ORTHOLOC® 3Di
Ankle Fracture System

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Having the ability to converse with your surgeon about an ankle fracture is a key factor in becoming an asset in his/her O.R. The more you know about ankle anatomy, fracture classification systems, and obstacles the surgeon may face, the easier these conversations become.

The information in this document is the basic knowledge you will need to begin your understanding of this complex indication. You should also review the instructions for use for complete indications and contraindications associated with the use of the ORTHOLOC® 3Di Ankle Fracture System. Other great sources for more in-depth knowledge include the following:

- AO Foundation, [www.ao.org](http://www.ao.org)
- Wheeless’ Online Textbook of Orthopedics, [www.wheelessonline.com](http://www.wheelessonline.com)
- Radiopedia online radiology resource, [www.radiopedia.org](http://www.radiopedia.org)
- Surgery of the Foot and Ankle, Eighth Edition, Coughlin, Mann, Saltzman
Ankle Anatomy

Bones and Articular Surfaces
The ankle is a modified hinge joint that does more than simply allow dorsiflexion and plantar flexion in the sagittal plane. The joint is much more complex, with coupled rotations in both the axial and coronal planes.

Anatomy of the Tibia
Medial Malleolus: Most distal medial extension of the tibia. The medial malleolus articulates with the talus on the medial side.
Posterior Malleolus: Most distal posterior extension of the tibia.
Pilon: Lower tibia metaphyseal expansion. Major load-bearing area.
Tibial Plafond: Articular surface of the distal tibia, setting just below the pilon.

Anatomy of the Fibula
Lateral Malleolus: The most distal part of the fibula, articulating with the lateral aspect of the talus, and forming the noticeable lump on the outside of the ankle.
Fibular Groove: Recessed portion of the posterior fibula, forming a space for the peroneal tendons.
Ligaments of the ankle joint

The ligaments of the ankle joint are comprised mainly of the collateral ligaments, both medial and lateral. These are extremely important in the stability of the ankle itself, and are often compromised during injury.

Lateral Collateral Ligaments

Made up of three distinct components (ATFL, CFL, and PTFL), the lateral ligament complex acts to restrain anterior displacement, internal rotation, talar inversion, and subtalar stabilization.

1. Anterior talofibular ligament (ATFL): passes from the fibula to the front of the talus.
2. Calcaneofibular ligament (CFL): connects the calcaneus to the posterior side of the fibula.
3. Posterior talofibular ligament (PTFL): passes from the back of the fibula to the rear surface of the calcaneus.
Medial Collateral Ligament (Deltoid)

The medial ligament, also known as the deltoid ligament, is considerably thicker and stronger than the lateral ligaments. Serving as the primary medial stabilizer, the ligament is divided into two portions, superficial and deep. The deltoid spreads out in a fan shape to cover the distal end of the tibia and the inner surfaces of the talus, navicular, and calcaneus.
Syndesmosis

The definition of a syndesmosis is a joint where the rough edges of two bones are held together by thick connective ligaments. The connection between the fibula and tibia is a syndesmosis joint.

The ankle syndesmosis is comprised of three ligamentous supports:

**Anterior Inferior tibiofibular ligament (AITFL):** Ligament crossing just above the anterior side of the ankle, connecting the tibia to the fibula.

**Posterior Inferior tibiofibular ligament (PITFL):** Runs along the same coronal plane as the AITFL, but on the posterior side of the ankle.

**Interosseous membrane (IM):** The long sheet of connective tissue that connects the entire length of the tibia and fibula.
Fracture Classification and Treatment

Ankle vs. Pilon Fractures

Ankle Fractures: Ankle Fractures are the most common intra-articular fracture of a weight-bearing joint, and are one of the most commonly treated indication in the foot and ankle. Fractures involving the medial, lateral, and/or posterior malleoli and do not involve the tibial plafond are considered ankle fractures. These fractures do not break-through the articular surface of the tibia. Ankle fractures are often associated with medial and/or lateral ligamentous injuries.

Pilon/Plafond Fractures: Fractures that involve a combination of ankle fractures and distal tibia metaphaseal fractures. These injuries usually involve the distal tibia articular surface (Plafond). Pilon fractures are much less common than ankle fractures, making up less than 1% of lower extremity fractures.

Fracture Classification

Why Classify?

Classification systems of injuries to the ankle have been designed to assist the surgeon in selecting treatment options and methodologies. Each classification corresponds to a proven treatment algorithm put in place to ensure consistent patient outcomes. Classification systems range in levels of complexity and differ for ankle and pilon fractures.

Ankle Fracture Classifications:

Lauge-Hansen System:
The Lauge-Hansen System is based on foot position and direction of force at time of injury. This system is highly complicated and difficult to learn. As a result, the system is rarely referred to when describing simple ankle fractures.

For more information regarding the Lauge-Hansen classification system visit www.aotrauma.com

Danis-Weber System

Often referred to as simply the Weber classification system, the Danis-Weber system is based on the location of the fibula fractures as it relates to the ankle joint. Because of its simplicity, the system is used very often in describing fractures.

**Weber type A**
- **Below** level of the ankle joint
- Tibiofibular syndesmosis intact
- Deltoid ligament intact
- Medial malleolus often fractured
- Usually stable, but occasionally require surgery

**Weber Type B**
- Originates at the level of the ankle joint
- Tibiofibular syndesmosis intact or only partially torn
- Medial malleolus may be fractured or deltoid ligament may be torn
- Variable stability

**Weber Type C**
- **Above** the level of the ankle joint
- Tibiofibular syndesmosis disrupted with widening of the distal tibiofibular articulation
- Medial malleolus fracture or deltoid ligament injury present
- Inherently unstable
Radiographic Evaluation

Normal Radiographic evaluation of the ankle joint is extremely important. Normal views needed include anteroposterior (AP) and mortise. X-rays are essential in determining the following:
- Mechanism of injury
- Severity of injury
- Surgical Approach
- Hardware Selection
- Post-op protocol

Mortise View: An oblique view of the ankle with 15-20° of internal foot rotation.

This view is important in evaluating the clear space of the ankle to determine ankle integrity and possible injuries. In the mortise view, the clear space (joint space) should appear symmetrical on the three sides surrounding the talus. Disruption of this space indicates an injury to the ankle structure.

Fixation Concepts

Goals of treatment:
- Anatomic Reduction
- Reconstruction of all joint surfaces
- Stability
- Weight-bearing as fast as patient tolerance allows

Weber A Fracture Fixation:

Weber A fractures fall below the ankle joint and are not associated with a syndesmotic injury or deltoid ruptures. When open reduction and internal fixation (ORIF) is required, the lateral malleolus is usually avulsed with a transverse fibula fracture line. In most cases, a small straight plate or small anterior lateral plate acting as a tension band is appropriate.

Important Note: The small lateral fibula plate and straight plates do not feature syndesmosis screw holes (see weber B fracture fixation).
Weber B Fracture Fixation

Webers B fractures start at the level of the joint and extend from distal anterior to proximal posterior. Fixation of these fractures is usually achieved with a lag screw in conjunction with a lateral or posterior fibula plate. Additionally, syndesmotic fixation may be required.

Lag Screw Technique.
In order to achieve compression and stability across a fracture line, a 3.5mm fully threaded screw is usually placed using a lag technique. This screw is placed anterior to posterior, ensuring no possible interference with the desired plate location.

Lag Screw Steps
1. Reduction of the fracture is achieved using reduction forceps.
2. A 3.5mm hole is drilled (Over-Drill) from anterior proximal to posterior distal. This drill hole runs from the anterior cortex and stops at the fracture line.
3. A pre-drill drill guide ("Top hat") is placed in the drill hole or through the over-drill drill guide.
4. A 2.5mm drill is used through the top hat, finishing the hole on the posterior side of the fibula.
5. A 3.5mm fully threaded screw is placed anterior to posterior achieving compression along the fracture line.

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1. Fracture Reduction
3. Pre-drill after over-drilling anterior fibula to fracture line
5. Screw is placed anterior to posterior for compression and stability
Plate Placement

A lateral neutralization plate is traditionally placed as a means to more stable fixation and more tolerable weight-bearing. Three points of fixation proximal and distal to the fracture line must be achieved when using a lateral neutralization plate. Distal screw fixation must be placed in a fashion to avoid the articular surface adjacent to the talus. A medium lateral fibula plate or 8-hole straight plate can be used laterally to achieve neutralization.

As an alternative to a lateral plate, a posterior anti-glide plate may be used. This plate position is considered more biomechanically sound, but placement of this plate can be more difficult. This position can also be a source of peroneal tendon irritation unless the plate is anatomically contoured to avoid the fibular groove and peroneal tendons.

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<th>Lateral Fibula Plate</th>
<th>Posterior Anti-glide Plate</th>
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<td>Lateral position easy to obtain</td>
<td>Posterior position more biomechanically sound</td>
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<td>Less soft-tissue coverage laterally</td>
<td>No risk of penetration into the joint</td>
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<td>Acceptable for most fractures with normal bone</td>
<td>Used in cases of weak or osteoporotic bone</td>
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Weber C Fracture Fixation

Weber C fractures are classified as fractures above the ankle mortise. These fractures are caused by an external rotation of the foot, and usually involve a disruption of the syndesmosis. In addition to a diaphyseal fracture of the fibula, medial malleolar fractures (tibia) are commonly seen in conjunction with a Weber C.

Treatment of Weber C fractures require restoration of fibular length and rotation and temporary fixation using bone clamps and k-wires. Straight and long anatomic lateral fibula plates may be used for ultimate fixation. Syndesmosis fixation, where needed, is usually achieved with 4.0mm cortical, fully threaded screws placed as directed (see syndesmosis fixation).

The medial malleolar fracture is addressed with a medial tibia or medial malleolar plate. Alternatively, the surgeon may use long solid or cannulated screws placed medial distal to lateral proximal to achieve reduction and fixation.

Syndesmotic Fixation

In many cases, a disruption to the tibial-fibular syndesmosis is associated with Weber B and C fracture types. After fibula length has been restored, the fibula fixed, and medial reconstruction achieved, fibular instability is determined and the decision whether or not to fix the syndesmosis is made. This decision can be made preoperatively using radiographs or intraoperatively through a series of syndesmotic stress test.

Syndesmotic reduction is achieved using a large tenaculum or pelvic reduction clamp. One or two 4.0mm fully-threaded, solid, cortical screws are placed through the fibula to the medial side of the tibia, achieving four points of cortical fixation. These screws run at a 25-30° anterior trajectory and parallel to the ankle joint. These screws are placed with the intent of no compression (i.e. no lag technique is used).