Role and importance of posterior malleolus fixation in trimaleolar fractures

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ABSTRACT: **Introduction** – ankle fractures are third when it comes to frequency, right after hip and wrist joint fractures. Posterior malleolus fractures are common, comprising 7% to 44% of all ankle fractures, and are very rare on their own; that is a Volkmann triangle fracture. Ankle is a supporting joint in the human body, and fractures generally occur within rotation of the body with different fixed foot positions. The posterior malleolus is a very important structure in distal tibiofibular joint. **Material and methods** - we retrospectively present a group of 21 patients who had a fracture of the ankle and were surgically treated at the Clinic for Orthopedics and Traumatology in Niš during the period from January 2013 to December 2015. The basic criterion for surgical treatment was the size of the fragment, > 25% from tibial joint surface and dislocation >2mm. We systemized all ankle fractures according to the Lauge Hansen system, which is based on the mechanism of injury. We evaluated treatment results according to the Olerud-Molander classification, followed by subjective and objective signs. We systemized posterior malleolus fractures into three types, according to the Haraguchi classification. **Results** - etiological causes of the fractures are: a fall at the same level - sport, skating in 11 (52.3%) patients, a fall from a height in 6 (28.6%) and traffic accident in 4 (21.1%) patients. According to the Lauge Hansen classification, there were 15 (71.4%) patients with a SER-type fracture, 4 (19%) of the PER type, and 2 (9.6%) of the PA type. End result of the treatment was excellent in 13 (61.9%) patients, good in 7 (33.4%) and poor in 1 (4.7%) patient. Post-traumatic arthritis (PTA) was assessed one year after the surgery and level 1 and 2 were present in 12 (57.1%) patients.

Keywords:– ankle, malleolus posterior, fixation, post-traumatic arthritis.

INTRODUCTION

Ankle fractures are relatively common, with an incidence of 187 fractures in 100,000 (1: 800) people per year [1], i.e. comprising 3.92% of all fractures in the body [2]. Posterior malleolus fractures are very common, comprising between 7% to 44% of all ankle fractures [3,4]; and are very rare on their own, and this is a fracture of the Volkmann triangle [5]. Ankle is a supporting joint in the human body, and fractures generally occur within rotation of the body with the foot fixed in different positions. Destot [6] was the first who described posterior malleolus in 1911, and Henderson [7] was the first who introduced the term trimaleolar fracture in 1932. Trimaleolar ankle fractures have a poorer prognosis than injuries without posterior malleolus fractures, so-called bimalleolar fractures [8,9] - fractured displacement, disorder of articular surfaces congruence, tibiotalar subluxation and instability of the ankle joint occure in this situation.The aim of ankle joint fracture treatment is to reduce and restrain talus in its anatomical position and inserting it into the ankle fork.

Posterior malleolus is a very important structure in the distal tibiofibular joint - providing restriction for distal fibula and stabilizing tibiofibular syndesmosis via posterior inferior tibiofibular ligament (PITFL) and inferior transvers ligament (ITL). Ogilvie-Harris et al. [10] state that PITFL enables 42% of strength and stability of syndesmosis. Integrity of the posterior malleolus and ligamentous adhesions is important for weight transfer, posterior talus stability, and rotational stability. This type of ankle joint fracture is associated with posterior tuberculum tibia fracture, to which the PITFL is attached.

Indications for internal fixation of posterior malleolus fracture depend on size and degree of fragment dislocation. Lateral radiography is used for fracture diagnostics, although computerized tomography (CT) is increasingly recommended. If the fragment comprises more than 25% of tibial ceiling and there is a dislocation larger than 2mm, then there is instability of ankle joint with associated syndesmosis injury, and persistent posterior talus subluxation – in this case there exists an absolute indication for surgery [11,12]. The images are also used to determine the angle between bimaleolar axis and posterior malleolus fracture line, up to 40°, representing the degree of external tibia rotation [12].

The posterior malleolus needs to be fixed for a number of reasons: it forms a part of articular tibia surface, with a fracture there occurs articular non-congruence of the ankle joint, contact pressure between joint surfaces is disrupted - the larger the fragment is, the larger the pressure [13]. Due to the attachment of PITFL from fibula to posterior malleolus, the non-fixed posterior malleolus eventually leads to secondary fibula dislocation, even though it is fixed, which creates a possibility for postero lateral talus instability. After reduction and posterior malleolus fixation, articular tibia surface is restored, fibula is not shortened, syndesmosis is stable and the patient's rehabilitation is faster [14].

Ankle joint fractures occure when external rotational force, abduction or adduction are applied to the foot that is fixed in supination (in 70% of occurence) or pronation (in 30% of occurence) [15].

The aim of this paper is to present the role and importance of posterios malleolus fixation during surgical treatman of trimaleolar fractures.

MATERIAL AND METHODS

We retrospectively present a group of 21 patients who had ankle joint fracture and were surgically treated at the Clinic for Orthopedics and Traumatology in Niš from January 2013 to December 2015. Fixation of posterior malleolus was also performed, with a minimum follow-up period of 18 months.

Criteria for including patients in this study are: 1) definitive diagnosis of a ankle joint fracture based on clinical and radiological findings, 2) fracture of posterior malleolus, 3) posterior malleolus fragment occupies >25% of tibial joint surface, 4) the fragment is unstable and misplaced > 2mm, 5) reduction and fixation of malleolus have been applied, 6) patients age is from 18 to 70 years, 7) complete clinical monitoring for 3,6,12 and 18 months.

Clinical and radiological examinations are necessary; post-injury and post-surgery CT should be performed, but we did not do it.

Size of the posterior malleolus fragment was determined in LL radiological image. It is obtained by dividing the length of distal articular surface of tibia by the length of the fragment - this is the distance from the fracture line to posterior edge of tibia, expressed in %. Vertical dislocation is measured in LL image, and it is the height of posterior tibia edge step, expressed in mm. We measured the degree of external rotation [12] in the same image (Figure 1).

Figure 1. Antero posterior and lateral radiographic presentation of a luxurious fracture with complete dislocation and trimaleolar fracture

We systematized all ankle fractures according to Lauge Hansen system [16], based on the mechanism of injury. The first word describes foot position, and the other describes movements of talus relative to the extremity. There are five types of ankle joint fractures: supinational external rotational type (SER), supinational adductional (SA), pronational external rotational (PER), pronational abductional (PA) and pronational dorsiflexional (PD) type. The posterior malleolus fractures most commonly occur (>70%) in SER type of fractures in stage IV, and subsequently in PER [17,18].

Haraguchi et al. [19] provided a classification for three types of posterior malleolus fractures.

Type I - posterior outer oblique fracture line, fragment is wedge-shaped and includes posterior outer part of tibial ceiling; appropriate surgical approach is posterolateral;

Type II - transversely internal fracture, the fracture line includes tibial noch (fibula dent) down to medial malleolus, and there are usually two fragments; appropriate surgical approach is medial or prolonged medial, with the aim of fixing only the medial fragment which is always larger;

Type III - small flaky fracture, that includes posterior edge of the tibia in the form of flake; this type of fracture does not require surgical intervention.

Having prepared the patient (early surgical intervention should be endeavored), we immediately performed surgery in spinal or I.V. conductive anesthesia with Tourniquet.

For direct reduction and fixation of posterior malleolus posterolateral approach was used and the screw was placed (1 or 2) in postero-anterior (PA) projection; we did not use the plate. Indirect reduction was achieved after osteosynthesis of lateral and medial malleolus with transfixation of syndesmosis; then we made an Rtg image and determined the position of posterior malleolus - if it is good, we place the screw in AP or PA position (Figure 2). In a number of patients, we did not perform fragment fixation due to its size (less than 15% of the tibia joint surface).

Figure 2. Antero posterior and lateral radiographic presentation of combined osteosynthesis of posterior, external and internal maleolus.

After the surgery, we placed a lower leg plaster orthosis for three weeks, and after 6 weeks, we allowed the patients to walk with crutches and lean on the treated leg, with a gradual load increase .

We perform radiological control examination after surgery in order to check the posterior malleolus reduction, and CT scan is also recommended. The reduction can be excellent (articular step is <1mm), when the articular surface is flat,good (when the step is <2mm); and poor reposition (> 2mm), when the surface is uneven [20].

We evaluated treatment results according to the Olerud-Molander classification [21], subjective and objective signs were monitored.

Post-traumatic arthritis (PTA) was determined in Rtg images during the follow-up of patients, and according to the following score: 0 - normal joint, 1 - osteophytes without joint space narrowing, 2 - joint space narrowing with or without osteophytes, 3 - joint space disappearing and deformation (22).

RESULTS

A series of 21 operated patients was presented. There were 12 (57.1%) women and 9 (42.9%) men, 18 to 70 years old (average age 48.8). Etiological causes of fracture are: a fall at the same level - sports, skating 11 (52.3%) patients, a fall from a height 6 (28.6%) and traffic accident 4 patients (21.1%).

The size of posterior malleolus fragment was 27,3% on the average (25% to 34%).

Degree of external rotation, i.e. angle between the two lines was 00 to 400

According to Lauge Hansen classification, there were 15 (71,4%) patients with fracture of type SER, 4 patients (19%) of type PER and 2 patients (9,6%) of type PA.

According to Haraguchi classification of posterior malleolus fracture, there were 12 (57,1%) of patients witi fracture of type I, 6 patients (28,5%) of type II and 3 patients (14,4%) of type III.

Elapsed time from the moment of injury to surgery was 1,6 days (1-5 days) on the average.

Direct reduction and screw fixation was applied in 6 patients, indirect reduction and fixation in 12, and in 3 patients a fixation of lateral and medial malleolus was applied, and thus a reduction of non-fixed posterior malleolus was achieved.

Postoperative direct reduction was excellent in 5 (83.3%) patients and good in 1 (16.7%). As for indirect fragment reduction, we had excellent results in 6 patients (50%), good in 3, and bad in another 3 (25 %). By comparing these results, it is evident that fracture reduction quality was significantly higher in direct reduction group,

compared to the group where reduction was performed indirectly (p = 0.039).
After follow-up period of 16 months (12 to 18 months) on the average, we evaluated the results according to the Olerud-Molander score. There were excellent results (91% - 100%) in 13 (61.9%) patients, good (61% - 90%)) in 7 (33.4%) patients, and poor (0% - 30%) in 1 (4.7%) patient (Figure 3A,B).

Figure 3. The photograph shows the anterolateral aspect of plantar (A) and dorsal (B) flexion of the foot.

Postoperatively, superficial wound infection occurred in 2 (9.4%) patients – it was treated with antibiotics, parenterally for 4 days, and postoperative thrombophlebitis in 1 (4.7%) patient – it was treated with low molecular Heparin. There were no fractured screws and all fractures healed in up to three months.
Post-traumatic arthritis (PTA) was evaluated one year after surgery and we obtained the following results: grade 0 in 9 (42.9%) patients, grade 1 in 10 (47.7%) patients, and grade 2 in 2 (9.4%)) patients - in total, 12 (57.1%) patients had PTA.

DISCUSSION

Ankle joint fractures are the third in frequency, right after hip and wrist joint fractures. Final functional outcome is better in bimaleolar, compared to trimalleolar fractures. They occur in young people, and with high energy trauma (accident, fall from a height and sport), and in elderly persons low-energy trauma causes fractures due to osteoporosis. In young people there is a risk of developing post-traumatic arthritis cousing changes in the quality of life, due to a reduction of ankle joint function and chronic pain. In elderly patients there is a risk of infection, wound complications and fixation disintegration [11].

Ankle joint fractures are intraarticular, resulting in articular surfaces injury, osteochondral layer disruption, joint surface displacement, and presence of blood and bone content in the joint [23].
From a biomechanical point of view, posterior malleolus plays a significant role in transmission of tibiotalar load. It has a preventive effect on posterior talus displacement, and with fragment size, the risk of posterior talus subluxation increases, especially if the fragment is larger than 25% of tibia joint surface [24,25]. Posterior maleolus is an important structure in distal tibiofibular joint - it provides bone restriction to distal fibula and syndesmosis stability via posterior inferior tibiofibular ligament (PITFL) and inferior transversum ligament (ITL).
Ramsey et al. and Lloyd et al. [26,27] indicate great intraarticular contact pressure in talus displacement as a result of ankle joint injury. Talus displacement by 1mm and external fibula rotation of 3° lead to a 40% decrease of tibiotalar contact, joint incongruence occurs, and decrease of contact surface causes increased pressure per unit of measurement. There is a great deal of stress that damages articular cartilage, which is the main factor in pathogenesis of PTA.

The goal of surgical intervention in posterior malleolus fractures is to achieve articular congruence, to achieve stability and restore ankle joint function. For these reasons, the imperative is to achieve anatomic reduction, and to provide a smooth and flat cartilage surface. Anatomical reduction of articular surfaces is essential factor for good treatment outcome of unstable posterior malleolus fractures [28].

Orthopedic reduction and posterior malleolus fixation can be direct and indirect. For direct access and reduction, posterior lateral approach is used, and lateral malleolus can be indirectly reduced [29]. Due to a deep position of posterior malleolus and tendon-neuro-vascular bundle of the area, this approach is very demanding and difficult. Haraguchi et al. [19] recommend this approach for type I posterior malleolus fracture. For type II fracture, a medially extended approach is recommended. Fragment fixation can be direct with screws or a plate [8]. Indirect fixation is performed by placing a screw in AP or PA direction, but only after performing lateral and medial malleolus osteosynthesis, and radiologically checking posterior malleolus position [12]. In posterior malleolus type III fractures, fragment repositioning can be achieved using the principle of ligamentotaxis, because after lateral malleolus repositioning and tibiofibular syndesmosis transfixation, there occurs a spontaneous posterior malleolus reposition – it is pulled to its place by intact PITFL [18,30]. The degree of fixation reduction and stability is the greatest in direct reposition and with the use of an osteosynthesis plate, and lower in indirect reposition and stabilization [31]. Huber et al. [32] report that indirect reduction and stability were achieved in 27% cases, while it was achieved in 83% in direct reduction and stabilization. Our results range within this frame.

Relationship and connection between posterior malleolus and tibiofibular syndesmosis is very important because of PITFL and ITL. These ligaments attach to fibula and posterior malleolus and are very important distal tibiofibular joint structures, as they provide stability to lateral ankle joint side, i.e. lateral part of talus and fibula. If the PITFL is preserved and open reposition and fixation of posterior malleolus is performed, syndesmosis stability will be better than stability in case when transsyndesmal fixation is performed. PITFL complex is the nucleus of tibiofibular syndesmosis stability. The fracture of posterior malleolus alters syndesmosis stability, because of the injury and loss of PITFL function [33]. Rigid fibula fixation and posterior malleolus reduction and fixation can adequately restore ligamentous tension of PITFL, and stabilize syndesmosis without transsyndesmal fixation. Gardner et al [34] found, after performing posterior malleolus repositioning and stabilization on cadavers, that 70% of distal tibiofibular joint stability was achieved, while after transindezmal fixation it was 40%.

Functional outcome of ankle joint fracture associated with posterior malleolus fracture depends on: the size of posterior malleolus fragment, its comminution, the quality of anatomic reposition and fixation stability, and on articular stability [18]. Our clinical results are good and similar to those reported by other authors [14,20,33].

A common late complication in posterior malleolus fractures is post-traumatic arthritis (PTA). The trigger for its formation is the change of articular surfaces, caused by trauma to distal tibia and talus [35]. Risk factors for PTA are: residual articular displacement, joint instability or subluxation caused by an injury, damage on articular surfaces at the moment of injury [36]. Boist and Dust [37] had PTA grades 2 and 3 in 67% of cases in their series, and the results presented in our series of patients are similar to theirs.

CONCLUSION

Posterior malleolus fractures are common in ankle injuries. Posterior malleolus fixation is necessary if the fragment is larger than 25% of tibial joint surface. Direct reduction and fixation should be performed, as the results are better. Fixation restores articular surface, PITFL and syndesmosis stability is achieved. CT helps in classifying the fracture type, and after surgery helps in determining the degree of fragment and joint surface reduction.

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