Post-Traumatic Mal-Alignment Evaluation & Treatment

Mal-Union Definition
Non-Anatomic Union Of A Bone Or Joint Following A Fracture Or Injury That is Functionally Or Cosmetically Unacceptable

Mal-Union Consequences
- Pain
- Weakness
- Loss Of Function
- Deformity
- Arthritis

Mal-Union Etiology
- Non-Operative Treatment
  - Loss Of Reduction
  - Poor Compliance
- Operative Treatment
  - Poor Initial Reduction & Fixation
  - Loss Of Fixation

Mal-Union Normal Alignment
- Mechanical Axis - Line Of Weight Bearing
- Anatomic Axis - Centers Of The Bone
- Lower Extremity – Crucial
- Upper Extremity – Less Important

Mal-Union How Much Mal-Alignment Can We Accept?
- Unknown
- Decreasing Over Time
- Literature Not Helpful
- Medical Legal Significance

Mal-Alignment Guidelines

<table>
<thead>
<tr>
<th>Bone</th>
<th>Angulation</th>
<th>Shortening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femur</td>
<td>5° - 7°</td>
<td>&lt; 12 mm</td>
</tr>
<tr>
<td>Tibia</td>
<td>5° - 7°</td>
<td>&lt; 12 mm</td>
</tr>
<tr>
<td>Humerus</td>
<td>10° - 15°</td>
<td>&lt; 20 mm</td>
</tr>
<tr>
<td>Forearm</td>
<td>&lt; 5°</td>
<td>&lt; 10 mm</td>
</tr>
</tbody>
</table>

Mal-Union Assessment
- Location
- Limb Length
- Limb Rotation
- Soft Tissue Status
- Joint Stability
- Articular Integrity
- Angular Deformity

Mal-Union Location
- Diaphyseal
- Metaphyseal
- Articular
### Mal-Union Assessment
- Location
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### Mal-Union Length Assessment
- CT Scan Gold Standard
- Precise To The Millimeter
- Easy To Do
- Assess Rotation Same Time

### Mal-Union Assessment
- Location
- Limb Length
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- Soft Tissue Status
- Joint Stability
- Articular Integrity
- Angular Deformity

### Mal-Union Rotational Assessment
- More Difficult To Assess
- Observation
- Walking / Gait
- Physical Exam
- Seated Foot Position
- Computed Tomography

### Mal-Union Rotational Assessment
- Location
- Limb Length
- Limb Rotation
- Soft Tissue Status
- Joint Stability
- Articular Integrity
- Angular Deformity

### Mal-Union Assessment
- Best Done In The Prone Position

### Mal-Union Rotational Assessment
- Location
- Limb Length
- Limb Rotation
- Soft Tissue Status
- Joint Stability
- Articular Integrity
- Angular Deformity

### Mal-Union Angulation Assessment
- Rarely Single Plane Deformity
- Multi-Planer Deformity
- Difficult To Measure On X-Ray
- Assessment Affected By:
  - Limb Shortening
  - Translation
  - Rotation
### Mal-Union Management

- Define The Deformity
- Patient Check List
- Pre-Operative Plan
- Corrective Osteotomy
  - Stable Internal Fixation
  - Circular Ring Fixation

### Mal-Union Osteotomy

- Location
  - Diaphyseal
  - Metaphyseal
  - Articular
- Open Or Percutaneous
- Single Or Multi-Plane
- Open Or Closing Wedge
  - Transverse
  - Oblique
  - Dome

### Mal-Union Fixation Options

- Acute Correction
  - Plate
  - Nail
- Gradual Correction
  - External Fixation
  - Nail
- Stability Essential !!!