Original article

UDC: xxxx
doi:10.5633/amm.2019.0425

FRACTURES OF FIBULAE ABOVE THE LOWER TIBIOFIBULAR SYNDESMOSIS

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Fractures of the ankle are common injuries. According to Lauge Hansen's classification, there are five types of ankle fractures. In certain types of fractures tibiofibular syndesmosis injury occurs, a fracture of the fibula above the syndesmosis and a fracture of the medial malleolus or a rupture of the deltoid ligament, and these types are: supination-eversion (SE), pronation-eversion (PE) and pronation-abduction (PA).

We present a group of 46 patients who were treated at the Department of Orthopedic Surgery and Traumatology due to the ankle fracture and rupture of the distal tibiofibular syndesmosis. All underwent surgery immediately after the injury, on average 28 hours after the injury occurred, when osteosynthesis of malleolus and transfixation of syndesmosis with spongiosum screw placed above it, were performed.

Postoperatively, we placed a plaster splint, which was worn for 3 weeks, and support on the injured leg was banned for up to 6 weeks. After removing the plaster, all patients were included in physical therapy. Osteosynthesis material was removed after 6 months.

We've evaluated the results of the treatment according to Olerud and Molander score. By tracking the subjective and objective signs we've acquired the following results: in the group of excellent and good results there were 34 (73,9%) patients, in the group of satisfactory, there were 7 (15,2%), in the group with poor results there were 5 (10,9 %) patients.

Lateral malleolus and tibiofibular syndesmosis are key to the anatomical reduction of displaced fractures, and restoring the integrity of the lateral malleolus establishes stability of the ancle.

Acta Medica Medianae 2019;58(4):xx-xx.

Key words: *tibiofibular syndesmosis, fibula fracture, osteosynthesis, transfixation of syndesmosis*

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Introduction

Fractures of the ankle joint are common in everyday life. Almost 2% of the general population will sustain an ancle fractur during their lifetime. Eponym of Dupuytren implies an indirect fracture of the fibula above the distal tibiofibular syndesmosis, syndesmosis rupture and rupture of the deltoid ligament or fracture of the medial malleolus. This results in the destruction of articular forks which causes the dislocation of the talus.

Tibiofibular syndesmosis consists of the fibular incisure of the tibia and fibula protrusion lying in incisure. Front edge of incisure of the tibia is much more developed than the rear one and crosses over the medial two-thirds of the fibula to serve as a support to the fibula in order to restrict movement forward (1, 2, 3, 4). Between the bone structure of sindesmosys there is no cartilage, there are adipose tissue, blood vessels and synovial recess of the upper ankle with length up to 1.5 cm, and through it syndesmosis communicates with the joint cavity.

The movements of plantar and dorsal flexion of the ankle joint are determined by the mechanical complex of the foot which consists of fibular malleolus, the tibiofibular syndesmosis and pars dorsalis of tibia - these are the key elements to the stability of the ankle. Ligaments of tibiofibular syndesmosis with their elasticity allow the movement of the fibula and move it into the syndesmosis, there are four:

lig. tibiofibulare anterior, lig. tibiofibulare posterior, lig. tibiofibulare interosseus and interosseus membrane. Rupture of all four ligaments causes diastasis of tibiofibular syndesmosis up to 7,3 mm (5, 6, 7).

The aim of this paper is to highlight the role and importance of the fibula and syndesmosis in the movements of the ankle, the types of injuries and the necessity for anatomic surgical reduction.

Materials and methods

With the permission of the ethical committee a research was conducted on 46 patients with fractures of the ankle and the disruption of the distal tibiofibular syndesmosis who were treated at the department of orthopedic surgery and traumatology clinical center in Niš, in the period from January 2011 to January 2013. Within the two-year period, there were 85 ankle joint injuries of this type, but in this paper we have only shown patients with this type of injury, who were regularly monitored after three, six and twelve months after the surgery.

For the classification of ankle fractures, we used Lauge Hansen classification, which is based on the mechanism of injuries, and there are 5 types: supination - eversion (SE) type, supination – adduction (SA), pronation – eversion (PE), pronation – adduction (PA) and pronation – dorsiflexion (PD) type (5, 8, 9).

The criteria for including the test subjects in the study were: a fracture above the lower tibiofibular syndesmosis, a rupture of syndesmosis and an injury of medial compartment of the ankle joint – a rupture of lig. deltoideum or a fracture of medial malleolus. This study includes test subjects with the upper part fibula fractures, the so called Maisonn fractures and open fractures of the ankle joint.

In this study we include three types of indirect fractures of the fibula above the distal syndesmosis. They are the result of different mechanisms of injury, and they are characterized by different lines of fracture in the distal and middle part of the fibula. In supination-eversion (SE) type, the supination and external rotation of the foot occur; fractures of the fibula are spiral, where the front top of the fracture line is positioned at 4 cm or more above the top of the malleolus and then goes backwards and up. The fracture of the medial malleolus or the rupture of deltoideum ligament occur in the final, fourth phase of the injury. In pronation-abduction (PA) type, deltoideum ligament is stretched and ruptures first, then rupture syndesmosis and fibula, the fracture line is curved and it is located at 6 centimeters or more from the top of malleolus. In pronation-eversion (PE) types of fracture, malleolus fracture occurs, or ruptures of the deltoideum ligament and then fibula fractures. The fracture line of the fibula is 5 centimeters or more from the top of malleolus (9, 10).

For the purposes of real insight and objective assessment of the fracture, as well as the assessment of response to treatment, radiography was performed in two basic projections, and stress radiography for diagnosing the rupture of lig. deltoideum (11, 12). Standard AP radiographs were obtained with the leg in 20 degree of internal rotation in men and 15 degree of internal rotation in women (13). We've measured the tibiofibular clear space (syndesmosis AB), and the overlap of the tibia and fibula (syndesmosis BC) (Figure 1). We observed that syndesmosis AB is normally < 5 mm and BC normally > 10 mm (14). We've measured the talocrural angle, it is normally 83 ± 4 degree (15) and medial clear space, > 4 mm is abnormal (16) (Figure 2). Radiological control was done at the time of admission, during and after the operation, after the first, third and twelfth month.

The surgical procedure was performed immediately after the admission and preparation for surgery, on average after 28 hours (from 1 to 6 days). The medial malleolus is fixed with malleolar screw, and rarely with Kirschner pin. Lig.deltoideum must be shown, it can be interpolated in the line of malleolus fracture or between the malleolus and the talus - in this case its reposition and suture with bioresorptive screw is done. For the purposes of operative approach to the lateral side, the shin is placed on a pillow not including the heel, since this would cause the frontal subluxation of the talus and malreduction. The foot is free and enables the orthopedic repositioning of the fracture, positioning of the talus and the control over talocrural angle of the injured side which is being compared to the counter-lateral, normal angle, and the length of fibula is thus confirmed. The fibular fracture is displayed by lateral incision over the lover fibula half. The reduction of the fracture is achieved through foot manipulation, a one-third-wrap-around board is placed at the height of lateral malleolus, it is then modeled to follow the axis with valgus position from 10 to 12 degrees. The board is centered between the front and rear bone edge, it is adjusted with Kirschner needles and an additional radiological shot is done. If the right length of fibula is achieved, the talocrural angle is reduced properly and the talus centered, then the fibula fracture is fixated (17).

Tibiofibular transfixion screw is placed individually or through one of the lower holes on the plate above the tibiofibular syndesmosis, ie. 1.5 to 3.5 cm above the hinge line (4). The bolt can affect four cortices, i.e. it can pass through the fibula and tibia, and it can pass through three cortices and the entire metaphyseal tibia (Figure 3). It is not necessary to tighten it greatly, or to place the foot at an angle of ninety degrees in relation to the lower leg while setting the screws (18). The stability and quality of reduction of the fracture were assessed roentgenographically.

Postoperatively plaster splint or a brace was placed for three weeks, and support on the operated leg was banned for 6 weeks (19, 20), afterward followed physical procedures and gradual support on the operated leg.

After 12 months of monitoring, functional results of the respondents were evaluated. There are many scoring systems, Joy Gregory (21), William Phillips (22), Foot and Ankle Outcome Score (FAOS) (23), we used Olerud and Molander's scoring system (24). The subjective symptoms of pain, deterioration in walking, difficulty in climbing the

stairs, aggravation in doing sports and limited working ability as well as objective symptoms were evaluated: skin condition, deformity, muscle atrophy, loss of motion in the ankle joint and loss of subtalar inversion - eversion.

Figure 1. AP radiograph of the ankle
Tibiofibular clear space (syndesmosis AB) is the space from the lateral border of the posterior tibial malleolus to the medial border of the fibula.
Overlap of the tibia and fibula (syndesmosis BC)

Figure 2. The talocrural angle is formed by a line perpendicular of the distal tibial articular surface and a line joining the tips of both malleoli. The medial clear space is the distance from the lateral border of the medial melleolus to the medial border of the talus.

Figure 3. Fibula fracture with tibiofibular rupture of syndesmosis and postoperative treatment

Results

In the group of 46 patients with disruption of the distal tibiofibular syndesmosis and fibular fractures were 28 (60,9%) men and 18 (39,1%) women, and the age of patients ranged from 16 to 79 years (average 36,7 years). As a cause of injury, dominate slip and fall, 32 (69.6%) patients, fall from a height 9 (19,6%) and traffic accidents 5 (10,9%) patients.

Using the Lauge Hansen classification, 24 (52,2%) patients had supinatio-eversion type of injury. In second place was pronation-abduction type of injury, a total of 17(37%) patients, and 5 (10,9%) injuries resulting in pronation-eversion type of ankle injury, (Table 1).

Table 1. Display the respondents by sex, cause of injury, type of fracture and the final results of the treatment

Sex		Cause injury		Type fract		Type injury		Evaluation system	
Male N (%)	28 (60.9)	Slipping	32 (69.6)	bimaleolar	30 (65.2)	Supenation-eversion	24 (52.2)	Excellent+good results	34 (73.9)
Female N (%)	18 (39.1)	Fall from height	9 (19.6)	trimaleolar	9 (19.6)	Pronation-abduction	17 (37)	Satisfactory results	7 15.2
		Traffic accident	5 (10.9)	unimaleolar	7 (15.2)	Pronation-everson	5 (10.9)	Poor results	5 10.9

In our series average dorsiflexion of the ankle was 16 degrees (ange, 8 to 30 degrees) and the average plantar flexion was 40 degrees (range, 15 to 60 degrees). The difference relative to the contralateral side averaged a loss of 5 degrees of dorsiflexion and 4 degrees of plantar flexion.

Based on the final functional result of treatment by Olerud and Molander's scoring system, the average ankle score for these patients was 87 points (range, 55 to 100 points).

In the group of excellent and good results there were 34 (73,9%) patients, 24 patients (52,2%) had an excellent result (a score of 90 to 100 points), and 10 (21,7%) had a good result (an ankle score of 80 to 89 points). They had no pain in the ankle, range of ankle joint motion was not restricted and there was no deformity. They were able to perform all work activities and to engage in sports.

In the group of satisfactory results there were 17 (37%) patients. They had occasional pain, which intensified during work, long standing and walking. They had a swollen ankle and foot and could not do the same job as before the injury. In the group with poor results there were 5 (10,9%) patients. They had constant pain in the ankle and took painkillers. They had a swelling and deformed ankle and foot. The movements of the ankle joint were reduced by more than 60%. Even with the help of a stick, it's hard for them to move and they are unable to work and do sports. In the monitored group of patients there were complications to:

- the dislocation of the fibula fracture and syndesmosis due to the short plate on the fibula and a short screw with which tibiofibular syndesmosis was fixed - two cases,
- a fracture of the syndesmosis screw because of the incorrect fixation and early loading of the operated leg – one case,
- the appearance of synostosis at the height of tibiofibular syndesmosis – one case,
- bad reposition and fixation of the medial malleolus - two cases,
- postraumatic arthrosis of the ankle after one year - three cases.

We've followed radiologically the size of tibiofibular space (syndesmosis AB), preoperative average value was 7 mm (from 5 to 13 mm), post treatment the average value was 4,5 mm (from 3 to 6 mm). The overlap between tibia and fibula (syndesmosis BC) after the ankle joint injury is 4 mm (from 0 to 11 mm), and after the treatment the average was 10.5 mm (from 10 to 13 mm). Talocrural angle was compared to the healthy side, the average postoperative was 84 degrees (from 80 to 86). All the malleous fractures were healed on average within 3,5 months. There was no widening of the free medial ankle space, that is its average postoperative value was not larger than 4 mm.

Discussion

Healthy distal tibiofibular syndesmosis is responsible for biomechanics and congruency of the concave part of the upper ankle joint. Together with the lateral malleolus it is the key to the stability of the ankle. Lauge-Hansen described the sequence of stages and the pathological mechanism of the fractures of the fibula above the syndesmosis based on his extensive experiments in cadavera. From the present study it is clear that there are three types of fractures of the fibula proximal to the syndesmosis each one produced by a typical sequence of stages in the development of a complete lesion. From the pattern of the fibular fracture, it is possible to conclude which lesions always accompany it (4, 6, 11, 19, 22, 25). In our series supination-eversion type is the dominant one, and other authors confirm it as well (10, 25).

Rupture of the tibiofibular ligaments, which constitute syndesmosis, results in separating the tibia and fibula, and the development of the conditions for the anterolateral rotary instability of the ankle joint, talar tilt and signs of anterior talus drawer (1, 5, 26).

Close (27) have shown that normal movement of the ankle depends on the precise relationship determined by the syndesmosis. If the syndesmosis is disrupted, there may be widening of the tibiofibular joint and lateral shift of the talus. Ramsey and Hamilton (28) reported that when the talus moved laterally by 1 mm the contact area of the tibio- talar articulation was decreased by 42%. Burns et al (29) has shown that a complete disruption of the syndesmosis combined with a tear of the deltoid ligament caused a decrease of 40% in the tibio-talar contact area, an increase of 36% in the tibio-talar contact pressure.

Today's attitude towards the treatment of tibiofibular syndesmosis rupture is surgical treatment, because the anatomic reduction with the closed method is almost impossible. The problem of diastase of syndesmosis is not treatment but diagnosis. For this reason targeted stress x-ray images,CT, NMR of the ankle are done, where one can see the degree of damage to the syndesmosis. This applies to the medial side of the ankle as well - if the medial malleolus is intact, and there is swelling, soreness and bruising then we need to look for the rupture of lig.deltoideum, radiologically or during the surgery (10, 11, 21).

Transfixed syndesmosis screw can be metal or bioresorptive (20, 30), we used a metal one. Some authors (20, 21) have recommended placing the screw across only three cortices so that normal motion can occur at the syndesmosis. In our series of treated patients we have also applied the same method of the stabilization of tibiofibular syndesmosis. It can be placed independently or as a part of the panel that is used for osteosynthesis of fibular fractures. It is always placed transversely at 1.5 to 3.5 cm above the wrist line, it is not recommended to place it through the syndesmosis, because it has a synovial recess through which it communicates with the joint cavity. On that level, there are also blood vessels of the front and rear tibiofibular ligaments that make up the tibiofibular syndesmosis. Blood vessels are lateral penetrating branches, a.peronealis and a.tibialis anterior (2, 9, 31, 32). The current recommendation to hold the foot at an angle of 90 degrees when operating syndesmosis transfixation is not justified. The same goes for excessive tightening of the screw, i.e. syndesmosis, because high compression has no effect on the range of motion in the ankle joint or on the course of healing of ligaments (18, 20, 33). During the operational work, we adhered to this rule as well, ie. we did not strive towards the tightening of the screws and dorsal flexion of the foot.

In our series we had 34 (73,9%) test subjects with excellent and good results and 12 (26,1%) with satisfactory and poor results. The movement circumference in an operated ankle joint is on average 89% of the healthy movement. Other authors have published similar results. Robert et al (19) in the study of 24 patients had 19 (79,2%) with excellent and good results, and 5 (20,8%) with satisfactory and poor results. The movements in operated ankle joint on average are 87% of the movements of non-operated ankle joint. David et al (20) in the series of 33 patients had excellent and good results in 23 (69,7%), and satisfactory and poor results in 10 (33,3%) patients. The average dorsiflexion value was 17 degrees, plantar flexion 40 degrees. Yablon et al (25) have shown the series of 53 patients, there were 14 (26,4%) patients with poor results i.e. there was a talar tilt. Dorsiflexion in the ankle joint has been reduced on average by 6 degrees, and plantar flexion by 10 degrees.

As to the question, when do we need to remove the transfixation screw, opinions are divided. One group of authors believes that it should be removed as soon as ligament structures coalesce - after 6 weeks, while others believe that the screw does not affect the function of the ankle and it can be removed after six months (7, 20, 21, 25, 30, 31). We removed the entire osteosynthetic material at once, six months after the operation.

After the surgery, we placed plaster immobilization and we ordered the exemption from loading for up to 6 weeks, which is the attitude of other authors as well (19, 20, 22).

Complications in treatment of the ankle joint fracture are possible, and they depend on the range of soft tissue injuries, the type of fracture and the degree of anatomical reduction. In our series we have had the following complications: synostasis, talar instability, screw rupture, postoperative wound moisturizing, displacement of the fibula fracture and medial malleolus and post-traumatic arthrosis. Other authors have listed complications as well. Bosman (30) lists postoperative displacement of the fibula fracture in 9 (8.8%) and postoperative wound moisturizing in 6 (5.9%) out of 102 patients. Yablon et al (25) in a study of 53 patients lists infection in 2, and painful contact between talus and lateral malleous, the so called impingement, in 3 patients. He also lists talar instability which is a predisposition for degenerative arthritis. Robert and Scott (19) list that post traumatic arthrosis of the ankle becomes clinically evident within one year of the injury.

Phillips et al (22) list that synostosis of distal tibiofibular syndesmosis was detected on the follow-up radiographs of 7 (5,1%) and degenerative changes after one year follow-up of 27 (19,6%) of the 138 patients.

Conclusion

We conclude that the basis of these studies is that the lateral malleolus and tibiofibular syndesmosis are the key to the anatomical reduction of displaced fractures, and that restoring the integrity of the lateral malleolus establishes stability of the ankle.

Acknowledgment

This work is part of the project „Virtual human osteoarticular system and its application in pre-clinical and clinical practise" (No. 41017), supported bywas funded by the Ministry of Educatio, Science an Technological Development of Serbia.

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Originalni rad **UDC: xxxx**
doi:10.5633/amm.2019.0425

PRELOMI FIBULE IZNAD DONJE TIBIOFIBULARNE SINDESMOZE

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Prelomi skočnog zgloba su česti u svakodnevnom životu. Prema Lauge Hansen – ovoj klasifikaciji postoji pet tipova preloma skočnog zgloba. Kod određenih tipova preloma nastaje povreda tibio fibularne sindesmoze, prelom fibule iznad sindesmoze i prelom medijalnog maleolusa ili kidanje deltoidnog ligamenta i to su: supinaciono – everzioni (SE), pronaciono – everzioni (PE) i pronaciono – abdukcioni (PA) tip. Povreda sindesmoze dovodi do nestabilnosti skočnog zgloba jer je ona sa lateralnim maleolusom i zadnjim rubom tibije njegov ključ stabilnosti.

Prikazujemo grupu od 46 ispitanika koja je lečena na Ortopedskoj klinici u Nišu, a zbog preloma skočnog zgloba i kidanja distalne tibio fibularne sindesmoze. Svi su operisani neposredno posle povređivanja, u proseku posle 28 časova kada je urađena osteosinteza maleolusa i transfiksacija sindesmoze spongioznim šrafom koji se postavlja iznad nje.

Post operativno smo postavljali gipsanu longetu koja je nošena 3 nedelje, a zabrana oslonca na operisanu nogu je do 6 nedelja. Posle skidanja gipsa svi ispitanici su bili uključeni u fizikalni tretman. Osteosintetski materijal je vađen posle 6 meseci.

Rezultate lečenja smo procenjivali prema Olerud - Molander - ovoj klasifikaciji. Praćeni su subjektivni i objektivni znaci i dobili smo sledeće rezultate: u grupi odličnih i dobrih rezultata bilo je 34 (73,9%) ispitanika, u grupi zadovoljavajućih bilo je 7 (15,2%) i u grupi sa lošim rezultatima bilo je 5 (10,9%) ispitanika.

Zaključak je da su, lateralni maleolus i tibio fibularna sindesmoza, ključ stabilnosti skočnog zgloba.

Acta Medica Medianae 2019;58(4):xx-xx.

Ključne reči: *tibiofibularna sindesmoza, prelom fibule, osteosinteza, transfiksacija sindesmoze*