

REVIEW ARTICLE

CONTENTS

Diagnostic challenges of Lisfranc joint injuries: A review of imaging methods

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ABSTRACT

Lisfranc injuries, which affect the tarsometatarsal joint and are relatively rare, have a 20% misdiagnosis rate. This can result in serious complications such as foot instability, degeneration, or chronic pain. Due to the absence of clear diagnostic guidelines, this article reviews existing literature and research to propose an algorithm for identifying potential Lisfranc injuries. The literature review summarizes information on diagnostic methods for Lisfranc complex injuries. It was executed using PubMed, Web of Science, and Google Scholar databases. Scientific publications published between 2016 and 2024 were counted in review and scientific before this period. Lisfranc complex injuries, especially subtle cases, are frequently missed due to both patient oversight and physician error. In diagnostic trials, tools like traditional X-rays or CT scans are commonly employed, however MRIs and ultrasounds are often overlooked. Weight-bearing X-rays and weight-bearing CT could be promising due to their high sensitivity. Appropriate patient interview and physical examination along with imaging are essential points for making an accurate diagnosis. It is important to diagnose Lisfranc injuries to prevent the development of serious complications. Greater patient awareness and a comprehensive diagnostic approach by doctors are key to improving detection rates. Subtle Lisfranc injuries are the greatest diagnostic challenge. Weight-bearing CT scans and radiographs could be very helpful in identifying these injuries. Further research is needed to optimize the use of these imaging methods.

KEY WORDS: Lisfranc, injury, tarsometatarsal, joint, diagnosis

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INTRODUCTION

The articulation between the tarsal bones (cuneiforms C1 to C3 and cuboid) and metatarsal bones (M1 to M5) forms the Lisfranc joint. The medial cuneiform (C1) and second metatarsal (M2) are connected by the three components of the Lisfranc ligament [1]. The name of the tarsometatarsal joint (TMT) comes from the name of a French surgeon serving in Napoleon's army, Jacques Lisfranc. He described a method involving quick amputation of the foot through the TMT joint [2]. A range of midfoot and tarsometatarsal (TMT) joint lesions are referred to as "Lisfranc injuries." These lesions can be as basic as a single joint injury or as complex as many fractures disrupting multiple distinct joints [3, 4]. Lisfranc injuries are rare fractures. It is estimated that they constitute approximately 0.2% of all fractures [3]. The incidence of this injury is estimated to be 1 in 55,000 people [1,5]. However, some studies suggest that the incidence is higher and the underestimation is due to the misdiagnosis of some cases [6]. Lisfranc injuries are more often caused by high-energy injuries, mainly as a result of traffic accidents, but they can also occur as a result of low-energy trauma, the most common cause of which in this case is practicing sports. The group most exposed to this type of injury are men, who suffer from it 2–4 times more often [3,7,8]. A big problem is the fact that up to 20% of cases are misdiagnosed or the correct diagnosis is made too late [5]. This may lead to serious health consequences such as poor treatment results, metatarsal instability, post-traumatic degenerative changes, chronic pain, and motor dysfunction of the foot [5,9,10].

AIM

The purpose of this review is to present the current literature on the correct diagnosis of Lisfranc injuries and the most common diagnostic problems in this type of injury in order to reduce the risk of an incorrect diagnosis or its delay.

MATERIALS AND METHODS

A literature search was conducted in February and March 2024. Databases such as PubMed, Web of Science, and Google Scholar were used. The following phrases were included in the search: "Lisfranc," "injury," "tarsometatarsal," "joint," and "diagnosis." Individually and in combination, they were checked in the databases. After checking the titles and abstracts, articles that did not meet the thematic criteria were removed because they did not correspond to the topic of our work, which focuses on assessing diagnostic possibilities of Lisfranc injury, the most common misdiagnosis errors, and how to deal with them. We carefully analyzed the remaining publications to determine which research studies and reviews were the most relevant. Two persons independently assessed the review. Inclusion criteria included scientific studies on diagnostic possibilities in Lisfranc injuries as well as systematic and interventional reviews in this field. The search was limited to scientific publications published between 2016 and 2024, including key scientific works from before this period.

REVIEW

BRIEF DESCRIPTION OF THE STATE OF KNOWLEDGE

ANATOMY

The tarsometatarsal joint, also called the Lisfranc joint, separates the midfoot from the forefoot. It is composed of five metatarsal bones (M1–M5), three cuneiform bones (C1 C3), and the cuboid bone. The complex also includes numerous ligaments [11]. The most important area of this joint is the location of the base of the second metatarsal bone (M2). It is located in the cavity formed by all three sphenoid bones (C1–C3). This bone connection, supplemented with the Lisfranc ligament complex, guarantees stabilization of the entire joint and prevents the bones from moving [12,13]. There are three groups of ligaments between C1 and M2: plantar (PLL), interosseous (ILL) and dorsal (DLL). There is still no uniform definition of the Lisfranc ligament. The authors are divided and use this term to refer to both the dorsal ligament, the interosseous ligament, and sometimes the entire complex. All three ligaments connect the medial cuneiform bone with the second metatarsal bone, and the plantar ligament consists of two bundles, one of which connects the medial cuneiform bone with the third metatarsal bone. The dorsal ligament is the most sensitive to injuries and is also very important in assessing damage to the remaining ligaments of this complex (Fig. 1) [14, 15].

INJURY PATHOLOGIES AND CLASSIFICATIONS

Etiology of the injury

Lisfranc dislocation most often occurs in the plantar flexion position of the foot. The longitudinal and medial/lateral rotational forces most often lead to hyperplantar flexion, which leads to damage to the dorsal Lisfranc ligament. These types of injuries are becoming more and more common among athletes. The disciplines in which such incidents occur include football, baseball, basketball, cross-country running, hockey, gymnastics, and windsurfing [16, 17].

Lisfranc injury classifications

In 1909, the first Lisfranc injury classification was developed. Its authors were Quentyn and Kuss, who created three categories for injuries based on radiographic evaluation: isolated, divergent, and homolateral. In 1982 and 1986, this classification was modified, but the problem remained that these classifications did not significantly influence therapeutic decisions. The change occurred in 2002, when the Nunley and Vertullo classification linked the stages of injury with therapeutic options. This classification focused on the low-energy stages of Lisfranc injuries, dividing them into three groups [4]. Stage I is a tear of the Lisfranc ligament without diastasis; in the second stage, a diastasis of 1 to 5 mm occurs, but there is no loss of arch height; and in the third stage, there is a loss of arch height and the diastasis is above 5 mm (Fig. 2) [18].

DIAGNOSTIC CAPABILITIES

Subtle injuries constitute the most important diagnostic challenge and may contribute to the greatest number of misdiagnoses. The 2021 study presented the most important problem of diagnosing subtle injuries. It is important that patients with subtle Lisfranc injuries (SLI) seek orthopedic care much less often and often delay contacting a doctor. Many patients with SLI have never consulted a specialist and have never been diagnosed. Lisfranc injuries may have a non-specific etiology and may not present overt symptoms; therefore, their diagnosis requires the great vigilance of the consulting physician [19-21].

Clinical symptoms of Lisfranc and physical examination

High-energy Lisfranc injuries, such as those from traffic accidents, are typically easier to diagnose due to the presence of foot deformities, swelling, pain, and an inability to walk. Subtle Lisfranc injuries could be challenging to diagnose due to the absence of obvious deformities. However, there are some key symptoms

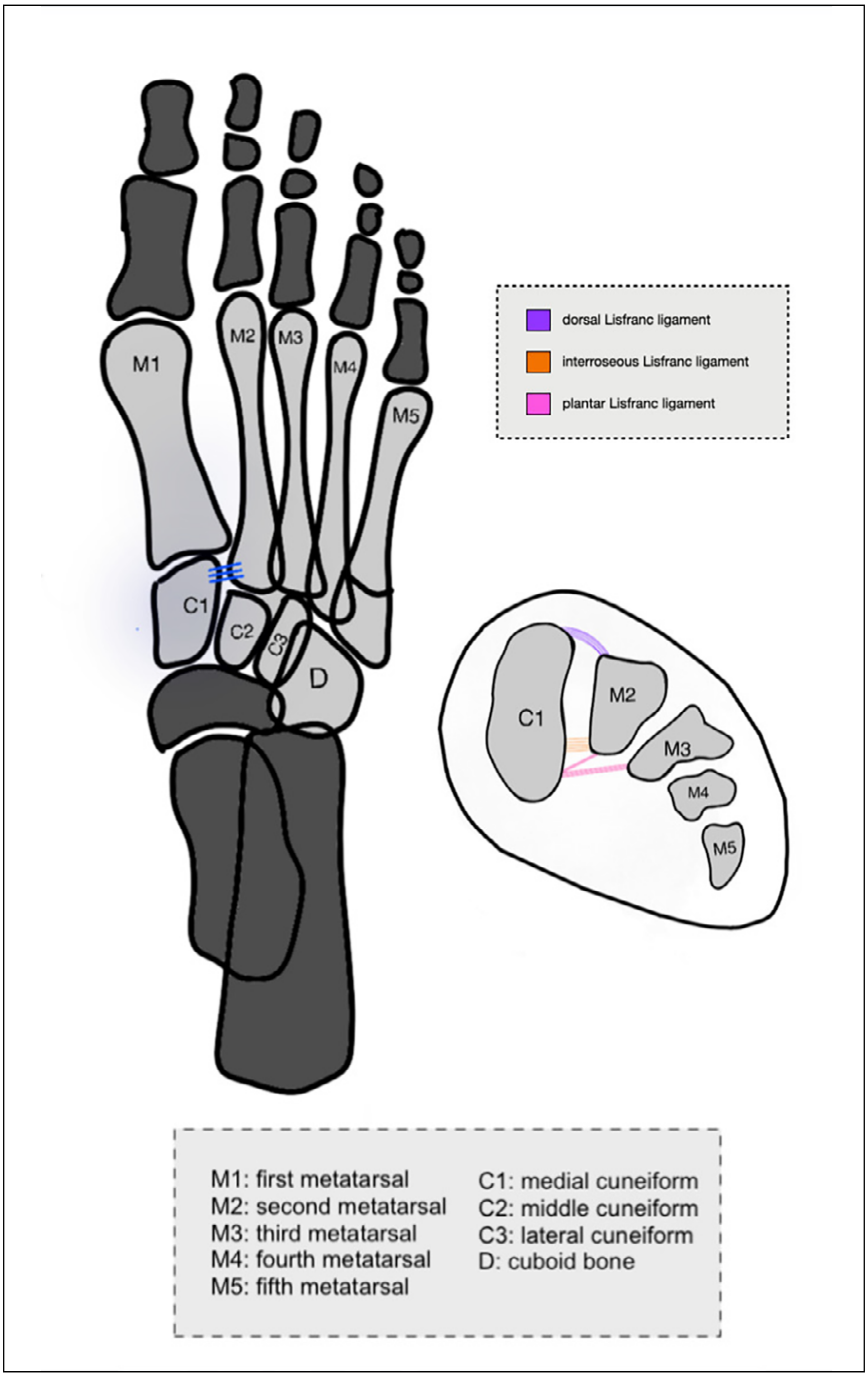

Fig. 1. Anatomy of the Lisfranc Joint Complex.

that indicate these injuries. Patients generally report swelling and pain in the midfoot area, as well as pain upon manipulation or palpation of the tarsometatarsal joints. They often described a sense of "pop" in the midfoot after the injury. A characteristic syndrome is also plantar ecchymosis at the level of the midfoot. Changed sensitivity in the back of the first intermetatarsal space can aid in early diagnosis, associated with post-traumatic neuropathy of the medial terminal branch of the deep peroneal nerve [8]. These kinds of symptoms typically present within 24-48 hours after what might seem like relatively minor injuries. Furthermore, patients might be unwilling or unable to effectively bear weight on the affected foot. Normal walking is usually impossible [1, 22]. After a visual inspection of the foot for any obvious symptoms of a Lisfranc injury, several techniques are used to assess the stability and function of the joint. One key technique is the pronation-abduction test, where the examiner holds the heel stable with one hand and pronates the forefoot with the other hand, checking for pain or instability in the Lisfranc joint. Another method is the 'piano key' test, which involves pressing down on the metatarsal heads like piano keys to detect abnormal movement or pain response, suggesting a possible Lis-

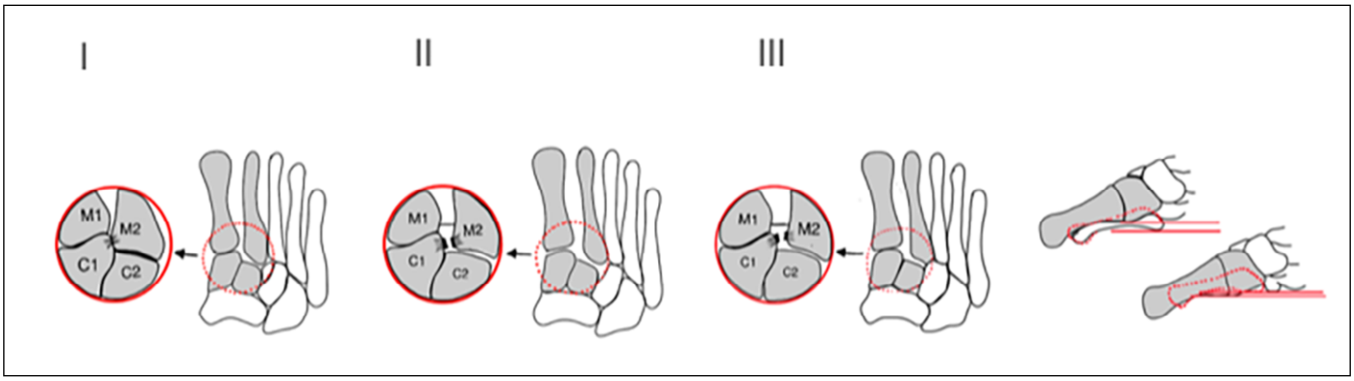

Fig. 2. The Nunley-Vertullo classification of Lisfranc injuries.

franc injury. It is also required to mention the positive gap sign, which is associated with an increase in the distance between the hallux and the second finger, indicating intercuneiform instability [8]. Additionally, the clinician should palpate the midfoot for tenderness, especially over the Lisfranc joint complex, and perform a passive range of motion test to assess the flexibility and integrity of the joints and ligaments in the foot [8].

X-RAYS

Non-weight bearing radiographs

Suspected Lisfranc injuries are typically examined by using non-weight-bearing (NWB) plain radiographs, which include three views: anteroposterior (AP), internal oblique, and lateral [4]. These images can reveal more evident fracture dislocations, though they often fail to detect subtler forms of the injury [23]. Cheng Chen et al. conducted a study involving 407 patients. The aim was to assess the reliability and diagnostic accuracy of conventional radiography for Lisfranc injuries. The results show that the classification accuracy, specificity, and sensitivity of radiographs for Lisfranc injury were 83.8%, 90%, and 81.8%, respectively. This indicates the limitations of this method, therefore in patients with negative results of classic radiography and the coexistence of positive physical symptoms, the diagnostics should be extended with another imaging test [24]. Also, a 2020 study conducted by Ville T. Ponkilainenn et al. showed that the classic non-weight-bearing X-ray is not a highly sensitive method for detecting Lisfranc injuries. The results showed that 24% of trauma cases were missed when analyzing conventional X-rays; therefore, the sensitivity was set at 76%. The largest number of missed cases involved non-displaced injuries. Also, in this case, it was considered necessary to expand diagnostic imaging to include other tests such as CT [25]. The assessment of radiographs should contain several key indicators that must be observed for the diagnosis of Lisfranc injuries. On the AP view, first metatarsal to second metatarsal diastasis of ≥ 2mm or second cuneiform to second metatarsal subluxation on the oblique view or anteroposterior view [26, 27]. Particular radiographic signs, such as the "fleck" sign, which is a small fragment of bone in the space between the bases of the first and second metatarsals, suggest a Lisfranc ligament avulsion [23].

Weight-bearing radiographs

Another imaging method is the use of weight-bearing (WB) X-rays. However, the disadvantage of this method is that it may cause pain in the affected limb, so it is suggested to perform them under regional anesthesia by blocking the ankle joint. WB X-rays are more effective than stress views because the force exerted by the entire body weight is greater than the force exerted manually on the tarsometatarsal joint (TMT) during weight-bearing views. Recent developments include a specific craniocaudal angulation of 28.9° on AP radiographs, which improves visibility of the Lisfranc joint in most patients. In cases where the diagnosis remains uncertain, WB radiographs of both feet may be performed to detect subtle discrepancies [23]. According to a study from 2022, bilateral foot WB radiography can successfully diagnose the instability of Lisfranc complexes. A particular assessment should concern the distance between the intermediate cuneiform and medial aspect of the second metatarsal base. The distance between the base of the second metatarsal and the medial cuneiform bone is an indicator of instability in the Lisfranc joint [28]. Kennelly et. al. indicate greater benefits resulting from the greater sensitivity of stress X-rays compared to computed tomography in detecting subtle Lisfranc injuries. This is highlighted by the fact that up to 54% of positive weight-bearing radiographs were equivocal or negative on computed tomography [29].

COMPUTED TOMOGRAPHY

Non-weight-bearing computed tomography (NWBCT)

Computed Tomography (CT) is a tool for identifying less obvious dislocations and fractures of the Lisfranc joint complex which might not be visible in standard radiographs [8]. Additionally, using computed tomography after radiography changes primary treatment decisions in 21.9% of cases [24]. However, the study results demonstrate the limitations of unloaded computed tomography in the diagnosis of subtle Lisfranc injuries. In the emergency room, weight-bearing X-rays may be particularly useful, as they work particularly well for subtle injuries [29]. Although CT scans offer detailed bone visualization, they may not accurately identify unstable Lisfranc injuries if the scans are conducted without bearing weight [30].

Weight-bearing computed tomography (WBCT)

Recently, weight-bearing computed tomography (WBCT) has emerged as a recognized method for detailed 3-dimensional (3D) evaluation of foot and ankle pathologies. This advanced imaging approach takes advantage of weightbearing scenarios combined with the vision of bone structures by CT technology, enhancing the detection of even minor joint instabilities [30, 31]. Wijetunga et al. conducted a study that compared the area of the Lisfranc joint on non-weight bearing CT (NWBA) to the area of the Lisfranc joint on weight-bearing CT (WBA). Studies indicate that the Lisfranc complex changes in morphology under weightbearing. They assessed the area difference of the Lisfranc joint between WBA and NWBA (AD) and the area ratio WBA/NWBA (AR). The result of AD beyond 7 mm^2 or AR greater than 9% might be a cut-off for detecting subtle Lisfranc instability [32]. Spencer Falcon et al. in a retrospective review of the WBCT of 56 patients with Lisfranc injury compared the affected and unaffected sides. The parameters assessed included the M2-C1 distance, which differed significantly between the healthy and diseased sides. The study shows that WBCT can be a very good tool for diagnosing patients with Lisfranc injury, especially when comparing the diseased and healthy sides [33]. Similar conclusions were reached by Shim et al., who also showed that comparing the sides in CT in the case of a suspected Lisfranc injury is very effective, additionally pointing out that the most sensitive parameter was the assessment of the difference in the C1-M2 distance between the sides [34]. A study from 2021 retrospectively analyzed 227 bilateral foot and ankle WBCT scans to state the effectiveness of using WBCT in diagnosing Lisfranc joint instability. The study compared one-dimensional, two-dimensional, and three-dimensional measurements in patients with operatively confirmed Lisfranc injuries, using their uninjured foot for internal control. Additionally, the study aimed to confirm the reliability of using the uninjured side as a reference by examining a separate control cohort without foot injuries who underwent the same WBCT scans. Results suggest that three-dimensional WBCT is the most sensitive for detecting instability, and the uninjured foot serves as a reliable internal control [35]. Most of the WBCT scanners are currently equipped with the capability to create 3D multiplanar reconstruction. Utilizing information from sequential 2D transverse slices, scanners rebuild reliable 3D images of both feet under full body weight's resistance to gravity and with muscle activation [36]. Additionally, they guarantee images with high spatial resolution, a cost comparable to other imaging methods, and a low radiation dose during tests [37].

MRI AND USG

The best method for imaging ligaments is magnetic resonance imaging. It is a very useful tool in diagnosing Lisfranc injuries because it allows the assessment of the entire ligament complex, which facilitates making the correct diagnosis [38]. A 2022 study conducted by Kaoru Katsukawa demonstrated the effectiveness of magnetic resonance imaging in diagnosing acute Lisfranc injuries. The problem was the assessment of the dorsal and C1-C2 interosseous ligaments, the MRI results of which differed from the postoperative description [39]. Ultrasound examination is also a useful tool. It enabled the assessment of the dorsal Lisfranc ligament. Its greatest advantage is the easy availability and low price of the test [38]. A 2020 study examined the effectiveness of ultrasound imaging of the dorsal ligament of lisfranc (DLL) in cadavers. It was shown that ultrasound can be used in the diagnosis of subtle Lisfranc injuries. It enables the assessment of soft tissues and additionally illustrates the joint gap. It can be an important support for doctors diagnosing this injury [40].

DISCUSSION

This article presents diagnostic methods for a Lisfranc injury and analyzes errors leading to an incorrect diagnosis. The complex anatomical structure of the Lisfranc joint makes it a challenging area for orthopedists to assess. Often, these injuries do not present significant clinical symptoms, and X-rays may appear normal. Lisfranc injury is relatively rare, yet it is characterized by a high frequency of misdiagnoses, reaching about 20% of cases [3]. These factors increase the likelihood of orthopedic surgeons overlooking this injury; thus, injuries to the midfoot should prompt vigilance and thorough patient analysis during diagnosis. The triviality of such injuries, especially subtle ones, often lead patients to downplay their symptoms and refrain from seeking medical consultations. This is another factor contributing to delayed diagnosis, which can lead to complications due to the lack of timely treatment. Better patient education regarding foot injuries and directing them to consult with a doctor capable of assessing injuries and ruling out potential trauma is essential in this regard [21]. Despite their widespread availability and relatively low cost, conventional X-rays have significant limitations in diagnosing Lisfranc injuries. It is effective in diagnosing displaced injuries and those with significant dislocation. However, studies demonstrate significant flaws in this method, especially in subtle injuries. Failure to diagnose the injury affects approximately 20% of cases, which is an unacceptable outcome. Therefore, in situations where clinical symptoms are present and X-rays appear normal, this method alone cannot rule out pathology [24,25]. In such cases, further imaging diagnostics, such as computed tomography (CT), should be employed for better visualization. Despite its superior imaging capabilities and 3D visualization, CT also has limitations. One of the studies demonstrated that CT can miss many Lisfranc injuries that are visible on weight-bearing X-rays. The limited benefits of CT necessitate the use of weight-bearing X-rays. In weight-bearing X-rays, measuring specific distances can be very helpful in diagnosing Lisfranc injuries [29]. A study conducted by Rikken demonstrated that the measurements of the distances between the middle cuneiform bone and the medial surface of the second metatarsal bone, as well as between the base of the second metatarsal bone and the medial cuneiform bone, can serve as indicators of instability, thereby aiding in the diagnosis of this pathology. Another study by Wijetung illustrated that load-bearing CT scans alter the morphology of the Lisfranc joint, enhancing its clarity and establishing critical cutoff points that streamline the diagnosis of Lisfranc injuries. Studies advocate for using the healthy side as a reference point in WBCT. This allows for more precise diagnostics and the detection of very small injuries that may be missed when only the injured side is visualized. Currently, this seems to be the most advanced method for diagnosing Lisfranc injuries, although it is significantly more expensive and less accessible compared to weight-bearing X-rays. However, further research is needed to establish precise cutoff points [32, 33, 35]. Ultrasound (USG) is an extremely useful tool in assessing injuries due to its high availability and low cost. A study indicates that USG can support the diagnosis of Lisfranc injuries by visualizing the dorsal ligament and joint gap, facilitating the detection of even minor injuries. However, foot ultrasound requires extensive skills and clinical experience, which may limit its routine use as a diagnostic method [40]. The last method characterized by the highest accuracy in assessing ligaments is MRI. The study confirms the effectiveness of MRI in diagnosing acute injuries, despite the difficulty in accurately visualizing interosseous ligaments. Unfortunately, MRI is a costly and less accessible examination, often not considered in such injuries [39].

CONCLUSIONS

Undetected Lisfranc injuries can lead to severe complications. There are no clear guidelines in the literature regarding the diagnosis of Lisfranc injury. The high number of misdiagnoses makes it necessary to establish a specific scheme to diagnose such injuries, especially when they are subtle. Weight-bearing CT scans and radiographs are essential for identifying subtle Lisfranc injuries, which pose the greatest diagnostic difficulty. Additional research is necessary to improve the effectiveness of these diagnostic techniques.

REFERENCES

1. Buchanan BK, Donnally III CJ. Lisfranc Dislocation. In: StatPearls. Treasure Island (FL): StatPearls Publishing; December 13, 2023.
2. Llopis E, Carrascoso J, Iriarte I, Serrano Mde P, Cerezal L. Lisfranc Injury Imaging and Surgical Management. Semin Musculoskelet Radiol. 2016;20(2):139-153. doi:10.1055/s-0036-1581119. DOI
3. Mascio A, Greco T, Maccauro G, Perisano C. Lisfranc complex injuries management and treatment: current knowledge. Int J Physiol Pathophysiol Pharmacol. 2022;14(3):161-170. Published 2022 Jun 15.
4. Grewal US, Onubogu K, Southgate C, Dhinsa BS. Lisfranc injury: A review and simplified treatment algorithm. Foot (Edinb). 2020;45:101719. doi:10.1016/j.foot.2020.101719. DOI
5. Yan A, Chen SR, Ma X, Shi Z, Hogan M. Updates on Lisfranc Complex Injuries. Foot Ankle Orthop. 2021;6(1):2473011420982275. Published 2021 Jan 25. doi:10.1177/2473011420982275. DOI
6. Stødle AH, Hvaal KH, Enger M, Brøgger H, Madsen JE, Ellingsen Husebye E. Lisfranc injuries: Incidence, mechanisms of injury and predictors of instability. Foot Ankle Surg. 2020;26(5):535-540. doi:10.1016/j.fas.2019.06.002. DOI
7. Sain A, Prendergast E, Wattage K, Elkilany A, Metry A. Lisfranc Injury: Recent Trends in Management. Cureus. 2023;15(8):e43182. Published 2023 Aug 9. doi:10.7759/cureus.43182. DOI
8. Moracia-Ochagavía I, Rodríguez-Merchán EC. Lisfranc fracture-dislocations: current management. EFORT Open Rev. 2019;4(7):430-444. Published 2019 Jul 2. doi:10.1302/2058-5241.4.180076. DOI

9. Wynter S, Grigg C. Lisfranc injuries. Aust Fam Physician. 2017;46(3):116-119.
10. Clare MP. Lisfranc injuries. Curr Rev Musculoskelet Med. 2017;10(1):81-85. doi:10.1007/s12178-017-9387-6. DOI
11. Won HJ, Oh CS. Classification of the interosseous tarsometatarsal ligaments of the foot. Foot Ankle Surg. 2022;28(1):72-78. doi:10.1016/j.fas.2021.01.010. DOI
12. Sripanich Y, Steadman J, Krähenbühl N, et al. Anatomy and biomechanics of the Lisfranc ligamentous complex: A systematic literature review. J Biomech. 2021;119:110287. doi:10.1016/j.jbiomech.2021.110287. DOI
13. Lalwani R, Kotgirwar S, Athavale SA. Support system of Lisfranc joint complex: An anatomical investigation with an evolutionary perspective. Foot Ankle Surg. 2022;28(7):1089-1093. doi:10.1016/j.fas.2022.03.004. DOI
14. Kaicker J, Zajac M, Shergill R, Choudur HN. Ultrasound appearance of the normal Lisfranc ligament. Emerg Radiol. 2016;23(6):609-614. doi:10.1007/s10140-016-1416-z. DOI
15. DeLuca MK, Boucher LC. Morphology of the Lisfranc Joint Complex. J Foot Ankle Surg. 2023;62(2):261-266. doi:10.1053/j.jfas.2022.07.004. DOI
16. Smith T, Ballard T, Ramanlal R, Butarbutar JC. Foot Dislocation. In: StatPearls. Treasure Island (FL): StatPearls Publishing; August 8, 2023.
17. Vopat BG, Vopat ML, van Dijk PAD, et al. Return to Sport after Surgical Treatment of Lisfranc Injuries in Athletes: A Retrospective Case Series. Kans J Med. 2019;12(4):141-145. Published 2019 Nov 25.
18. Jacqueline C, Batard E, Perez L, et al. In vivo efficacy of continuous infusion versus intermittent dosing of linezolid compared to vancomycin in a methicillin-resistant Staphylococcus aureus rabbit endocarditis model. Antimicrob Agents Chemother. 2002;46(12):3706-3711. doi:10.1128/AAC.46.12.3706-3711.2002. DOI
19. Singh A, Lokikere N, Saraogi A, Unnikrishnan PN, Davenport J. Missed Lisfranc injuries-surgical vs conservative treatment. Ir J Med Sci. 2021;190(2):653-656. doi:10.1007/s11845-020-02364-7. DOI
20. Kura H, Luo ZP, Kitaoka HB, Smutz WP, An KN. Mechanical behavior of the Lisfranc and dorsal cuneometatarsal ligaments: in vitro biomechanical study. J Orthop Trauma. 2001;15(2):107-110. doi:10.1097/00005131-200102000-00006. DOI
21. Herscovici D Jr, Scaduto JM. The LISFRANC JUT: A physical finding of subtle LISFRANC injuries. Injury. 2021;52(4):1038-1041. doi:10.1016/j.injury.2020.12.026. DOI
22. Mayich DJ, Mayich MS, Daniels TR. Effective detection and management of low-velocity Lisfranc injuries in the emergency setting: principles for a subtle and commonly missed entity. Can Fam Physician. 2012;58(11):1199-e625.
23. Welck MJ, Zinchenko R, Rudge B. Lisfranc injuries. Injury. 2015;46(4):536-541. doi:10.1016/j.injury.2014.11.026. DOI
24. Chen C, Jiang J, Wang C, Zou J, Shi Z, Yang Y. Is the diagnostic validity of conventional radiography for Lisfranc injury acceptable?. J Foot Ankle Res. 2023;16(1):9. Published 2023 Mar 1. doi:10.1186/s13047-023-00608-0. DOI
25. Ponkilainen VT, Partio N, Salonen EE, et al. Inter- and intraobserver reliability of non-weight bearing foot radiographs compared with CT in Lisfranc injuries. Arch Orthop Trauma Surg. 2020;140(10):1423-1429. doi:10.1007/s00402-020-03391-w. DOI
26. Seow D, Yasui Y, Chan LYT, et al. Inconsistent radiographic diagnostic criteria for lisfranc injuries: a systematic review. BMC Musculoskelet Disord. 2023;24(1):915. Published 2023 Nov 27. doi:10.1186/s12891-023-07043-z. DOI
27. Sripanich Y, Weinberg MW, Krähenbühl N, et al. Imaging in Lisfranc injury: a systematic literature review. Skeletal Radiol. 2020;49(1):31-53. doi:10.1007/s00256-019-03282-1. DOI
28. Rikken QGH, Hagemeijer NC, De Bruijn J, et al. Novel values in the radiographic diagnosis of ligamentous Lisfranc injuries. Injury. 2022;53(6):2326-2332. doi:10.1016/j.injury.2022.02.044. DOI
29. Kennelly H, Klaassen K, Heitman D, Youngberg R, Platt SR. Utility of weight-bearing radiographs compared to computed tomography scan for the diagnosis of subtle Lisfranc injuries in the emergency setting. Emerg Med Australas. 2019;31(5):741-744. doi:10.1111/1742-6723.13237. DOI
30. Talaski GM, Baumann AN, Walley KC, Anastasio AT, de Cesar Netto C. Weightbearing Computed Tomography vs Conventional Tomography for Examination of Varying Degrees of Lisfranc Injures: A Systematic Review of the Literature. Foot Ankle Orthop. 2023;8(4):24730114231209767. Published 2023 Nov 23. doi:10.1177/24730114231209767. DOI
31. de Cesar Netto C, Bernasconi A, Roberts L, et al. Foot Alignment in Symptomatic National Basketball Association Players Using Weightbearing Cone Beam Computed Tomography. Orthop J Sports Med. 2019;7(2):2325967119826081. Published 2019 Feb 21. doi:10.1177/2325967119826081. DOI
32. Wijetunga CG, Roebert J, Hiscock RJ, et al. Defining Reference Values for the Normal Adult Lisfranc Joint Using Weightbearing Computed Tomography. J Foot Ankle Surg. 2023;62(2):382-387. doi:10.1053/j.jfas.2022.09.008. DOI
33. Falcon S, McCormack T, Mackay M, et al. Retrospective chart review: Weightbearing CT scans and the measurement of the Lisfranc ligamentous complex. Foot Ankle Surg. 2023;29(1):39-43. doi:10.1016/j.fas.2022.08.011. DOI
34. Shim DW, Choi E, Park YC, Shin SC, Lee JW, Sung SY. Comparing bilateral feet computed tomography scans can improve surgical decision making for subtle Lisfranc injury. Arch Orthop Trauma Surg. 2022;142(12):3705-3714. doi:10.1007/s00402-021-04182-7. DOI
35. Bhimani R, Sornsakrin P, Ashkani-Esfahani S, et al. Using area and volume measurement via weightbearing CT to detect Lisfranc instability. J Orthop Res. 2021;39(11):2497-2505. doi:10.1002/jor.24970. DOI

36. Godoy-Santos AL, Bernasconi A, Bordalo-Rodrigues M, Lintz F, Lôbo CFT, de Cesar Netto C. Weight-bearing cone-beam computed tomography in the foot and ankle specialty: where we are and where we are going – an update. Radiol Bras. 2021;54(3):177-184. doi:10.1590/0100-3984.2020.0048. DOI
37. Godoy-Santos AL, Cesar C. Netto; Weight-bearing CT International Study Group. Weight-bearing computed tomography of the foot and ankle: an update and future directions. Acta Ortop Bras. 2018;26(2):135-139. doi:10.1590/1413-785220182602188482. DOI
38. Reijnierse M, Griffith JF. High-resolution ultrasound and MRI in the evaluation of the forefoot and midfoot. J Ultrason. 2023;23(95):e251-e271. Published 2023 Nov 23. doi:10.15557/jou.2023.0033. DOI
39. Kitsukawa K, Hirano T, Niki H, Tachizawa N, Mimura H. The Diagnostic Accuracy of MRI to Evaluate Acute Lisfranc Joint Injuries: Comparison With Direct Operative Observations. Foot Ankle Orthop. 2022;7(1):24730114211069080. Published 2022 Jan 21. doi:10.1177/24730114211069080. DOI
40. DeLuca MK, Walrod B, Boucher LC. Ultrasound as a Diagnostic Tool in the Assessment of Lisfranc Joint Injuries. J Ultrasound Med. 2020;39(3):579-587. doi:10.1002/jum.15138. DOI

CONFLICT OF INTEREST

The Authors declare no conflict of interest.

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