The Eurasia Proceedings of Health, Environment and Life Sciences (EPHELS)
ISSN: 2791-8033

The Eurasia Proceedings of Health, Environment and Life Sciences (EPHELS), 2025

Volume 18, Pages 10-17

ICMeHeLS 2025: International Conference on Medical, Health and Life Sciences

Arthroscopy in Acute Ankle Fractures: A Weber Classification-Based Analysis

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Abstract: Ankle fractures are common orthopedic injuries, often treated with open reduction and internal fixation (ORIF). However, 21% to 45% of patients report unsatisfactory outcomes, possibly due to intraarticular pathology. This study aimed to assess these injuries arthroscopically and statistically analyse their prevalence and relation to the Weber classification. A prospective cohort study was conducted on 48 patients with acute ankle fractures at the University Clinic for Surgical Diseases "St. Naum Ohridski" from January 2020 to January 2023. Patients underwent standard preoperative radiographic examinations and were classified according to the Weber classification, followed by arthroscopic intraarticular examination and ORIF. The arthroscopic examination evaluated syndesmotic injury, chondral lesions, loose bodies, and deltoid ligament injuries. Forty-eight patients were studied, with intraarticular pathology found in 33 cases (68.75%). For Weber fractures: type A had 58.33%, type B had 72.73%, and type C had 84.21% of intraarticular pathology. Syndesmotic injury appeared in 33.33% of type A, 50% of type B, and 41.67% of type C fractures. Chondral lesions occurred in 41.67% of type A, 54.55% of type B, and 66.67% of type C fractures. Loose bodies were detected in 8.33% of type A, 18.18% of type B, and 25% of type C fractures. Deltoid ligament injuries were observed in 16.67% of type A, 27.27% of type B, and 41.67% of type C fractures. The study concludes that arthroscopy during ORIF in ankle fractures is valuable for diagnosing intraarticular pathology. It highlights the Weber classification's importance, noting that type C fractures have a higher chance of such involvement. Understanding arthroscopy's diagnostic value in these cases helps surgeons decide on concurrent interventions during ORIF, potentially improving patient outcomes. Further research may investigate how arthroscopy-guided interventions affect clinical outcomes.

Keywords: Ankle fracture, Ankle arthroscopy, Weber classification, Intra-articular injury

Introduction

Fractures of the ankle joint represent one of the most common injuries encountered in everyday trauma practice. These injuries are estimated to account for 10% of all bone injuries (Heckman et al.,2014). The highest incidence occurs in women aged 60–69, and in most cases, it involves an isolated injury sustained from a fall from standing height (Thur et al.,2012).

Anatomy

Anatomically, the ankle joint consists of three parts: the talocrural, talocalcaneonavicular, and subtalar segments (Brockett & Chapman., 2016). In everyday communication, when referring to the ankle joint, we usually mean

- Selection and peer-review under responsibility of the Organizing Committee of the Conference

the talocrural part. To avoid confusion, in this text the term "ankle joint" will be used as a synonym for the talocrural joint, even though this is not anatomically precise. The talocrural joint is formed by the tibia, fibula, and talus, along with the ligaments connecting them (Knupp et al., 2006).

Anteriorly, the Anterior Inferior Tibiofibular Ligament (AITFL) extends from the Chaput tubercle of the tibia, slightly distally to the anterior aspect of the lateral malleolus. This attachment is often referred to as the Wagstaffe tubercle. Other key elements are the Posterior Inferior Tibiofibular Ligament (PITFL) and the Inferior Transverse Ligament (ITL). The PITFL attaches to the posterior malleolus and runs obliquely distaly to the back of the lateral malleolus. The ITL lies distal and parallel to it. A short distance above the ankle joint, at the midpoint between the two bones, the tibiofibular interosseous membrane forms a thickening known as the Interosseous Ligament (IOL). These four components together form the distal tibiofibular syndesmosis. Rupture of these elements leads to loss of structural integrity of the ankle joint, causing the joint mortise to open and the talus to displace laterally, resulting in loss of normal alignment between the talus and the load-bearing surface of the tibia.

The deltoid ligament is made of a superficial and deep bundle. Its superficial portion attaches on the anterior aspect of the medial malleolus, runs distally to the talus, calcaneus, and navicular bone. The primary medial stabilizer of the ankle joint is the deep portion of the deltoid ligament, which attaches to the posterior-lateral part of the medial malleolus. The articular surfaces of the tibia and talus are covered with cartilage, which is particularly susceptible to damage during ankle fractures (Chen et al., 2015).

Biomechanics

In 1976, Inman defined the "empirical axis" of the ankle joint (Inman, 1976), which is a line running just behind the tips of the lateral and medial malleoli. Normal movement of the talocrural joint involves rotation around this axis, which is obliquely oriented relative to the articular surface between the tibia and talus. The articular surface forms an angle with the midline of the tibia, averaging 93 degrees, but this is in the opposite direction from the slope of the empirical axis. In practice, this means an average valgus angulation of the foot of 3 degrees. The angle between the empirical axis and the plane of the tibial plafond is called the talocrural angle and is 83 ± 4 degrees (Sarafian, 1983). This angle is one of the radiographic indicators for evaluating the normal anatomical alignment of the bony components of the talocrural joint.

The fundamental principle for treating any malleolar fracture is restoration of the normal anatomical relationship between the three bones that form the joint, achieving congruence of the articular surfaces to ensure appropriate distribution of loading forces across the entire surface of the talus.

Classification

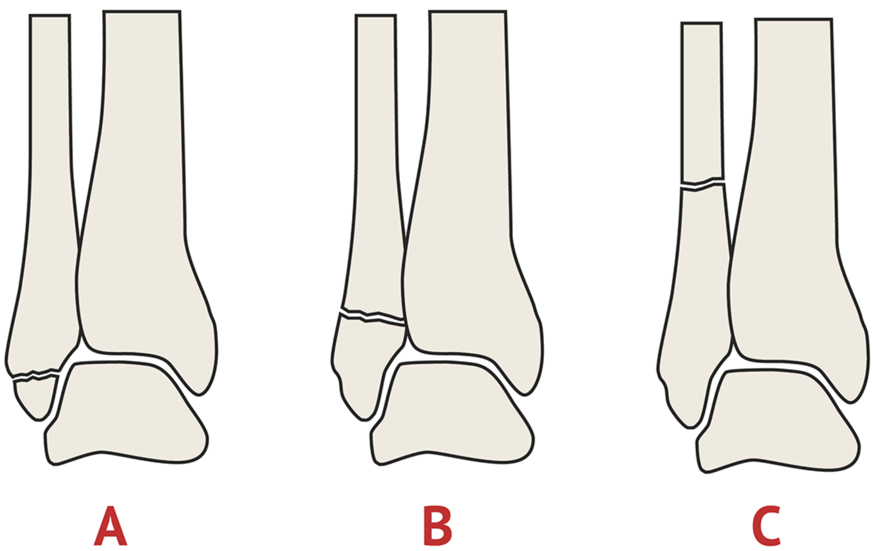

Figure 1. Weber classification

The Weber classification system (Figure 1) is one of the most widely used schemes for categorizing ankle fractures and is based on the level of the fibular fracture in relation to the syndesmosis. It differentiates between type A (fracture below the syndesmosis), type B (at the level of the syndesmosis), and type C (above the syndesmosis) fractures (Weber, 1972). This classification is frequently used in clinical practice due to its simplicity, reproducibility, and its relevance in predicting fracture stability and associated ligamentous injuries (Michelson, 1995; Ovaska et al., 2013).

Furthermore, studies have shown that higher-grade Weber fractures are more likely to be associated with post-traumatic degenerative changes, highlighting the classification's prognostic value (van Dijk et al., 2005). For these reasons, the Weber classification was adopted in this study to allow for meaningful analysis of intra-articular pathology across different fracture patterns. Other classification systems exist—such as the Lauge-Hansen or AO/OTA classifications—but were not applied in this study due to their complexity or limited relevance to the study objectives (Lauge-Hansen, 1950; Ovaska et al., 2013).

Diagnostic Protocol

The usual diagnostic protocol in surgical institutions in our country includes radiographs in two views (Musgrave et al., 1998), additional projections upon request from the attending traumatologist or orthopedist, and possibly a CT scan for cases with complex fracture morphology where more detail is needed for surgical planning (Magid et al., 1990). The value of these diagnostic methods is well established; they are essential for assessing bony structures, fracture lines, displacement, and comminution of fragments and their relationships. However, they are not sufficient for detecting intra-articular non-bony injuries. MRI can identify some of these injuries, especially osteochondral injuries of the talus (Mintz et al., 2003). Its sensitivity in detecting such injuries varies in the literature from 62% to 83% (Bae et al., 2012; Laumann et al., 2011; Verhagen et al., 2005). On the other hand, detecting ligamentous injuries with MRI in the acute phase is nearly impossible. Additional factors include the availability of MRI in the facility and scan waiting time. All these factors make its practical value debatable in the acute phase of injury.

Treatment

In some of these injuries, the anatomical relationship is not disrupted—they are stable and amenable to conservative treatment. Larsen showed in his study that for certain groups of patients with displaced fractures who achieved initial closed reduction and immobilization, outcomes could be expected to be similar to those in surgically treated patients (Larsen et al., 2019). Fractures for which reduction cannot be achieved or maintained using conservative methods (such as casting or orthotic devices) are considered unstable (Browner et al.,2019). Unstable ankle fractures, according to evidence-based recommendations, are treated with open reduction and internal fixation. The goal of such treatment is to restore anatomical alignment of the joint surfaces through open manipulation of the fragments and achieve absolutely stable fixation using one of the available osteosynthesis materials (Ruedi, 2007)

The standard surgical treatment is based on the principles established by the AO group (Ruedi, 2007) and consists of open reduction and fixation of the lateral malleolus through a lateral approach. This is followed, if necessary, by fixation of the medial and/or posterior malleolus, depending on the fracture morphology and instability. In the presence of a syndesmotic injury, fixation of the distal tibiofibular syndesmosis is performed, most commonly with one or more cortical screws or, more recently, with dynamic fixation using suture-button systems. The choice of fixation method is usually left to the surgeon's discretion, depending on experience, availability of materials, and assessment of the mechanical stability required.

Postoperative treatment includes short-term immobilization and early initiation of passive range-of-motion exercises. Weight-bearing is typically delayed until radiographic confirmation of fracture healing. Studies suggest that early mobilization leads to better functional outcomes, provided the fixation is stable (Rammelt et al., 2008; Day et al., 2001).

Although surgical treatment of ankle fractures has advanced significantly, complications still occur. The most common complications include infection, malunion or nonunion, posttraumatic osteoarthritis, and hardware-related issues. Among these, posttraumatic arthritis is one of the most significant, as it often leads to chronic pain and functional limitations. Its incidence is directly related to the degree of initial articular surface damage and the quality of reduction. Hence, achieving and maintaining an anatomical reduction is paramount.

Objectives

For our study we defined the following objectives:

1. To arthroscopically and minimally invasively identify intraarticular injuries associated with ankle fractures.
2. To establish a correlation between the type of fracture and the intraarticular injuries identified.

Method

The research represents an interventional, prospective, clinical study of a series of patients, conducted with the approval of the professional board of the University Clinic for Surgical Diseases “St. Naum Ohridski” – Skopje. The study included 48 patients (22 women and 26 men) who were surgically treated at the University Clinic for Surgical Diseases “St. Naum Ohridski” by the first author during the period from January 2020 to January 2023. Prior to inclusion in the study, each patient signed an informed consent form. Inclusion criteria for the study were patients over 18 years of age with isolated, unstable, closed ankle fractures where open reduction and internal fixation was indicated according to current recommendations for surgical treatment of this type of fracture, with the injury sustained no more than 14 days prior.

Patients were excluded from the study if they had old, healed fractures or prior surgical interventions on the ankle joint, congenital deformities of the affected limb, open ankle fractures, multiple injuries, acute infections, mental illness, or high anesthetic risk. The surgical interventions were performed under general endotracheal or spinal anesthesia, depending on the anesthesiologist’s recommendation and the patient’s preference. The patient was positioned supine on the operating table, with the foot placed at the edge to allow for unimpeded plantar and dorsal flexion, without the use of traction. A tourniquet was used to create a bloodless field. The topographic anatomy was marked with a marker before the beginning of the intervention.

Two standard arthroscopic portals were established – anteromedial and anterolateral. The portals were created by making a skin incision with a No. 11 scalpel, followed by blunt dissection with a clamp to the joint capsule to avoid injury to anatomical structures surrounding the portals. After perforating the joint capsule with the clamp, an arthroscopic camera with a diameter of 4.0 mm and a 30-degree angle was inserted. Through the other portal, synovectomy and removal of fracture hematomas and debris were performed using a shaver to improve visualization of the ankle joint structures.

A systematic inspection of the ankle joint was performed following the Ferkel protocol (Ferkel & Fasulo, 1994), with detailed documentation of intra-articular injuries, including syndesmotic ligament injuries, deltoid ligament injuries, chondral or osteochondral lesions, as well as loose bodies within the joint. From the lateral side, the syndesmosis was visualized and its status documented—whether ruptured or intact. Any unstable remnants of the syndesmotic ligaments were removed with the shaver or stabilized using arthroscopic electro-cautery.

From the medial side, after synovectomy with the shaver, inspection of the deep bundle of the deltoid ligament was carried out, with documentation of its condition, as well as the character, direction, and comminution of the fracture lines of the medial malleolus, in cases where such a fracture was present. Small bony and chondral fragments were removed and documented. Chondral injuries were thoroughly documented, measured, and classified according to the Outerbridge classification (Outerbridge, 1961). Chondroplasty was performed using a shaver and electro-cautery. In patients with high-grade chondral lesions, micro fracturing was performed using a chondro-pick.

Upon completion of the arthroscopy, standard open reduction and internal fixation were performed in accordance with AO principles (Ruedi, 2007). The lateral malleolus was fixed with one or more cortical screws (when allowed by the fracture configuration) and a 3.5 mm one-third tubular steel plate. If the arthroscopic findings indicated syndesmotic rupture, fibulo-tibial transfixation was performed using a single screw. Fractures of the medial malleolus were fixed with two screws, a combination of a screw and a Kirschner wire, or a tension-band (Zuggurtung) technique, depending on the size and configuration of the fractured fragment. After completing osteosynthesis, a repeat arthroscopic inspection of the ankle joint was conducted to assess the quality of the reduction and the stability of the tibiofibular syndesmosis under direct visual control. The surgical wounds were closed in layers and dressed in sterile bandages.

Results and Discussion

This study included a total of 48 patients, of whom 22 were women and 26 were men, each with an unstable ankle fracture treated surgically. According to the Weber classification, 12 patients (25%) had Weber type A fractures, 22 patients (45.8%) had Weber type B fractures, and 14 patients (29.2%) had Weber type C fractures. Table 1 shows the distribution of fracture types.

Table 1. Distribution of fracture types by weber classification

Fracture Type	Number of Fractures	Percentage
Weber A	12	25.0%
Weber B	22	45.8%
Weber C	14	29.2%

Intraarticular pathology was identified in 33 of the 48 patients (68.75%). The most common injuries were syndesmotic ruptures, found in 21 patients (43.75%), followed by chondral lesions in 26 patients (54.17%). Deltoid ligament injuries were observed in 13 patients (27.08%), and loose bodies were present in 9 patients (18.75%). Table 2 presents the distribution of intraarticular injuries across the three Weber groups.

Table 2. Intra-articular Injuries by fracture type

Injury Type	Weber A (%)	Weber B (%)	Weber C (%)
Intraarticular pathology	58.33%	72.73%	84.21%
Syndesmotic injury	33.33%	50.00%	41.67%
Chondral lesions	41.67%	54.55%	66.67%
Loose bodies	8.33%	18.18%	25.00%
Deltoid ligament injuries	16.67%	27.27%	41.67%

Deltoid ligament injuries were more commonly seen in Weber C fractures, present in 41.67% of such cases, followed by 27.27% in Weber B, and 16.67% in Weber A fractures. Syndesmotic injuries were most frequently observed in Weber B fractures (50%), followed by 41.67% in Weber C and 33.33% in Weber A fractures. Chondral lesions followed a pattern of increasing frequency with fracture severity, found in 41.67% of type A, 54.55% of type B, and 66.67% of type C fractures. Loose bodies were least frequent in Weber A fractures (8.33%) and more common in Weber B (18.18%) and C (25%) fractures.

These findings suggest that the presence and severity of intraarticular pathology correlate with the Weber classification, with Weber C fractures being most frequently associated with complex intraarticular involvement. The frequency of intraarticular injuries in 68.75% fractures in this study supports the existing literature, which has demonstrated high prevalence of chondral and ligamentous injuries associated with ankle fractures. In their study of arthroscopically evaluated ankle fractures, Chen et al. (2015) reported chondral lesions in 63.3% of patients. Another study (Leontaritis et al., 2009) demonstrated that the severity and number of chondral lesions increase with fracture complexity.

Among the subjects in this study, chondral lesions were found in 54.17% of fractures, and their rate increased proportionally with the extent of osseous damage — i.e., with the severity of the fracture. In Weber C fractures, chondral lesions were present in 66.67% of patients. A level II evidence study (Stufkens et al., 2010) showed that the degree of cartilage damage may predict the clinical outcome of treatment, which could be of significant value in properly setting patient expectations.

There are several methods for assessing syndesmotic integrity in ankle fractures. Standard radiographs and stress radiographs are the most used, but Nielson has suggested that there is no correlation between the tibiofibular clear space on AP X-rays and the presence of ligamentous injury on MRI (Nielson et al. 2005). Intraoperative assessment of syndesmotic stability—and thereby the integrity of the ligamentous complex—is usually performed using the Cotton test. Many techniques for this test have been described, but there is no consensus on cutoff values that define a positive result. A recent level I study reported a very low sensitivity rate and questioned the utility of this test (van den Bekerom, 2011). Takao et al. (2011) compared standard radiographs to direct arthroscopic visualization for evaluating syndesmotic injuries. Their results showed identification of 42% of syndesmotic injuries using AP views and 55% using oblique radiographs. In contrast, all syndesmotic injuries were identified with direct arthroscopic visualization.

This study further confirms the value of arthroscopy in diagnosing such ligamentous injuries. We arrived at the same observation in our patient cohort, where visualization of the syndesmosis was a direct factor in deciding whether tibiofibular fixation was necessary. As for the incidence of syndesmotic injury in the context of ankle fractures, the rate reported in the literature ranges from 77% to 78% (Chen et al., 2015; Takao et al., 200). Our study found syndesmotic disruption in 43.75% of patients, which is approximately 10–15% lower than in other series. This discrepancy may be due to differences in the distribution of high-energy versus low-energy trauma patients among the studies.

Deltoid ligament injuries are difficult to diagnose, especially in the presence of a fracture. There is currently no consensus, but values of 4 to 6 mm of tibiofibular widening on radiographs have been proposed as thresholds for a positive finding (Lafferty et al., 2009). At the time of this writing, no published values for arthroscopically diagnosed deltoid ligament lesions in the context of ankle fractures had been found in the literature. The results obtained in this study suggest that arthroscopy is a reliable method for diagnosing this injury, and it revealed a higher prevalence of deltoid ligament ruptures in isolated Weber A fractures.

The presence of free chondral or osteochondral fragments in the joint during fracture has been reported by Tordardson (Tordardson et al., 2001) in 55% of cases, and by Yassin (Yassin et al., 2017) in 36%. We found loose bodies in 18.75% of cases, with distribution by fracture type suggesting a direct correlation with injury severity.

Beyond its diagnostic value in identifying intraarticular injuries accompanying ankle fractures, arthroscopy also enables lavage and debridement of the joint, thereby reducing inflammatory burden. This may theoretically improve therapeutic outcomes by increasing range of motion, reducing pain, and lowering the risk of post-traumatic arthritis (Adams et al., 2017). Our study not only provides a statistical overview of the distribution of intraarticular injuries across different fracture types but also supports previous literature showing that arthroscopy during the surgical treatment of ankle fractures offers significantly better insight into these injuries and enables their concurrent management when indicated.

Conclusion

This study confirms that intraarticular injuries are commonly associated with ankle fractures and that their prevalence increases with fracture severity, as classified by the Weber system. Arthroscopic assessment during ORIF offers a valuable diagnostic advantage, allowing for direct visualization and treatment of chondral lesions, syndesmotic instability, deltoid ligament injuries, and loose bodies. These findings support the integration of arthroscopy as a complementary tool in selected cases of ankle fractures, particularly those with suspected intraarticular involvement, to improve diagnostic accuracy and potentially optimize clinical outcomes.

Recommendations

Based on the findings of this study, we propose the following recommendations:

- Consider routine arthroscopic evaluation during ORIF of ankle fractures, particularly in Weber B and C types, where intraarticular pathology is more prevalent.
- Use arthroscopy as a diagnostic adjunct in cases where preoperative imaging does not provide sufficient detail regarding chondral or ligamentous injuries.
- Standardize documentation of intraarticular findings during surgery to enhance post-treatment planning, rehabilitation, and patient counseling.
- Further prospective, randomized studies with larger cohorts are encouraged to evaluate the long-term clinical outcomes and cost-effectiveness of arthroscopy-assisted fracture fixation.
- Improve training in ankle arthroscopy for orthopedic surgeons to ensure safe and effective execution of the technique, particularly in trauma settings.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPHELS journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

Funding

* This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Acknowledgements or Notes

* This article was presented as an oral presentation at the International Conference on Medical, Health and Life Sciences (www.icmehels.net) held in in Peja, Kosovo on 10-13 July 2025.

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To cite this article:

Todorov, R. & Kuzmanovska, B. (2025). Arthroscopy in acute ankle fractures: A weber classification-based analysis. *The Eurasia Proceedings of Health, Environment and Life Sciences (EPHELS), 18,* 10-17.