Ankle Fracture Update

OTA Resident Core Curriculum Lecture Series
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Objectives

Following this session, you should be able to:

1. State the indication to fix isolated fibular fractures.

2. Define the specific articular pathology associated with SA and PAB fractures.

3. List the 3 common posterior malleolar fracture patterns.

4. State the indication to fix posterior malleolar fractures.

1. Enumerate the ways to ensure syndesmotic reduction.
Recommendations to Improve Retention of this Material

1. Write down the objectives

2. Search for the answers to the objectives in the powerpoint talk [hint- look for blue boxes]

3. Test yourself at the end by reviewing the objectives

4. Watch the show on “normal view” and look at the notes at the bottom of the slides. They will provide guidance to the progression of logic and sources of information. Classic references are listed throughout. Annotated recent references are listed at the end.
Outline

- Evaluation: Clinical & Radiographic
- Classification: Lauge-Hansen
- Specific Problem Areas: Posterior Malleolus and Syndesmosis
- Surgical Goals
- Outcome
Evaluation: Clinical

**HISTORY**
- Mechanism
- Timing
- Soft-tissue injury
- Bone quality
- Comorbidities
- Associated Injuries

**PHYSICAL EXAM**
- Skin
- Nerves
- Vasculature
- Pain
- Deformity
Evaluation: Radiographic

Anteroposterior View

- Tibiofibular overlap ~ 10mm
- Tibiofibular clear space <5mm
- Talar tilt

Comparison Radiograph?
10 degrees internal rotation of 5th MT with respect to a vertical line
Evaluation: Radiographic Mortise View

- Medial joint space
- Talocrural angle: <8 or >15 degrees
- Tibia/fibula overlap: >1mm

Comparison Radiograph?
Evaluation: Radiographic Mortise View

Fig. 3 a and b. The radiology of the sprung mortice:
- Sprung mortice:
  1. Irregular width of joint space; widening medially;
  2. “Spike” of fibula too proximal;
  3. Broken line from the lateral part of the articular surface of the talus to the distal fibula
- Normal ankle joint

FIBULAR LENGTH:
1. Shenton’s Line of the ankle
2. The dime test
Evaluation: Radiographic
Lateral View

PM

Talar subluxation

Distal fibular translation &/or angulation

Syndesmotic relationship

Associated or occult injuries
  – Lateral process talus
  – Posterior process talus
  – Anterior process calcaneus
Evaluation: Radiographic
Other Imaging Modalities

**Stress Views**
- Gravity
- Manual

**CT**
- Articular involvement
- Posterior malleolus

**MRI**
- Ligament and tendon injury
- Talar dome lesions
- Syndesmosis injuries
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Lauge-Hansen

Cadaveric study

First word: position of foot at time of injury

Second word: force applied to foot relative to tibia at time of injury

Types:
- SER
- SA
- PER
- PA
Several stages per type

Imperfect system:
– Not every fracture fits exactly into one category
– Even mechanism→specific pattern has been questioned
  – Inter and intraobserver variation not ideal
  – Still useful and widely used
Supination-External Rotation

Stage 1 - AITFL

Stage 2 - Fibula fx

Stage 3 - PITFL or PM fx

Stage 4 - Deltoid or MM fx

70% of ankle fractures
Stage 2
Supination-External Rotation
Stage 2: Stable

Lateral Injury: classic posterosuperior → anteroinferior fibula fracture

Medial Injury: Stability maintained

Standard: Closed management

Kristensen Acta Orthop Scand 1985
Supination-External Rotation
Stage 4: Unstable

Lateral Injury: classic posterosuperior → anteroinferior fibula fracture

Medial Injury: medial malleolar fracture &*/or deltoid ligament injury

Standard: Surgical management
GOAL: TO EVALUATE DEEP DELTOID [i.e. INSTABILITY]

METHOD:

- MEDIAL TENDERNESS
- MEDIAL SWELLING
- MEDIAL ECCHYMOSIS

STRESS VIEWS - GRAVITY OR MANUAL
Gravity Stress Exam

Manual Stress Exam
• Both are effective
• Gravity stress requires XR education.
• Manual stress requires time and more radiation exposure.

Indication to fix isolated fibular fractures
Decision-Tree:
Understand the Logic

Assumptions:

1. Fibular fractures associated with a stable ankle mortise heal without significant functional consequence.

2. Fibular fractures associated with an unstable ankle mortise heal with significant functional problems...because instability allows for talar shift.
Decision Tree:
Understand the Logic

Stress View

Splintage
Decision-Tree:
Understand the Logic

Does a Positive Ankle Stress Test Indicate the Need for Operative Treatment?

- MRI to evaluate all patients with lateral malleolar fracture and positive stress test (n=21).
- If deep deltoid partially intact $\rightarrow$ nonop treatment
  - Good clinical outcomes.

Choose a technique to evaluate stability. Base your decision to operate on your findings and the risk:benefit ratio.

Indication to fix isolated fibular fractures
Supination Adduction

Stage 1: transverse Weber A or B fibula

Stage 2: vertical medial malleolus
Supination Adduction: Stage 2

Lateral Injury: transverse fibular fracture at/below level of mortise

Medial injury: vertical shear type medial malleolar fracture

BEWARE OF IMPACTION

McConnell J Orthop Trauma 2001
Supination Adduction: Stage 2

Important to restore:

– Ankle stability

– Articular congruency- including medial impaction
Consider anteromedial approach

Marginal impaction reduction +/- grafting

Medial antiglide plate

Specific articular pathology associated with SA
Pronation-External Rotation

Stage 1 - deltoid or medial malleolus

Stage 2 - AITFL and IO membrane

Stage 3 – spiral Weber C fibula

Stage 4 – PITFL or posterior malleolus
Pronation External Rotation:
Stage 4

Medial injury: deltoid ligament tear &/or transverse medial malleolar fracture

Lateral Injury: spiral proximal lateral malleolar fracture

HIGHLY UNSTABLE...SYNDESMOTIC INJURY COMMON
Tibia radiograph

Syndesmotic disruption expected

Restore:
- Fibular length and rotation
- Ankle mortise
- Syndesmotic stability
Pronation-Abduction

Stage 1 – transverse MM

Stage 2 – PITFL or PM fracture

Stage 3 – compression bending fibula fracture
Pronation-Abduction

Medial injury: tranverse to short oblique medial malleolar fracture

Lateral Injury: comminuted impaction type lateral malleolar fracture
Medial malleolar fixation drives stability. Go there 1\textsuperscript{st}.

Fibular comminution $\rightarrow$ length stable construct?

Stress the syndesmosis last

JBJS 89A: 276-81, 2007
Specific articular pathology associated with PAB
PAB:
Specific Articular Pathology
Outline

• Evaluation: Clinical & Radiographic
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  • Specific Problem Areas: Posterior Malleolus and Syndesmosis
• Surgical Indications and Goals
• Outcome
Posterior Malleolus Fractures

Function:
- Stability: prevents posterior translation of talus & enhances syndesmotic stability
- Weight bearing: increases surface area of ankle joint
Posterior Malleolus Fractures: Radiographic Evaluation

Fracture pattern:

- Variable

- Difficult to assess on standard lateral radiograph
  - External rotation lateral view [Decoster FAI 2000]
  - CT scan [Haraguchi JBJS 2006]
Posterior Malleolus Fracture: Radiographic Evaluation

Indication for fixation: > 25% joint surface on lateral

Problem: Fragment size hard to determine on lateral view
  - Reason: Fracture orientation not purely in coronal plane
    - Nearly always associated with the pull of the posterior tib-fib ligament
      - larger laterally than medially
        - obliquely oriented
        - involves the incisura

...but other fracture patterns have also been defined
Posterior Malleolus Fracture

3 common PM fracture patterns

Type I- posterolateral oblique type

Type II- medial extension type

Type III- small shell type

67% 19% 14%
Posterior Malleolus Fractures: Indications for Fixation

Stability
- Posterior translation of talus*
- ER of talus [syndesmotic widening]

Articular congruence
- Stress = Force/Area
- Excessive stress → posttraumatic arthritis
  - Maximize area for stress distribution**

*fibula and anterior tibiofibular ligament act as primary restraint [Raasch JBJS 1992]

**contact stress changes significantly with posterior malleolar size >33% [Hartford CORR 1995]
Posterior Malleolus Fracture: Fixation

Screws

Plates
Syndesmotic Injury

**FUNCTION:**

Stability- resists external rotation, axial, & lateral displacement of talus

Weight bearing- allows for standard loading
Syndesmosis

IF INSTABILITY PRESENT → OPERATIVE INTERVENTION

OBTAINING & MAINTAINING ANATOMIC REDUCTION REDUCES LONG TERM DISABILITY & IMPROVES sMFA

Leeds JBJS 1984
Weening JOT 2005
Syndesmosis: Instability

How do you determine if instability is present?
– Manual Stress Test

When do you perform the manual stress test?
– After you have fixed the other indicated components of the fracture
Syndesmosis

If instability present ➔ Operative intervention

Obtaining & maintaining anatomic reduction reduces long term disability & improves sMFA

Leeds JBJS 1984
Weening JOT 2005
Syndesmosis:
Obtaining a Reduction

Before Fixation

After Fixation

DF unnecessary

Tornetta JBJS 2001
Syndesmosis: Obtaining a Reduction

Incidence of malreduction based on CT scan “standard”: >50%


Ways to ensure appropriate reduction:

– Direct visualization
  • FAI 30: 419-26, 2009

– Radiographic imaging in multiple planes
Problem?
The CT definition of an anatomic syndesmosis

Elgafy et al. Skeletal Radiology 39: 559-64, 2010
Syndesmosis

IF INSTABILITY PRESENT ➔ OPERATIVE INTERVENTION

OBTAINING & MAINTAINING ANATOMIC REDUCTION REDUCES LONG TERM DISABILITY & IMPROVES sMFA

Leeds JBJS 1984
Weening JOT 2005
 Syndesmosis: 
Maintaining a Reduction

Single Screw
3 cortices

Single Screw
4 cortices

2 Screws
6 cortices

2 Screws
8 cortices
Syndesmosis:
Maintaining a Reduction

3.5 mm vs 4.5 mm screw(s)

3 cortices vs 4 cortices

Retain vs Removal

Metallic vs Bioabsorbable

NO CONSENSUS
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Surgical Goals

1.1 Aims of the AO Method

*Rapid Recovery of the Injured Limb*

This is accomplished by:

*Anatomic reduction* of the fracture fragments particularly in joint fractures.

*Preservation of the blood supply* to the bone fragments and the soft tissue by means of atraumatic surgery.

*Stable internal fixation* designed to fulfill the local biomechanical demands.

*Early active painfree mobilization* of muscles and joints adjacent to the fracture. In this way the development of "fracture disease" is prevented.

The fulfilment of these four conditions is the prerequisite for a perfect internal fixation. Such fixation will result in the best healing not only of the bone but also of all components of the injury.
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Outcome

At one year following surgery, patients are generally doing well

Most have few restrictions and little pain

There is a significant improvement at one year compared to six months

Younger age, male sex, absence of diabetes, and lower ASA class are predictive of functional recovery at one year

Egol JBJS 2006
Fracture severity influences the rate of development and the latency time to endstage ankle arthritis.

The occurrence of postop complications has a negative influence on long-term results.

The patient’s age at the time of injury correlated negatively with the OA latency time (i.e. if you are older when you sustain an ankle fracture, you are more likely to develop end-stage OA sooner than if you had been younger).
Specific findings in the history noted to have an adverse effect on outcome include:

- Advanced age
- Osteoporosis
- Diabetes mellitus
- Peripheral vascular disease
- Female sex
- High American Society of Anesthesiology (ASA) class

- Ganesh et al. JBJS 87A: 1712-1718, 2005
- Egol et al. JBJS 88: 974-979, 2006
- SooHoo et al. JBJS 91A: 1042-1049, 2009
Social factors noted to be independent predictors of lower physical function postoperatively

– Smoking

– Alcohol use

– Lower level of education

Complications

Perioperative
  – Malreduction
  – Inadequate fixation
  – Intra-articular hardware penetration
    Early Postoperative
    – Wound edge dehiscence/necrosis
      – Infection
      – Compartment syndrome
    Late
      – Stiffness
  – Distal tibiofibular synostosis
    – Malunion
    – Nonunion
    – Post-traumatic arthritis
    – Hardware related complications
  – Complex regional pain syndrome type 1
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• Special Scenario: The Diabetic Ankle Fracture
Diabetic Ankle Fractures

Problems:

– Diabetes mellitus is a common medical condition that is increasing in prevalence
– Both closed and open management of ankle fractures in diabetics have higher complication rates

Solution:

– So do we change the indications and goals of treatment?

Wukich, Kline. JBJS 90: 1570-78, 2008
Chaudhary et al. JAAOS 16: 159-70, 2008
Diabetic Ankle Fractures

Answer- NO

– Unstable ankle fractures in diabetics are still best treated with anatomic restoration of the ankle mortise and stable internal fixation, but...

– Because the soft tissue complications are higher, increased care must be given to atraumatic soft tissue techniques (limb at level of heart, careful of SQ incisions)

– Because the osseous complications are higher, increased care must be given to empowering fracture fixation constructs (screws from fibula into tibia, double stacked 1/3 tubular plates)

– Postoperative care varies in that immobilization, non-weightbearing mobilization, and subsequent protected weightbearing all take a longer course (SLC 6-12 weeks, NWB 12 wks)
Summary

At this point, you should be able to:

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4. State the indication to fix posterior malleolar fractures.

1. Enumerate the ways to ensure syndesmotic reduction.
Anotated Bibliography of Recent Articles of Interest

SooHoo NF, Krenek L, Eagan MJ, Gurbani B, Ko CY, Zingmond DS: Complication rates following open reduction and internal fixation of ankle fractures. *J Bone Joint Surg Am* 2009;91(5):1042-1049. Prognostic Level II. California’s discharge database was queried for patients that had undergone ORIF of an ankle fracture over a ten year period with complications reviewed and discussed. Open injuries, diabetes, and peripheral vascular disease were strong risk factors for short-term complications.

Strauss EJ, Frank JB, Walsh M, Koval KJ, Egol KA: Does obesity influence the outcome after the operative treatment of ankle fractures? *J Bone Joint Surg Br* 2007;89(6):794-798. Retrospective review evaluating the number of comorbidities, incidence of complications, time to fracture union, fracture type, and level of function between obese and non-obese patients with ankle fractures. At two years postop, obesity did not seem to have an effect on the incidence of complications, time to fracture union, or level of function.

White BJ, Walsh M, Egol KA, Tejwani NC: Intra-articular block compared with conscious sedation for closed reduction of ankle fracture-dislocations. A prospective randomized trial. *J Bone Joint Surg Am* 2008;90(4):731-734. Therapeutic Level I. Prospective, randomized trial comparing conscious sedation and intraarticular block for analgesia and the ability to allow for ankle fracture reduction and application of a splint. No difference in analgesia or allowance for reduction was noted. The intraarticular block allowed for a shorter average time for reduction and splinting.
Anotated Bibliography of Recent Articles of Interest

Boraiah S, Paul O, Parker RJ, Miller AN, Hentel KD, Lorich DG: Osteochondral lesions of talus associated with ankle fractures. *Foot Ankle Int* 2009;30(6):481-485.  Level IV.  Retrospective case series evaluating the incidence and effect of osteochondral lesions of the talus in ankle fractures that were operatively treated.  All patients were assessed preoperatively by MRI and functional outcome was measured at a minimum of 6 months using Foot and Ankle Outcome Scoring.  Osteochondral lesions were noted in 17% of cases but showed no statistically significant effect on outcome.

Koval KJ, Egol KA, Cheung Y, Goodwin DW, Spratt KF: Does a positive ankle stress test indicate the need for operative treatment after lateral malleolus fracture? A preliminary report. *J Orthop Trauma* 2007;21(7):449-455.  Retrospective review of patients who had a positive ankle stress test after an isolated Weber B lateral malleolar fracture.  An MRI was ordered to evaluate the status of the deep deltoid ligament.  If the deep deltoid was partially torn, patients were treated non-operatively.  At a minimum 12 month followup, all fractures had united without evidence of medial clear space widening or post-traumatic arthritis.

Anotated Bibliography of Recent Articles of Interest


Miller AN, Carroll EA, Parker RJ, Boraiah S, Helfet DL, Lorich DG: Direct visualization for syndesmotic stabilization of ankle fractures. Foot Ankle Int 2009;30(5):419-426. Level III. Case control. An established protocol for treatment of ankle fractures with syndesmotic injury was evaluated retrospectively. Patients that underwent stabilization of the syndesmosis with direct visualization were compared with historic controls that underwent indirect fluoroscopic syndesmotic visualization. All patients had postoperative CT scans. Based on their definition of an anatomic syndesmotic reduction, malreductions were significantly decreased in the direct visualization group.

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