



Higher Incidence of Proximal Extension of the Ligamentous Disruption in Adolescents Lisfranc Injuries.

Amr Abdelgawad* MD, MBA; Ahmed Elabd¹, MD; Aden Springer², MS; Ahmed M Thabet³ MD, PhD.

1. Department of Orthopaedic Surgery, Medstar Washington Hospital Center, Washington, DC, 20010, USA.
2. Texas Tech University Health Science Center of El Paso, El Paso, TX, 79905, USA.
3. Orthopedic Department. Texas Tech University Health Science Center of El Paso El Paso, TX, 79905, USA

Corresponding Author: Dr. Amr Abdelgawad, Orthopedic Department. Maimonides Medical Center. Brooklyn, NY, 11USA

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Received Date: October 17, 2022

Published Date: November 01, 2022

Abstract

Back Ground: Lisfranc injuries are a rare injury in the adolescent age group and can be easily missed. This study aimed to report pathological pattern of Lisfranc injury in adolescent patient and if it was different from the common adult patients and assess results of surgical treatment of these injuries.

Materials: This is a retrospective study of adolescent patients (10-18 years old) with Lisfranc injury treated via surgical intervention at a Level 1 trauma center between 2012 and 2019.

Results: A total of 9 patients met the study inclusion criteria. Mean age was 15.4 years old, male to female ratio of 5:4, mean follow-up time was 9.5 months. All the cases achieved full union and follow-up course went with two minor complications related to the used implant. Intraoperative findings in 6/9 (66.6 %) cases demonstrated a Lisfranc injury pattern with proximal extension through the inter-cuneiform ligament. Surgical treatment in cases of proximal extension included added fixation between the middle cuneiform and middle cuneiform (screws or plates). Also noted in 2 cases, that the 1st tarso-metatarsal joint was not affected (in contrast to classic Lisfranc injury in adults).

Conclusion: These results shows that Lisfranc injury in adolescent has frequently different pathology that in counterpart in adults in the fact that it commonly involves proximal extension of the ligament disruption. It also sometimes spares the ligaments of the 1st TMT joint. Orthopedic surgeons should be aware of these changes as it implies changes in the treatment construct.

Clinical level of evidence: Case series, level of evidence IV

Key Words: Lisfranc; adolescent; tarsometatarsal; pediatric; foot; ligamentous.

Introduction

Lisfranc injuries account for 0.2% of all fractures, affecting 55,000 people per year with an increasing incidence. 4,7,8,10 As many as 20% of Lisfranc injuries are missed on initial presentation which can lead to complications that have a great potential for long term disability. 10, 14

The Lisfranc injuries are well discussed in adult literature while relatively little evidence exists about them in the pediatric and adolescent population. 7,19 These injuries in children are not only rare but are also commonly misdiagnosed just as they are in adult population. 9,12

The degree of Lisfranc injury can range from simple to complex. A more complex presentation of Lisfranc injury consists of proximal extension of ligamentous damage, an uncommon presentation of injury requiring a specific intraoperative stabilization. Lack of recognition of this injury can lead to misdiagnosis, inadequate stabilization and greater morbidity. 5,18

The aim of our study was to present a descriptive analysis and clinical outcome of a small cohort of adolescent patients who were treated for Lisfranc injuries at our institution to add to the current sparse literature on this topic besides exploring the prevalence of inter-cuneiform (medial and middle cuneiform ligament) instability in ligamentous Lisfranc injuries in adolescent population.

Materials and Methods

This is an IRB approved retrospective study of adolescent patients with Lisfranc injury treated at a Level 1 trauma center between 2012 and 2019. After institutional review board approval, the institutional electronic medical records were searched for patient with diagnosis including “Lisfranc injury; tarsometatarsal joint injury”. The definitive cohort was then identified through a comprehensive chart review utilizing the following inclusion criteria: (a) Clinical diagnosis of Lisfranc injury (b) Age 10-18 years. (c) Patient treated with surgical intervention. Exclusion criteria were (a) Patient outside the age scope of study. (b) Patients received non-operative treatment. (c) open fractures.

Patient records was further reviewed to collect demographic information (age, gender), body mass index (BMI), mechanism of injury, injury laterality, operative interventions with main focus on the intraoperative finding of the ligamentous pattern of injury, method of fixation. Pre-operative radiographs were reviewed for fracture classification; intra-operative radiographs were reviewed for the method of fixation. When applicable, any further imaging (CT or MRI) was reviewed for further assessment. Follow up radiographs were reviewed for time to bony union and any post-traumatic

complications. Outcomes include wound healing status, the union status of the fracture, and complications that may arise along with treatment and follow-up.

Results

Initial review of charts included 75 total cases diagnosed as Lisfranc injuries in our level-one trauma hospital. After exclusive parameters were set, a total of 9 patients (5 males, 4 females) with mean age of 15.4 years (range: 14- 17) were included in the study. Average BMI was 25.4 kg/m² (range: 17.8- 35.9) (Table 1). The mechanism of injury was sports related injury in 3 patients, 1 automobile accident, 1 Fall, 3 were not reported. Fracture side was 5 right sided injuries and 4 left sided injuries. Two patients had associated metatarsal fractures. All patients were operated within a week of injury. All patients were diagnosed depending on radiographs while 4 patients (44.4%) had advanced imaging (CT scans) for pre-operative planning. Intraoperative findings in 6/9 (66.6 %) cases demonstrated a Lisfranc injury pattern with proximal extension through the inter-cuneiform ligament. (Documented in the operative report). In one case it reached the ligament between the navicular and the medial cuneiform. In 2 cases, the 1st tarsometatarsal joint was not affected (in contrast to classic Lisfranc injury in adults). In these cases, no fixation was need for the 1st TMT joint.

Surgical treatment in cases of proximal extension included added fixation between the medial cuneiform and middle cuneiform (screws or plates). Four fractures were fixed using plate and screws while the other 5 were fixed with screws only in different patterns according to the fracture pattern.

One patient didn't have follow up and was excluded from the follow up assessment. For the 8 patients available, mean follow-up time was 7.5 months (range 2-12). All of the eight cases achieved full union and achieved their preinjury level of activity. Follow-up course went without complications except in 2 cases. In the first case, a screw became prominent under the skin and had to be removed in the office under local anesthesia. In the other case, there was screw breakage without any complaints.

Patient	Gender	Age	BMI	Injury Side	Mechanism of Injury	Associated fractures	Fixation Method	Follow up / months	Outcome	Screw removal	Proximal Extension
1	M	16	25.5	Left	Sizures	None	Screws	5	Healed	No	No
2	M	16	35.6	Left	Football	None	Plate and Screws	12	Healed	No	Yes
3	M	14	22.2	Left	Unknow	2-4 MTS fracture	Screws	8	Healed	Yes	Yes
4	F	14	18.8	Right	MVA	2-3 MTS Fractures	Plate and Screws	2	Healed	Yes	Yes
5	F	15	35.9	Right	Unknown	None	Screws	3	Healed	No	No
6	F	17	25.16	Right	Wrestling	None	Plate and Screws	N/A	N/A	N/A	No
7	F	13	25.2	Right	Fall	None	Plate and Screws	9	Broken screws	No	Yes
8	M	17	22	Left	Unknown	None	Screws	12	Healed	No	Yes
9	M	17	17.8	Right	Football	None	Screws	9	Healed	No	Yes

Table 1: Showing patient data

Discussion:

Lisfranc injuries in pediatric and adolescent patients are rare encounters in pediatric orthopedic practice. There is paucity of literature about this injury in this population and consists primarily of case series. 9,12 In addition, the evidence from the adult literature is sometimes incorrectly applied to pediatric Lisfranc injuries. Yet, the optimal treatment approaches for the two populations may differ. 9

Lisfranc injuries in sports often result from indirect mechanisms in which an axial load is applied to a plantarflexed foot. The forefoot plantarflexes excessively, leading to ruptures of the weak dorsal ligaments. When the force progress further, the plantar aspect of the metatarsal base fractures or the plantar ligaments ruptures. 18 The force of injury can extend even more proximally through the intercuneiform joint of the medial and middle cuneiforms and exit medially out the navicular-medial cuneiform joint. 1,15

Recently, multiple studies have pointed to an injury variant where the intercuneiform joint of the medial and middle cuneiforms can be injured which is usually quite subtle injury but, if unrecognized and untreated, may lead to a significantly increased risk of degenerative arthritis of the naviculo-cuneiform joint. 13,17

Porter et al reported 50% prevalence rate of the proximal extension of the Lisfranc ligamentous injury into the inter-cuneiform ligament in their cohort of 82 patients with sport related Lisfranc injuries with average age of 21 (range 12-40). “The ligament disruption of the medial and middle cuneiform ligament was not rare in these subtle, sport Lisfranc injuries. Undetected inter-cuneiform ligament injury can be a source of misdiagnosis or incomplete diagnosis” stated by the authors. In addition, they recommend close evaluation of the inter-cuneiform ligament, especially in these purely ligamentous injuries in athletes. The author also proposed a new classification for these injuries based on their finding. They classified these injuries into 3 types: Traditional dislocation, Medial column dislocation, and proximal extension dislocation. The traditional injury type includes tears the ligaments between the medial cuneiform and first metatarsal, medial cuneiform–second metatarsal “Lisfranc ligament”, and middle cuneiform–second metatarsal. The medial column dislocation type involves tears of both the “Lisfranc ligament” (medial cuneiform to second metatarsal) and the inter-cuneiform ligament (medial cuneiform to middle cuneiform ligaments) while preserving the first TMT ligament. The proximal extension injuries include combination of traditional and medial column dislocations that resulted in lateral shift of the first and second metatarsal as well as widening between the 2 medial and middle cuneiforms. 17

Lewis et al recognized this injury type in their cohort and reported that these subtle injuries had a higher involvement of proximal instability. The clinical signs include widening at the inter-cuneiform joint or naviculo-cuneiform joint on stress views, medial shift of the medial facet of the navicular, and/or hypermobility of the first ray on physical examinations. Patients with the proximal variant injury may have an unstable first ray with hypermobility and difficulty with a push-off or heel rise. 13 Cadaveric studies have also shown that disruption of the Lisfranc ligament and the interosseous ligament between the medial and middle cuneiforms results in longitudinal instability of the midfoot. 11

In our cohort, the inter-cuneiform ligament injury detected intra-operatively in 6/9 patient with a prevalence rate of (66%). All the 6 patient sustained the injury through low energy trauma except one patient who had a motor vehicle accident. This supports the finding reported by Porter et al that reported 50% prevalence rate of this injury pattern in their cohort.

Nonoperative treatment is rarely indicated for unstable Lisfranc injuries. The extent of displacement correlates with the outcome. 5,8 Residual displacement of 2 mm can decrease the articular contact area and lead to joint arthritis if left untreated. 6,8,16 Patients who demonstrate any instability on imaging, open injuries, or injuries associated with compartment syndromes should undergo operative

stabilization to obtain anatomic reduction. Also, patients with a proximal- or medial-column variant injury with any displacement will require surgery to stabilize the medial column. 14 With all types of tarsometatarsal injuries, when anatomic reduction is achieved, 50 to 95% of patients have good or excellent results. This is compared with 17 to 30% good or excellent results for patients without anatomic alignment. 2,3,8,16

For predominantly ligamentous injuries, the traditional gold standard surgical treatment has been interosseous trans-articular screw fixation to maintain the reduction during ligament healing period. However, for patients with a proximal ligamentous variant injury, it was essential to perform fixation across the medial and intermediate cuneiforms as well as between the medial cuneiform and the second metatarsal. 13 Sometimes, fixation of the first metatarsal was not necessary as they are not involved in the injury. Two patients in our cohort who had proximal ligamentous injury didn't require any fixation through 1st metatarsal with good outcome (Fig 1).

In our cohort we didn't remove the TMT fixation unless symptomatic. Two patients had screw removal and one had broken screws with no symptoms. This is different from Lewis et al approach when they routinely removed the screws at 4 to 6 months post-operatively. However, due to the potential risk for late diastasis, they elected not to remove the intercuneiform screw used for the proximal- or medial-column variants.

In this study, we report on a notable ligamentous injury pattern in adolescent Lisfranc injuries. The Lisfranc ligamentous injury extension into the intercuneiform ligament was recognized and treated in 66% of our cohort. Undetected intercuneiform ligament injury can be a source of misdiagnosis or incomplete diagnosis. Understanding the prevalence of intercuneiform disruption can be helpful in avoiding a misdiagnosis. The lack of recognition of this proximal extension of the ligamentous injury pattern could lead to inadequate stabilization and greater morbidity. (9,10). Surgeons must account for the intercuneiform ligament in evaluation and treatment protocols.

Although our study is strengthened by being focused on adolescent patients, the study is not without limitations. The retrospective nature is an inherited limitation. The small number of included subjects prevented from further statistical analysis due to the rarity of injury in this age particularly. The short follow-up period is another limitation. Larger, multicenter studies need to be done in order to support the specific findings of this study.

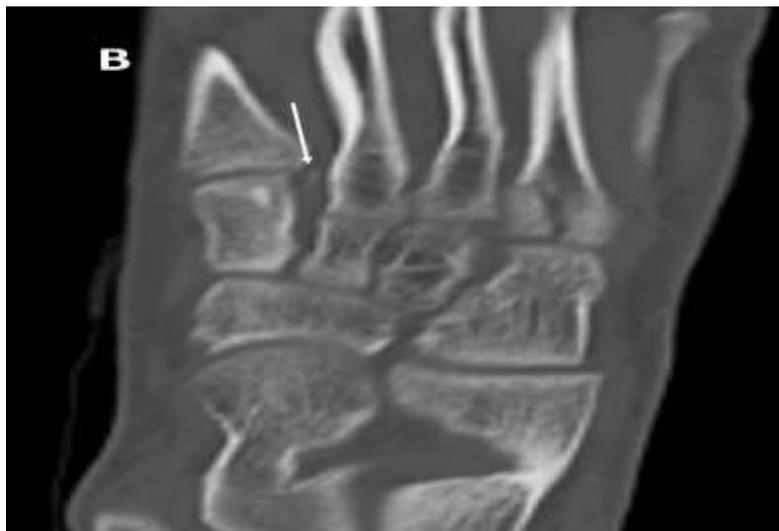




Fig 1: Patient number 8 in table 1, A: Anteroposterior radiograph of the left foot showing widening of the distance between the medial cuneiform and second metatarsal. B: CT scan showing the increased distance and the bone shin indicating Lisfranc ligament injury (arrow). C: Intraoperative fluoroscopy showing the increased distance between the medial cuneiform and middle cuneiform (arrows) with the stress applied by Senn retractor indicating the extension of the ligamentous injury proximally. Intraoperative, no instability was found in the first MT joint. D: Fixation construct performed based on the pathology affected.

Conclusion

Lisfranc injury in adolescent has frequently different pathology than its counterpart in adults in the fact that it commonly involves proximal extension of the ligament disruption. It also sometimes spares the ligaments of the 1st TMT joint. Orthopedic surgeons should be aware of these changes as it implies changes in the treatment construct. Surgical fixation of the Lisfranc in adolescents usually results in full restoration of function.

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