Upper Extremity Trauma: Shoulder

Goal

Better 3-D Understanding of The Shoulder
- **Anatomy**
- **Imaging**

Objectives

a) Illustrate Anatomy
- 3-D Scapula
- Glenohumeral Joint

b) Imaging Techniques
- Radiographic Views
- *CT Optimization*

c) Shoulder Trauma
- *How not to miss a posterior dislocation*

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

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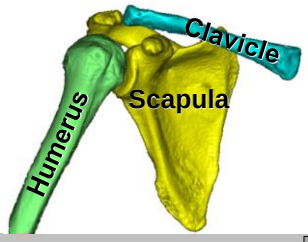
Shoulder: 3 Bones



Bones Ⓢ Ⓒ Ⓗ
Radiographs
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Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

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Scapula: Anterior View

"Flat Bone"
- ✓Scapula
- ✓Skull
- ✓Pelvis
- ✓Sternum
- ✓Ribs

➢As opposed to **"Long Bones"**
- ✓Humerus
- ✓Clavicle
- ✓…

Scapula has complex 3-D anatomy
- ➢ Helps to look at it from multiple views

Bones Ⓢ Ⓒ Ⓗ
Radiographs
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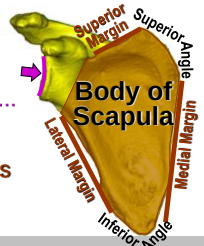
Scapula: Anterior Medial View

Parts:

➢**Glenoid**
- ✓Shallow Socket
  - ❖Dislocates…

➢**Body**
- ✓Triangular
  - ❖3 Margins
  - ❖2 Angles



Bones Ⓢ Ⓒ Ⓗ
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Conclusion

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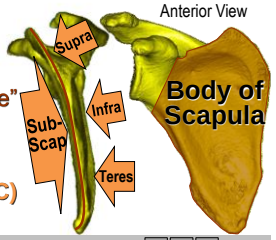
Scapula: Medial View

Parts:

➢**Body**
- ✓Razor Thin
  - ❖"Shoulder Blade"
- ✓No articular surfaces
- ✓Origin of all 4 Rotator Cuff (RC) Muscles



Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
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Anterior
Posterior
CT
Final Case
Conclusion

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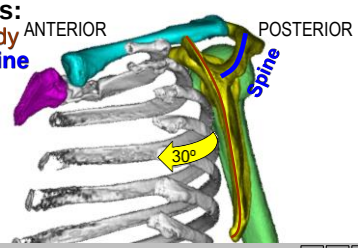
Scapula: Medial View

Parts:

➢Body

➢Spine



Bones Ⓢ Ⓒ Ⓗ
Radiographs
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Y & ACJ
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GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

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Upper Extremity Trauma: Shoulder

Scapula: Posterior Medial View

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

Parts:

- Body
- **Spine**
  - ✓Posterior Structure
    - ❖Off back of Body
  - ✓Defines RC muscles
    - ❖**Supraspinatus** *Above the spine*
    - ❖**Infraspinatus** *Below the spine*

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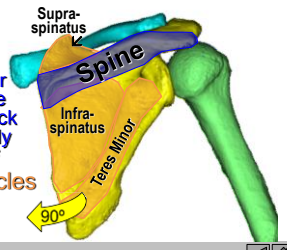
Scapula: Posterior View

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

Parts:

- Body
- **Spine**
  - ✓Posterior Structure
    - ❖Off back of Body
- Origin of RC Muscles



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Scapula: Lateral View

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
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Posterior
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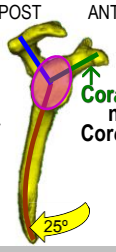
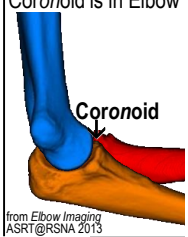
"Y-view"

- 3 Limbs:
  - ✓Body
    - ❖Inferior
  - ✓Spine
    - ❖Posterior
  - ✓Coracoid
    - ❖Anterior
- Glenoid
  - ❖Shallow Socket





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Scapula: Anterior Lateral View

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
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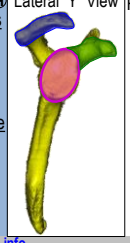
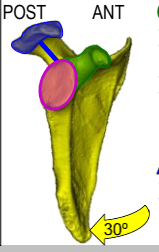
Conclusion





Coracoid

- Most anterior part of the scapula
- Arises from anterior glenoid

Acromion

- Arises from posterior spine
  - ✓Points anterior

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Clavicle: [L] "collarbone", "key"

fastener of the shoulder

etymonline.com

Bones Ⓢ Ⓒ Ⓗ
Radiographs
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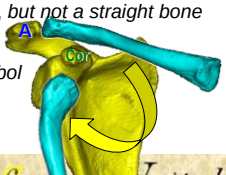
Conclusion

"Long Bone", *but not a straight bone*

- ✓elongated-S
- ✓elongated-*f*
- ✓*Integral Symbol*

$$\int_a^b f(x)\,dx$$



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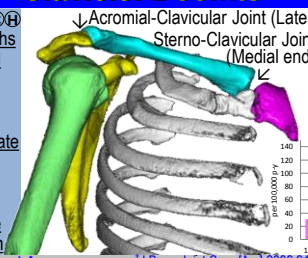
Clavicle: 2 Joints

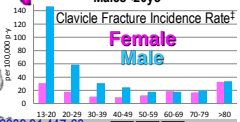
fastener of the shoulder

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion



Only bone connects scapula to the thorax

- ☺Shoulder has wide ROM
- ☹***The*** most fractured bone?
  - ✓3-10% of ***all*** fractures‡
  - ✓35% of shoulder injuries†
  - ✓**Males<20yo**



†J Bone Joint Surg [Am] 2009;91:447-60
‡Robinson, J Bone Joint Surg [Br] 1998;80-B:476-84
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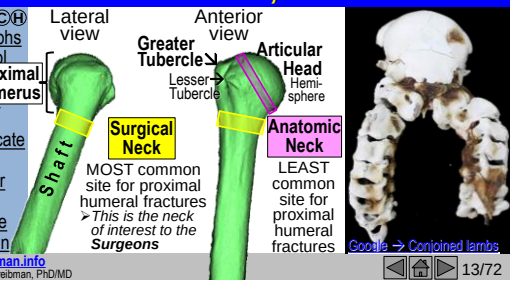
Upper Extremity Trauma: Shoulder

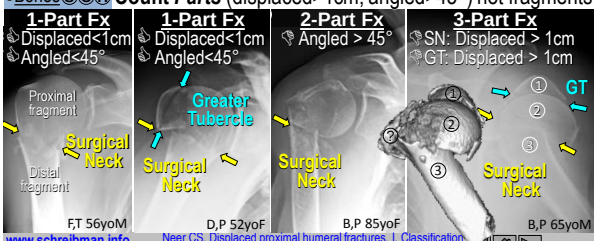
Humerus: 1 Head, 2 Necks

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion



Neer Classification Proximal Humerus Fractures

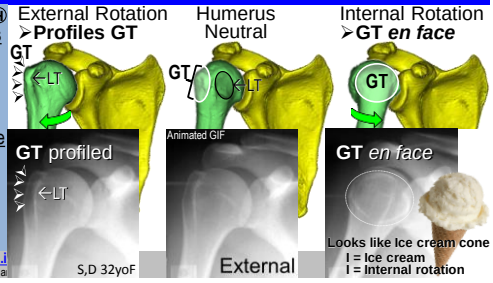
Bones Ⓢ Ⓒ Ⓗ **Count *Parts*** (displaced>1cm, angled>45°) not fragments



Neer CS. Displaced proximal humeral fractures. I. Classification and evaluation. J Bone Joint Surg Am. 1970;52 (6): 1077-89

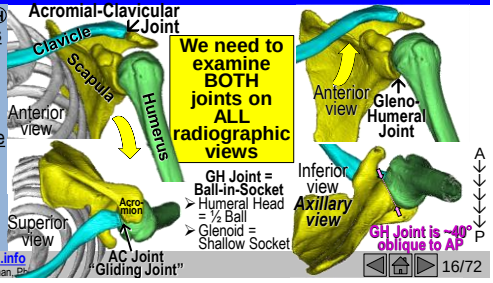
Humerus: External vs Internal Rotation

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion



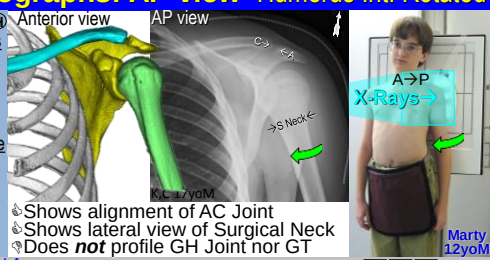
Shoulder: 3 Bones & 2 Joints

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion



Radiographs: AP view Humerus Int. Rotated

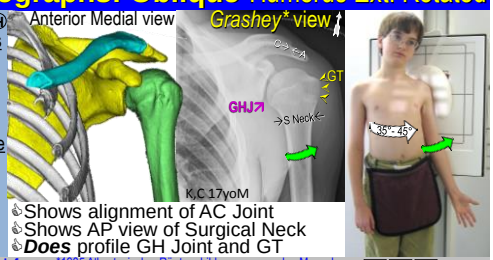
Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion



- Shows alignment of AC Joint
- Shows lateral view of Surgical Neck
- Does ***not*** profile GH Joint nor GT

Radiographs: Oblique Humerus Ext. Rotated

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion



- Shows alignment of AC Joint
- Shows AP view of Surgical Neck
- ***Does*** profile GH Joint and GT

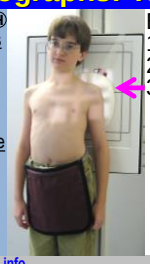
*1905 Atlas typischer Röntgenbilder vom normalen Menschen p.38-39 [books.google.com]

Upper Extremity Trauma: Shoulder

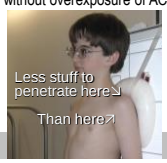
Upper Extremity Trauma Shoulder

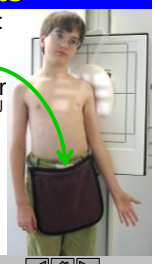
Radiographs: Technical Points

Bones Ⓢ Ⓒ Ⓗ
Radiographs
○AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion



Both AP & Oblique:
1) Shot Standing
2) Shield Genitals
3) Boomerang Filter
Allows good exposure of GHJ without overexposure of ACJ





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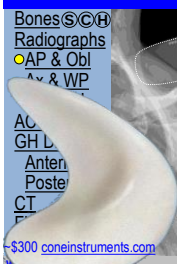
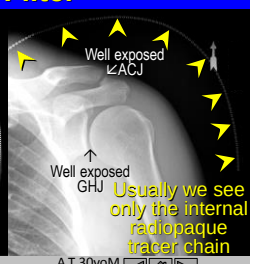
Upper Extremity Trauma Shoulder

Boomerang Filter

Bones Ⓢ Ⓒ Ⓗ
Radiographs
○AP & Obl
Ax & WP
AC
GH L
Anter
Poste
CT





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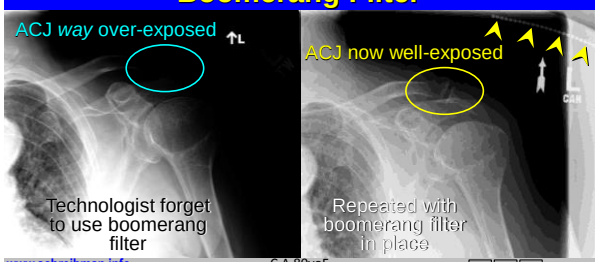
Upper Extremity Trauma Shoulder

Boomerang Filter



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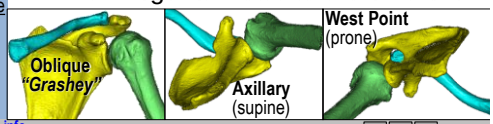
Upper Extremity Trauma Shoulder

Radiographs: Need Orthogonal Views +

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
○Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

AP/Obl = Orthogonal views of humerus
➢Internal/External rotation of humerus
AP/Obl ≠ Orthogonal views of GH joint
➢AP doesn't even profile glenohumeral joint
The 3 Orthogonal views to the GHJ are:



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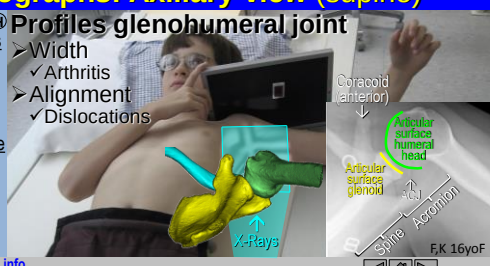
Upper Extremity Trauma Shoulder

Radiographs: Axillary view (supine)

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
○Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

Profiles glenohumeral joint
➢Width
✓Arthritis
➢Alignment
✓Dislocations



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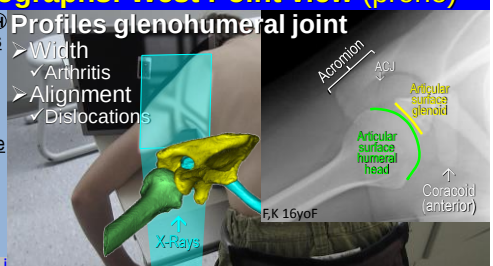
Upper Extremity Trauma Shoulder

Radiographs: West Point view (prone)

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
○Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

Profiles glenohumeral joint
➢Width
✓Arthritis
➢Alignment
✓Dislocations



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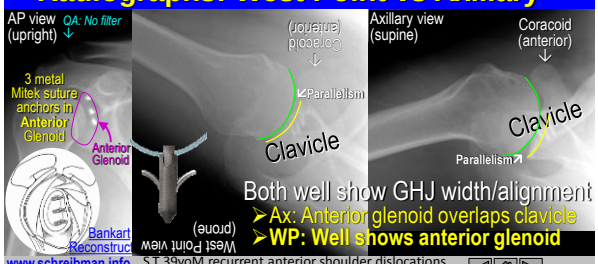
Upper Extremity Trauma: Shoulder

Upper Extremity Trauma Shoulder

Radiographs: West Point vs Axillary



S,T 39yoM recurrent anterior shoulder dislocations

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Upper Extremity Trauma

Radiographs: UW 3-view series

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

Standard (trauma, pain)
1) AP
2) Oblique
3) Axillary
2-views of: ✓ACJ ✓Proximal Humerus
2-views of: ✓Glenohumeral Joint

Instability (3-views Glenohumeral Joint)
1) Oblique
2) Axillary
3) West Point

If need orthogonal views Scapula, ACJ
4) Lateral ("Scapular Y", "Arch"/"Outlet")

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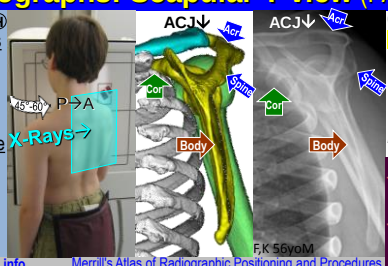
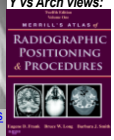
Upper Extremity Trauma Shoulder

Radiographs: Scapular Y view (PA)

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion



Orthog. view:
➢Scapula
✓Body
✓Coracoid
✓Spine
✓Acromion
➢AC Joint
For discussion of Y vs Arch views:



F,K 56yoM

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Upper Extremity Trauma Shoulder

Radiographs: AC Joints (Bilateral) *Without* weights

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
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Posterior
CT
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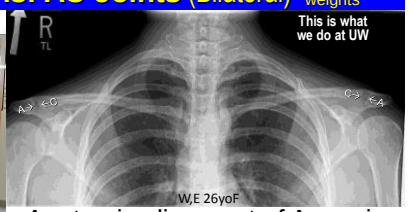

Marty 18yoM

Anatomic alignment of Acromia with lateral ends of Clavicles

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Upper Extremity Trauma Shoulder

Radiographs: AC Joints (Bilateral) *With* weights

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
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GH Dislocate
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Posterior
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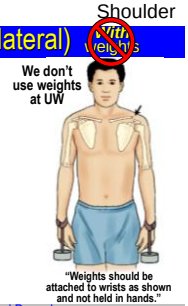

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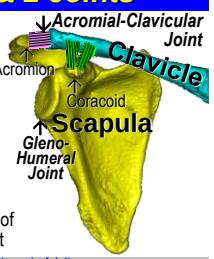
Upper Extremity Trauma Shoulder

Shoulder: 3 Bones & 2 *Joints*

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

2 Ligaments attach clavicle to scapula:
➢**AC Lig** Acromio-Clavicular
➢**CC Lig** Coraco-Clavicular

AC injury types based on:
✓Which ligaments are torn
✓Degree/direction of A-C displacement



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Rockwood & Green's Fractures in Adults 8th Ed. ©2015 [Kindle Edition] Chapter 41

Upper Extremity Trauma: Shoulder

Upper Extremity Trauma Shoulder

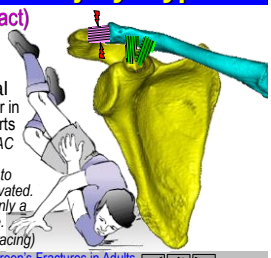
Acromioclavicular Injury: Type 1

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

- ➢**AC Lig: Sprain** (intact)
- ➢**CC Lig: Intact**
- ➢ACJ: Aligned
  - ✓Radiographs: Normal

AC injuries most commonly occur in males <30 related to contact sports

Galen (120-199AD) diagnosed his own AC dislocation received from wrestling. Treated himself with tight bandages to hold clavicle down, keeping arm elevated. He abandoned the treatment after only a few days as it was so uncomfortable. (Low compliance rate of shoulder bracing)



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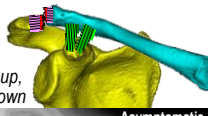
Upper Extremity Trauma Shoulder

Acromioclavicular Injury: Type 2

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

- ➢**AC Lig: Torn**
- ➢**CC Lig: Intact**
- ➢ACJ: Subluxated
  - ✓*While clavicle appears displaced up, it's the scapula that's displaced down*



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Rockwood & Green's Fractures in Adults 8th Ed. ©2015 [Kindle Edition] Loc 60286

Upper Extremity Trauma Shoulder

Acromioclavicular Injury: Type 3

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

- ➢**AC Lig: Torn**
- ➢**CC Lig: Torn**
- ➢ACJ: Dislocated
  - ✓C↔C distance is increased ***less*** than twice the normal distance

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Upper Extremity Trauma Shoulder

Acromioclavicular Injury: Type 5

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

- ➢**AC Lig: Torn**
- ➢**CC Lig: Torn**
- ➢ACJ: ***Very*** Dislocated
  - ✓C↔C distance is increased ***more*** than twice the normal distance

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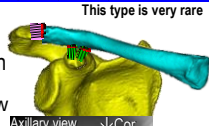
Upper Extremity Trauma Shoulder

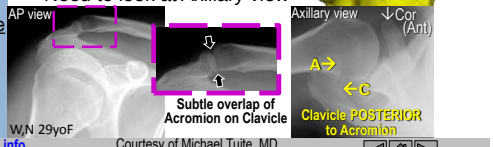
Acromioclavicular Injury: Type 4

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

- ➢**AC Lig: Torn**
- ➢**CC Lig: Torn**
- ➢Clavicle **Posterior** to Acromion
  - ✓Hard to see on AP view
  - ✓Need to look at Axillary view

This type is very rare





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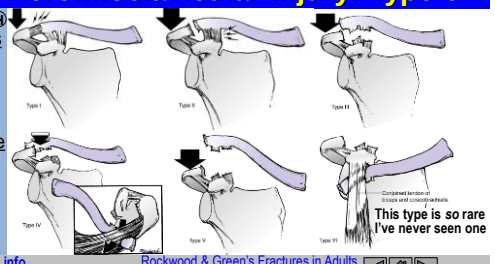
Courtesy of Michael Tuite, MD Vice Chair, UW Radiology Dept.

Upper Extremity Trauma Shoulder

Acromioclavicular Injury: Type 6

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion



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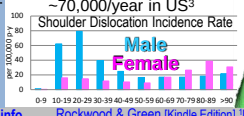
Upper Extremity Trauma: Shoulder

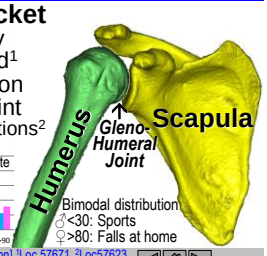
Shoulder: 3 Bones & 2 Joints

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

GHJ: Shallow Socket

- Glenoid covers only ~25% humeral head[1]
- ☺ 360° range of motion
- ☹ **Most** dislocated joint
  - ✓45% of **ALL** dislocations[2]
  - ~70,000/year in US[3]





Bimodal distribution
♂<30: Sports
♀>80: Falls at home

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Rockwood & Green [Kindle Edition] [1]Loc 57671 [2]Loc57623 [3]Zacchilli: J Bone Joint Surg Am. 2010;92(3):542-549

Shoulder Range of Motion

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

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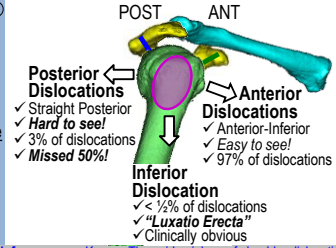
Nature v498 483-6 27June2013

Gleno-Humeral Dislocations

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion



- ➢Glenoid
  - ✓Shallow Socket
- ➢3 Limbs:
  - ✓Body
    - ❖Inferior
  - ✓Coracoid
    - ❖Anterior
  - ✓Spine
    - ❖Posterior

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Krøner. The epidemiology of shoulder dislocations. Arch Orthop Trauma Surg. 1989;108:288-90.

GH Dislocations: Inferior

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

Luxatio Erecta [L] "Dislocation" "Upright"

- ➢Humerus stuck in abduction
  - ✓"Hands up dislocation"

B,T 40yoM

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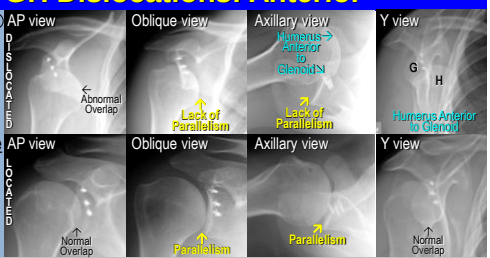
GH Dislocations: Anterior

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion



S,T 39yoM recurrent anterior shoulder dislocations

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GH Dislocations: Subcoracoid

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

Humerus Anterior-Inferior to Glenoid

- ➢*Easy to see on all radiographic views*
- ⅔ Anterior Dislocations are **subcoracoid**

M,D 37yoM

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Upper Extremity Trauma: Shoulder

GH Dislocations: Subglenoid

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
○Anterior
Posterior
CT
Final Case
Conclusion

Humerus Anterior-Inferior to Glenoid

➢*Easy to see on all radiographic views*

⅓ Anterior Dislocations are **subglenoid**

Y,C 90yoF

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GH Dislocations: Anterior

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
○Anterior
Posterior
CT
Final Case
Conclusion

Humerus Anterior-Inferior to Glenoid

➢*Easy to see on all radiographic views*

✓AP: Abnormal G-H overlap

✓**Obl: Lack of G-H parallelism**

✓**Ax: Humeral Head Ant. to Glenoid**

➢Subcoracoid=⅔, Subglenoid=⅓

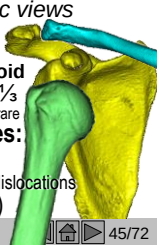
✓Subclavicular, Intrathoracic, *Luxatio Erecta* = all rare

Can have characteristic fractures:

➢**H**umeral Head (**H**ill-Sachs)

✓40-90% single disloc. ~100% recurrent dislocations

➢Anterior Glenoid (Bony Bankart)



Rockwood & Green [Kindle Edition] Loc 57895

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GH Dislocations: Anterior

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
○Anterior
Posterior
CT
Final Case
Conclusion

2 Very rare types (I've never seen either…)

➢Subclavicular ➢Intrathoracic

Courtesy of Michael Tuite, MD
Vice Chair, UW Radiology Dept.

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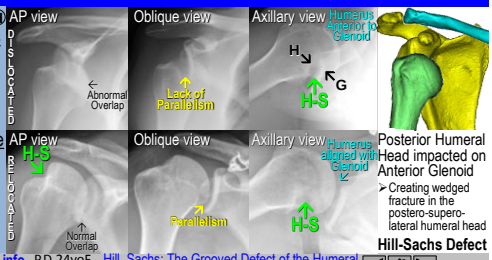
GH Dislocations: Hill-Sachs

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
○Anterior
Posterior
CT
Final Case
Conclusion



Posterior Humeral Head impacted on Anterior Glenoid

➢Creating wedged fracture in the postero-supero-lateral humeral head

Hill-Sachs Defect

P,D 24yoF

Hill, Sachs: The Grooved Defect of the Humeral Head. Radiology 1940; 35:690-700

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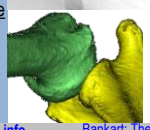
Mechanism

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
○Anterior
Posterior
CT
Final Case
Conclusion



Anterior humerus dislocates, postero-superior head impacts into anterior-inferior glenoid (creating Hill-Sachs fracture)

± fracture antero-inferior glenoid

➢**Bankart fracture**

✓***"Bony Bankart"***

✓The defect Bankart described was not of the bone, but of the cartilaginous labrum

Bankart: The Pathology and Treatment of Recurrent Dislocation of the Shoulder. JBJS 1938 v26 p23-9

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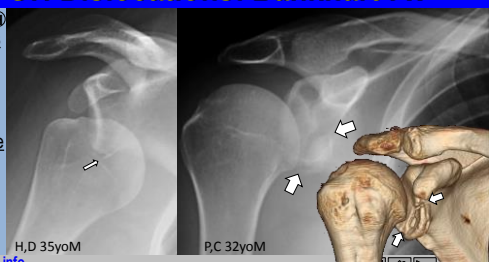
GH Dislocations: Bankhart Fx

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
○Anterior
Posterior
CT
Final Case
Conclusion



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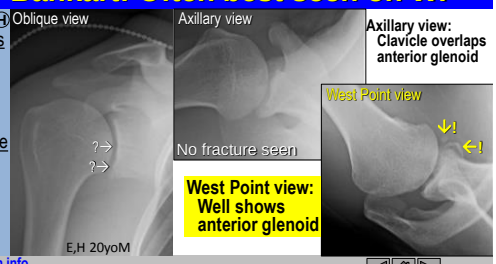
Upper Extremity Trauma: Shoulder

Upper Extremity Trauma Shoulder

Bankart: Often best seen on WP

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
○Anterior
Posterior
CT
Final Case
Conclusion



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Upper Extremity Trauma Shoulder

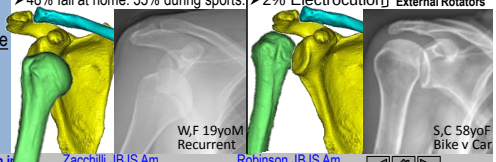
Dislocations: Anterior v Posterior

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
○Posterior
CT
Final Case
Conclusion

Anterior Dislocations (97%)
- Goes Anterior & Inferior
  - ✓ ***Easy to see***
- Indirect trauma
  - ✓ Rarely from direct blow
- 48% fall at home. 35% during sports.

Posterior Dislocations (3%)
- Goes Straight Posterior
  - ✓ ***Harder to see***
- 67% Trauma (Falls > MVA > Sports)
- 31% Seizure
- 2% Electrocution

Internal Rotators overwhelm weaker External Rotators



Zacchilli JBJS Am 2010:92(3):542-549
Robinson JBJS Am 2011:93(17)1605-1613

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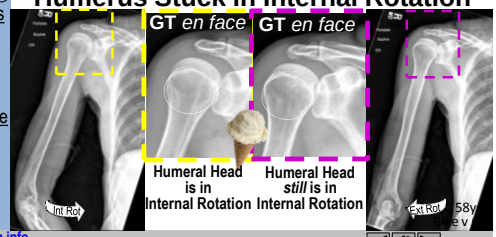
Upper Extremity Trauma Shoulder

Posterior Dislocation Clues: 1

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
○Posterior
CT
Final Case
Conclusion

Humerus Stuck in Internal Rotation



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Upper Extremity Trauma Shoulder

Posterior Dislocation Clues: 2

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
○Posterior
CT
Final Case
Conclusion

Lack of Parallelism on Oblique View

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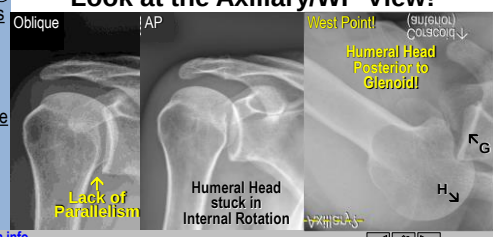
Upper Extremity Trauma Shoulder

Posterior Dislocation Clues: 3!

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
○Posterior
CT
Final Case
Conclusion

Look at the Axillary/WP View!



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Upper Extremity Trauma Shoulder

Posterior Dislocation Clues: Bonus

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
○Posterior
CT
Final Case
Conclusion

Trough Line Sign (Reverse Hill-Sachs)

- ***Anterior*** Dislocation:
  - ✓ Anterior Glenoid impacts into
  - ✓ Posterior Humerus
  - ✓ **"Hill-Sachs"**
- ***Posterior*** Dislocation:
  - ✓ Posterior Glenoid impacts into
  - ✓ Anterior Humerus
  - ✓ **Trough Line Sign**

AJR 1978; 130: 945-950

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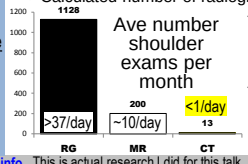
Upper Extremity Trauma: Shoulder

Shoulder Exams at UW DOR

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

Searched UW PACS (10/1/13 – 9/30/14)

- Body Region: Shoulder. Sorted by Modality
  - ✓Recorded total number of exams each month
  - ✓Counted number of MR and CT exams
  - ✓Calculated number of radiographic exams (RG)



Ave number shoulder exams per month

- ❖ Doesn't include fluoroscopic injections (not listed by joint)
  - »We do daily shoulder injections for pain (steroids), MR-Arthro (Gd)
  - »Train all UW Residents
- ❖ Doesn't include Ultrasound (not listed by joint)
  - »UW MSK US Clinic
  - »Dx: Rotator Cuff
  - »Rx: Steroids. Lavage Ca^{++} Tendonitis

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Shoulder: What to Order When

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

Radiographs (Obl + Ax + AP/WP ± Y) **$207**

- ➢Hx: Trauma (Fractures, Dislocations)
- ➢Hx: Pain (Arthritis, Calcific Tendonitis, …)

MR

- ➢Rotator Cuff tears (without contrast) **$2,946**
- ➢Labral tears (*with* intra-articular contrast) **$4,325**

US

- ➢Dx: Rotator Cuff tears *(sizeable tears)* **$665**
- ➢Rx: Calcific Tendonitis Lavage* **$1,519**

CT: *Mostly for surgical planning* **$1,473**

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Optimizing Bone CT: General

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

There are always 3 things technologists can do to optimize Bone CT

1) Optimize Patient Positioning

- ✓Try to center the bone
- ✓Get other bones/metal out of scanning FOV

2) Optimize Scanning Technique

- ✓Thin slices, 50% overlap
- ✓Use small focal spot, small display FOV

3) Optimize Reformats

- ✓2D: Angle slices relative to ANATOMY
- ✓3D: Rotate & Segment

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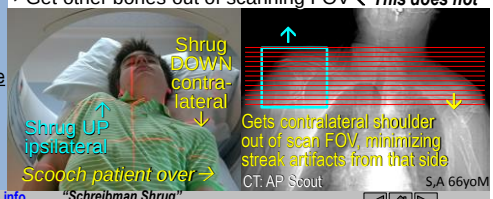
Optimizing Bone CT: Shoulder

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

1) Optimize Patient Positioning

- ✓Try to center the bone ←***This depends on body habitus***
- ✓Get other bones out of scanning FOV ←***This does not***



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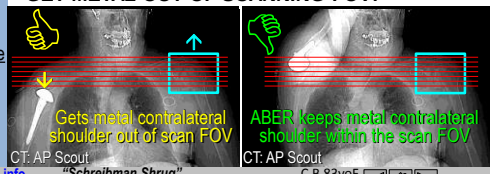
Optimizing Bone CT: Shoulder

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

1) Optimize Patient Positioning

- ✓Try to center the bone ←***This depends on body habitus***
- ✓Get other bones out of scanning FOV ←***This does not***
- ✓**GET METAL OUT OF SCANNING FOV!**



"Schreibman Shrug" C,B 83yoF

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Optimizing Bone CT: General

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

2) Optimize Scanning Technique

(This is what my physicist tells me..)

a) Use Small Focal Spot

- ➢Cannot manually select small focal spot
- ➢Small focal spot comes on automatically if the mA<particular value, based upon the kV
  - ✓Ask your Application person for your CT scanner
- ➢Can use Automatic Exposure Control (AEC)
  - ✓Set the Max mA value to be less than the maximum allowed mA for the small focal spot

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Upper Extremity Trauma: Shoulder

GE CT Scanner mA Limits

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

Scanner Name	Scan FOV	140 kV	120 kV	100 kV	80 kV
Discovery CT750HD	Normal mode: Large Focal Spot	715	835	800	700
	Hi Res mode: Large Focal Spot	540	625	750	700
	Normal mode: Small Focal Spot	10 - 490	10 - 570	10 - 680	10 - 620
	Hi Res mode: Small Focal Spot	10 - 360	10 - 420	10 - 500	10 - 620
LightSpeed VCT 64, LightSpeed 16 Pro, & Optima CT 580	Large Focal Spot	715	800	770	675
	Small Focal Spot	10 - 335	10 - 335	10 - 310	10 - 300
Revolution Evo & Optima CT660	Large Focal Spot	515	560	480	400
	Small Focal Spot	10 - 170	10 - 200	10 - 240	10 - 300
LightSpeed 16, & LightSpeed 8	Large Focal Spot	380	440	420	400
	Small Focal Spot	10 - 170	10 - 200	10 - 240	10 - 300

What kV to use?

- Adults:
  - ✓ **At least 120**
- Large Adults:
  - ✓ **Use 140**
- Small child:
  - ✓ **Use 100**

Courtesy of Frank Ranallo, PhD, DABR
Physicist- UW Radiology Department

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Optimizing Bone CT: General

Bones Ⓢ Ⓒ Ⓗ
Radiographs
AP & Obl
Ax & WP
Y & ACJ
AC Injury
GH Dislocate
Anterior
Posterior
CT
Final Case
Conclusion

2) Optimize Scanning Technique
(This is what my physicist tells me..)

b) Thin slices with 50% overlap

- Shoulder: Thin but not too thin (1-1.5mm)
  - ✓<1mm slices may be too noisy (We use 1.25mm)
- 50% overlap yields better reformats
  - ✓Adds information to the stack of axial images
- Pitch close to 0.5
  - ✓Reduces helical artifacts
  - ✓Uses less mA, hence use small focal spot

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2) Optimize Scanning Technique
(This is what my physicist tells me..)

c) Use smallest possible display FOV to maximize resolution

- Display FOV always = 512 pixels
- ↓Display FOV → smaller pixel size
- Smaller pixel size → higher resolution

Just a little math…

50cm display FOV / 512 pixels → pixel size ≈ 1 mm
25cm display FOV / 512 pixels → pixel size ≈ ½mm

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Optimizing Bone CT: Shoulder

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2) Optimize Scanning Technique
(This is what my physicist tells me..)

d) Use "Ultra High Resolution" (UHR)…
…if available on your CT scanner

- On any CT scanner, resolution degrades dramatically as you move away from center
  - ✓***This will always be an issue with shoulders***
- Hi Res uses fluctuating focal spot position
  - ✓Minimizes off-center sharpness degradation
  - ✓***Particularly useful for shoulders***

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Optimizing Bone CT: Shoulder

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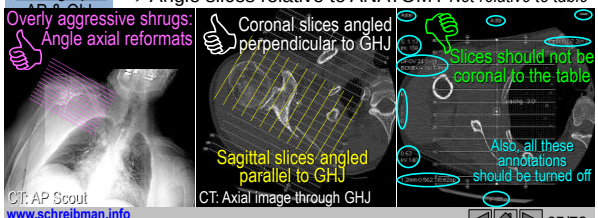
3) Optimize Reformats

- Angle slices relative to ANATOMY *Not relative to table*



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Optimizing Bone CT: Shoulder

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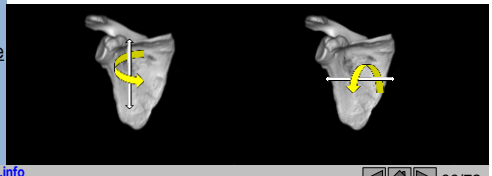
3b)Optimize 3-D Reformats

- ✓Series of 36 rotating images, 10° intervals
  - ❖Rotate around both vertical and horizontal axes
- ✓Disarticulate humerus/scapula



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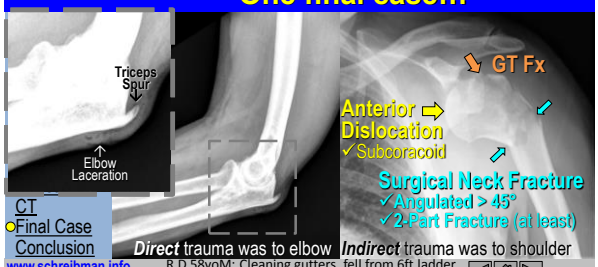
Upper Extremity Trauma: Shoulder

One final case…



CT
Final Case
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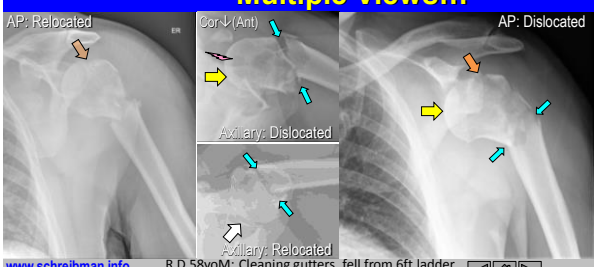
Multiple Views…



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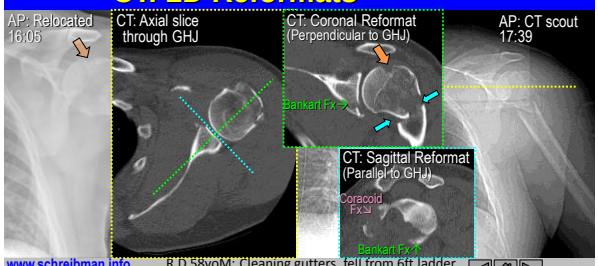
CT: 2D Reformats



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CT: 3D Reformats

Bones Ⓢ Ⓒ Ⓗ Scapula only
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AP & Obl
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Y & ACJ
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Goal: Better 3-D Understanding of Shoulder

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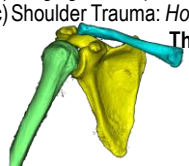
Objectives:

a) Illustrate Anatomy: 3-D Scapula, Glenohumeral Joint
b) Imaging Techniques: Radiographs, CT Optimization
c) Shoulder Trauma: *How not to miss posterior dislocation*



Three Easily Missed Dislocations:

1) Every **Elbow**, look for **Radial Head** dislocation
2) Every **Shoulder**, look for **Posterior** dislocation
3) Every **Foot**, look for **Lisfranc** dislocation

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Questions?

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