

LIS FRANC DISRUPTION: SHOULD ULTRASOUND BE REGARDED IN THE DIAGNOSTIC WORKUP FOR MIDFOOT INJURIES?

ASUM 2024:1-3RD November
BRISBANE CONVENTION CENTRE
AUSTRALIA



CHERYL HIRSCHBERG,DMU,MMUS- CQU ,CANOPY HEALTHCARE, PALMERSTON NORTH, NEW ZEALAND

ABSTRACT

- An injury to a ligamentous complex of the foot with implications. Foot injuries that present to the ultrasound department require careful evaluation. The Lis Franc ligament provides stability to the mid and forefoot. Instability can lead to debilitating osteoarthritis when not correctly treated. If a patient presents with swelling, bruising and pain to the dorsal or plantar forefoot, concern for damage to this complex should be considered. Any previous imaging should be carefully evaluated. A clear history of the patients mechanism of injury should be taken. Initially these injuries may not be assessed due to the presence of other more serious injuries or to the patient not realising the potential severity of the injury. Misdiagnosis or missed diagnosis has long term consequences for patient pain, and mobility and has resulted in litigation cases. A systematic approach using ultrasound to evaluate the forefoot can be used to help diagnose damage to the dorsal band ligament and thus joint complex. Further evaluation with CT or MRI can be suggested to aid in diagnosis of the extent of the injury.
- Referral can be then made to specialist care for surgical repair if required.
- **KEYWORDS:** Lis Franc, Ultrasound, Litigation

INTRODUCTION



SHOULD ULTRASOUND BE REGARDED IN THE DIAGNOSTIC WORKUP FOR MID FOOT INJURIES?

NOTORIETY: A French Army Surgeon who performed forefoot amputations through this tarsometatarsal complex in the 1800's.^{2,3}

LIS FRANC JOINT COMPLEX: Injured by fracture and or dislocations. Injury accounts for 0.2% of orthopaedic injuries with male and athlete dominance.^{2,3,4} 18% of athletes are reported as not been able to return to their sport.²

LIS FRANC LIGAMENT STRUCTURE: The dorsal and plantar band can be readily demonstrated with high resolution ultrasound. The larger interosseous band cannot be seen due to the narrow joint complex it supports.⁵

RETTEDAL ET AL⁴ : 20% of midfoot injuries presenting in accident and emergency departments are not diagnosed. The consequences for the patient can be far reaching.⁵ 50% end in a posttraumatic osteoarthritis, or degenerative arthritis.^{2,5}

LITIGATION: Against Radiologists and Emergency Department Doctors can be significant should this injury be overlooked or misdiagnosed.^{2,4}

MECHANISM OF INJURY: Occur in two quite different manners and as such can make diagnosis of the seriousness of the injury difficult.

High Impact, such as a motor vehicle accident. Other serious injuries may also be present, and the midfoot pain could be overlooked.²

Low Impact injuries can also occur when the foot is twisted from a plantar flexed position, usually sports.^{2,3,4}

XRAY: Historically first mode for diagnosis of the foot. These can be reported as normal due to the bony structures overlying each other.⁵ Weightbearing xray views visualise any displacement of the joints, and as such elude to ligamentous damage, however these are not always obvious.⁴

ULTRASOUND: A reliable method of imaging the dorsal band of the Lis Franc Ligament and of inferred injury to the entire ligamentous complex.⁴

ANATOMY OF THE FOREFOOT

The Lis Franc Ligament Complex:

:Three separate components that work together to stabilise the midfoot joint articulations.²

:The weaker **dorsal** ligament is demonstrated in Figure 2.

:The ligament **able** to be demonstrated with ultrasound.⁵

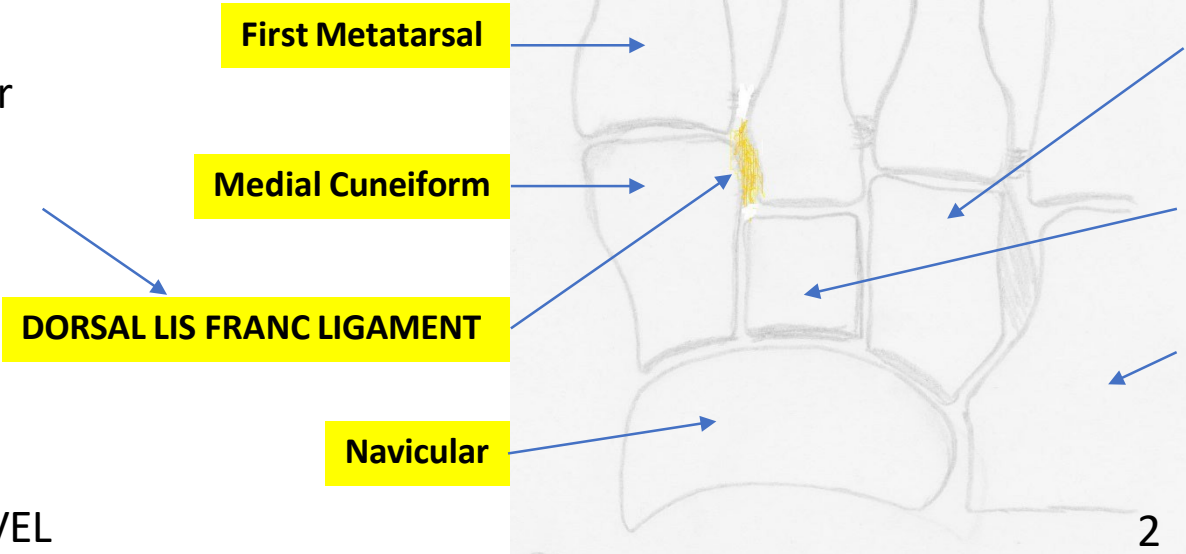


Figure 2: Shows an AP view of the forefoot. ⁶ (p511)

AXIAL MIDFOOT LEVEL METATARSAL BASES

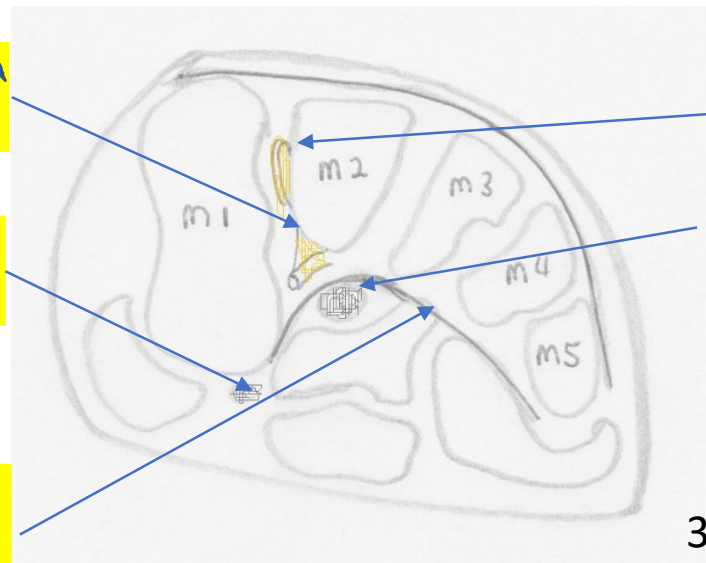


Figure 3: Shows an axial view of the forefoot at the level of the metatarsal bases. ²(p515)

: Figure 3 demonstrates the stronger **plantar** and **interosseous** ligaments.

: The base of second metatarsal (M2) and articulations is the keystone to the arch support of foot.²

: M2 is the longest metatarsal between medial and lateral cuneiforms.⁷

: The interosseous ligament is **not able** to be visualized with ultrasound.⁵

PLANTAR LISFRANC LIGAMENT

Flexor Hallucis Longus Tendon

Normal Transverse Arch Line

INTEROSSEOUS LIGAMENT

Peroneus Longus Tendon

CLINICAL ASSESSMENT

REVIEW



LOOK



LISTEN



FEEL



:Previous imaging and reports.

:Xray as in Figure 4 shows if more than 2mm diastasis between medial cuneiform and second metatarsal base injury to complex is confirmed.^{2,4}



4

Fig 4: AP Xray of a left foot demonstrating diastasis due to damage to the Lisfranc Complex.⁵



5

Fig 5: Dorsal aspect photo comparing contralateral side.⁸

:Compare both sides.

:Look at dorsal and plantar aspects for swelling and bruising in form of ecchymosis as seen in Figure 5.⁵

:“Toe up “ sign if first phalanx is angled dorsally.⁷

Gather information from patient.

:Mechanism of injury. High or low impact?

:Areas of numbness?²

: When injury occurred?

:Area of pain?

:Can they weight bear?⁴



6

Fig 6: Plantar aspect medial foot post low impact injury.⁸

:Gain patients consent.

:Carefully palpate the area of concern.⁴

:Lis Franc injuries have a much **higher pain** level than ankle or foot sprains.³

:Dynamically assess

movement of toes, ankle plantar and dorsi flexion, abduction and adduction of the foot to observe for areas of restriction to target ultrasound exam.⁴

:Differential diagnosis of tibialis anterior or posterior rupture, ankle sprain, or compartment syndrome of foot should also be considered.^{4,7}

ULTRASOUND OF THE DORSAL BAND OF THE LISFRANC LIGAMENT

- **WOODWARD ET AL⁵** have described a scanning technique to visualize the dorsal band of the Lis Franc ligament in a way that can be reliably repeated.

➔ **1:**The ultrasound technique to image this ligament involves using a **high frequency linear** probe.

➔ **2:**Plenty of ultrasound gel must be applied to visualize this **superficial** structure.

➔ **3:**Move the probe in **transverse** along the dorsal forefoot long axis of the first and second metatarsal from distal to proximal until the **first metatarsal cuneiform joint** is visualized.⁵

➔ **4:** Orientate probe to **visualize** the **base** of the **second metatarsal** keeping the **lateral border** of the **medial cuneiform** in view to see the long axis of the Dorsal Lis Franc Ligament.⁵

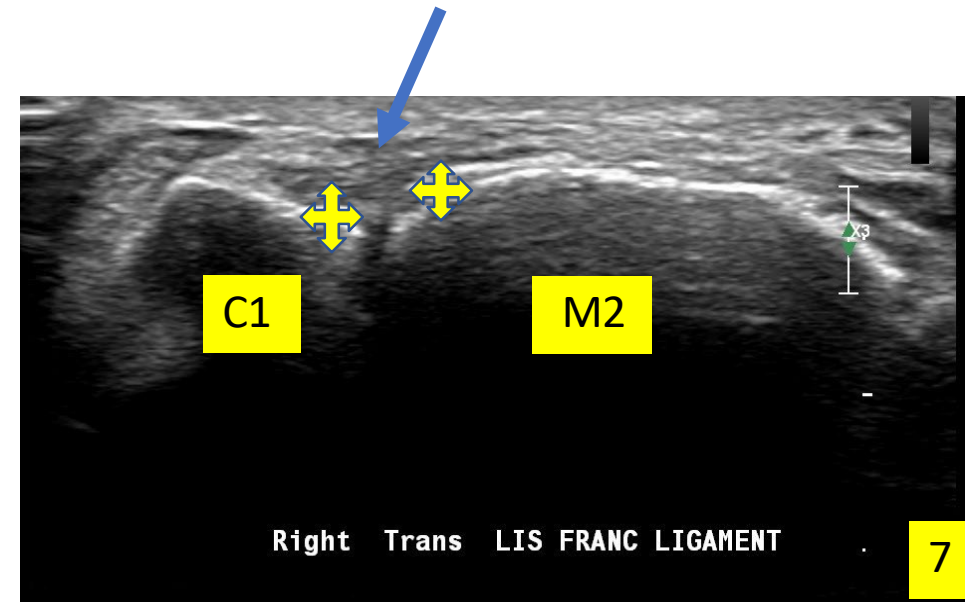


Figure 7:Normal dorsal band of a Lis Franc Complex between the Medial Cuneiform(C1), and the Second metatarsal base(M2). Normal hyperechoic linear striations between the two bones.⁵ Normal joint space between C1 and M2.⁸

PATHOLOGY OF DORSAL BAND OF THE LIS FRANC LIGAMENT COMPLEX

- LESIC ET AL⁷: The biomechanical importance of this foot articulation complex that allows humans to have a functional gait.
- The bones form an **osseous arch** connected by ligaments with a joint capsule. **Apex** being the **second metatarsal**.
- Dorsal ligaments are reinforced by the Tibialis Anterior, and Posterior tendons.
- Plantar ligaments are stronger and reinforced by the Plantar Fascia and Peroneus Longus tendon.
- **No** intermetatarsal ligament between first and second metatarsal. Injury can occur in the form of diastasis, as only the Lis Franc ligament is present in this joint articulation.
- Decreased sensation to first web space due to damage to branches of **deep peroneal nerve** from **odema** of muscle and subcutaneous tissue. **Atrophy** to EHB(extensor hallucis brevis), and EDB (extensor digitorum brevis) with **fatty infiltration** chronically, indicates neuropathic compromise.²

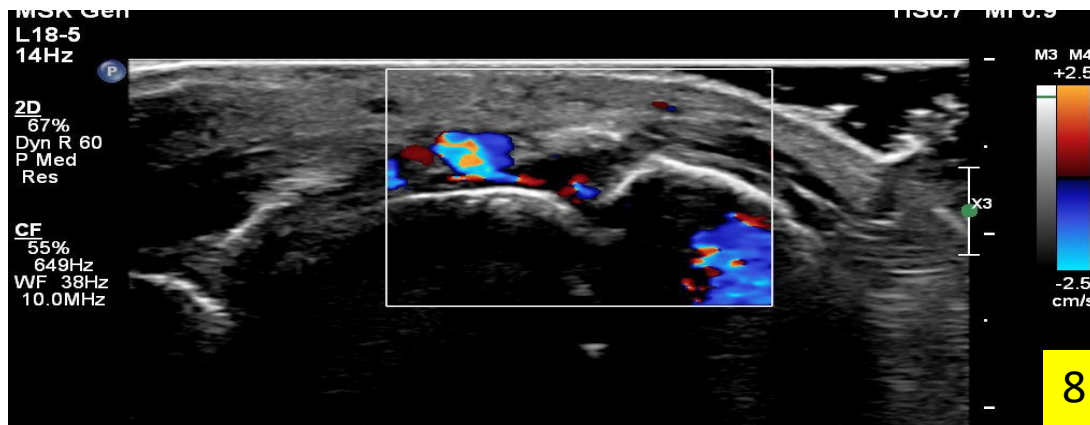


Figure 8: Rupture to the dorsal band with heterogenous echotexture, thickening and hyperaemia. Subcutaneous odema.^{5,8}

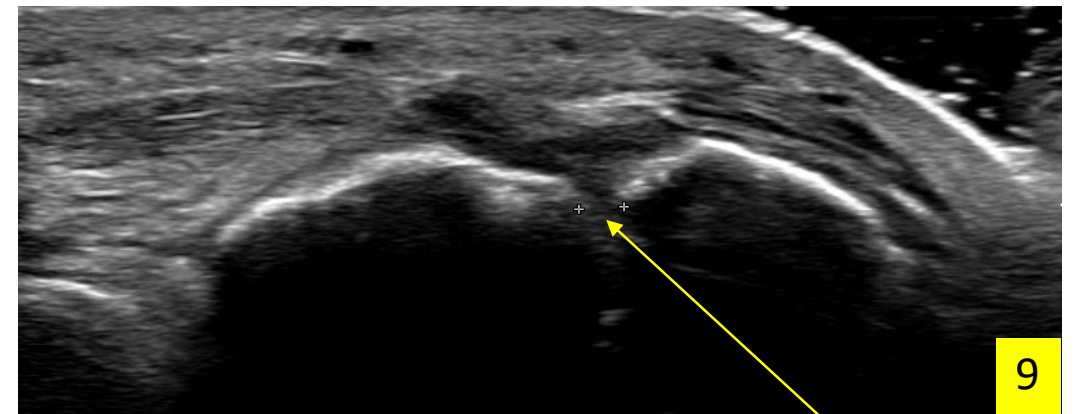


Figure 9: Rupture to the dorsal band with a small diastasis of the joint complex marked by calipers.⁸

RETTEDAL ET AL⁴: Showed reliability of using ultrasound to image the dorsal band of the Lis Franc ligament complex. They determined that the most reproducible results were with weight bearing and 15 degrees external rotation, as demonstrated in Figure 9.

DIAGNOSTIC IMAGING OF THE LIS FRANC COMPLEX ?



- **Xray**-AP foot view and weightbearing.
- -? Diastasis of more than 2mm between C1 and M2. Figure 4.^{2,4,5}
- -? Fleck sign when small fracture from base of C1 or M2 with high impact in 90%.²

Ultrasound-Few studies have been reported using this modality. However Woodward et al⁵ have shown reliability in demonstrating the dorsal band of the ligament which infers damage to the rest of the complex.

Ultrasound is relatively inexpensive, portable, doesn't involve the use of radiation, can assess the region dynamically, and can give referring practitioner valuable information to plan for the patient going forward.⁴

CT-best for subtle bony fractures and in high impact cases. Not as diagnostic for ligamentous damage.^{2,5}

Radionuclide scans-useful in low grade sprains where abnormal radiotracer uptake occurs.² Difficult to routinely access this service.

MR-best for ligamentous images especially in low impact as uses multiple imaging planes. Demonstrates disruption, elongation, and odema of the ligaments and surrounding structures.^{2,4,9}

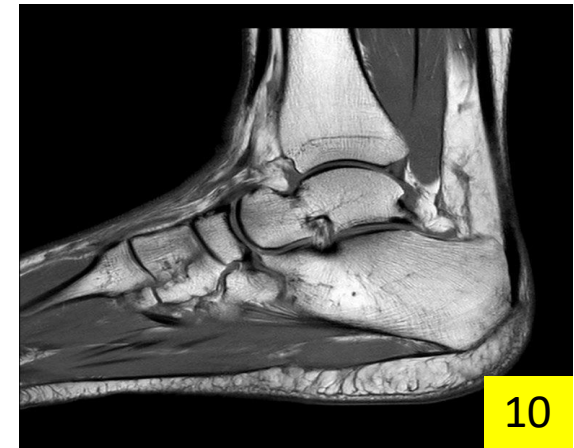


Figure 10: MR Right foot lateral view demonstrating medial cuneiform second metatarsal articulation and comminuted fracture of medial cuneiform.⁸

TREATMENT PROTOCOLS FOR A LISFRANC INJURY

HIGH GRADE-MYERSON CLASSIFICATION²

A :COMPLETE - METATARSALS 1-5 DISPLACED TOGETHER

B :PARTIAL - M1 MEDIALLY DISPLACED

- M2-5 LATERALLY DISPLACED

C :PARTIAL - M1 AND SOME MT's DISPLACED OPP DIRECTIONS

:COMPLETE - M1 DISPLACED IN OPP DIRECTION TO REST MT's

LOW GRADE-NUNLEY-VERTULLO CLASSIFICATION²

STAGE 1- LOW GRADE LIGAMENT SPRAIN

STAGE 2- DORSAL LIGAMENT DISRUPTION

- 2-5mm M1 M2 DIASTASIS

STAGE 3 - INTEROSSEOUS AND PLANTAR DISRUPTION

- GREATER THAN 5mm M1 M2 DIASTASIS

SUMMARY OF LITERATURE TREATMENTS

Diagnosis 4 WEEKS=Open Reduction Internal Fixation(**ORIF**) reduces chance of **further articular damage**. Use of plates as opposed to screws gives best results.^{10,11}

Diagnosis 6 WEEKS=Staged treatment using **external fixation** to gradually distract Lis Franc joint. Avoids deep peroneal nerve and dorsalis pedis artery involved with the contraction of soft tissues post injury, **then ORIF**.¹⁰ Arthrodesis best performed if arthritis present or a neuropathic deformity. ^{10,11}

STAGE 1:Siddiqui et al² propose conservative stance. Non weightbearing for 6 weeks and if pain remains then removable boot for a further 4 weeks.

STAGE 2 and 3: Surgical goal involves **achieving anatomical alignment** by **ORIF** with screw instead of K wires. OA occurred in 50% of cases but only 8% required subsequent arthrodesis for pain. For **comminuted fractures at MT bases** of M1 and 2 **Arthrodesis** is recommended. Achieves stability with stiffness as a trade off. ²

Recent paper Jan 2019 by Han et al³ Data bases from 1998-2018 has concluded that primary arthrodesis as opposed to ORIF resulted in lower pain levels and a better functional gait. However further study was still required.

CONCLUSION

Should ultrasound be part of the primary diagnostic process in the question of injury to the Lisfranc complex?

- **Ultrasound** could be very valuable in the **diagnostic workup** where timing can make a significant difference to patient outcomes to lessen the chance of developing arthritis.³
- **Ultrasound** can give definitive information of the **integrity** of the **Dorsal Band** of the Lisfranc ligament between C1 and M2.⁴
- **Compromise to branches of the Deep Peroneal Nerve** can be **inferred** with **ultrasound**. Acutely as **subcutaneous edema**, with numbness first metatarsal webspace. Chronically as **atrophy, fatty infiltration** EHB,EDB.²
- **Ultrasound** can be used to **triage** for further imaging and specialist referral secondary to xrays. Even when xray is reported as no abnormality seen.⁴
- **Treatment** options for best patient outcomes are **varied** and **literature** is **relatively limited** on the best process.³
- **Ultrasound** technology development and examination techniques are now reaching levels to be part of **normal diagnostic practice**. This will enable a **reduction** in incidence of **litigation** for missed diagnosis when used effectively in imaging this complex.

Neurovascular bundle

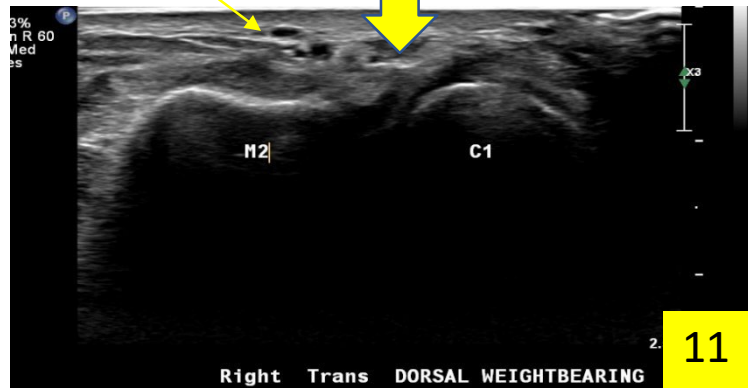


Figure 11: Ultrasound of injured dorsal band of Lisfranc ligament with patient weightbearing.⁸

REFERENCES

1. Available from: <https://medialibrary.mcec.com.au/#availformatlist>
2. Siddiqui N, Galizia M, Almusa E, Omar I. Evaluation of the tarsometatarsal joint using conventional radiography, CT, and MR imaging. *Radiographics*. (Internet). 2014. (cited 2019 July 28); 34 (2):514-531. Available from: <http://www.rsna.org/education/search/RG>.doi: 10.1148/rg.342125215.
3. Han P, Zhang Z, Chen C, Han Y, Wei X, Li P. Comparison of primary arthrodesis versus open reduction with internal fixation for Lis Franc injuries: Systematic review and meta-analysis. *J Postgrad Med*. (Internet). 2019. (cited 2019 August 18); 65:93-100. Available from: <http://www.jpgmonline.com>.doi: 10.4103/JPGM.jpgm_414_18.
4. Rettedal D, Graves N, Marshall J, Frush K, Vardaxis. Reliability of ultrasound imaging in the assessment of the dorsal Lisfranc ligament. *J Foot Ankle Res*. (Internet). 2013. (cited 2019 July 30); 6:1-7. Available from: <http://www.jfootankleres.com/content/6/1/7>.
5. Woodward S, Jacobson J, Fermino J, Morag Y, Fessell D, Dong Q. Sonographic evaluation of Lis Franc ligament injuries. *J Ultrasound Med*.(Internet).2009.(cited 2019 July 30);28:351-357. Available from: <http://onlinelibrary.wiley.com/journal/10.1002/> (ISSN)1550-9613.
6. Clemente CD. *Anatomy a regional atlas of the human body*.3. Baltimore, Munich: Urban & Schwarzenberg; 1987.511.
7. Lesic A, Krivokapic B, Atkinson D, Bojan K, Bumbasirevic M. Injuries of the Lisfranc joint. *Acta Chir iugosl*. (Internet).2015. cited 2019 August 6);LX11:75-79. Available from: https://www.researchgate.net/.../284190048_injuries_of_the_Lisfranc_joint.doi:10.2298/ACI1501075L.
8. Authors own images. Acknowledged with consent from patient.
9. Ablimit A, Ding H, Liu L. Magnetic resonance imaging of the Lisfranc ligament. *JOR spine*. (Internet).2018. (cited 2019 August 6);13:282.1-5. Available from <https://doi.org/10.1186/s13018-018-0968-x>
10. Feng p, Li Y, Li J, Ouyang X, Deng W, Chen Y, et al. Staged management of missed Lisfranc injuries: a report of short-term results. *JOR spine*. (Internet). 2017. (cited 2019 August 6); 9:54-61. DOI:10.1111/OS.12320
11. Ren W, Li H, Lu J, Hu Y. Un displaced subtle ligamentous Lisfranc injuries, conservative or surgical treatment with percutaneous position screws? *Chin J Traumatol*. (Internet). 2019. (cited 2019 August 6); DOI: 10.1016/j.cjtee.2019.03.005