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The Final Thesis

Treatment of C Type Ankle Fractures

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Declaration

I hereby declare that I have written this dissertation without the unauthorised help of third parties and without the use of other and without the use of other than the stated aids; the thoughts taken directly or directly or indirectly from outside sources are identified as such. marked as such.

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I would like to thank Assoc. Prof. Igoris Šatkauskas, who supervised this work and provided invaluable guidance throughout this thesis.

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1. SUMMARY

The thesis reports from a 32- year old male who was presented to the emergency department after he sustained an ankle injury, causing persistent pain on the left ankle. Manual compression of the proximal part of the left lower leg raised suspicion for a fracture of the fibula, which was later, together with a rupture of the tibiofibular syndesmosis, confirmed by imaging studies. Because of the proximal fibula fracture in combination with the rupture of the deltoid ligament, the anterior syndesmotic band and the interosseous membrane, this type of fracture is considered to be in the Weber C3 or rather an AO/OTA 44C3. fracture category. The paper discusses the importance of a complete examination in suspected ankle fractures and the need for removal of a syndesmotic screw.

2. INTRODUCTION

2.1. ANATOMY OF THE ANKLE JOINT

The ankle joint is a functional joint complex which is composed of talus, fibula and tibia. It is counted among the synovial joints, more specifically the hinge joints and has two articulations. The joint is divided into articulatio talocruralis and articulatio talotarsalis.
The ankle joint enables dorsiflexion and plantar flexion of the foot. The subtalar and midtarsal joints permit a certain degree of pronation and supination. Throughout the first phases of gait the heel functions as a shock absorber.

The ankle joint is stabilised by the lateral and the medial collateral ligaments. The compound does not only ensure full stability but also good mobility of the joint. The medial collateral ligament is composed of the tibionavicular ligament, the tibiocalcaneal ligament and the tibiotalar ligament. Its function is to strengthen the medial aspect of the joint in order to prevent over-eversion. The lateral collateral ligament consists of the anterior talofibular ligament, the posterior talofibular ligament and the calcaneofibular ligament. As the name suggests, it assists lateral stabilization and thus prevents over-inversion.

The nerve supply to the ankle joint comes from the tibial and sural nerves as well as deep fibular nerve, also called the peroneal nerve. The ankle joint receives blood from the malleolar branches of the peroneal artery and the anterior and posterior tibial artery. The venous blood drains through the homonymous veins.

Plantar flexion is performed by gastrocnemius and soleus muscles. Furthermore, the muscles fibularis longus and tibialis posterior, flexor hallucis longus, flexor digitorum longus contribute to plantar flexion. The muscles extensor digitorum longus, extensor hallucis longus, tibialis anterior and fibularis tertius are located on the anterior part of the ankle joint. All together they enable dorsal flexion. The dorsiflexor fibularis tertius and the plantar flexors fibularis longus and fibularis brevis perform eversion, whereas the main dorsiflexor of the foot, the tibialis anterior, as well as tibialis posterior, which acts as a plantar flexor, enable inversion. [1,2]

2.2. MOVEMENT OF THE ANKLE JOINT

Since the the ankle joint is a hinge joint the foot can perform about 20° of dorsiflexion and 30-50° of plantar flexion. Lifting of the medial foot edge with simultaneous lowering of the lateral foot edge, also called supination, is possible up to 50°. Lifting of the lateral foot edge with simultaneous lowering of the medial foot edge, also called pronation, is possible up to 30°. Exceeding the range of motion results in an injury to the musculoskeletal system occurs. The Weber C fracture often results from a combination of pronation and forceful external rotation. In the upright position the angle between the leg and the foot is 90° and in the neutral position the joint has 0-10° plantar flexion. [3] The combination of these motion patterns allows for a wide range of motion but at the same time makes it susceptible to injury.

2.3. WEBER FRACTURE C

In 1949 , Robert Danis first expressed the Danis- Classification system, which was later (1972) modified by Bernhard Georg Weber. The classification is more known by the term Weber fracture classification. The Weber classification describes ankle fractures, by classifying the lateral malleolar fractures and their level in relation to the distal tibiofibular syndesmosis. The classification is divided in three categories, which would be type A, type B and, type C. [4] However, this thesis focuses on the type C fracture. In a type C fracture the fibula is fractured proximal to the syndesmosis (suprasyndesmotic). It is an unstable fracture, in combination with an injury to the distal syndesmosis formed between the distal tibia and fibula. [5] It may encompass a deltoid ligament fracture or a medial malleolus fracture. The type C fracture is associated with a widening of the distal tibiofibular articulation. It is mandatory to visualise the injured knee or full length tibia-fibula, since the fracture may be too proximal to be visible on an ankle image. Since this type of fracture is usually unstable it is necessary to perform open reduction-internal fixation. There are three subclassifications, which would be the C1, the C2 and the C3 sub- classification. The C1 subclassification indicates a diaphysial fracture of the fibula and is described as simple fracture. The C2 subclassification indicates a diaphysial fracture of the fibular but is complex, unlike the C1 classification. The C3 sub-classification describes a proximal fracture of the fibula , called Maisonneuve fracture. It is defined by an injury which results from external rotation above the syndesmosis or an abduction movement, which results in the disruption of the joint. Furthermore, is its linked with a medial lesion. [6,7] This type of fracture is relatively rare in clinical practice and accounts for about 5% of all ankle injuries. It is provoked by pronation in combination with a forceful external rotation. [8]

3. KEYWORDS

Weber C type fractures, Fibula fractures, Syndesmosis injuries, Ankle joint, Fracture fixation, Maisonneuve fracture, Syndesmotic screw

4. CLINICAL CASE

4.1 CLINICAL PRESENTATION

A 32- year old male patient presented to the Respublikinė Vilniaus universitetinė Ligoninė. The patient complained about pain around the joint after he experienced a direct trauma on the left ankle. He stated that he had neither a previous injury nor a surgery of the joint. The ankle exhibited a swelling and a haematoma. Additionally, the patient did not tolerate weight on his left ankle. The clinical examination was performed and did not reveal any deformations nor a neuromuscular impairment. The pulse of dorsalis pedis and posterior tibial artery were palpable. The patient experienced pain during external rotation of the joint and had a restricted range of motion. Painful palpation of the proximal part of the left lower leg raised suspicion for a fracture of the fibula. The rest of his anamnesis and physical examination was unremarkable. Laboratory examinations revealed no significant abnormalities.

4.2 IMAGING EXAMNIATION

For further investigation a x-ray of the left ankle, foot and distal part of the lower leg in mortise view (preoperative) (figure 1) was performed. It revealed an enlarged gap between the talus and the tibia and its medial malleolus whereas the tibia and the fibula compared to the normal standards (figure 2) [9]. The talus was shifted laterally, since the fibula is not in the right position. Usually the gap, the so called medial clear space indicated with two yellow arrows, should exhibit ≤4mm. Additionally, a decreased tibiofibular overlap (normal >6 mm on anterior posterior view), indicated by a red arrow, and an increased tibiofibular clear space (normal <6 mm on anterior posterior view) (green arrow) can be observed. [10] These findings indicated a tear of the interosseous membrane and the tibiofibular ligament. There was no fracture observed in the distal part of the lower limb.

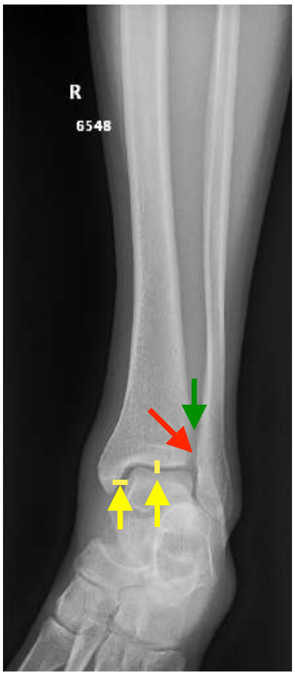

Figure 1. X-Ray image of the left ankle, foot and distal part of the lower leg in a mortise view (preoperative) The X-ray image with an internal rotation of 15 degrees showed a decreased tibiofibular overlap (indicated with a red arrow), an increased medial clear space (indicated with two yellow arrows) and an increased tibiofibular clear space (indicated with a green arrow).

Figure 2. X-Ray image of the left ankle, foot and distal part of the lower leg in anterior posterior view (norm)
The X-ray image showed a normal tibiofibular overlap ,a normal medial clear space and a normal tibiofibular clear space.

The radiograph of the medial view of the lower limb (figure 3) did not reveal any fractures. On this radiograph it was not possible to make a proper diagnosis. The talus and the tibia can be visualised but nothing remarkable can be observed. Further X-rays from another angle and another level had to be performed.

Figure 3. X-Ray image of the left ankle, foot and distal part of the lower leg in medial view (preoperative)

Due to the fact that the patient felt a painful palpation of the proximal part of the left lower leg a X-ray image of the left proximal part of the lower leg in anterior and lateral view was performed. The X-ray revealed a fracture of the proximal diaphysis of the fibula (figure 4 and 5), which indicated a suprasyndesmotic fracture. A spiral fracture line, such as extended from anterosuperior to posteroinferior (red arrows), can be observed in the proximal third of the fibula from anterior posterior view (figure 4) and the lateral view (figure 5). The increased gap between the tibia and the fibula indicated a torn interosseous membrane (figure 4) (blue arrow). In combination with the findings on previous radiographs and the clinical presentation of the patient the diagnosis of an AO/OTA 44C3 fracture was assumed.

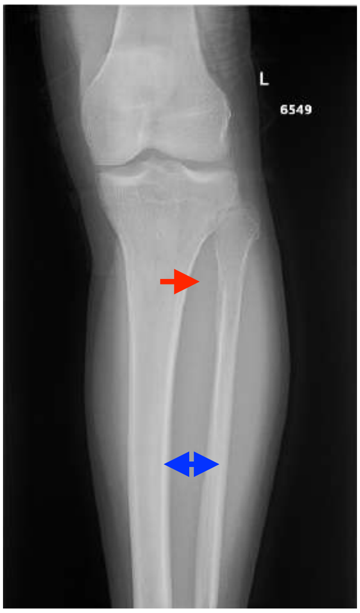

Figure 4. X-Ray image of the left proximal part of the lower leg in anterior view (preoperative) The anterior view indicated a fracture of the proximal diaphysis of the fibula. (indicated by a red arrow). The increased gap indicates a torn interosseous membrane (indicated by a blue arrow).

Figure 5. X-ray image of the left proximal part of lower leg in lateral view (preoperative) The lateral view exhibited a fracture of the proximal diaphysis of the fibula. (indicated by a red arrow).

Anterior view of the computed tomography scan of the left ankle with a frontal view (figure 6) and a scan of the left leg transverse view (figure 7) was performed. The computed tomography with a frontal view of the left ankle shows the tibia medially (red arrow). Regarding the fibula only the lateral malleolus (blue arrow) is visible. The. CT confirmed again, an increased medial clear space (yellow arrow) between the medial side of the talus and the lateral surface of the medial malleolus. Furthermore, the axial view at the level of the distal epiphysis of the lower limb confirmed the instability of the fibula and showed an increased gap between the two bones, fibula and tibia, so called tibiofibular clear space (red arrow), which should not exceed ≤6mm. [11] Moreover, it confirms the suspicion of the rupture of the tibiofibular syndesmosis.

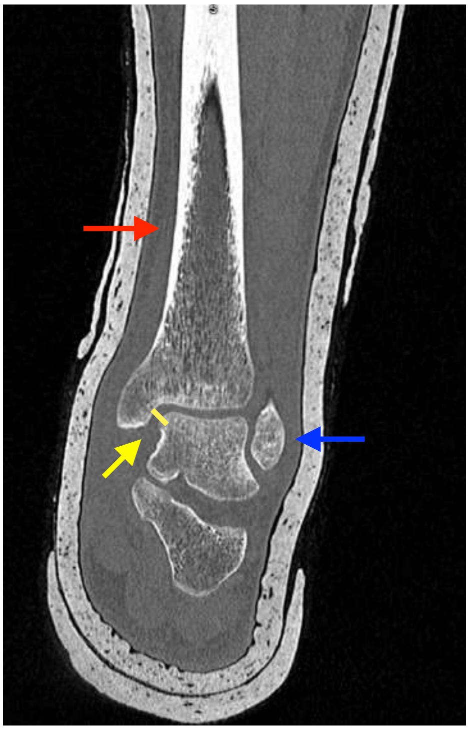

Figure 6. Computed tomography scan of the left ankle and the distal part of the lower leg in anterior view (preoperative) The anterior view visualised the tibia medially (indicated by red arrow) and the lateral malleolus of the fibula (indicated by blue arrow). An increased medial clear space (indicated by a yellow arrow) can be observed.

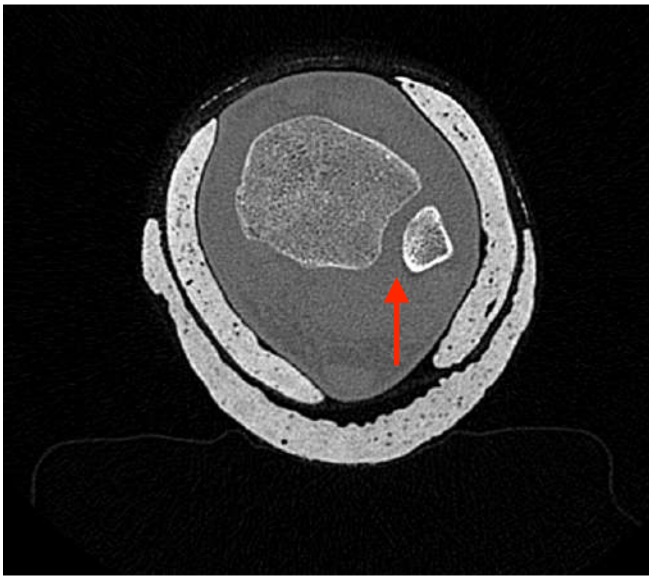

Figure 7. Computed tomography of the lower limb in an axial view (preoperative) The scan shows an axial view of the lower limb at the level of the distal epiphysis. It confirmed the instability of the fibula due to an increase gap between the two bones, fibula and tibia, which exceeds ≤6mm (indicated by red arrow).

4.3 FINAL DIAGNOSIS

The findings of the physical examination and the imaging studies, wich revealed a proximal location of the fibular fracture in combination with the rupture of the deltoid ligament, the interosseous membrane and the anterior tibiofibular ligament classifies this injury as an AO/OTA 44C3.1 according to the AO Foundation.[12] With the diagnosis, so called operation is always recommended. [13]

4.4 TREATMENT

In order to treat the fracture open reduction internal fixation in general anaesthesia was performed. The operation was carried out after the swelling of the soft tissue around the ankle joint subsided and the skin was not tensed anymore. Premature operation may lead to inadequate wound closure and bears the risk of wound infection and poor healing. [14] The radiograph showed the postoperative situation. Two suprasyndesmotic positioning screws (red arrow) were used to stabilise the joint (figure 8 and figure 9). During this procedure the screws are inserted from the lateral side of the fibula and run through the fibula und the tibia. This ensures stabilisation of the structures and holds them in the correct position. [15] Two suprasyndesmotic positioning screws were inserted through a stab incision above the joint space, which placed the fibula against the tibia. The talus, the tibia and the fibula were in good alignment. The medial clear space (yellow arrow) exhibited a normal distance (≤4mm). As Tibiofibilar overlap (normal >6 mm on anterior posterior view) (blue arrow) as well as physiologic tibiofibular clear space (normal <6 mm on anterior posterior view) (green arrow) were re-established. [16] There was no need to stabilise the proximal fracture at the fibula itself. [17]

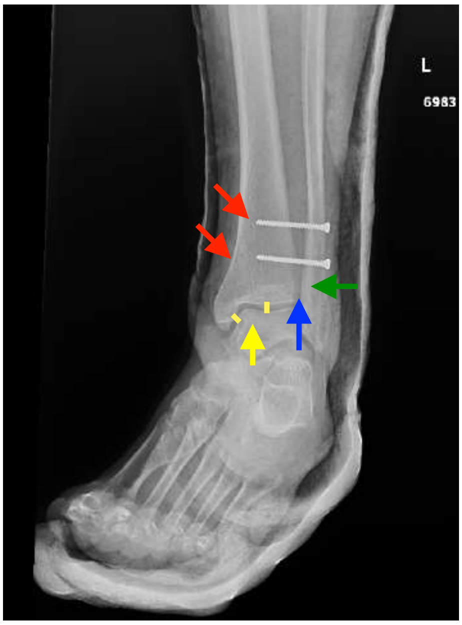

Figure 8. X-ray image of the left lower limb with in a lateroanterior view (postoperative) The scan was made after the operation. Medially, it showed the tibia and laterally, it showed the fibula. Two suprasyndesmotic screws (indicated by red arrows) were inserted from the lateral side of the fibula to stabilise the joint. The patient's foot was in a cast. It showed a physiological tibiofibular overlap (indicated with a blue arrow), a normal medial clear space (indicated with a yellow arrow) and a normal tibiofibular clear space (indicated with a green arrow).

Figure 9. X-ray image of the left lower limb in a medial view (postoperative) The medial view of the left lower limb was made after the operation. Two suprasyndesmotic screws (indicated by red arrows) were inserted from the lateral side of the fibula to stabilise the joint. The patient's foot was in a cast.

4.5 OUTCOME AND FOLLOW-UP

Postoperatively, the ankle was immobilised in a short-leg cast. The patient was not allowed to bear any weight on his left ankle. Seven weeks after the operation new radiographs were obtained. The fracture line was blurred and the joint was in a stable position. The tibia and the fibula were still in good alignment. (figure 10)

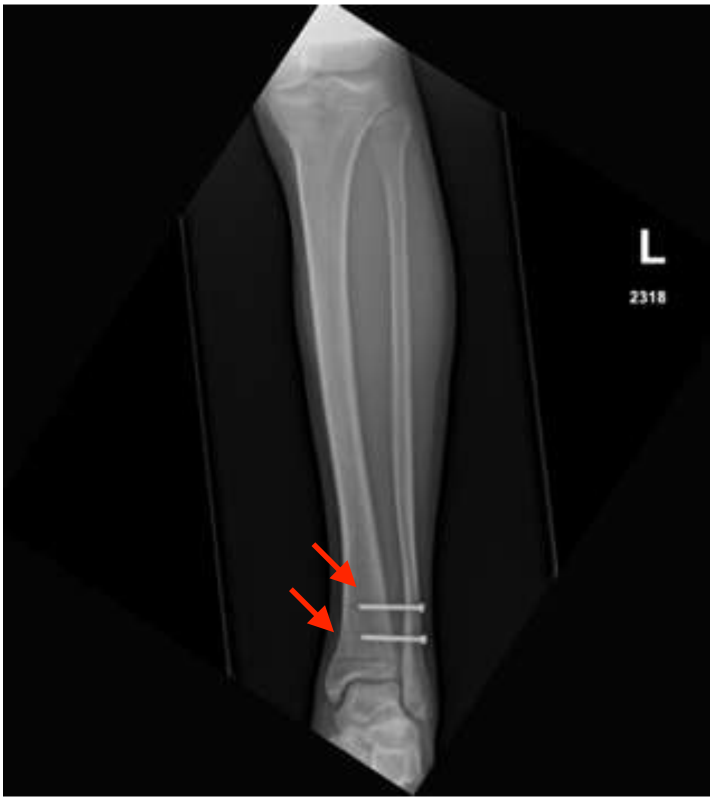

Figure 10. X-ray image of the left lower limb in an anterior view (postoperative) This scan was made seven weeks after the operation. Medially, it showed the tibia and laterally, it showed the fibula. Two suprasyndesmotic screws (indicated by red arrows) were inserted from the lateral side of the fibula to stabilise the joint.

5. DISCUSSION

5.1 MISSED AO/OTA 44C3 FRACTURE

Twisting of the ankle joint is one of the most common conditions presenting to the emergency department. [18] In spite of the fact, that most of these injuries turn out to be strained ligaments, it is important to perform a precise diagnostic workup to be able to rule out differential diagnoses, including fractures, conscientiously. The fractures can present in various ways and exhibit several grades of stability or rather instability. The AO/OTA 44C3 fracture accounts for one of the most unstable injuries with regard to the ankle joint fractures. [19] Patients suffering from this type of fracture often present to the emergency department with moderate to severe pain in the area of the ankle joint. Furthermore, they often do not tolerate any weight on the affected leg or foot. The fact that the patients do not tolerate any weight means that the proximal part of the fibula is not loaded. This in turn explains why patients report little to no pain in the region of the fracture. Despite its unusual location, the AO/OTA 44C3 fracture is referred to and classified as an ankle fracture. This is due to the fact that the injury mechanism leads to lesions of the ankle joint regardless of the location of the fracture. [20] Several cases of patients who sustained an AO/OTA 44C3 fracture report repeated misdiagnosis due to incorrect diagnostic workup. [21] These cases underline once again how quickly such a fracture can be missed and how crucial it is to make a proper diagnosis. It is of big importance to emphasise the causes of misdiagnosis in order to prevent incorrect treatment and its severe consequences. As mentioned earlier, this type of fracture often causes little to no pain at rest. Additionally, the pain in the ankle often drowns out the pain of the fibula fracture. This can lead to a lack of attention to the proximal part of the lower leg. This in turn eliminates the need for palpation of the proximal fibula and therefore the need for an x-ray. Moreover, the investigation in the emergency department is usually problem focused. The attending physician often focuses on the patient's symptoms and the regions where they occur. As a result, the focus is then usually on the ankle joint and proximal structures are ignored. [22] Often, the diagnostic focus and distal pain prompts the treating physician to order an image exclusively from the distal part of the leg. Consequently, the proximal fracture is not visualised and this in turn increases the likelihood that the fracture will be missed. X-rays made in the emergency department are usually not stress-radiographs. However, stress-images are important, as they can cause stress widening of the syndesmosis or the ankle mortise. This can make possible injuries visible. If the injured joint is not loaded, injured structures may return to their original positions. This can result in the affected area not showing any injuries and remaining inconspicuous. [23] In a study of 14 patients who suffered from an AO/OTA 44C3 fracture, four patients reported feeling no pain. It was found that 14% with this type of fracture were misdiagnosed. The authors emphasise the importance of early diagnosis of the fracture, as this is the only way to ensure good treatment, which in turn usually leads to a good outcome. [24,25]

5.2 REMOVAL OF THE SCREWS

In the context of ankle fractures, it is particularly important to recognise syndesmosis injuries and ruptures in order to treat them appropriately, since an injured syndesmosis always results in a structural alteration of the ankle joint. A changed load between the inner and outer ankle due to the syndesmosis can always lead to osteoarthritis. Insufficient or altered width between the inner and outer ankle also leads to a change in the position of the ankle bone in the joint under load and thus to the development of ankle arthrosis. [6] The gold standard for ensuring and restoring stability of the ankle joint after a fracture remains the syndesmotic screw. [26] Generally speaking if the syndesmosis is unstable, it is stabilized so that it heals in the desired position. This is done by positioning one or two screws through the fibula into the tibia so that these bones are fixed and the syndesmosis can heal. [27] After healing of the syndesmosis, the screws loose their function.

An important matter which arises regarding the AO/OTA 44C3 fracture is whether the syndesmotic screws should be removed or not. There are several papers who deal with the question whether the removal of the syndesmotic screw is justified. The current data supports the theory that there is no difference. [28,29] After healing, some surgeons advocate a removal of the screw due to the reduced mobility in the ankle joint and presence of a needless foreign body. [30] Another reason for the removal of the screw is the risk that the screws can break after weight bearing due to several reasons e.g. an increased BMI. [31] A study from 2021 reported that in 49% of patients who did not undergo the removal of the hardware experienced screw breakage. [32] The reasons listed may lead one to believe that routine removal is reasonable.

Nevertheless, there are many reasons for a retention of the screw. A meta analysis from 2021 summarised the results from 7 studies with 522 patients included in this review. The score of American Orthopedic Foot And Ankle Society (AOFAS) and the visual analogue scale for pain (VAS) were taken into account, with the result that there are no differences. In addition, there is no data to support either the routine removal of the screws or the fear of a worse outcome. Moreover, the routine operation increases the diseased state and also constitutes a financial burden on the health care system. [33,34,35] Besides, a paper from 2015 stated that the complication rate after the removal of the synsdemotic screw was 6%. 5% of cases were caused due to bacterial infection mostly caused by S. aureus. [36] Administering antibiotics 60 min before the operation is recommended to reduce the risk of infection. [37] Rethinking routine removal could thus reduce an infection rate or the administration of antiobiotics. However, there is still no clear agreement on the routine removal of the syndesmotic screw. [38]

A randomised Controlled Trial analysed patients who had their screw removed after 3 months and compared those with patients who did not have their screw removed. The result showed that one year postoperatively there were no significant differences and thus the removal made neither a clinical nor a functional difference. [31] For this purpose, 51 patients were recruited with an average age of 33.5 years. After all patients underwent a fibular osteosynthesis and syndesmotic screw fixation, they were randomly assigned. One group was scheduled to undergo screw removal after 3 months and the other group was scheduled to retain the screw. The Olerud-Molander ankle score, the mean American Orthopedic Foot and Ankle Society ankle-hindfoot score, the mean American Academy of Orthopedic Surgeons foot and ankle score, the mean visual analogue pain score (VAS) scores were taken into account. Furthermore, the mean active dorsiflexion, the plantar flexion and the mean radiological tibiofibular clear space were evaluated. Despite the high breakage and/or screw loosening rate of 76% none of the above scores showed a significant difference.

6. CONCLUSION

An AO/OTA 44C3 fracture always requires surgery. Aim of the operation is, if necessary, the reduction and stabilisation of the fracture of the fibula, the stabilisation of the inferior tibiofibular ligament and, if applicable, other injured ligaments. In order to ensure a correct diagnosis, it is of particular importance to perform x-ray stress-imaging, to avoid missing any injuries. The physician should keep a proximal fracture of the fibula in mind when an ankle injury is suspected. In addition, according to the current data, routine removal of the screws is not recommended. Nevertheless, this can be decided individually with the patient. Further long-term studies need to be done to work out the best approach.

7. RECOMMENADTION

The AO/OTA 44C3 fracture should be treated surgically. If the fracture is located in the upper third of the fibula, there is no indication for an open reduction and internal fixation for the fracture itself. The inferior tibiofibular ligament should be stabilised with two syndesmotic screws. Furthermore, there is no requirement to repair the deltoid ligament surgically. In order to reduce missed diagnosis of AO/OTA 44C3 fractures it is crucial to perform a conscientious examination. Although routine removal of the screws is still common the current state of studies does not support this. In summary, it is important to mention a comprehensive examination and evidence-based treatment by an experienced surgeon have the best outcome for the patient.

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