



Araştırma Makalesi / Research Article

Journal of Medical Topics & Updates (Journal of MTU)

Doi: 10.58651/jomtu.1325159

Comparison of cannulated screw, tension band, and mini-fragment t-plate fixation in medial malleolus fractures

Medial malleol kırıklarında kanüle vida, gergi bandı ve minifragment t-plak fiksasyonun karşılaştırılması

İsmail GÜZEL¹ Serkan Akpancar²

Malatya Training Research Hospital, Department of Orthopedics and Traumatology, Malatya, Türkiye.

ABSTRACT

Background: The study aimed to compare the clinical results of cannulated screw (KS), tension band, and mini-fragment T-plate (MTP) fixation in medial malleolus fractures.

Materials and Methods: The present study employed a retrospective cohort design to investigate the outcomes of patients who underwent treatment for medial malleolus fractures at our clinic between January 2016 and January 2019. A total of 90 patients were included in the study, and they received one of three fixation methods: cannulated screw, tension band, or mini-fragment T-plate. The evaluation of ankle and foot functions was conducted using the American Orthopedic Foot and Ankle Surgery score, number of fluoroscopy shots, duration of surgery, and ankle joint range of motion measurements.

Results: After a 12-month follow-up, there was no significant difference between the groups ($p=0,263$, $p=0,432$ and $P=0,376$) in terms of the AOFAS score. The ankle joint range of motion was similar in all groups. According to the radiographs, the compression ability was weaker in the mini-plate group than in the other groups. The mean duration of surgery was shorter in the cannulated screw group ($p<0.001$). The mean number of scopy shots was not similar between the groups ($p<0.001$). One patient in the mini-fragment T-plate group developed a superficial infection and recovered with a 2-week oral antibiotic treatment. In the tension band group, one patient experienced skin problems successfully resolved with a one-week treatment regimen. Additionally, three patients treated with cannulated screws required screw removal after fracture union due to their dissatisfaction with screw prominence. No patient underwent revision surgery.

Conclusions: The findings of the study revealed that patients treated with tension bands and cannulated screws demonstrated better clinical outcomes. However, it was observed that these techniques were less favorable compared to the mini-plate procedure due to their potential for tissue irritation.

Keywords: Medial malleolus, Fracture, Cannulated screw, Tension band, Mini plate, Aofas

ÖZET

Amaç: Çalışmamızın amacı medial malleol kırıklarında kanüle vida, gergi bandı ve minifragment t-plak fiksasyonun klinik sonuçlarının karşılaştırılmasıdır.

Materyal ve Metot: Çalışmamız retrospektif kohort çalışması olarak planlandı. Ocak 2016 ile Ocak 2019 yılları arasında kliniğimizde medial malleol kırığı nedeniyle kanüle vida, gergi bandı ve minifragment t-plak fiksasyonu ile tedavi edilen 90 hasta çalışmaya dahil edildi. Hastalar ayak bileği ve ayağın işlevini değerlendirmek için American Orthopaedic Foot and Ankle Surgery skoru, skopi sayısı, ameliyat süresi, ayak bileği eklem hareket açıklığı değerleri kullanılarak karşılaştırıldı.

Bulgular: 12 aylık takip sonrasında her gruplar arası AOFAS skorunda anlamlı fark görülmedi ($p=0.263$, $P=0,432$ ve $P=0,376$). Ayak bileği eklem hareket açıklığının tüm gruplarda benzer olduğu görüldü. Çekilen grafilerde kompresyon yeteneğinin miniplak grubunda diğer gruplara göre daha zayıf olduğu görüldü. Ortalama ameliyat süresinin kanüle vida grubunda daha kısa olduğu görüldü ($p<0.001$). Ortalama floroskopi uygulama sayısının gruplar arasında benzer olmadığı görüldü ($p<0.001$). Çalışmamızda Minifragment T-plak grubunda 1 hastada 2 haftalık oral antibiyotik tedavisi ile iyileşen yüzeysel enfeksiyon, Gergi bandı grubunda 1 hastada 1 haftalık tedaviye cevap veren deri problemleri gelişti. Kanüle vida ile tedavi edilen 3 hastada ise vida basısından dolayı memnuniyetsizlik oluştuğu için kaynama sonrası vidaları çıkarıldı. Hiçbir bir hastaya revizyon cerrahisi uygulanmadı.

Sonuç: Gergi bandı ve kanüle vida yapılan hastalarda daha iyi klinik sonuçlara sahip olduğunu fakat doku irritasyonu açısından mini plağa göre dezavantajlı olduğu görülmektedir.

Anahtar Kelimeler: Medial malleol, Kırık, Kanüle vida, Gergi bandı, Mini plak, Aofas

Received / Geliş Tarihi: 10.07.2023, Accepted / Kabul Tarihi: 24.08.2023

Corresponding Author / Sorumlu Yazar: İsmail GÜZEL, Malatya Training Research Hospital, Department of Orthopedics and Traumatology, Malatya, Türkiye. e-mail: dr.ismailguzel@gmail.com

INTRODUCTION

Malleolus fractures can be seen at any age and account for half of all ankle fractures (Deniz & Akpancar, 2019; Koca et al., 2017). In severe ankle traumas, malleolus fractures are usually seen as bimalleolar and trimalleolar but can also occur as isolated fractures (Bucholz, Henry, & Henley, 1994; Herscovici, Scaduto, & Infante, 2007). Surgery is generally recommended due to its proximity to the joint area and significant contribution to ankle stability. It has been stated in some articles that conservative treatment should be chosen for non-displaced fractures (Barnes, Cannada, & Watson, 2014; Herscovici et al., 2007).

Various surgical methods have been described for the treatment. The primarily used surgical methods are unicortical partially threaded compression screws, bicortical fully threaded screws, buttress plates, neutralization plates, tension bands, and mini-fragment T-plates (Carter, Duckworth, & White, 2019; Dumigan, Bronson, & Early, 2006). The partially threaded cannulated screw technique applied in a closed state is a frequently applied method. It has become prominent in studies with its low morbidity, postoperative pain, and wound complications (Amanatullah et al., 2012; Kochai et al., 2018; Ricci, Tornetta, & Borrelli Jr, 2012). There are a limited number of studies on the mini-fragment T-plate technique. Some studies have shown that this technique provides biomechanically more stable fixation and is clinically successful compared to other methods (Ahmed et al., 2017; Kitaoka et al., 1994). In the tension band technique, on the other hand, a passive fixation is performed at the edges of the fracture without real tension or compression (Aiyer, Zachwieja, Lawrie, & Kaplan, 2019; Alam & Parviz, 2007).

This study compared the clinical results of cannulated screw (CS), tension band, and mini fragment T-plate (MTP) fixation in medial malleolus fractures.

MATERIALS AND METHODS

The study utilized a retrospective cohort design and included 90 patients who underwent treatment for medial malleolus fractures at our clinic between January 2016 and January 2019. The patients were treated with three fixation methods: a cannulated screw (CS), a tension band, and a mini-fragment T-plate (MTP). Prior to conducting the study, ethical approval was obtained from the local Clinical Research Ethics Committee (Malatya Turgut Ozal University - 2021/18), and informed consent was obtained from all participating patients.

The inclusion criteria for this study were as follows:

- Age between 18-70
- Displaced medial malleolus fractures
- A follow-up of at least 12 months

The exclusion criteria for this study were as follows:

- Open fractures
- Pathological fractures
- Cases with metabolic bone disease
- Patients followed up for less than 12 months
- Cases with systemic diseases such as diabetes, hypertension, and hyperlipidemia

The patients were homogenized and divided into three groups according to their demographic characteristics: age, sex, and the type and side of the fracture. Group A included 30 patients treated with cannulated screws with closed or open techniques. Group B included 30 patients with open mini-fragment T-plate (MTP) fixation. Group C included 30 patients who were treated with a tension band.

Surgical Methods

In patients in Group A, firstly, closed fracture reduction was attempted. In patients who could not achieve closed reduction, 2 K-wires were inserted in parallel, perpendicularly to the fracture line. After the scopy control, the screws were inserted into the cannula by drilling over the K-wires. A 3-cm incision was made subcutaneously over the fracture in patients who could not achieve closed reduction. The reduction was successfully achieved through the debridement of the fracture line. Two K-wires were inserted in parallel, passing perpendicularly to the fracture line. After the scopy control, the screws were inserted into the cannula by drilling over the K-wires. The surgery was terminated after scopy control.

In patients in Group B, a 3-cm incision was made over the fracture after anesthesia. The reduction was achieved by debriding the fracture line. The 2.0 mm mini-fragment T-plate was bent and fixed, enclosing the medial malleolus. The surgery was terminated after scopy control.

In patients in Group C, a 3-cm incision was made over the fracture after anesthesia. The fracture line was debrided, and the reduction was achieved. Two K-wires and wire cerclage were used for fixation. The surgery was terminated after scopy control.

Postoperative Evaluation

Patients were asked to move their ankle and knee joints two days after the surgery and perform range of motion exercises on the postoperative 15th day. Mobilization with a partial load was recommended when signs of the union were seen in the x-rays taken for control (6 weeks on average). The American Orthopedic Foot and Ankle Surgery (AOFAS) score was used to evaluate the ankle and foot function at the final follow-up examination.

The comparison of cannulated screw (CS), tension band, and mini-fragment T-plate (MTP) fixation in medial malleolus fractures was examined within the study using the G*Power 3.1 program. The sample size was determined as 60 (each group 30) with an effect size of 0.70, margin of error of 0.05, a confidence level of 0.95, and a population representation of 0.95. (Faul, Erdfelder, Burchner & Lang, 2009). This sample size calculation ensured adequate statistical power for meaningful comparisons within the study. The analysis of the data included in the research was carried out with the SPSS (Statistical Program in Social Sciences) 25 program (IBM SPSS Statistics 25, SPSS Inc., an IBM Co., Somers, NY). The Kolmogorov Smirnov Test was used to check whether the data included in the study conformed to the normal distribution. The Kruskal Wallis test analysis was performed for

comparisons in multiple independent groups. Mann Whitney Analysis was used as a post hoc test for the variables with difference. Bonferroni-corrected p value was used as the p value would increase depending on the increase in the number of comparisons and calculated with “(0.05/number of binary comparisons)”. After the Kruskal-Wallis test, the p values obtained by the Mann-Whitney test are compared with the calculated p values and the result is decided. In the analysis of categorical data, Chi-square (χ^2) analysis was performed by creating cross tables.

RESULTS

Results from 90 patients were included in the study (Group A: Cannulated Screw: 30 patients; Group B: Mini-fragment T-plate: 30 patients; Group C: Tension Band: 30 patients). There was no difference between the groups in terms of age, sex, site of the fracture or fracture classification ($p > 0,05$) (Table 1). A statistically significant difference was found between the types of surgery according to age and duration of surgery ($p < 0,05$). A statistically significant difference was found between group a and group b for age and statistically significant difference was found between group a and group b, group a and group c, group b and group c for the duration of surgery ($p < 0,017$).

Table 1. Comparison of Demographic Variables by Groups

| Variables | Group | | Operation | | | Total | χ^2 | p |
|---------------------|---------------|---|---------------------|--------------------------|-----------------|----------------|------------------------|-------|
| | | | A(Cannulated Screw) | B(Mini-fragment T-plate) | C(Tension Band) | | | |
| Gender | Female | n | 16 | 17 | 16 | 49 | 0,090 | 0,956 |
| | | % | 53,3% | 56,7% | 53,3% | 54,4% | | |
| | Male | n | 14 | 13 | 14 | 41 | | |
| | | % | 46,7% | 43,3% | 46,7% | 45,6% | | |
| Side | Right | n | 13 | 17 | 14 | 44 | 1,159 | 0,560 |
| | | % | 43,3% | 56,7% | 46,7% | 48,9% | | |
| | Left | n | 17 | 13 | 16 | 46 | | |
| | | % | 56,7% | 43,3% | 53,3% | 51,1% | | |
| Reoperation | none | n | 30 | 30 | 30 | 90 | | |
| | | % | 100,0% | 100,0% | 100,0% | 100,0% | | |
| Total | | n | 30 | 30 | 30 | 90 | | |
| | | % | 100,0% | 100,0% | 100,0% | 100,0% | | |
| Variables | | | A(Cannulated Screw) | B(Mini-fragment T-plate) | C(Tension Band) | Kruskal Wallis | p | |
| Age | Mean ± sd | | 75,5 ± 7,99 | 71,9 ± 6,25 | 70,7 ± 4,73 | 7,764 | 0,021* (A-C) | |
| | M (Min - Max) | | 76,5(60-88) | 72(60-81) | 70(63-79) | | | |
| Duration of surgery | Mean ± sd | | 17,6 ± 1,79 | 39,43 ± 4,42 | 35,8 ± 4,96 | 63,944 | 0,001* (A-B, A-C, B-C) | |
| | M (Min - Max) | | 17,5(15-20) | 40(30-46) | 35(27-44) | | | |

Data are shown as mean ± standard deviation, M; Median, Minimum-Maximum or frequency, Test; Kruskal Wallis Test, * $p < 0,05$; there is a statistically significant difference between the groups.

After a 12-month follow-up, there was no significant difference between the groups in terms of the AOFAS score, plantar flexion, inversion and eversion ($p > 0,05$). A statistically significant difference was found between the groups in the number of scopy and dorsiflexion measurements ($p < 0,05$). Statistically significant difference was

found between group a and group b in dorsiflexion measurement ($p < 0,017$). According to the radiographs, the compression ability was weaker in the miniplate group than in the other groups. The groups' mean number of scopy shots was not similar ($p < 0,017$) (Table 2).

Table 2. Comparison of intraoperative-postoperative and clinical variables by groups

| Variables | Groups | Mean \pm sd | M (Min - Max) | Test | p |
|---------------------|--------|-----------------|---------------|--------|------------------------|
| AOFAS scores | A | 16,5 \pm 2,98 | 16,5(11-22) | 1,952 | 0,377 |
| | B | 15,5 \pm 3,05 | 15,5(9-22) | | |
| | C | 16,1 \pm 2,73 | 16(10-22) | | |
| Scopy Shots | A | 8,3 \pm 0,84 | 9(7-9) | 53,994 | 0,001* (A-B, A-C, B-C) |
| | B | 6,2 \pm 0,85 | 6(5-7) | | |
| | C | 6,8 \pm 0,41 | 7(6-7) | | |
| Dorsi flexion (°) | A | 48,4 \pm 6,64 | 49(36-60) | 6,379 | 0,041* (A-B) |
| | B | 52,5 \pm 6,53 | 50(40-65) | | |
| | C | 50,7 \pm 6,82 | 50(37-64) | | |
| Plantar flexion (°) | A | 45,7 \pm 4,81 | 45(35-55) | 2,048 | 0,359 |
| | B | 47,8 \pm 5,83 | 50(38-56) | | |
| | C | 46,9 \pm 5,82 | 45(37-55) | | |
| Inversion (°) | A | 16,5 \pm 1,36 | 16(14-19) | 3,2 | 0,202 |
| | B | 17,7 \pm 2,35 | 18(13-22) | | |
| | C | 17,1 \pm 2,43 | 15(14-20) | | |
| Eversion (°) | A | 12,9 \pm 0,84 | 13(11-14) | 2,614 | 0,271 |
| | B | 13,6 \pm 1,59 | 14(12-16) | | |
| | C | 12,8 \pm 2,12 | 12(10-15) | | |

Data are shown as mean \pm standard deviation, M; Median, Minimum-Maximum or frequency, Test; Kruskal Wallis Test, * $p < 0,05$; there is a statistically significant difference between the groups.

One patient in the mini-fragment T-plate group developed a superficial infection and recovered after a 2-week oral antibiotic treatment. One patient in the tension band group developed skin problems that were eliminated after a 1-week treatment. In three patients who were treated with cannulated screws, the screws were removed after the union because the patients were dissatisfied due to the prominence of the screws. There is no additional surgical intervention in all patients.

DISCUSSION

Medial malleolus fractures are isolated due to trauma or accompany other ankle fractures, especially in young patients. There are various surgical options for the treatment of these fractures. We compared the commonly used tension band, cannulated screw, and miniplate treatments. As a result, we observed that tension bands and cannulated screws with similar results were better than the miniplate treatment.

Various problems can occur due to the application of surgical methods. Soft tissue infection can be seen due to the surgical incision in the mini-plate method, and pain and discomfort can be experienced due to the prominence of the screw in the cannulated screw method. Headless cannulated screws have been used in the literature to reduce this prominence and discomfort. However, they have the disadvantage of

weak compression abilities. In our study, one patient in the mini-fragment T-plate group developed a superficial infection and recovered after a 2-week oral antibiotic treatment. One patient in the tension band group developed skin problems that responded to a 1-week treatment. Three patients who underwent the cannulated screw technique complained of screw prominence; therefore, their screws were removed in a second surgery.

In the literature, the duration of the radiological union in surgical methods has been reported as ten weeks on average. It is known that there are differences between surgical techniques in these studies. Alam et al. (Alam & Parviz, 2007) reported that malleolar screws provided radiological union in 12 weeks and that the tension band procedure provided union in 9 weeks. In their study, Kochai et al. (Kochai et al., 2018) compared patients who received tension bands, partially threaded cannulated compression screws, and headless cannulated compression screws after surgery. As a result of the study, they determined significant differences between these methods. The researchers observed that the headless compression screws resulted in the shortest duration (9 weeks on average), followed by the tension band method (10 weeks on average). The longest duration of radiological union was achieved with partially threaded cannulated compression

screws (12 weeks on average). In our study, we saw significant differences between the groups. On average, the tension band achieved union in 10.5 weeks, the cannulated screw in 11.8 weeks, the miniplate in 12.8 weeks. Considering that the radiological union provides early mobilization and an earlier return to daily activities, we can suggest that the tension band procedure is more advantageous.

We did not encounter any non-union in any of our surgical methods. We observed delayed union at a rate of 6.7 % in 2 patients who received only the miniplate treatment. In studies in the literature, few complications related to medial malleolus fractures have been seen. Union was achieved in all patients who were treated with cannulated screws in the study of Barnes et al. (Barnes et al., 2014), who were treated with tension bands in the study of Öçgüder et al. (Öçgüder, Fırat, Özdemir, & Tecimel, 2017), and who were treated with screw fixation and tension bands in the study of Alam et al. (Alam & Parviz, 2007). Due to insufficient blood supply to the medial malleolus, immobilization after fracture, and osteoporosis in elderly patients, osteoarthritis or nonunion is frequently seen in fractures of this region (Ballmer, Hertel, Noetzli, & Masquelet, 1999; De Souza, Gustilo, & Meyer, 1985; Gilbert, Horst, & Nunley, 2004; Öçgüder et al., 2017). In the study of Sneppen et al. (Sneppen, 1969), it was stated that the rate of osteoarthritis was 45% (from the previous literature). In our study, 10% of the patients had osteoarthritis (Cannulated Screw: 4 patients; Minifragment T-plate: 3 patients; Tension Band: 2 patients). Non-union was not seen in any of the patients; a delayed union was achieved in 2 patients (mini-plate group). Although most patients with osteoarthritis were in the cannulated screw group, no difference was seen between the groups. Medial malleolus fractures are intra-articular fractures that trigger the formation of osteoarthritis, but the literature and the results of our study support the high possibility of union.

Issues such as the duration of the plaster-splint application and the time of load application differ between studies in the literature and different surgical methods. In some studies, plaster-splint was not postoperatively used, while plaster-splint applications were performed for 2 to 4 weeks. Furthermore, patients started joint range of motion exercises immediately after surgery, at the end of the second week, and towards the end of the 4th week in some studies. Tekin et al. (Tekin et al., 2016) suggested mobilization with partial load in the 8th week and full load in the 10th week. At the end of the 2nd week, the plaster was removed in patients whose tissue healing was completed and whose stitches were removed, and joint range of motion exercises were recommended. On the other hand, Lee et al. (Lee, Lin, Hamid, & Bohl, 2019) did not apply a

plaster-splint to any patient. Isometric exercises were recommended on the second postoperative day, ankle function-specific exercises on the third day, and mobilization with partial load in the 3rd-4th week. Kochai et al. (Kochai et al., 2018) removed the plaster and suggested ankle exercises in the 4th week, mobilization with a partial load in the 6th week, and mobilization with a full load in the 10th week. In our study, we removed the plaster and recommended foot-ankle exercises in the 2nd week after removing sutures in all groups. We recommended partial load for 6-8 weeks and full load for 12 weeks for patients who were treated with cannulated screws and tension bands. In our study, there was no difference between the groups. We reached similar results as in other studies.

CONCLUSION

The retrospective design, limited number of patients, and lack of a control group are the limitations of the study. As a result, it was seen that the tension band and cannulated screw techniques resulted in better clinical results in patients. However, they were disadvantageous compared to the miniplate method in terms of tissue irritation.

Acknowledgement

Thanks to: We thank Dr. Feyza İnceoğlu for her support of our study.

Ethics Committee Approval: Ethical approval was obtained from the local Clinical Research Ethics Committee (Malatya Turgut Ozal University-2021/18)

Financial Resource/ Sponsor's Role: No financial support was received for the study.

Conflict of Interest: The authors declare that there is no personal or financial conflict of interest within the scope of the study.

Author Contributions:

Idea/Concept: İsmail GÜZEL; **Design:** İsmail GÜZEL; **Supervision/Consulting:** İsmail GÜZEL, Serkan AKPANCAR; **Data Collection and/or Processing:** Serkan AKPANCAR; **Analysis and/or Interpretation:** İsmail GÜZEL; **Literature Review:** Serkan AKPANCAR; **Writing of the Article:** İsmail GÜZEL; **Critical Review:** İsmail GÜZEL; **Resources and Funding:** İsmail GÜZEL

REFERENCES

Ahmed, M., Sohal, H.S., Garg, R.S., Jindal, S., Wadhvani, J. & Bansal, V. (2017). Minifragment T-plate fixation: an alternative method for medial malleolus fracture fixation. *Journal of Foot and Ankle Surgery (Asia Pacific)*, 3(1), 10-14.

- Aiyer, A.A., Zachwieja, E.C., Lawrie, C.M. & Kaplan, J.R. (2019). Management of isolated lateral malleolus fractures. *JAAOS-Journal of the American Academy of Orthopaedic Surgeons*, 27(2), 50-59.
- Alam, N. & Parviz, S. (2007). Comparative study of malleolar fractures by tension-band and malleolar screw. *BOS J*, 12(1), 13-19.
- Amanatullah, D.F., McDonald, E., Shellito, A., Lafazan, S., Cortes, A., Curtiss, S. & Wolinsky, P. R. (2012). Effect of mini-fragment fixation on the stabilization of medial malleolus fractures. *Journal of Trauma and Acute Care Surgery*, 72(4), 948-953.
- Ballmer, F., Hertel, R., Noetzli, H. & Masquelet, A. (1999). The medial malleolar network: a constant vascular base of the distally based saphenous neurocutaneous island flap. *Surgical and Radiologic Anatomy*, 21(5), 297-303.
- Barnes, H., Cannada, L.K., & Watson, J.T. (2014). A clinical evaluation of alternative fixation techniques for medial malleolus fractures. *Injury*, 45(9), 1365-1367.
- Bucholz, R.W., Henry, S. & Henley, M.B. (1994). Fixation with bioabsorbable screws for the treatment of fractures of the ankle. *JBJS*, 76(3), 319-324.
- Carter, T.H., Duckworth, A. & White, T. (2019). Medial malleolar fractures: current treatment concepts. *The Bone & Joint Journal*, 101(5), 512-521.
- De Souza, L., Gustilo, R.B., & Meyer, T.J. (1985). Results of operative treatment of displaced external rotation-abduction fractures of the ankle. *JBJS*, 67(7), 1066-1074.
- Deniz, G. & Akpancar, S. (2019). Fractures in Geriatric Cases. *Geriatric Bilimler Dergisi*, 2(1), 14-19.
- Dumigan, R.M., Bronson, D.G. & Early, J.S. (2006). Analysis of fixation methods for vertical shear fractures of the medial malleolus. *Journal of Orthopaedic Trauma*, 20(10), 687-691.
- Faul, F., Erdfelder, E., Buchner, A. & Lang, A.G. (2009). Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, 41(4), 1149-1160.
- Gilbert, B.J., Horst, F. & Nunley, J.A. (2004). Potential donor rotational bone grafts using vascular territories in the foot and ankle. *JBJS*, 86(9), 1857-1873.
- Herscovici, D., Scaduto, J. & Infante, A. (2007). Conservative treatment of isolated fractures of the medial malleolus. *The Journal of Bone & Joint Surgery British Volume*, 89(1), 89-93.
- Kitaoka, H.B., Alexander, I.J., Adelaar, R.S., Nunley, J.A., Myerson, M.S. & Sanders, M. (1994). Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. *Foot & Ankle International*, 15(7), 349-353.
- Koca, K., Erşen, Ö., Akpancar, S., Akyıldız, F., & Gürer, L. (2017). Demographic features of patients with extremity and spine fractures in emergency departments. *Eurasian Journal of Emergency Medicine*, 16(1), 19.
- Kochai, A., Türker, M., Çiçekli, Ö., Özdemir, U., Bayam, L., Erkorkmaz, Ü. & Şükür, E. (2018). A comparative study of three commonly used fixation techniques for isolated medial malleolus fracture. *Joint Diseases & Related Surgery*, 29(2), 104-109.
- Lee, S., Lin, J., Hamid, K.S. & Bohl, D.D. (2019). Deltoid ligament rupture in ankle fracture: diagnosis and management. *JAAOS-Journal of the American Academy of Orthopaedic Surgeons*, 27(14), e648-e658.
- Öçgüder, D.A., Fırat, A., Özdemir, M. & Tecimel, O. (2017). Is the use of headless compression screws appropriate in arthroscopic ankle arthrodesis? *Joint Diseases and Related Surgery*, 28(3), 171-176.
- Ricci, W.M., Tornetta, P. & Borrelli Jr, J. (2012). Lag screw fixation of medial malleolar fractures: a biomechanical, radiographic, and clinical comparison of unicortical partially threaded lag screws and bicortical fully threaded lag screws. *Journal of Orthopaedic Trauma*, 26(10), 602-606.
- Sneppen, O. (1969). Long-term course in 119 cases of pseudarthrosis of the medial malleolus. *Acta Orthopaedica Scandinavica*, 40(6), 807-816.
- Tekin, A.Ç., Çabuk, H., Dedeoğlu, S.S., Saygılı, M. S., Adaş, M., Büyükkurt, C.D.,...Tekin, Z.N. (2016). Anterograde headless cannulated screw fixation in the treatment of medial malleolar fractures: evaluation of a new technique and its outcomes. *Medical Principles and Practice*, 25(5), 429-434.