ORIGINAL RESEARCH

Clinical Efficacy of Posteromedial Approaches for Haraguchi Type II Fracture

Feng Tian, MM; Rui Xia, PhD; Lei Liu, MM; Shiyuan Fang, MM; Wei Xu, MM

ABSTRACT

Objective • This study was to analyze and compare the clinical efficacy of open reduction and internal fixation through posterolateral and the posterior medial approach to treat Haraguchi Type II posterior malleolar fracture.

Methods • The clinical data of 91 patients with trimalleolar fractures sent to our hospital from January 2018 to January 2020 were analyzed.All of the patients were the result of traumatic injuries, such as sprains or car accidents. All patients were treated with open reduction and internal fixation and divided into control group and observation group according to different surgical approaches. Forty-five cases were treated with the posterolateral approach(control group) and forty-six cases treated with the posteriormedial approach(observation group) . The operation status of the two groups (operating time, intraoperative blood loss, postoperative drainage, and hospital stay), postoperative status (visual analogue scale (VAS) before the operation, 1d, 3d and 7d after operation), the score of patient's American orthopedic foot and ankle society (AOFAS) at the time of discharge, fracture healing time and full weight-bearing time), efficacy and safety were recorded.

Results • All cases underwent surgery, with no significant difference in the time from fracture to surgery between the control and observation groups ($P > .05$). Compared to the control group, the operating time, intraoperative blood loss, postoperative drainage, and hospital stay in the observation group were significantly reduced ($P < .05$). One day after the operation, no significant difference was shown in VAS between 2 groups ($P > .05$), while AOFAS score in the observation group was significantly increased ($P < .05$). Three and 7 days after the operation, VAS, fracture healing time, and full weight-bearing time were significantly decreased in both groups ($P < .05$). In the control group, the cases with excellent, good, fair, and poor efficacy were 26, 8, 5, 6, with an acceptable rate of 86.67% (39/45). In the observation group, the cases with excellent, good, fair, and poor efficacy were 29, 10, 5, and 2, with an acceptable rate of 95.65% (44/46). There was no significant difference in efficacy between the 2 groups ($P > .05$). During the follow-up time of 12~27 months (the median time of 18.5 months), all patients showed first-stage grade A healing, and osseous union with good fixation position and no fracture, deformation, loosening or prolapse, and no sural nerve injury or incision infection occurred.

Conclusion • Both the posterolateral approach and posterior medial approach open reduction and internal fixation can be used to treat Haraguchi type II posterior malleolus fractures, with good efficacy and safety. The posterior medial approach showed faster recovery and less damage than the posterolateral approach.Overall, the posterolateral approach is more dominant in the treatment of Haraguchi Type II posterior malleolar fracture. (*Altern Ther Health Med.* 2024;30(4):162-166)

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INTRODUCTION

Triple ankle fracture is a type of fracture with high incidence, with a high incidence of low-energy injuries such as sprains and falls. The posterior ankle fracture may trigger complications such as posterior ankle dislocation, so improper treatment could easily lead to serious complications such as ankle osteoarthritis ,chronic pain and limited mobility.[1] Currently, the purpose of treating ankle fractures is to maintain ankle stability and recover ankle function as much as possible by the accurate reduction of the broken articular surface and the stable fixtion,,patients can hace the early weight-bearing and functional exercises.So surgical treatment are often advocated.[2] The treatment principles of medial and lateral ankle fractures are nearly uniform, but there is more controversy about the approach of the posterior malleolus.[3] At present, the posterior ankle fracture mass occupation rate of the anteroposterior ankle surface was used as an indicator of surgical fixation, and it is generally believed that the posterior malleolus fracture block of more than 1/4 of the articular surface needs surgical fixation.[4]

Medial extension type fractures (Haraguchi type II) are a type of uncommon posterior ankle fracture among three ankle fractures.[5] The fracture mass extends medially and is difficult to expose clearly.Conventional posterolateral surgical approach is difficult to expose and immobilize. However, the posterior medial approach can provide good exposure to the fractures. In this study, 91 patients with Haraguchi type II posterior malleolus fracture treated by posterior medial and posterolateral approach with open reduction and internal fixation in our department from January 2018 to January 2020 were retrospectively analyzed. The results of the two surgical approaches were compared in order to find a better choice for this clinical problem.

METHODS

Patient demographics and basic characteristics

The patients were diagnosed with Haraguchi type II posterior malleolus fracture with three ankle fractures based on 3D scans were retrospectively reviewed from January 2015 to January 2017 in the hospital. The diagnosis was based on the report of Haraguchi (5). Inclusion criteria and exclusion criteria were shown in Table1.

Finally, a total of 91 patients, including 55 males and 36 females, met the criteria. The age of these patients ranged from 19 to 76 years, with a mean age of 46.51 ± 19.20 years old. Fracture combination: 15 cases combined with proximal fibula fracture and 10 cases combined with distal fibula fracture; Cause of fracture: 35 cases by traffic accidents, 29 cases by sprains, 21 cases by falls, and 6 cases by other reasons; There were 45 cases and 46 cases with left and right ankle fractures, respectively. The main manifestations were ankle swelling, deformation, and severe limitation of movement. All patients were treated within 24h after injury. The patients were divided into 2 groups according to the operation difference: 45 cases were treated with the posterolateral approach (control group), and 46 cases (observation group) were treated with the posterior medial approach. There was no significant difference in sex ratio, age, body mass index (BMI), cause of fracture, combined fracture, affected side, and other general conditions of the two groups (P > .05), as shown in Table 1. All patients or family members signed informed consent.

Surgery

Relevant imaging examinations were completed before surgery, including anteroposternal and lateral x-rays of both ankle joints and three-dimensional CT reconstruction of the affected ankle joint. After admission, routine detumescence treatment should be given first, and surgery should be performed when vital signs are normal and meeting surgical testimony. Surgery procedures:1.After epidural or general anesthesia, the patient was at a supine position. Tourniquet was applied at the proximal end of the affected leg and assisted with a disinfection towel. 2.In the control group, the posterior lateral approach of the lateral malleolus was used to expose the fractured end of the lateral malleolus and reduce the lateral malleolus fracture. The distal locking plate was placed on the outside of the fibula, drilled, and fixed with screws. 3.The posterior malleolar fracture was exposed from the flexor hallucis longus tendon to peroneus muscle, and 4.0mm hollow screw was drilled or fixed with T-shaped locking plate and 1/3 tubular plate. 4.The medial malleolus was exposed by medial incision with two 4.0mm hollow nails or a Kirschner wire tension band.5. The fracture reduction was confirmed with intraoperative fluoroscopy, then a drainage tube was placed, and incisions were closed layer by layer. In the observation group, the posteromedial approach of the ankle joint was used to stretch the tibial posterior muscle and flexor tendon of the toe long, exposing the broken end of the internal posterior malleolus and resetting the ankle joint. And other operations in the observation group were the same as in the control group.

Prophylactic cefuroxime sodium was given 30min before surgery and 1 and 2 days after surgery, Anticoagulation with low molecular weight heparin was started on the first day after surgery to elevate the affected limb and promote swelling reduction On the second day after surgery, the incision drainage tube was removed. On the first day after surgery, the patient was instructed and encouraged to perform active movements of the toe joint and passive movements of the ankle joint and quadriceps muscle. Stitches were removed 14 days after surgery, non-weight-bearing exercise was performed 2 weeks after surgery, and protective weight-bearing exercise was performed 8 weeks after surgery. After 12 weeks, the fracture was to be recovered, and full weight-bearing was performed. If the lower tibiofibular screw were inserted intraoperatively, it would be removed about 12 weeks after surgery under local anesthesia before full weight bearing.

Outcome Measures

Operative situation. Operative time, intraoperative blood loss, postoperative drainage and hospital stay were recorded in the two groups.

Postoperative situation. Visual analog scale (VAS) was performed in the two groups before and 1 d, 3 d, 7 d after operation.VAS pain rating scale is a visual simulation method to evaluate the severity of pain. The scale is divided into 10 equal parts using a ruler,0 is no pain,1-3 is mild pain,4-6 is moderate pain, and 7-10 is severe pain. Ankle-Hindfoot Scale, according to Patients' American foot and Ankle Society (AOFAS) at discharge were recorded, as well as the fracture healing time and full weight-bearing time.

Efficacy and safety. Postoperative regular follow-up was conducted to observe incision healing, fracture healing time, and complications. Efficacy was assessed according to the AOFAS criteria (6), with 90-100 points being excellent, 76-89 points being good, 50-74 points being fair, and < 50 points being poor. Acceptable efficacy rate = (excellent + good + fair) / number of total cases × 100%.

Statistical analysis

Data was analyzed using Statistic Package for Social Science (SPSS) 21.0 (BMI, Armonk, NY, USA), and the measurement data were expressed as mean ± standard deviation ($\bar{x} \pm s$). For comparison the continuous data between the two groups, the *t* test was used. The Chi-square test was performed for the comparison of counting data, with $P < .05$ indicating a significant difference.

Table1. Inclusion criteria and exclusion criteria of the patient

Inclusion criteria	exclusion criteria
the diagnosis was unilateral ankle fracture, and the posterior ankle fracture involved 25% to 50% of the ankle surface with subtyping of Haraguchi type II through the 3D scan	patients with pre-fracture ankle dysfunction or pathological fracture;
patients with normal ankle function prior to fracture and without other serious ankle diseases	patients with bilateral lower limb fracture or ipsilateral lower limb fracture with other site fracture
patients with complete clinical and radiographic data	patients with Hemiplegia affecting lower limb function, mental disorders, lower limb vascular nerve injury, or osteofascial compartment syndrome
patients were able to be followed up for > 18 months	patients complicated with severe cardiac, hepatic and renal dysfunction;
	pregnant or lactating women.

Table 2. General information and clinical characteristics of the patients between the two groups

Item	Control group	Observation group	t/χ^2	*P* value
Case	45	46		
Man: Woman	25:20	30:16	0.888	.346
Age (year)	46.10±18.91	46.89±19.45	0.039	.844
BMI (kg/m^2)	21.36±1.32	21.09±1.26	0.996	.321
Cause of fracture			2.995	.392
Traffic accident	19	16		
Sprains	15	14		
Falls	10	11		
Others	1	5		
Combined with fracture			0.027	.870
Proximal fibula fracture	7	8		
Distal fibula fracture	5	5		
Affected side			2.470	.116
left ankle fractures	26	19		
Right ankle fractures	19	27		

Abbreviaitons: BMI: body mass index BMI.

Table 3. Comparison of surgical conditions between the two groups

Group	Case	Fracture to operative time (day)	Operation duration (min)	Intraoperative blood loss (ml)	Postoperative drainage (ml)	Length of stay (day)
Control group	45	5.62±1.16	72.54±15.27	72.16±12.35	6.57±1.25	12.45±1.59
Observation group	46	5.39±1.32	62.35±16.38	46.25±14.28	3.98±1.39	11.06±1.74
t		0.778	9.413	85.547	87.226	15.806
P value		.380	.003	.000	.000	.000

RESULTS

Comparison of surgical situations between the two groups

All 91 cases underwent surgery, and the two groups had no significant difference in the time from fracture to operation ($P > .05$, Table 1). Compared with the control group, the operation time, intraoperative blood loss, postoperative drainage volume and hospital stay in the observation group were significantly reduced ($P < .05$, Table 3).

Comparison of postoperative conditions between the two groups

Before and 1d after surgery, there was no significant difference in the VAS between the two groups ($P > .05$), while on 3 and 7 days after surgery, VAS in the observation group significantly decreased ($P < .05$). In addition, compared to the control group, the AOFAS score was significantly higher, and fracture healing time and time to full-weight bearing were significantly decreased in the observation group ($P < .05$, Table 4).

Treatment efficacy of the two groups

After treatment, patients with excellent, good, fair, and poor efficacy were 26, 8, 5, and 6 cases, respectively, with an acceptable efficacy rate of 86.67% (39/45), and in the observation group, the patients with excellent, good, fair, poor efficacy were 29, 10, 5 and 2 cases, with an acceptable efficacy rate of 95.65% (44/46). There was no significant difference of the efficacy difference between the 2 groups ($P > .05$, Table 5).

Follow up

During the follow-up time of 12~27 months (the median time of 18.5 months), all patients showed first-stage grade A healing, and osseous union with good fixation position and no fracture, deformation, loosening or prolapse, and no sural nerve injury or incision infection occurred. Imaging data of typical cases are shown in Figure 1.

DISCUSSION

Ankle fracture is one of the most common fracture types in clinic. Due to the different therapeutic concepts and surgical methods, the clinical effects vary. However, as typical intra-articular fractures, the treatment principles of ankle fractures are consistent to recover the normal anatomic relationship of the ankle joint and early functional exercise to the greatest extent by firmly fixed, so as to minimize complications.[7] Previously, the posterior malleolar fracture block was thought to not need to be treated, and only the lateral malleolar fracture needed to be reduced and fixed.[8]

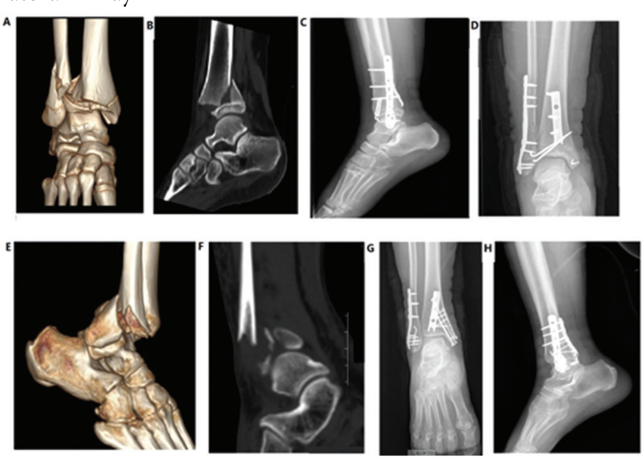
Table 4. Comparison of postoperative conditions between the two groups

Group	Case	VAS (point) Preoperative	1 d postoperation	3 d postoperation	7 d postoperation	AOFAS score (point)	Fracture healing time (d)	Full weight bearing times (w)
Control group	45	5.32±1.27	6.22±1.05	5.01±0.98	3.57±0.72	82.24±15.75	68.25±9.34	12.26±1.39
Observation group	46	5.56±1.31	6.39±1.09	4.48±0.97	3.17±0.73	89.36±16.23	72.84±8.25	10.36±1.28
t		0.787	0.574	6.722	6.923	4.508	6.163	45.955
P value		0.377	.451	.011	.010	.037	.015	.000

Table 5. Comparison of treatment efficacy between the two groups

Group	Case	Excellent	Good	Fair	Poor	Acceptable efficacy rate (%)
Control group	45	26	8	5	6	39(86.67)
Observation group	46	29	10	5	2	44(95.65)
χ^2						2.291
P value						.130

Figure 1. Images before and after fracture treatment. Patient 1: A 44-year-old female patient suffered a Haraguchi II type right posterior malleolus fracture caused by a fall and was treated with open reduction and support plate internal fixation through lateral and posterolateral approach at the supine position. (A) 3D CT reconstruction; (B) Preoperative lateral X-ray film; (C) Preoperative anteroposterior X-ray film; (D) Preoperative lateral X-ray film. Patient 2: A 35-year-old male patient with a sprained Haraguchi II right posterior malleolus fracture was treated with open reduction and support plate internal fixation through lateral and posteromedial approach at the supine position. (E) 3D CT reconstruction; (F) Preoperative lateral X-ray film; (G) Preoperative anteroposterior X-ray film; (H) Preoperative lateral X-ray film



With the development of relevant research, the necessity of posterior ankle fracture fixation was accepted.[9] Without fixation, retrogression of the talus may occur, leading to subluxation of the joint and a significant increase of traumatic arthritis incidence. Therefore, it was suggested that for posterior malleolar fracture, the operative indication was that the fracture thickness from the surface was above 1mm, and the fracture area was more than 25% of the anteroposterior diameter of the articular surface of the tibia.[10] Drijfout et al. found that the size of the posterior ankle fracture block was positively correlated with the incidence of traumatic arthritis of the ankle joint, and anatomic reduction of posterior malleolus fracture is recommended.[11]

Haraguchi et al.[5] conducted a pathological and anatomical study on 57 patients with posterior malleolar fracture, and according to the direction of posterior malleolar fracture line shown in CT images of the articular surface of the distal tibia, the posterior malleolar fracture was divided into three types: type I (posterior oblique), accounting for 67%, with wedge fracture block and involving the posterior external angle of the articular surface of the distal tibia; Type II (medial extension), accounting for 19%, with the fracture line extending from the fibular notch of the distal tibia to the medial malleolus. The posterior malleolar mass of 9 cases was divided into posterior external and posterior internal parts. Type III (small shell or small piece stripping type), accounting for 14%, was characterized by one or more small shell bone segments at the distal posterior margin of the tibia. Studies have shown that posterior or posteromedial ankle fractures can be caused by external rotation of the talus or direct impact against the talus. Some scholars believed that the cases of posterior malleolar fracture involving the medial posterior colliculus were consistent with the characteristics of Haraguchi type II fracture.[12-14] It was found that most of these fractures were combined with talus dislocation or subluxation, relatively large posterior malleolar fracture mass, and poor functional prognosis.[15] This type of fracture is called a posterior pilon fracture. The typical posterior pilon fracture is a coronal fracture involving the posterior colliculus and even part of the anterior colliculus of the medial malleolus. The posterior mass is usually split along the sagittal plane into posterior and posterolateral parts, and the posterolateral fracture is usually a collapse fracture.

Traditional medial and lateral approaches are mainly used for the treatment of bilateral malleolus fractures. When bilateral malleolus is combined with posterior malleolus fractures, posterior structural exposure, fracture reduction assessment, and internal fixation are restricted to a great extent. Therefore, the traditional medial and lateral approaches are more suitable for patients with small posterior malleolus fractures and getting indirect reduction through ligament pulling after reduction and fixation of internal and lateral malleolus fractures. Many scholars currently use the posterolateral, posterior medial, or combined approaches to treat complex posterior malleolar fractures to fully expose the fracture, facilitate surgical operation, and achieve anatomical reduction and firm fixation.[16]

The conventional posterolateral approach is not good at exposing the medial posterior malleolus fracture, and requires the lateral floating or prone position, which inconveniences the surgeon. As shown in the results of this study, compared with the posterolateral approach alone, a combination of posterior medial approach can effectively expose and fix the posterior malleolus fracture, which can shorten operation time and reduce intraoperative blood loss, postoperative drainage volume and hospital stay. Meanwhile, unified incision treatment of medial malleolus fracture is quite simple and convenient, and the internal fixation methods are beneficial to reduce postoperative pain, fracture healing time, and full weight-bearing time. The internal fixation methods include indirect reduction with anteroposteric screw fixation, direct reduction with anteroposteric screw fixation, and posterior support plate fixation.We found that the posteromedial approach reduced operative time, blood loss, and length of hospital stay, improved VAS and AOFAS scores, and resulted in faster recovery.

In terms of internal fixation, hollow screw fixation is suitable for a single small fracture block. However, during the weight-bearing functional exercise of the affected limb, the fracture end fixed by a hollow screw is vulnerable to bearing large shear force in the longitudinal direction, resulting in a cutting effect and easy to lead to the loosening of internal fixation.[17] Plate fixation is suitable for patients with large fracture mass, strong shear force or serious osteoporosis. Liu et al. believed that the injury mechanism of Haraguchi II posterior malleolus fracture included axial stress and shear force, which resulted in displacement and compression of large posterior malleolus fracture blocks and, therefore, must be fixed with supporting plates.[18] In this study, all the patients were fixed with the supporting plate so they could begin functional exercise earlier, which is conducive to the functional recovery of the ankle joint and the repair of articular cartilage.The posterior internal approach to this type of fracture has its unique advantages and benefits the patient.

There are several limitations to our study.This is a retrospective study and the sample size is not sufficient. No specific criteria for investigating postoperative results were outlined during the study period, leaving the decision for evaluation to the discretion of the resident or staff surgeon. Follow-up studies we will increase the sample size and summarize specific criteria to make the results more accurate.

CONCLUSION

Both the posterolateral approach and the posterior medial approach can be used for the treatment of Haraguchi type II posterior malleolar fracture with good efficacy and safety. Compared with the posterolateral approach, the posterior medial approach might cause less damage and faster recovery.

CONFLICT OF INTEREST

The authors have no potential conflicts of interest to report relevant to this article.

AUTHOR CONTRIBUTIONS

(I) Conception and design: FT; (II) Administrative support: WX; (III) Provision of study materials or patients: FT and RX; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: LL and SF; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

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ETHICAL COMPLIANCE

This study was approved by the ethics committee of the First Affiliated Hospital of USTC, Division of Life Sciences and Medicine, University of Science and Technology of China.

REFERENCES

1. Fernández-Rojas E, Herrera-Pérez M, Vilá-Rico J. Posterior malleolar fractures: indications and surgical approaches. *Rev Esp Cir Ortop Traumatol*. 2023;67(2):160-169. doi:10.1016/j.recot.2022.10.019
2. Klammer G, Kadakia AR, Joos DA, Seybold JD, Espinosa N. Posterior pilon fractures: a retrospective case series and proposed classification system. *Foot Ankle Int*. 2013;34(2):189-199. doi:10.1177/1071100712469334
3. Bartoníček J, Rammelt S, Tuček M, Naňka O. Posterior malleolar fractures of the ankle. *Eur J Trauma Emerg Surg*. 2015;41(6):587-600. doi:10.1007/s00068-015-0560-6
4. Bartoníček J, Rammelt S, Tuček M. Posterior Malleolar Fractures: Changing Concepts and Recent Developments. *Foot Ankle Clin*. 2017;22(1):125-145. doi:10.1016/j.fcl.2016.09.009
5. Haraguchi N, Haruyama H, Toga H, Kato F. Pathoanatomy of posterior malleolar fractures of the ankle. *J Bone Joint Surg Am*. 2006;88(5):1085-1092. doi:10.2106/JBJS.E.00856
6. Van Lieshout EM, De Boer AS, Meuffels DE, et al. American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Score: a study protocol for the translation and validation of the Dutch language version. *BMJ Open*. 2017;7(2):e012884. doi:10.1136/bmjopen-2016-012884
7. Terstegen J, Weel H, Frosch KH, Rolvien T, Schlickewei C, Mueller E. *Classifications of posterior malleolar fractures: a systematic literature review.* Arch Orthop Traum Su; 2022, doi:10.1007/s00402-022-04643-7.
8. Wang J, Jia HB, Zhao JG, Wang J, Zeng XT. Plate versus screws fixation for the posterior malleolar fragment in trimalleolar ankle fractures. *Injury*. 2023;54(2):761-767. doi:10.1016/j.injury.2022.10.032
9. Yang L, Yin G, Zhu J, et al. *Posterolateral approach for posterior malleolus fixation in ankle fractures: functional and radiological outcome based on Bartonicek classification.* Arch Orthop Traum Su; 2022, doi:10.1007/s00402-022-04620-0.
10. Serlis A, Konstantopoulos G, Poulios P, Konstantinou P, Ditsios K, Aftzoglou M. The Management of Posterior Malleolus Fractures in Unstable Ankle Injuries: Where Do We Stand Now? *Cureus*. 2022;14(12):e32191. doi:10.7759/cureus.32191
11. Drijfhout van Hooff CC, Verhage SM, Hoogendoorn JM. Influence of fragment size and postoperative joint congruency on long-term outcome of posterior malleolar fractures. *Foot Ankle Int*. 2015;36(6):673-678. doi:10.1177/1071100715570895
12. Blom RP, Meijer DT, de Muinck Keizer RO, et al. Posterior malleolar fracture morphology determines outcome in rotational type ankle fractures. *Injury*. 2019;50(7):1392-1397. doi:10.1016/j.injury.2019.06.003
13. Mitchell PM, Harms KA, Lee AK, Collinge CA. Morphology of the Posterior Malleolar Fracture Associated With a Spiral Distal Tibia Fracture. *J Orthop Trauma*. 2019;33(4):185-188. doi:10.1097/BOT.0000000000001398
14. Bali N, Aktselis I, Ramasamy A, Mitchell S, Fenton P. An evolution in the management of fractures of the ankle: safety and efficacy of posteromedial approach for Haraguchi type 2 posterior malleolar fractures. *Bone Joint J*. 2017;99-B(11):1496-1501. doi:10.1302/0301-620X.99B11.BJJ-2017-0558.R1
15. Chaparro F, Ahumada X, Urbina C, et al. Posterior pilon fracture: epidemiology and surgical technique. *Injury*. 2019;50(12):2312-2317. doi:10.1016/j.injury.2019.10.007
16. Zbeda RM, Friedel SP, Katchis SD, Weiner L. Open Reduction and Internal Fixation of Posterior Malleolus Fractures via a Posteromedial Approach. *Orthopedics*. 2020;43(3):e166-e170. doi:10.3928/01477447-20200213-01
17. Gao YJ, Jia B, Zhang Y, et al. [Closed reduction and percutaneous hollow screw fixation with prototypical retractor for the treatment of calcaneal fracture]. *Zhongguo Gu Shang*. 2012;25(12):1045-1048.
18. Liu Z, Xin J, Liang J. [Clinical features in the diagnosis and treatment of ankle fracture with Wagsaffe fragment]. Zhonghua Yi Xue Za Zhi. 2014 Feb 25;94(7):529-32. Chinese. PMID: 24767297.