Fracture Classifications

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Objectives

• To understand the need for classification systems

• To understand the evolution of classification systems

• To look at the importance of soft tissue injury associated with fractures
Why do we have classifications?

• Organize knowledge

• Transfer information

• Guide treatment

• Estimate prognosis

• Enhance education and communication
History of Classification Systems

- Ancient Egypt

- The Edwin Smith Papyrus classified injuries as:
  - “An ailment which I will treat”
  - “An ailment with which I will contend”
  - “An ailment not to be treated”
History of Classification Systems

• **18th and 19th Century**
  - Descriptive classifications based on appearance of limb

  “Dinner Fork Deformity”
History of Classification Systems

• 20th Century
  • The advent of radiographs created numerous classification systems
    • Brought about the ability to identify location, amount, and displacement of fracture lines
    • Not without problems as radiographic views and quality can be inconsistent
History of Classification Systems

• The last 40 Years
  • CT has allowed for further understanding and classification of intra-articular fractures
History of Classification Systems

• Believe it or not there’s more to consider than just bones!
  • X-rays or CT alone can underestimate the severity of the overall injury and don’t consider patient status
What makes a good classification?

- **Inter-observer Reliability**
  - Do different physicians agree on the classification of a particular fracture?

- **Intra-observer Reproducibility**
  - For a given fracture, does the same physician classify it the same way at different times?
Types of Classification Systems

• Fracture-Specific

• Universal

• Soft Tissue Injury Associated with Fracture
Examples of Fracture-Specific Descriptive Classifications

- **Garden** – guides management/surgical plan
- **Neer** – assists describing fracture for communication
- **Schatzker** – can predict associated injuries and prognosis
- **Lauge-Hansen** – provides insight into mechanism
- **Sanders** - an example of CT-based classification
Garden Classification

I  Valgus impacted or incomplete
II Complete
   Non-displaced
III Complete
   Partial displacement
IV Complete
   Full displacement
** Portends risk of AVN and Nonunion**

Images courtesy of Frank Liporace, MD
Garden Classification

Pros
- Determining displaced vs nondisplaced is critical for dictating management
- Classification has highest inter- and intra- observer reliability when compared to Pauwel’s and AO classifications

Cons
- Poor interobserver reliability between Types I and II
- Classification based on AP radiograph only → can underestimate degree of displacement

Neer Classification

- Based on anatomic segments of the proximal humerus
- Considered to be a "part" if arbitrarily displaced 1 cm or angulated 45°
- Classification has good intraobserver reliability, but only moderate interobserver reliability, though still useful for communication purposes

Schatzker Classification

I: Lateral Split
II: Split Depression
III: Lateral Depression
Schatzker Classification

IV: Medial Plateau

V: Bicondylar

VI: Metaphyseal-Diaphyseal Dissociation
Schatzker Classification

• Study to compare the inter-observer reliability and intra-observer reproducibility of the Schatzker, AO, and Hohl and Moore classifications of tibial plateau fractures

• Four observers at different points in their careers classified 50 tibial plateau fractures

• Schatzker showed superior inter-observer reliability and intra-observer reproducibility compared to AO and Hohl and Moore

  --> though still not perfect
Schatzker Classification

• Associated Injuries By Fracture Type
  • Schatzker II → Lateral meniscal tears
  • Schatzker IV → medial meniscal tears, ACL injury, vascular injury
  • Schatzker VI → ACL injury, compartment syndrome

Lauge-Hansen Classification

Based on position of ankle and direction of force applied at time of injury

Supination External Rotation

Supination Adduction
Lauge-Hansen Classification

Based on position of ankle and direction of force applied at time of injury

Pronation External Rotation

Pronation Abduction
# Lauge-Hansen Classification

<table>
<thead>
<tr>
<th><strong>Pros</strong></th>
<th><strong>Cons</strong></th>
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<tbody>
<tr>
<td>- Provides understanding of</td>
<td>- Found to have the lowest</td>
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<tr>
<td>mechanism for rotational ankle</td>
<td>interobserver reliability when</td>
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<tr>
<td>fractures</td>
<td>compared to the AO and Danis-</td>
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<td></td>
<td>Weber classifications</td>
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<tr>
<td>- Enables interprofessional</td>
<td>- Classification cannot be used</td>
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<tr>
<td>communication for rotational</td>
<td>for non-rotational ankle fractures</td>
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<tr>
<td>ankle fractures</td>
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Sanders Classification

• CT-based classification looking at the widest part of the calcaneus:
  • Number articular fracture fragments
  • Location of fragments

• Compare to x-ray-based Essex-Lopresti it provides increased insight:
  • Fracture pattern
  • Pre-op planning
  • Prognosis
Sanders Classification

- **Type I:** all fractures with <2mm displacement
- **Type II:** two-part fractures of the posterior facet
- **Type III:** three-part fractures of the posterior facet
- **Type IV:** highly comminuted fracture with four or more fracture lines

Sanders Classification

• Cross-sectional study of 100 pre-op CT scans of patients with intra-articular calcaneus fractures operated on by a single surgeon

• Researchers reported:
  • Good to excellent intra-observer reproducibility
  • Moderate inter-observer reliability (which was better than what was previously reported in the literature).

• Validity was reported to be fair
Universal Classification System
OTA/AO Classification

• Alphanumeric classification that can be applied throughout the skeleton, based on fracture location and morphology

• Created in the 1960’s and multiply updated to include classifications of the pelvis and acetabulum
OTA/AO Classification

• Fracture Location
  • Which bone?
    • Each bone is assigned a specific number
OTA/AO Classification

• Fracture Location
  • Which part of the bone?
    • 1. Proximal end segment
    • 2. Diaphyseal segment
    • 3. Distal end segment
OTA/AO Classification

• Fracture Morphology

  • Diaphyseal segment
    • Type A: Simple fractures
      • spiral, oblique, transverse
    • Type B: Wedge fractures
      • spiral, bending, fragmented
    • Type C: Multifragmentary fractures
      • spiral wedge, segmented, irregular
OTA/AO Classification

• Fracture Morphology

  • End segment
    • Type A: Extra-articular
    • Type B: Partial articular
    • Type C: Complete articular
OTA/AO Classification

• Now have additional Subgrouping
  • Goal of Subgrouping: to increase the precision of the classification
  • Subgroups differ amongst each bone
OTA / AO Classification Subgrouping

- Complex and value not fully known (Example: Distal Femur)
But what about the soft tissues?
Soft Tissue-Based Classifications

• Oesterne and Tscherne Classification
• Gustilo-Anderson Classification
• OTA Open Fracture Classification
Oesterne and Tscherne Classification

• Classification of soft tissue damage in the setting of a closed fracture

<table>
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<tr>
<th>Grade</th>
<th>Soft Tissue Injury</th>
<th>Bony Injury</th>
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<tbody>
<tr>
<td>Grade 0</td>
<td>Minimal soft tissue damage&lt;br&gt;Indirect injury to limb</td>
<td>Simple fracture pattern&lt;br&gt;Ex: low energy spiral fractures</td>
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<tr>
<td>Grade 1</td>
<td>Superficial abrasion/contusion</td>
<td>Mild fracture pattern&lt;br&gt;Ex: rotational ankle fracture-dislocations</td>
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<tr>
<td>Grade 2</td>
<td>Deep abrasion with skin or muscle contusion&lt;br&gt;Direct trauma to limb</td>
<td>Severe fracture pattern&lt;br&gt;Ex: segmental fractures</td>
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<tr>
<td>Grade 3</td>
<td>Extensive skin contusion or crush&lt;br&gt;Severe underlying muscle damage&lt;br&gt;Subcutaneous avulsion&lt;br&gt;Possible compartment syndrome</td>
<td>Severe fracture pattern</td>
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Gustilo-Anderson Classification

- **Type I**: wound ≤1 cm, minimal contamination or muscle damage
- **Type II**: wound 1-10 cm, moderate soft tissue injury
- **Type IIIA**: wound usually >10 cm, high energy, extensive soft-tissue damage, contaminated, but with adequate tissue for flap coverage
- **Type IIIB**: extensive periosteal stripping, wound requires soft tissue coverage (rotational or free flap)
- **Type IIIC**: vascular injury requiring vascular repair, regardless of degree of soft tissue injury

**Appropriate classification can only be made intraoperatively**

OTA Classification of Open Fractures

- Assigns severity to five essential factors for treatment

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<th>Essential Factor</th>
<th>Severity</th>
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| Skin             | 1. Can be approximated  
                  2. Cannot be approximated  
                  3. Extensive degloving |
| Muscle           | 1. No muscle in area/no appreciable necrosis  
                  2. Loss of muscle; intact function, localized necrosis  
                  3. Dead muscle, loss of function |
| Arterial         | 1. No injury  
                  2. Arterial injury without ischemia  
                  3. Arterial injury with ischemia |
| Contamination    | 1. None or minimal  
                  2. Surface contamination  
                  3. Imbedded in bone or deep tissues |
| Bone Loss        | 1. None  
                  2. Bone missing or devascularized, but still contact present between proximal and distal segments  
                  3. Segmental bone loss |

Reliability of Classification Systems

- OTA Open Fracture Classification System appears superior to Gustillo-Anderson Classification System in both reliability and validity
  - 86% overall interobserver agreement vs 60% for G-A
  - JOT: 2013 vol 27; pp379-384
- Interobserver **RELIABILITY** is different than **VALIDITY**
  - If surgeons agree on a measurement pre-operatively (“reliability”), that may not prove to be accurate intra-operatively (“validity”)
  - JAAOS: 2002 vol 10; pp290-297
Use of Soft Tissue and Open Fracture Classifications

- Prospective study to determine if descriptive classifications of diaphyseal tibia fractures are predictive of prognosis

- Compared AO, Gustilo-Anderson, Tscherne, and Winquist-Hansen classifications and looked at union, need for future surgery, and subsequent infection

- Found that the Tscherne Classification was most predictive of final outcome
Summary

• Classifications are essential for communication, education, treatment guidelines, and as a prognostic tool

• As imaging technology has advanced so have our fracture classifications

• The soft tissue can’t be ignored and classification systems taking the soft tissue envelope into consideration are essential for creating a complete prognostic picture
References


