9). The study greatly elaborates on why the re-approximation of the Lisfranc complex as anatomic as possible is required to reduce chronic disability.

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Methods

A search of the literature was conducted regarding Lisfrancs injuries until February 2018. References from the appropriate articles were also reviewed to find all reports and outcomes of PF in the literature.

Case Report:

29-year-old male presents to the office with the complaint of left foot pain after a "falling incident". He was trying to change his baby's diaper, four days prior, when he was tripped by his dog. He states that he lost his balance and jumped back to avoid stepping on his dog. In turn, he ended up slamming his forefoot against the ground. Radiographs at the emergency department showed a second metatarsal base fracture. CT scan and radiographic stress views were obtained after a podiatry consult, which showed significant comminution at the base of the second

Figure 1. AP radiograph of the left foot demonstrating a second metatarsal base fracture with a positive fleck sign.

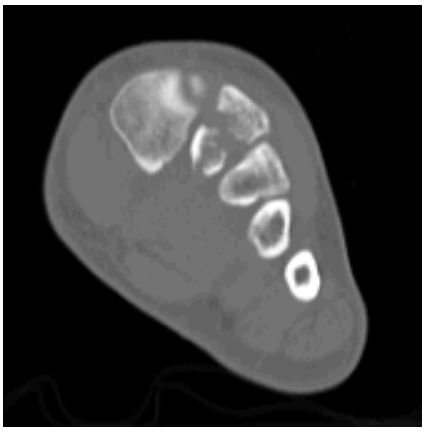

Figure 2. Coronal view of the left foot demonstrating a comminuted second metatarsal base fracture

metatarsal along with gross diastasis between the medial and intermediate cuneiform. Surgical intervention was suggested to the patient due to the severity of the fracture and evidence of Lisfrancs disruption. The patient was in agreement and was brought back to the OR in the supine position. Again, the patient's foot was stressed under fluoroscopy to verify significance of instability. Instability was noted to exist only between the medial and intermediate cuneiforms so ORIF was chosen over partial primary arthrodesis. A four-centimeter incision was made over the second TMTJ to evaluate the comminuted metatarsal base. An Arthrex T-plate was used to span the comminuted fracture of the second metatarsal base. A guidewire for a 4.0 mm screw was placed between the medial aspect of the first metatarsal to the central plantar aspect of the medial cuneiform. A second guidewire was then passed from the medial cuneiform to the intermediate cuneiform. Due to the location of the metatarsal base comminution no screw could be passed from medial cuneiform to the second metatarsal base to recreate the path of Lisfranc's ligament. Using reduction forceps to maintain compression, the two 4.0 mm screws were inserted. Post reduction stress views were then obtained verifying there was no more instability. Adequate reduction and stability was noted at this time. Patient was placed in a posterior splint and will be non-weightbearing with crutches.

Figure 3. Post-operative films demonstrating adequate reduction and fixation with a t-plate, and two 4.0 mm full threaded screws

Four weeks post-operatively, the patient was noticeably less swollen and with little pain. He was then transferred to protected weight bearing in a removable cast boot. He remained in the boot for another 4 weeks at which time he was allowed to start transferring to normal shoe gear. Ten weeks post-operatively, the patient is in normal shoe gear with no pain. Final radiographs showed maintenance of anatomical alignment. No radiolucency was noted but the inter-cuneiform screw appeared to be backing out. Discussed with patient this screw may need removal at a later date, however, he is currently asymptomatic.

Discussion:

As noted previously, a consensus exists that closed reduction followed by casting is unsuccessful in the majority of Lisfranc fracture-dislocations and that initial reduction is often lost when soft tissue swelling subsides (1,4 ,6). The two main options for treatment of Lisfranc fracture-dislocations is either ORIF or primary arthrodesis. Mulier et al. retrospectively compared ORIF to primary arthrodesis for treatment of severe Lisfranc dislocations. They found no significant difference in outcome scoring between the ORIF and partial arthrodesis group. They did note, however, that patients who underwent arthrodesis of TMTJs 1-5 yielded poorer results in comparison to those who did not have the lateral column fused (15). A level I study by Henning et al. also looked to compare the outcomes of patients treated with primary arthrodesis versus those treated with ORIF. There were no statistical differences between primary arthrodesis and ORIF in terms of physical functioning and satisfaction rates at an average postop follow up of 53 months. They did find, however, that the ORIF group had a greater rate of planned and unplanned secondary surgeries, 78.6% versus 16.7% (6). Ly and Coetzee's level I study looked to compare short and medium-term functional outcomes of primarily ligamentous Lisfranc joint injuries repaired by ORIF vs primary arthrodesis. 41 patients with primarily ligamentous Lisfranc injuries were enrolled in the study and were randomized into either an arthrodesis group (n=21) or ORIF group (n=20). At forty-two months post-op, the AOFAS midfoot scores were greater in the arthrodesis group than in the ORIF group, 86.9 compared to 57.2 respectively. They also found that the arthrodesis group was able to return to a higher percentage of preinjury level of functional participation, 92% versus 65% at 24 months post op. The ORIF group required more prominent/painful hardware removal and had greater incidence of loss of correction, increased deformity and arthrosis, 5 of which required conversion to arthrodesis. The authors postulated that healing of the ligaments and capsules provided insufficient strength to maintain the initial reduction and recommended that patients with a primarily ligamentous Lisfranc injury should be treated with primary arthrodesis (3). They later retracted this statement in a separate article and stated that primary arthrodesis should not be used too liberally for all Lisfranc injuries. "If there is not multidirectional instability with manipulation, a fusion should not be done" (18). He gives the example of a hyper-plantarflexion injury where partial or complete disruption of the dorsal structures occurs and the plantar ligaments are spared. In less severe injuries, patients will do reasonably well with conventional ORIF.

Conclusion:

There is not a general consensus in the literature as to the ideal treatment option for Lisfranc injuries and it is safe to assume that there may never be a single correct way in treating all of these injuries. Overall, Lisfranc injuries respond almost equally well to ORIF and primary arthrodesis. One major difference is the higher incidence of secondary procedures in the ORIF group, whether it be planned or unplanned hardware removal or conversion to arthrodesis for symptomatic arthrosis.

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