

Interfragmentary screws in Danis and Weber type B ankle fractures: is it necessary to maintain the stability of the joint?

Parafusos interfragmentários nas fraturas de tornozelo tipo B de Danis e Weber: são necessários para manter a estabilidade da articulação?

Tornillos interfragmentarios en fracturas de tobillo tipo B de Danis y Weber: ¿es necesario para mantener la estabilidad de la articulación?

Steve Jhosue Muñoz-Granja<https://orcid.org/0000-0003-0601-2857> Medical Resident. Medical Doctor, UDLA, Ecuador
drstevemunozg@gmail.com (correspondence)**Katherine Cristina Guano Zambrano**<https://orcid.org/0000-0001-8845-651X> Medical Resident in Traumatology and Orthopedics San Francisco University Quito – HSFQ. Medical Resident HSFQ, Ecuador
kcgz_c@hotmail.com**Juan Carlos Proaño-Durán**<https://orcid.org/0000-0002-9733-305X> Chief of Service – HSFQ, Ecuador. Specialist in Traumatology and Orthopedics
juan.proanod@iess.gob.ec**Vanessa Michelle García-Gudiño**<https://orcid.org/0000-0001-9269-5986> Medical Resident. Medical Doctor, UDLA, Ecuador
vanemi1@hotmail.com**Josselyn Nicole Villarreal Enríquez**<https://orcid.org/0009-0009-7726-8025> Medical Resident. Medical Doctor, UDLA, Ecuador.
nickythg3estudiar@gmail.com**ARTICLE HISTORY****Received:** 29-06-2023**Revised Version:** 21-09-2023**Accepted:** 24-09-2023**Published:** 30-09-2023**Copyright:** © 2023 by the authors**License:** CC BY-NC-ND 4.0**Manuscript type:** Article**ARTICLE INFORMATIONS****Science-Metrix Classification (Domain):**

Health Sciences

Main topic:

Interfragmentary screws / ankle fractures

Main practical implications:

The use of interfragmentary screws in weber type B ankle fractures is not universally necessary. Anatomical reduction remains crucial and the use of screws increases costs, recovery time and complications.

Originality/value:

The article presented is original, the methodology was written and analyzed with the knowledge of the authors, it has general and theoretical concepts that were taken from basic books.

ABSTRACT

OBJECTIVE: This study aimed to investigate whether the presence or absence of an interfragmentary screw significantly impacts surgical time, bleeding, consolidation, complications, and overall recovery in patients with Weber type B ankle fractures. **METHODS:** A cross-sectional analytical study was conducted, involving 47 patients with Weber type B ankle fractures between January 2022 and January 2023 at San Francisco General Hospital in Quito. Patients with multi-fragment fractures were excluded, and two groups were established: patients with interfragmentary screws and those without. Variables such as surgical time, bleeding, complications, and consolidation time were assessed using JASP 0.16.0.0 software and statistical tests. **RESULTS:** Out of all patients, 53.19% were treated with interfragmentary screws, while 46.80% were not. No statistically significant differences were observed between the two groups. Complications occurred in 7 out of 25 patients with interfragmentary screws and in 4 out of 22 patients without them, with average follow-up periods of 82.81 and 76.8 days, respectively. Consolidation time was similar in both groups, with no statistical differences. **CONCLUSION:** Although interfragmentary screws are beneficial for achieving primary consolidation, this study suggests that they may not be universally necessary, especially when precise anatomical reduction is accomplished. Anatomical reduction remains pivotal in fracture management. While interfragmentary screws can provide compression, their use may increase costs, recovery time, and complications.

Keywords: Interfragmentary screws; Danis and Weber; ankle fractures; traumatology.**RESUMO**

OBJETIVO: Este estudo teve como objetivo investigar se a presença ou ausência de um parafuso interfragmentário impacta significativamente o tempo cirúrgico, o sangramento, a consolidação, as complicações e a recuperação geral em pacientes com fraturas de Weber tipo B do tornozelo. **MÉTODOS:** Foi realizado um estudo analítico transversal, envolvendo 47 pacientes com fraturas de tornozelo tipo B de Weber entre janeiro de 2022 e janeiro de 2023 no Hospital Geral de São Francisco, em Quito. Foram excluídos pacientes com fraturas multifragmentares, e foram estabelecidos dois grupos: pacientes com parafusos interfragmentares e aqueles sem. Variáveis como tempo cirúrgico, sangramento, complicações e tempo de consolidação foram avaliadas por meio do software JASP 0.16.0.0 e testes estatísticos. **RESULTADOS:** Do total de pacientes, 53,19% foram tratados com parafusos interfragmentares e 46,80% não. Não foram observadas diferenças estatisticamente significativas entre os dois grupos. As complicações ocorreram em 7 dos 25 pacientes com parafusos interfragmentários e em 4 dos 22 pacientes sem eles, com seguimento médio de 82,81 e 76,8 dias, respectivamente. O tempo de consolidação foi semelhante nos dois grupos, sem diferenças estatísticas. **CONCLUSÃO:** Embora os parafusos interfragmentares sejam benéficos para alcançar a consolidação primária, este estudo sugere que eles podem não ser universalmente necessários, especialmente quando a redução anatômica precisa é realizada. A redução anatômica continua sendo fundamental no tratamento de fraturas. Embora os parafusos interfragmentários possam fornecer compressão, seu uso pode aumentar os custos, o tempo de recuperação e as complicações.

Palavras-chave: Parafusos interfragmentários; Danis e Weber; fraturas de tornozelo; traumatologia.**RESUMEN**

OBJETIVO: Este estudio tuvo como objetivo investigar si la presencia o ausencia de un tornillo interfragmentario impacta significativamente el tiempo quirúrgico, el sangrado, la consolidación, las complicaciones y la recuperación general en pacientes con fracturas de tobillo tipo B de Weber. **MÉTODOS:** Se realizó un estudio analítico transversal, involucrando a 47 pacientes con fractura de tobillo tipo B de Weber entre enero de 2022 y enero de 2023 en el Hospital General San Francisco de Quito. Se excluyeron los pacientes con fracturas multifragmentarias, y se establecieron dos grupos: pacientes con tornillos interfragmentarios y aquellos sin ellos. Variables como tiempo quirúrgico, sangrado, complicaciones y tiempo de consolidación se evaluaron mediante el software JASP 0.16.0.0 y pruebas estadísticas. **RESULTADOS:** Del total de pacientes, el 53,19% fueron tratados con tornillos interfragmentarios, mientras que el 46,80% no. No se observaron diferencias estadísticamente significativas entre los dos grupos. Se produjeron complicaciones en 7 de 25 pacientes con tornillos interfragmentarios y en 4 de 22 pacientes sin ellos, con periodos de seguimiento promedio de 82,81 y 76,8 días, respectivamente. El tiempo de consolidación fue similar en ambos grupos, sin diferencias estadísticas. **CONCLUSIÓN:** Aunque los tornillos interfragmentarios son beneficiosos para lograr la consolidación primaria, este estudio sugiere que pueden no ser universalmente necesarios, especialmente cuando se logra una reducción anatómica precisa. La reducción anatómica sigue siendo fundamental en el tratamiento de las fracturas. Si bien los tornillos interfragmentarios pueden proporcionar compresión, su uso puede aumentar los costos, el tiempo de recuperación y las complicaciones.

Palabras clave: Tornillos interfragmentarios; Danis y Weber; fracturas de tobillo; traumatología.

INTRODUCTION

An important injury in trauma emergencies is ankle fracture, which constitutes 9% of all fractures and can have a significant impact on the patient's quality of life. Therefore, timely management is essential to restore joint functionality and stability (Koehler, 2022)

The tibiofibular astragalus joint or ankle joint is composed of the medial tibial malleolus, posterior tibial malleolus, lateral malleolus, and talus bone. The tibia and fibula are harmoniously united by a membrane known as syndesmosis.

The prevalence of ankle fractures is high among young patients, athletes, and elderly individuals with significant comorbidities such as osteoporosis. It is a common injury in both genders, but as a higher occurrence among males (Cluett, 2023). Fractures can be classified by the number of malleoli compromised: unimalleolar in 66% of cases, bimalleolar in 25% of cases, and trimalleolar in 7% of cases (Proaño, García, Muñoz, Villareal, & Guano, 2023)

Conversely, ankle fractures are classified into three groups according to Danis and Weber's, based on the level of occurrence on the fibula: suprasyndesmotoc fracture (Weber C), transsyndesmotoc fracture (Weber B), and infrasyndesmotoc fracture (Weber A) (Cluett, 2023)

Weber type B fractures are the most frequent; usually their management is surgical to achieve anatomical reduction and restore joint stability. The osteosynthesis technique is based on internal fixation with a plate and screws (Kyriacou, Mostafa, Davies, & Khan, 2021)

Depending on the type of fracture, either absolute or relative stability can be ensured. Relative stability is necessary in fractures with multiple fragments and typically in extra-articular fractures, where micro-movements can occur. Secondary consolidation with the formation of callus bone takes place in these cases.

On the other hand, fracture where there are not multiple fragments but the articular component is compromised, absolute stability can be done with the usage of an interfragmentary screw in the peroneal malleolus. This ensures proper stabilization and primary fracture consolidation without the formation of bone callus (Park, Cho, Choi, & Kim, 2020)

Although literature recommends interfragmentary screw placement, limited data exist on its necessity and impact on fracture healing. This study seeks to compare outcomes between fracture management with and without interfragmentary screws.

Within the existing literature, the placement of interfragmentary screws is commonly advocated. However, there remains limited information regarding the differentiations between implementing or refraining from the use of this device and the consequential effects on the consolidation of fractures of this nature. It is in light of this knowledge gap that we have opted to embark upon this article, affording us the opportunity to compare and contrast the outcomes inherent to each individual procedure.

METHODS

Data related to Weber type B fractures was subjected to analysis using a cross-sectional analytical study design between January 2022 and January 2023. The study involved 47 patients who had been diagnosed with Weber type B ankle fracture and sought treatment at the orthopedics department of San Francisco General Hospital in Quito.

An important exclusion criterion for this study was the presence of multi-fragmentary ankle fractures (comminuted); as in this type of injury, the placement of an interfragmentary screw becomes highly challenging. Additionally, these types of fractures can pose significant complexity for surgical correction, often resulting from high-energy trauma.

Standardized equipment were used to ensure consistent radiographic criteria, evaluating both anteroposterior and mortise views (with a 10-degree internal rotation) of each patient's ankle.

Within this framework, two distinct study groups were delineated: those who underwent interfragmentary screw fixation in the fibular fracture and those without the same.

The accumulated data from the study facilitated the examination of several key variables: surgical time, amount of bleeding, postoperative complications, and consolidation time. The analysis of these variables was conducted using the JASP 0.16.0.0 system to determine the p-value, using Chi-square test and ANOVA.

RESULTS

A total of 47 patients with Weber type B ankle fractures from San Francisco General Hospital in Quito, were analyzed. The study involved the evaluation of their radiographic images to assess the presence of interfragmentary screws and how they impacted anatomical reduction, surgical time, intraoperative bleeding, joint stability restoration, complications, consolidation, and non-union.

Out of the total sample, 53.19% (27 patients) had interfragmentary screws placed to achieve compression at the fracture site and promote primary consolidation. This was assessed through diagnostic radiographs (Figure 1). The 46.80% (22 patients) did not have interfragmentary screws (Figure 2).



Figure 1. Male patient diagnosed with right Weber type B ankle fracture, preoperative and postoperative with interfragmentary screw placement.



Figure 2. Male patient diagnosed with left Weber type B ankle fracture, preoperative and postoperative without interfragmentary screw placement.

After analyzing surgical time and the amount of bleeding in each surgery, it was determined that surgeries with interfragmentary screws had a mean duration of 83.12 minutes, compared to 81.3 minutes for those without the interfragmentary screw. The statistical analysis yielded a p-value of 0.854, indicating no significant difference (Table 1).

Table 1. ANOVA Test (surgery time in minutes and interfragmentary screw)

Table 1. ANOVA Test (surgery time in minutes and interfragmentary screw)					
Cases	Sum of Squares	df	Mean Square	F	p
Interfragmentary screw	36.099	1	36.099	0.034	0.854
Residuals	47559.731	45	1056.883		

Source: the authors, 2023.

Additionally, the mean bleeding in patients with interfragmentary screws was 52.8 mL, while the mean bleeding in patients without the interfragmentary screws was 50 mL, showing no significant changes in this aspect (Tables 2 and 3).

Table 2. Bleeding and Interfragmentary Screw

Table 2. Bleeding and interfragmentary screw							
Interfragmentary screw	Bleeding						Total
	0	20	30	50	60	100	
NO	1	2	2	12	2	3	22
YES	0	6	0	10	5	4	25
Total	1	8	2	22	7	7	47

Source: the authors, 2023.

Table 3. Chi-Square Test (Bleeding and Interfragmentary Screw)

Table 3. Chi-Square Test (Bleeding and Interfragmentary Screw)			
	Value	df	p
X ²	6.445	5	0.265
N	47		

Source: the authors, 2023.

Regarding complications and follow-up time, it was observed that out of the 25 patients with interfragmentary screws, 7 patients experienced complications such as limitation in pronosupination and dorsal flexion, decreased range of motion, gastrocnemius atrophy due to immobility, ambulation-limiting pain, and pain upon digit pressure. The average postoperative follow-up time was 82.81 days (Tables 4, 5, and 6).

Table 4. Complications and Interfragmentary Screw

Table 4. Complications and Interfragmentary Screw			
Interfragmentary screw	Complications		Total
	NO	SI	
NO	16	6	22
YES	18	7	25
Total	34	13	47

Source: the authors, 2023.

Table 5. Chi-Square Test (Complications and Interfragmentary Screw)

Table 5. Chi-Square Test (Complications and Interfragmentary Screw)			
	Value	df	p
X ²	1.265	2	0.531
N	47		

Source: the authors, 2023.

Table 6. ANOVA Test (Consolidation Time and Interfragmentary Screw)

Table 6. ANOVA Test (Consolidation Time and Interfragmentary Screw)					
Cases	Sum of Squares	df	Mean Square	F	p
Interfragmentary screw	313.555	1	313.555	0.091	0.765
Residuals	155675.551	45	3459.457		

Source: the authors, 2023.

On the other hand, among the 22 patients without interfragmentary screws, 4 patients experienced complications including decreased range of motion, pain upon ambulation, and pain upon digit pressure. Their average follow-up time was 76.8 days (Tables 4, 5, and 6).

In both groups, the consolidation time was sufficient to ensure anatomical reduction of the fracture, as indicated by radiographic analysis of various parameters such as talocrural and bimalleolar angles, circle signs, among others. The calculated p-value was 0.765, indicating no statistical difference.

DISCUSSION

Through our study, we have conducted a comprehensive analysis that encompasses the detailed follow-up of 47 patients who have experienced Weber type B ankle fractures. These fractures primarily originated due to a mechanism of injury characterized as pronation, resulting in an oblique fracture pattern in the distal region of the fibula, according to the Lauge Hansen classification.

In order to effectively address these fractures, a surgical procedure and technique were performed involving a lateral approach, open reduction with a backhaus forceps, and fixation with Kirschner wires prior to plate placement. Once the plate was fixed, the Kirschner wires were removed. Through this approach, successful fracture reduction was achieved, followed by osteosynthesis to ensure the stability and proper recovery of the compromised bone structure.

It's important to note that in our medical setting, the most commonly used approach for this type of fracture is the use of a one-third tubular plate. This choice is based on the highly positive results and cost-effectiveness previously demonstrated in a similar focused study. (Park, Cho, Choi, & Kim, 2020)

In the study "Management of Weber Type B Ankle Fractures: How Does Positional Screw Influence Stability?", the combination of precise fracture reduction and stability provided by osteosynthesis has led to satisfactory recovery in our patients. Furthermore, the fact that this technique has proven to be economically viable compared to other options reinforces its prominence in our medical practice (Proaño, García, Muñoz, Villareal, & Guano, 2023)

Dr. Manoharan on "Distal fibula oblique fracture fixation using one-third tubular plate with and without lag screw – A biomechanical study of stability," it was found that the interfragmentary screw does not significantly influence biomechanical stability (Manoharan, Singh, Kuiper, & Nokes, 2018)

In a 2020 prospective study involving 76 patients and focusing on the necessity of the interfragmentary screw in locked plates for fractures caused by a mechanism of supination and external rotation over a 12-month period, it is noted that the use of the screw is not essential, as both groups achieved final consolidation without significant differences and/or clinical complications. (Park, Cho, Choi, & Kim, 2020)

Hoon Ahn, in a 2021 study, points out that the head of an interfragmentary screw influences the fixation of the one-third tubular plate, preventing proper placement of it. Conversely, they use two Kirschner wires as a temporary method for plate osteosynthesis, as it allows for better positioning. This applies to both one-third tubular plates and locking plates,

yielding similar consolidation results (Ahn, Cho, Jeong, & Kim, 2021).

The key to managing these types of fractures is neutralizing torque through a plate that should be anatomically contoured as much as possible and fixed with screws following AO principles from the most proximal point. This means that the force required to bend a plate by applying screws must be counteracted by an equal or greater force in the bone to prevent fracture displacement (Zhao, Michalski, Eitan Ingall, & Kwon, 2023).

Complications at the fibular level are relatively unknown and infrequent. These include osteo-arthritis, which is usually related to non-anatomical reduction leading to consolidation in shortening or external rotation. However, this problem can be clinically identified with parameters such as the Weber circle or coin sign (circle sign between distal fibula and lateral area of the talus), Shenton's line (between the medial surface of the fibular joint and surface of the distal tibial joint; normal incongruence up to 1mm in AP), talocrural angles ($83 \pm 4^\circ$), and bimalleolar angles ($8-15^\circ$). These are the main signs defining fibular shortening (Canton, y otros, 2021)

As part of the postoperative treatment for fractures, it is imperative to consider proper weight-bearing on the affected limbs. In certain situations, early weight-bearing and premature mobility can significantly impact the alignment of the fracture site, underscoring the importance of a careful and methodical approach to patient care (Sharma & Farrugia, 2022).

Standard practice dictates a period of immobilization typically extending to approximately six weeks after surgical intervention. During this initial period, weight-bearing on the affected limb is limited, and the patient is kept under relative rest. However, it is crucial to emphasize that this weight-bearing cannot be complete, as it could compromise the integrity of the surgical repair and the stability of the fracture. At this point, collaboration with physical therapists becomes essential to safely and effectively initiate assisted ambulation.

According to Thomas B., the phases of gradual weight-bearing progress follow a specific pattern, including the following weight-bearing phases (Anderson & Duong., 2023):

- Non-weight bearing: During the immobilization period, the limb bears no weight, and crutches or other support devices are used.
- With touch-down weight bearing: Subsequently, toe-touching on the ground is allowed solely for balance purposes, without exerting significant pressure.
- Partial weight bearing: Later on, partial weight-bearing on the affected limb is authorized, gradually increasing.
- With weight bearing as tolerated: As the patient progresses, they are allowed to support from 50% to 100% of their body weight on the limb, depending on tolerance.
- With full weight bearing: Finally, full weight-bearing is achieved, and the affected leg is capable of bearing the entire body weight, allowing normal ambulation.

This stepped and supervised approach has proven beneficial in the postoperative care of fractures, facilitating effective and safe recovery for our patients. However, in our study, the minimum immobilization time is four weeks.

From our study, we conclude that the interfragmentary screw is not strictly necessary. In the studied population, consolidation was achieved with adequate alignment and fibular length without significant differences between the groups. However, the use of the screw is associated with increased cost, recovery time, and certain complications due to inadequate plate positioning, as the head of the interfragmentary screw can influence fixation and cause some degree of displacement.

CONCLUSION

The interfragmentary screw allows us to achieve compression in a fracture and obtain primary consolidation (per prima). However, in patients who did not have this screw placed, no cases of non-union were observed, raising doubts about the necessity of such a screw.

One of the disadvantages of using the interfragmentary screw, which has become evident in the Orthopedics Department of the San Francisco General Hospital in Quito, is that when patients opt for the removal of the osteosynthesis material, a more extensive surgical approach is required when the interfragmentary screw is present.

The interfragmentary screw is a highly important tool within the techniques of the Orthopedics, as it assists us in maintaining fracture reduction while we apply a neutralization plate. However, in the specific case of the ankle, this study demonstrates that anatomical reduction and preservation of vascularity are more critical than bone compression.

REFERENCES

Ahn, J. H., Cho, S. H., Jeong, M., & Kim, Y.-C. (27 de 10 de 2021). *PUBMED*. Obtenido de One-Third Tubular Plate Remains a Clinically Good Option in Danis-Weber Type B Distal Fibular Fracture Fixation: <https://pubmed.ncbi.nlm.nih.gov/34708569/>

Anderson, T. B., & Duong, H. (01 de 05 de 2023). *PUBMED*. Obtenido de Weight Bearing: <https://www.ncbi.nlm.nih.gov/books/NBK551573/>

Canton, G., Sborgia, A., Maritan, G., Roberto Fattori, F. R., Tomic, M., Morandi, M. M., & Murena, L. (18 de 05 de 2021). *PUBMED*. Obtenido de Fibula fractures management: <https://pubmed.ncbi.nlm.nih.gov/34055584/>

Cluett, J. (15 de 03 de 2023). *VERYWELLHEALTH*. Obtenido de Tipos de fracturas en tobillos rotos: <https://www.verywellhealth.com/broken-ankle-2548484>

Koehler, S. M. (01 de 04 de 2022). *UPTODATE*. Obtenido de Fracturas de tobillo en adultos.: <https://www.uptodate.com/contents/ankle-fractures-in-adults#!>

Kyriacou, H., Mostafa, A. M., Davies, B., & Khan, W. (07 de 04 de 2021). *PUBMED*. Obtenido de Principios y directrices en el tratamiento de las fracturas de tobillo en adultos.: <https://pubmed.ncbi.nlm.nih.gov/33826430/>

Manoharan, G., Singh, R., Kuiper, J. H., & Nokes, L. D. (17 de 05 de 2018). *PUBMED*. Obtenido de Distal fibula oblique fracture fixation using one-third tubular plate with and without lag screw - A biomechanical study of stability: <https://pubmed.ncbi.nlm.nih.gov/29881191/>

Park, Y. H., Cho, H. W., Choi, G. W., & Kim, H. J. (01 de 07 de 2020). *PUBMED*. Obtenido de Necessity of Interfragmentary Lag Screws in Precontoured Lateral Locking Plate Fixation for Supination-External Rotation Lateral Malleolar Fractures: <https://pubmed.ncbi.nlm.nih.gov/32389050/>

Proaño, J., García, V., Muñoz, S., Villareal, J., & Guano, K. (30 de 07 de 2023). *IBERO-AMERICAN JOURNAL OF HEALTH SCIENCE RESEARCH*. Obtenido de Manejo de las fracturas de tobillo Danis y Weber B ¿cómo influye el tornillo posicional sobre la estabilidad?: <https://health.iberojournals.com/index.php/IBEROJHR/article/view/585>

Sharma, T., & Farrugia, P. (20 de 10 de 2022). *PUBMED*. Obtenido de Early versus late weight bearing & ankle mobilization in the postoperative management of ankle fractures: A systematic review and meta-analysis of randomized controlled trials: <https://pubmed.ncbi.nlm.nih.gov/35337752/>

Zhao, J. Z., Michalski, M. P., Eitan Ingall, P. T., & Kwon, J. Y. (01 de 02 de 2023). *PUBMED*. Obtenido de Does Screw Order Matter? A Technique Tip to Prevent Loss of Fracture Reduction during Surgical Fixation of Lateral Malleolus Fractures: <https://pubmed.ncbi.nlm.nih.gov/37538130/>

Contribution of each author to the manuscript:

Task	% of contribution of each author				
	A1	A2	A3	A4	A5
A. theoretical and conceptual foundations and problematization:	20%	20%	20%	20%	20%
B. data research and statistical analysis:	20%	20%	20%	20%	20%
C. elaboration of figures and tables:	20%	20%	20%	20%	20%
D. drafting, reviewing and writing of the text:	20%	20%	20%	20%	20%
E. selection of bibliographical references	20%	20%	20%	20%	20%
F. Other (please indicate)	-	-	-	-	

Indication of conflict of interest:

In this cross-sectional analytical study, important information regarding Weber type B fractures was reviewed in the research. We hereby declare that there are no personal, collective, or third-party interests related to the study data. This study aims to review and enhance the surgical technique in patients from various contexts

Source of funding

There is no source of funding

Acknowledgments

Special thanks to Dr. Ana Mena and Dr. Mateo Fabara who assisted us in the manuscript translation process.