

Are There Any Parameters to Predict the Risk of Screw Breakage Following the Transarticular Screw Fixation in Lisfranc Injuries? A Retrospective Study on 61 Patients

● Selim Ergün, ● Mehmet Süleyman Abul, ● Engin Eceviz

Department of Orthopaedics and
Traumatology, Kartal Dr. Lütfi Kırdar
City Hospital, İstanbul, Turkey

Submitted: 04.05.2021
Accepted: 09.09.2021

Correspondence: Selim Ergün,
Kartal Dr. Lütfi Kırdar Şehir
Hastanesi, Ortopedi ve Travmatoloji
Kliniği, İstanbul, Turkey
E-mail: drselimergun@gmail.com



Keywords: Breakage;
lisfranc; screw diameter;
screw implant failure;
transarticular screw.



This work is licensed under a Creative Commons
Attribution-NonCommercial 4.0 International License.

ABSTRACT

Objective: The Lisfranc complex is an osseo-ligamentous structure consisting of multiple tarsal and metatarsal bones, joints, and ligaments. The transarticular screw method is the most commonly preferred fixation technique in patients with Lisfranc injury. However, screw breakage complications can be seen with a considerable frequency. Although there are studies in the literature that associate the risk of screw breakage with the diameter or structure of the screw used, there is still no consensus. The aim of this study is to predict the risk of screw breakage by examining many parameters.

Methods: We retrospectively evaluated 61 patients with lisfranc injuries who underwent transarticular fixation with screws of different diameters and properties. We found screw breakage complications in 9 (14.7%) of the patients. Some demographic and radiological parameters were examined to predict screw breakage in these patients. Age, gender, weight, diameter and structure of the screw used, presence of accompanying cuneiform, cuboid or metatarsal base fracture, how many tarsometatarsal joints were involved and whether anatomical reduction was achieved. In addition, the development of post-traumatic arthritis during the 2-year follow-up, and the American Orthopedic Foot and Ankle Association (AOFAS) -Middle Foot Score and Visual Analogue Scale (VAS) scores were also compared in clinical evaluations.

Results: We could not find any radiological or demographic parameter that could predict the screw breakage complication in the results. We found only that post-traumatic arthritis was significantly more common in patients with screw breakages. We also found that there was no significant difference in AOFAS-midfoot and VAS scores in patients with or without screw breakage complications.

Conclusion: In the transarticular screw fixation of Lisfranc injury; screw's diameter, cannulated or solid structure, the presence of accompanying tarsal or metatarsal injuries and the reduction quality of the injured anatomic structures do not pose any risk factors for the screw breakage complication.

INTRODUCTION

Multiple tarsal and metatarsal bones, joints, and ligaments form the complex Osseo-ligamentous structure called the Lisfranc complex. The anatomically and clinically most important structure of this complex is the Lisfranc ligament, connecting the base of the second metatarsal to the medial cuneiform.^[1] Instability of this complex structure following an injury requires anatomical stabilization with Kirschner wires, screw fixation, bridging plates or suture-button fixation across the joints.^[2-5]

Screws are the most commonly preferred materials used to reduce and stabilize diastasis at the Lisfranc joint. 3.5, 4.0 or 4.5 mm, cannulated or cortical type are the most commonly used screw sizes. Iatrogenic damage to the articular surface of the joints and screw head irritation are the known complications of transarticular screw fixation. To reduce this point, fixation with smaller screws such as 2.7 mm is also reported in the literature.^[6] However, the incidence of screw breakage (23%) was found to be quite high before the 12-month follow-up visit.

Screw breakage is not a rare complication in Lisfranc injuries. Fully threaded solid cortical screws are recommended instead of partially threaded cannulated screws because of their higher ultimate loads and yield strengths.^[7,8] But in a recent study, cannulated screws were found to be as robust as solid cortical screws in stabilizing the midfoot under physiological loads.^[9] In the literature, the recommended screw type or size to prevent screw breakage in the treatment of Lisfranc injuries is not fully clear. Moreover, it is not certain whether this complication has a negative clinical reflection in patients with screw breakage.^[6]

The aim of the authors in this study was; 1) to identify the risk factors for screw breakage by considering the demographic factors, injury mechanism, coexisting injury, and material-related factors, 2) to reveal the clinical outcome in patients having screw breakage complications. We hypothesized that screw breakage is more common in patients fixed with cannulated screws and/or screws with a shorter diameter.

MATERIALS AND METHODS

68 patients with Lisfranc injury who were operated on between 2015 and 2018 were retrospectively evaluated. Those who underwent plate-screw fixation or primary arthrodesis were excluded from the study.

First, the energy of the injury was grouped as high or low. Athletic activity, ground-level twisting or fall from less than 4 feet were accepted as low energy mechanism injuries as previously described by Ly et al.^[10] Motor vehicle crash, motorcycle crash, direct crush, and fall from greater than 4 feet were accepted as high energy mechanism injuries.^[10] All patients were operated with open reduction. No patient underwent closed reduction and percutaneous fixation. The screw properties used in each patient were the same, different screw types or diameters were not used in the same patient. Screws used were; 2.7 mm full thread solid cortical, 3.3 mm full thread headless cannulated compression, 3.5 mm full thread solid cortical, and 4.0 mm partial thread cannulated. Different screws were selected in different patients because the operations were performed by different surgeons, although they were performed in the same clinic.

All patients were immobilized with a below-knee cast for the first 6 weeks postoperatively. Low Molecular Weight Heparin subcutaneous injection was prescribed for throm-

boembolic prophylaxis. At the end of week 6, the plaster cast was discontinued. Partial weight-bearing was allowed at the end of week 8, and full weight-bearing was allowed at the end of week 12. In radiological evaluation, the number of accompanying cuneiform bone fractures, the presence of cuboid fractures, metatarsal base fractures, and the number of tarsometatarsal (TMT) joints included were noted. Besides, whether TMT joint reduction was achieved anatomically or not was among the parameters examined in the first post-operative radiography. The American Orthopedic Foot & Ankle Society (AOFAS) -Midfoot Score and Visual Analogue Scale (VAS) results calculated in the second post-operative year of the patients were also included in the study. Lastly, in terms of post-traumatic arthritis, radiographs taken in the 2nd year were evaluated, and any osteophytes at TMT or intertarsal joints were noted.

Statistical analysis

All continuous variables were compared with Student's t-test, and all categorical variables were compared with Fisher's Exact test. Significance was set for all analyses at $p < .05$. Excel (Microsoft Inc, Seattle, WA) was used for all statistical analysis.

RESULTS

One patient had primary arthrodesis, and 6 patients had plate and screw fixation. The remaining 61 patients were included in the study. There is only one patient who developed a superficial infection without any signs of deep infection or osteomyelitis.

Screw breakage occurred in 9 (14.7%) of 61 patients. Implant removal was not performed in any patient. There was no difference in age, gender, weight, and injury mechanism in patients with or without screw breakage (Table 1). Similar results were found regarding the number of accompanying cuneiform fractures, the presence of cuboid fractures, the number of metatarsal base fractures, and the number of TMT joints included (Table 2). Comparing the screw diameters and cannulated or cortical features, no difference was found between patients with and without screw breakage (Table 2). In some patients, it was observed that TMT joint reduction could not be achieved anatomically. However, no significant difference was found in the number of non-anatomical reductions (Table 2).

Table 1. Comparison of demographic characteristics and injury mechanism of patients with and without screw breakage

	NSB (n=52)	SB (n=9)	p-value
Age	39.7±12.8	33.1±16.6	>0.05
Gender	35 male, 17 female	8 male, 1 female	>0.05
Weight (kg)	76.9±14.3	76.1±15	>0.05
Injury mechanism	21 high energy, 31 low energy	5 high energy, 4 low energy	>0.05

NSB: No screw breakage; SB: Screw breakage.

Table 2. Comparison of accompanying tarsal and metatarsal injuries, screw properties, and reduction quality as a risk factor for screw breakage, and post-traumatic arthritis and intergroup clinical scores findings

	NSB (n=52)	SB (n=9)	p-value
Number of accompanying cuneiform fractures (mean±SD)	1.67±0.79	1.66±0.81	>0.05
Number of accompanying metatarsal base fractures (mean±SD)	2.06±0.99	1.88±1.27	>0.05
Accompanying cuboid fractures (total number)	10	1	>0.05
Number of TMT joints included (mean±SD)	2.62±1.39	2.88±1.16	>0.05
Number of cannulated screws (total number)	22	2	>0.05
Screw diameters	2.7 mm: 11 patients 3.3 mm: 3 patients 3.5 mm: 19 patients 4.00 mm: 19 patients	2.7 mm: 2 patients 3.3 mm: no patients 3.5 mm: 5 patients 4.00 mm: 2 patients	>0.05
Reduction quality	Non-anatomic reduction: 9 patients Anatomic reduction: 43 patients	Non-anatomic reduction: 3 patients Anatomic reduction: 6 patients	>0.05
Post-traumatic arthritis	28	9 (all patients)	<0.05
AOFAS Midfoot score (mean value±SD, at the last visit)	84.65±14.2	79±14.9	>0.05
VAS score (mean value±SD, at the last visit)	3.44±3.02	4.22±3.73	>0.05

NSB: No screw breakage; SB: Screw breakage; TMT: Tarsometatarsal; AOFAS: American Orthopedic Foot & Ankle Society; VAS: Visual Analogue Scale; SD: Standard deviation.

AOFAS midfoot scores and VAS pain scores were found to be similar between patients with and without screw breakage (Table 2). All patients were able to ambulate without support. Examining the simultaneous radiographs, all nine patients with screw breakage had post-traumatic arthritis (Fig. 1), while only 28 of 52 patients without screw breakage had it, which was a significant difference ($p<0.05$) (Table 2).

DISCUSSION

In this retrospective study, the complication rate of screw fracture was found to be 14.7% in patients who underwent open reduction and transarticular screw fixation with the diagnosis of Lisfranc injury. Various demographic and radiological risk factors, especially screw diameter and type, were investigated in terms of screw breakage, but contrary to similar studies in the literature and the hypothesis



Figure 1. Anterior-posterior view of a patients' feet that underwent open reduction and internal screw fixation for the left one following a lisfranc injury. One of the screws in the medial column fixation was found to be broken in the post-operative follow-up period.

of the present study, no demographic or radiological risk factors were found for screw breakage.

There are studies in the literature to predict and prevent screw breakage complications in the treatment of Lisfranc injuries. While some of these studies recommend fully threaded solid cortical screws over partially threaded cannulated ones due to their higher ultimate loads and yield strengths, Rozell et al.^[9] recently found that the cannulated screws were as robust as solid cortical screws in stabilizing the midfoot under physiological loads.^[7,8] While the issue of screw preference is still controversial, new risk factors have begun to be defined in the literature. VanPelt et al.^[11] found that increased Body Mass Index (BMI) values were directly proportional to screw breakage and advanced age with loss of reduction. In the present study, no difference was found between the ages and weights of patients with and without screw breakage. In this way, both patient groups can be considered more randomized in comparison of screw properties and radiological findings. In the present study, patient weight was taken into account instead of BMI. This is because the authors of the study thought that it was the patient's weight rather than BMI that increased the deforming force at the Lisfranc joint, which may cause bias in an overweight but tall patient or a thin but short patient.

In the study conducted by Renninger et al.,^[12] patients with Lisfranc injuries were investigated in two groups according to injury mechanism as low- or high-energy injuries. Low-energy Lisfranc injuries were found to be more isolated and primarily ligamentous injuries sparing the lateral column, but the high energy group had more concomitant foot fractures (78% vs 4%), cuboid fractures (31% vs 6%),

metatarsal base fractures (84% vs 29%), displaced intra-articular fractures (59% vs 4%), and involvement of all 5 rays.^[12] In the present study, there was no difference in the injury mechanism between patients with and without screw breakage complications. Similarly, both patient groups can be considered more randomized in comparison of screw properties and radiological findings. In addition, according to these findings, the number of accompanying cuneiform bone fractures, the presence of cuboid fractures, the number of metatarsal base fractures, and the number of injured TMT joints were not found to be a risk factor in terms of screw breakage. One of the results of the study was that all patients with screw breakage had post-traumatic arthritis. This result was found to be significant when compared to the lower findings of arthritis in patients without screw breakage complications. However, this significant difference cannot be considered as a risk factor or precursor for screw breakage, it is an effect rather than a cause.

This study has some limitations. First, the retrospective study design and low sample size are the weaknesses of the study. The second is that the operations were performed by different surgeons. On the other hand, there are some strengths of this study. Patients with and without screw breakage were found to be randomized in terms of independent variables such as age, gender, weight, and injury mechanism.

In conclusion, in the transarticular screw fixation of the Lisfranc injury; the diameter of the screw, its cannulated or solid structure, the presence of accompanying tarsal or metatarsal injuries, and the reduction quality of the injured anatomic structures do not pose any risk factors for the screw breakage complications.

Ethics Committee Approval

This study approved by the Kartal Dr. Lutfi Kirdar City Hospital Clinical Research Ethics Committee (Date: 12.05.2021, Decision No: 2021/514/201/2).

Informed Consent

Retrospective study.

Peer-review

Internally peer-reviewed.

Authorship Contributions

Concept: E.E.; Design: E.E.; Supervision: E.E.; Data: M.S.A.;

Analysis: S.E.; Literature search: M.S.A.; Writing: S.E.; Critical revision: S.E.

Conflict of Interest

None declared.

REFERENCES

- Ouzounian TJ, Shereff MJ. In vitro determination of midfoot motion. *Foot Ankle Int* 1989;10:140–6. [\[CrossRef\]](#)
- Ghate S, Sistla V, Nemade V, Vibhute D, Shashane S. Screw and wire fixation for Lisfranc fracture dislocations. *J Orthop Surg* 2012;20:170–5. [\[CrossRef\]](#)
- Panchbhavi VK, Vallurupalli S, Yang J, Andersen CR. Screw fixation compared with suture-button fixation of isolated Lisfranc ligament injuries. *J Bone Joint Surg Am* 2009;91:1143–8. [\[CrossRef\]](#)
- Cho J, Kim J, Min TH, Chun DI, Won SH, Park S, et al. Suture button vs conventional screw fixation for isolated lisfranc ligament injuries. *Foot Ankle Int* 2021;42:598–608. [\[CrossRef\]](#)
- Alberta FG, Aronow MS, Barrero M, Diaz-Doran V, Sullivan RJ, Adams DJ. Ligamentous Lisfranc joint injuries: a biomechanical comparison of dorsal plate and transarticular screw fixation. *Foot Ankle Int* 2005;26:462–73. [\[CrossRef\]](#)
- Park YH, Ahn JH, Choi GW, Kim HJ. Percutaneous reduction and 2.7-mm cortical screw fixation for low-energy lisfranc injuries. *J Foot Ankle Surg* 2020;59:914–8. [\[CrossRef\]](#)
- Arntz CT, Veith RG, Hansen ST Jr. Fractures and fracture-dislocations of the tarsometatarsal joint. *J Bone Joint Surg Am* 1988;70:173–81. [\[CrossRef\]](#)
- Buzzard BM, Briggs PJ. Surgical management of acute tarsometatarsal fracture dislocation in the adult. *Clin Orthop Relat Res* 1998;353:125–33. [\[CrossRef\]](#)
- Rozell JC, Chin M, Donegan DJ, Hast MW. Biomechanical comparison of fully threaded solid cortical versus partially threaded cannulated cancellous screw fixation for lisfranc injuries. *Orthopedics* 2018;41:222–7. [\[CrossRef\]](#)
- Ly TV, Coetzee JC. Treatment of primarily ligamentous Lisfranc joint injuries: primary arthrodesis compared with open reduction and internal fixation. *J Bone Joint Surg Am* 2006;88:514–20. [\[CrossRef\]](#)
- VanPelt MD, Athey A, Yao J, Ennin K, Kassem L, Mulligan E, et al. Is Routine hardware removal following open reduction internal fixation of tarsometatarsal joint fracture/dislocation necessary? *J Foot Ankle Surg* 2019;58:226–30. [\[CrossRef\]](#)
- Renninger CH, Cochran G, Tompane T, Bellamy J, Kuhn K. Injury characteristics of low-energy lisfranc injuries compared with high-energy injuries. *Foot Ankle Int* 2017;38:964–9. [\[CrossRef\]](#)

Transartiküler Vidalarla Tespit Edilmiş Lisfrank Yaralanmalı Hastalarda Vida Kırılma Riskini Öngörebilecek Parametreler Var Mı? 61 Hasta Üzerinde Geriye Dönük Çalışma

Amaç: Lisfrank kompleksi çoklu tarsal metatarsal kemik, eklem ve bağlardan oluşan osseo-ligamentöz bir yapıdır. Lisfrank yaralanması olan hastalarda en sık tercih edilen tespit yöntemi transartiküler vida yöntemidir. Ancak bu yöntem ile tespit edilen hastalarda azımsanmayacak sıklıkta vida kırılması komplikasyonu görülmektedir. Literatürde vida kırılma riskini kullanılan vidanın çapı ya da yapısı ile ilişkilendiren çalışmalar bulunmasına rağmen yine de tam bir fikir birliği oluşmamıştır. Bu çalışmanın amacı, vida kırılma riskini çok sayıda parametreyi inceleyerek önceden öngörebilmeyi sağlamaktır.

Gereç ve Yöntem: Bu çalışmada farklı çapta ve özellikte vidalar ile transartiküler tespit yapılmış 61 lisfrank yaralanmalı hastayı geriye dönük değerlendirdik. Hastaların dokuzunda (%14.7) vida kırılma komplikasyonunu saptadık. Bu hastalarda vida kırılmasını öngörebilmek için bazı demografik ve radyolojik parametreler incelendi. Yaş, cinsiyet, ağırlık, kullanılan vidanın çapı ve yapısı, eşlik eden küneiform, kuboid ya da metatars bazisi kırığının bulunması, yaralanmanın kaç tarsometatarsal eklemi ilgilendirdiği ve redüksiyonun anatomik olarak sağlanıp sağlanamamasıydı. Ayrıca iki yıllık takiplerde post-travmatik artrozun gelişip gelişmediği, klinik değerlendirmelerde Amerikan Ortopedik Ayak ve Ayak Bileği Derneği (AOFAS) -Orta Ayak Skoru ile Görsel Analog Skala (VAS) skorları da karşılaştırıldı.

Bulgular: Sonuç olarak, küçük çaplı ya da kanüllü vidalarda daha fazla vida kırılması komplikasyonunu beklerken, vida kırılmasını öngörebilecek anlamlı bir parametreyi bulamadık. Vida kırılması olan hastalarda post-travmatik artrozu daha sık tespit ettik. Ayrıca AOFAS-orta ayak ve VAS skorlarında, vida kırılması yaşamayan hastalara kıyasla anlamlı bir fark olmadığını da gördük.

Sonuç: Lisfrank yaralanmasının transartiküler vida fiksasyonunda; vida çapı, vidanın kanüllü veya solid yapısı, eşlik eden tarsal veya metatarsal yaralanmaların varlığı ve yaralanan anatomik yapıların redüksiyon kalitesi, vida kırılması komplikasyonu için herhangi bir risk faktörü oluşturmamaktadır.

Anahtar Sözcükler: İmplant yetmezliği; lisfrank; transartiküler vida; vida çapı; vida kırılması.