

Comparison of Fully Threaded Cannulated Screw, Half Threaded Cannulated Screw, and Tension-Band Wiring in the Fixation of Herscovici Type C Medial Malleolus Fractures: A Retrospective Clinical Study

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ABSTRACT

Objective: Surgical treatment is often preferred for medial malleolus fractures to achieve anatomic reduction and enable early mobilization. This study aims to evaluate the clinical and radiological outcomes of fixing Herscovici Type C medial malleolus fractures using tension-band wiring (TBW) and half and fully threaded cannulated screws.

Methods: This retrospective study included patients aged 18 to 65 who underwent surgery for isolated medial malleolus fractures between January 2012 and December 2022. Exclusion criteria were a follow-up period of less than one year, fractures other than Herscovici Type C, open fractures, use of other implants, or loss to follow-up. Radiological evaluations were conducted using preoperative anterior-posterior, lateral, and mortise radiographs, along with computed tomography scans. The talocrural angle, corner angle, and alignment between the talus and tibial plafond were assessed. Clinical outcomes were measured using the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale. Statistical analysis was performed using SPSS software.

Results: A total of 178 patients were included: 55 (30.9%) underwent TBW fixation, 60 (33.7%) had half-threaded cannulated screw fixation, and 63 (35.4%) received fully threaded cannulated screw fixation. The mean follow-up period was 76 months, and the mean age was 32.2 years. The TBW group had a significantly longer follow-up period than the other groups ($p=0.000$), with no difference between the half and fully threaded screw groups. There were no differences among the groups regarding fracture side, trauma mechanism, or need for implant removal. Postoperative talocrural angles were similar across groups ($p=0.530$). The postoperative corner angle was significantly lower in the TBW group (mean: 63.4) compared to the half-threaded (mean: 65.8) and fully threaded (mean: 65.2) screw groups ($p=0.049$). AOFAS scores were significantly higher in the half-threaded screw group (mean: 89.1) compared to the TBW (mean: 84.2) and fully threaded screw groups (mean: 85.9) ($p=0.02$). No significant difference was found between the half-threaded and fully threaded screw groups regarding the alignment between the superior facet of the talus and the anterior tibial plafond. The TBW group had a significantly higher number of patients with misaligned joints compared to the other groups ($p=0.000$).

Conclusion: Radiological outcomes were better in the half and fully threaded cannulated screw fixation groups compared to the TBW fixation group. The AOFAS scores were highest in the half-threaded screw fixation group. No significant differences were found among the groups regarding complications. The study concludes that cannulated screw fixation is a safer and more effective method for treating isolated medial malleolus fractures than the TBW fixation method.

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Submitted: 08.06.2024

Revised: 25.06.2024

Accepted: 20.07.2024

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Keywords: Cannulated screw fixation; medial malleolus fracture; tension-band wiring method.



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INTRODUCTION

Medial malleolus fractures are common among ankle and talocrural region fractures, with an annual isolated medial malleolus fracture incidence of 10-12/100,000. In addition, it is rare among other talocrural region injuries.^[1] Clinical and biomechanical studies suggest that the medial malleolus has primary significance in ankle stability.^[2] Isolated medial malleolus fractures make up only 10% of all ankle fractures.^[3-5] The surgical treatment of these fractures is still controversial. While conservative follow-up is suggested in displaced and non-displaced cases, there are also surgeons in favor of surgical treatment. Surgical treatment stands out when it comes to early mobilization of the patients and essential joint range of motion (ROM).^[6] The alignment of the ankle mortise is vital for the functioning of the tibiotalar joint. Even one millimeter of talar displacement can decrease tibiotalar joint contact by 40%, accelerating the development of osteoarthritis (OA), which results in poor functional outcomes. Thus, surgical treatment is preferred in medial malleolus fractures to provide anatomic reduction and early joint ROM.^[5-7] The aim of this study is to evaluate the clinical and radiological outcomes of the fixation of Herscovici Type C medial malleolus fractures by using the tension-band wiring (TBW) (Zuggurtung) technique and half and fully threaded cannulated screws.

MATERIALS AND METHODS

The study is approved by Ümraniye Training and Research Hospital Ethics Committee for Clinical Trials (registration no: 240623882). This single-centered retrospective study examined a total of 243 patients between 18-65 years of age who were operated on due to isolated medial malleolus fractures between January 2012 and December 2022. Patients with a follow-up period of less than one year, with fractures other than Herscovici Type C, with open fractures, and patients having another implant, and those lost to follow-up were excluded from the study. After the exclusion of the aforementioned patients, a total of 178 patients who attended their last follow-up visit were included in the study. The patients in Group 1 (55 patients, 30.9%) were treated using the TBW technique with Kirschner wire and transosseous cerclage wire. The fractures of Group 2 (60 patients, 33.7%) and Group 3 (63 patients, 35.4%) were fixated using half-threaded cannulated screws and fully threaded cannulated screws, respectively. The fixation method depended on the preference of the surgeon. The fractures were postoperatively classified according to the fracture classification system described by Herscovici et al.^[8] Only the patients with Herscovici Type C were included in the study.

Preoperative views of anterior-posterior, lateral, and mortise radiographs, and computed tomography (CT) scans were considered in the radiological evaluation. The unseen fracture pattern and/or the bone callus tissue that forms the fracture pattern were accepted as a sign of radiological bone union in the radiographs. The alignment of the

talocrural angle, corner angle, talus, and tibia plafond were evaluated from the radiographs taken in the latest follow-up visits. An experienced orthopedic specialist (MD), who did not participate in the surgical process, carried out the radiological measurements and all clinical evaluations. The American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale (AHFS) score was used for the evaluation of the clinical outcomes.^[9]

All patients were followed up according to the standard postoperative follow-up protocol of our clinic. Thus, all patients were immobilized with short leg braces in the first four weeks. After the removal of the braces, active and passive ankle joint ROM exercises were started. Weight bearing was allowed only after the patients showed recovery not only in clinical examination results but also in radiological findings. All patients were postoperatively prescribed aspirin 100 mg/day for 4 weeks as standard venous thromboprophylaxis treatment.

Surgical Technique

The patients were positioned in the supine position and received intravenous prophylactic cefazolin. After the placement of the thigh tourniquets, the operations were begun. Through the incisions made over the medial malleolus, the fractures were anatomically reduced and fixated. In the TBW technique, the incisions were slightly extended proximally, and a bone tunnel was made 4-5 cm proximal to the malleolus, and the cerclage wire was passed through this tunnel (Figure 1). Fixations were achieved with two parallel screws in the half and fully threaded cannulated screw fixation methods (Figure 2-3).

Statistical Analysis

The data was analyzed using the Statistical Package for the Social Sciences (SPSS) software (ver. 22.0; IBM Corp., Armonk, NY, USA). The normal distribution of the data was evaluated with the Shapiro-Wilk test and Levene test. Non-parametric variables were analyzed using the Mann-Whitney U test, and parametric variables were analyzed using the Student t-test and ANOVA test. Categorical variables were compared using Pearson's chi-squared test, Monte Carlo simulations, and Fisher's exact test. Quantitative variables were described as mean±standard deviation or interquartile range (IQR), and median. Qualitative variables were described as frequencies or rates. A p-value less than 0.05 was considered statistically significant.

RESULTS

A total of 178 patients were included in the study. Of these patients, 55 (30.9%), 60 (33.7%), and 63 (35.4%) were in Group 1 (TBW fixation group), Group 2 (half-threaded cannulated screw fixation group), and Group 3 (fully threaded cannulated screw fixation group), respectively. The mean follow-up period was 76 (13-127) months, and the mean age was 32.2 (18-65) years. The mean follow-up period was significantly longer in Group 1 compared to the other two groups ($p=0.000$), but there



Figure 1. Post-union radiograph of the patient fixed with tension band wiring.



Figure 2. Fixation with fully threaded cannulated screw early post operative radiograph.



Figure 3. Fixation with half threaded cannulated screw.

was no significant difference between Group 2 and Group 3. There was no difference among the groups regarding age, fracture side, trauma mechanism, and the need for implant removal ($p=0.307$, $p=0.949$, $p=0.112$, $p=0.105$, re-

spectively) (Table 1). There was no significant difference among the groups in terms of postoperative talocrural angles ($p=0.530$). Postoperative corner angle was found to be significantly lower (mean:63.4) in Group 1 than in the

Table 1. Demographic characteristics of the patients

Age	Group 1 (n=55)		Group 2 (n=60)		Group 3 (n=63)		Total	p
	Mean	±SD	Mean	±SD	Mean	±SD		
	27.3	12.4	38	15.4	30.5	13.6		0.307
	n	%	n	%	n	%		
Gender								
Female	16	35.6	20	44.4	9	20	45 100%	0.038
Male	39	29.3	40	30.1	54	40.6	133 100%	
Fracture Side								
Right	23	31.1	24	32.4	27	36.5	74 100%	
Left	32	30.8	36	34.6	36	34.6	104 100%	0.949
Trauma mechanism								
Distortion	16	43.2	9	24.3	12	32.4	37 100%	
Traffic accident	22	32.4	20	29.4	26	38.2	68 100%	
Falling	14	26.4	19	35.8	20	37.7	53 100%	0.112
Crush injury	3	15	12	60	5	25	20 100%	

Group 1: Tension-band wiring Fixation. Group 2: Half threaded cannulated screw Fixation. Group: Fully threaded cannulated screw Fixation.

Table 2. Comparison of post operative radiologic and clinical values of the patients

Group 1			
Mean	12.2	63.4	84.2
Max	19	75	100
Min	5	53	73
±SD	2.95	5.13	7.15
Group 2			
Mean	12.8	65.8	89.1
Max	18	78	100
Min	7	55	68
±SD	2.76	4.95	7.73
Group 3			
Mean	12.7	65.2	85.9
Max	20	80	100
Min	4	50	75
±SD	3.28	6.09	7.39
p	0.530	0.049	0.02

Group 1: Tension-band wiring Fixation. Group 2: Half threaded cannulated screw Fixation. Group: Fully threaded cannulated screw Fixation
AOFAS: American Orthopaedic Foot and Ankle Society.

other two groups, but there was no difference between half- (mean:65.8) and fully (mean:65.2) threaded cannulated screw fixation groups ($p=0.049$). AOFAS scores ob-

tained at the last follow-up visit were significantly higher in Group 2 (mean: 89.1) compared to the other two groups, but there was no significant difference between Group 1 (mean:84.2) and Group 3 (mean:85.9) ($p=0.02$). There was no significant difference between Group 2 and Group 3 regarding the alignment of the superior facet of the talus and anterior tibial plafond. The number of patients with misaligned joints was found to be significantly higher in Group 2 than in the other two groups ($p=0.000$) (Table 2).

DISCUSSION

The surgical treatment of ankle medial malleolus fractures constitutes an anatomical joint surface and ensures early mobilization exercises and early weight-bearing to accelerate patients' return to normal life. Studies suggest that prognosis depends on anatomic reduction and the maintenance of this reduction, which is crucial for the union of ankle fractures.^[10] The medial malleolus is also supposed to be aligned in the ankle mortise for normal tibiotalar joint alignment.^[9] The medial malleolus and anterior talofibular ligaments prevent the medial translation of the talus.^[9] Due to the anatomical importance of medial malleolus fractures, surgical treatment is preferred to minimize joint misalignments, instability, and arthritis formation due to trauma.^[11,12]

There are many methods for fracture fixation in the literature. In this study, we compared three of the most com-

mon methods of fixation. Lee YK et al.^[13] carried out a study on 12 fresh cadavers and found that after Herscovici Type C fractures, the mean contact area decreased by 9%, and a 2 mm displacement increased mean contact pressure by 8%. After Herscovici Type C fractures, a 2 mm displacement showed significant changes in contact area and contact pressure when compared to a normal tibiotalar joint.^[13] Except for the treatment method, the degree of the fracture displacement was also an independent risk factor for a lower functional result.^[5]

Many methods have been described in the surgical fixation of the medial malleolus.^[7,14-18] The most common ones are the TBW technique that involves Kirschner wire and cerclage wire, and fixation with cancellous lag screws.^[7,19-21] There is no clear evidence on which method is superior to the others.^[7] Studies indicated that the TBW technique was more effective in medial malleolus avulsion fractures, comminuted fractures, and osteoporotic fractures.^[7] TBW converts tensile force on the fracture pattern into compression force. Wire and cerclage tension can be adjusted according to the type of fracture. It can also be used for cracked or rebroken fractures during the fixation process with screws.^[22-23] In one study, functional scores were found to be better in fixation with TBW when compared to fixation with screws. TBW fixation was also found to cause less fixation failure and delayed union.^[22]

Ebraheim et al.^[24] carried out a study evaluating implants according to medial malleolus fracture types and found that fixation with TBW had fewer complications and lower revision rates when compared to screw fixation in Herscovici Type C fractures. However, screw fixation demonstrated better outcomes compared to TBW fixation in Herscovici Type D fractures. TBW was superior in small broken bone pieces, poor bone quality, and transverse fractures, while screws were superior in young patients and oblique fractures. They concluded that when the suitable fixation method was chosen according to the size and type of the fracture and the patient's general condition, excellent clinical and radiological results could be achieved without any complications.^[23,24] However, in our study, no functional superiority was observed in patients who underwent the TBW procedure, and the outcomes were similar for both TBW fixation and fully threaded cannulated screw fixation. We also found TBW fixation to have poorer outcomes compared to half-threaded cannulated screw fixation. The TBW fixation group was also observed to have poorer joint alignment and a smaller ankle corner angle. Contrary to the literature, TBW fixation was observed to have poorer clinical and radiological outcomes. We concluded that the poor clinical outcomes of TBW fixation corresponded to the radiological evaluations. Although we found no significant difference among fixation methods regarding complications, TBW was found to have other disadvantages when compared to screw fixation. These disadvantages were the proximal extension of the incision to the fracture pattern and the necessity of a secondary surgery.^[22,23] We believe that one of the reasons

for the TBW group having the lowest AOFAS score was patient dissatisfaction due to implant irritation.

In a biomechanical and clinical study by Ricci et al.,^[25] fully threaded cannulated screws were used in 46 patients, and half-threaded cannulated screws were used in another 46 patients. Fully threaded cannulated screws had better biomechanical, radiographical, and clinical outcomes when compared to half-threaded cannulated screws. Screw loosening was found to be significantly higher (11 times) in fully threaded cannulated screw fixation when compared to half-threaded cannulated screw fixation. In transverse fractures, the strongest fixation was observed in the fully threaded screw fixation group after the tension and compression forces.^[19,25] In a study by Yamine et al.,^[26] they emphasized less screw loosening and less necessity for implant removal in fully threaded cannulated screw fixation when compared to half-threaded cannulated screw fixation.

They also stated that fixation with screws might not achieve rigid fixation in this region due to the spongiform nature of the distal tibial metaphysis, especially in the presence of osteoporosis. They supported that fully threaded cannulated screws provided better compression in the distal tibial metaphysis region and showed better outcomes by increasing tensile force.^[27] When compared with TBW fixation, fully and half-threaded cannulated screw fixations were found to have shorter operation times, less need for implant removal due to less implant irritation, and the incisions could be made smaller during operations.^[28] However, in our study, we did not find any significant difference between half-threaded and fully threaded cannulated screw fixation groups, but we obtained better results regarding AOFAS scores in the half-threaded cannulated screw fixation group.

In a biomechanical study by Parker et al.,^[29] 4 mm fully threaded cancellous screws were found to apply a significantly higher amount of compression into the fracture region when compared to partially threaded isometric cancellous screws.

Our study had limitations. Headless compression screws were not included in the study as we did not use them due to their high cost. Bone density (DEXA) scans were not carried out to evaluate the bone quality of the patients, and time to union for the fractures was not assessed. We also believe that potential bias might have occurred due to the retrospective design of the study, the relatively low number of patients, the lack of a biomechanical comparison with other fixation methods, and the lack of an independent orthopedist's evaluation. The strength of our study was the assessment of similar isolated medial malleolus fractures.

Conclusion

Our study demonstrated satisfying results in all three fixation methods used for medial malleolus fractures. Moreover, the incidence of pain/sensitivity and palpation of the

medial malleolus associated with implant irritation was lower in the fully threaded cannulated screw group when compared to the other two groups. Radiological measures were found to be better in the TBW group than in the other two groups, and the AOFAS score was found to be higher in the half-threaded cannulated screw group. No significant difference was found among the three groups regarding complications. We concluded that fixation with cannulated screws was a safer and more effective method when compared to the TBW method in the treatment of the medial malleolus. There is a shortage of studies comparing these three methods in the literature. We believe our study will make a valuable contribution to the literature. Prospective, double-blind, randomized controlled studies are needed to reach more accurate results.

Ethics Committee Approval

The study was approved by the Ümraniye Training and Research Hospital Ethics Committee (Date: 28.03.2024, Decision No: 240623882).

Informed Consent

Retrospective study.

Peer-review

Externally peer-reviewed.

Authorship Contributions

Concept: S.B.; Design: M.E.K.; Supervision: S.K.Ç.; Fundings: B.K.; Materials: M.M.O.; Data: F.B.; Analysis: M.E.K.; Literature search: S.B.; Writing: S.B.; Critical revision: M.E.K.

Conflict of Interest

None declared.

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Herscovici Tip C Medial Malleol Kırıklarında Tam Yivli Kanüle Vida, Yarım Yivli Kanüle Vida ve Gergi Bandı ile Tespitin Karşılaştırılması: Retrospektif Bir Klinik Çalışma

Amaç: Medial malleol kırıklarında anatomik redüksiyon sağlamak ve erken mobilizasyonu mümkün kılmak için genellikle cerrahi tedavi tercih edilir. Bu çalışma, Herscovici Tip C medial malleol kırıklarının tension-band wiring (TBW) ve yarım ve tam yivli kanüle vidalar kullanılarak tespit edilmesinin klinik ve radyolojik sonuçlarını değerlendirmeyi amaçlamaktadır.

Gereç ve Yöntem: Bu retrospektif çalışma, Ocak 2012 ile Aralık 2022 arasında izole medial malleol kırığı nedeniyle ameliyat edilen 18-65 yaş arası hastaları içermektedir. Bir yıldan az takip süresi olanlar, Herscovici Tip C dışındaki kırıkları olanlar, açık kırıkları olanlar, başka implant kullananlar veya takibi kaybedilenler çalışma dışı bırakıldı. Radyolojik değerlendirmeler, preoperatif anteroposterior, lateral ve mortis radyografileri ile bilgisayarlı tomografi taramaları kullanılarak yapıldı. Talokrural açı, köşe açısı ve talus ile tibia tavanı arasındaki hizalanma değerlendirildi. Klinik sonuçlar, Amerikan Ortopedik Ayak ve Ayak Bileği Derneği (AOFAS) Ayak Bileği-Arka Ayak Skalası kullanılarak ölçüldü. İstatistiksel analiz SPSS yazılımı kullanılarak yapıldı.

Bulgular: Toplam 178 hasta çalışmaya dahil edildi: 55'i (%30.9) TBW tespiti, 60'ı (%33.7) yarım yivli kanüle vida tespiti ve 63'ü (%35.4) tam yivli kanüle vida tespiti uygulandı. Ortalama takip süresi 76 ay ve ortalama yaş 32.2 yıldır. TBW grubunun takip süresi diğer gruplara göre anlamlı derecede daha uzundu ($p=0.000$), yarım ve tam yivli vida grupları arasında fark yoktu. Kırık tarafı, travma mekanizması veya implant çıkarma ihtiyacı açısından gruplar arasında fark yoktu. Postoperatif talokrural açı gruplar arasında benzerdi ($p=0.530$). Postoperatif köşe açısı, TBW grubunda (ortalama: 63.4), yarım yivli (ortalama: 65.8) ve tam yivli (ortalama: 65.2) vida gruplarına göre anlamlı derecede daha düşüktü ($p=0.049$). AOFAS skorları, yarım yivli vida grubunda (ortalama: 89,1), TBW (ortalama: 84.2) ve tam yivli vida gruplarına (ortalama: 85.9) göre anlamlı derecede daha yüksekti ($p=0.02$). Talus'un üst yüzeyi ile anterior tibia tavanı arasındaki hizalanma açısından yarım ve tam yivli vida grupları arasında anlamlı fark bulunmadı. TBW grubunda yanlış hizalanmış eklem sayısı diğer gruplara göre anlamlı derecede daha yüksekti ($p=0.000$).

Sonuç: Radyolojik sonuçlar, yarım ve tam yivli kanüle vida tespiti gruplarında TBW tespiti grubuna göre daha iyiydi. AOFAS skorları, yarım yivli vida tespiti grubunda en yüksekti. Komplikasyonlar açısından gruplar arasında anlamlı fark bulunmadı. Çalışmada, kanüle vida tespitinin izole medial malleol kırıklarının tedavisinde TBW tespiti yöntemine göre daha güvenli ve etkili bir yöntem olduğu sonucuna varıldı.

Anahtar Sözcükler: Gergi bandı yöntemi; kanüle vida ile tespit; medial malleol kırığı.