


Upper Extremity Trauma: Shoulder

Upper Extremity Trauma Shoulder

Goal Better 3-D Understanding of The Shoulder
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 ©©H
 Radiographs
 AP & Obl
 Ax & WP
 Y & ACJ
 AC Injury
 GH Dislocate
 Anterior
 Posterior
 CT
 Final Case
 Conclusion

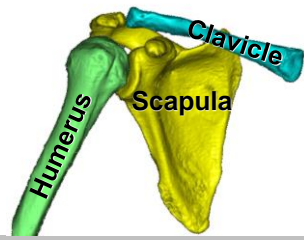


www.schreibman.info Ken Schreibman, PhD/MD Professor of Radiology University of Wisconsin – Madison 1/72

Upper Extremity Trauma Shoulder

Shoulder: 3 Bones

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Upper Extremity Trauma Shoulder

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



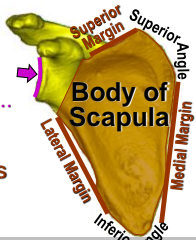
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Scapula: Anterior Medial View

Parts:
 > **Glenoid**
 ✓ Shallow Socket
 ❖ Dislocates...
 > **Body**
 ✓ Triangular
 ❖ 3 Margins
 ❖ 2 Angles



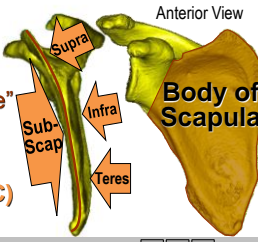
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Scapula: Medial View

Parts:
 > **Body**
 ✓ Razor Thin
 ❖ “Shoulder Blade”
 ✓ No articular surfaces
 ✓ Origin of all 4 Rotator Cuff (RC) Muscles



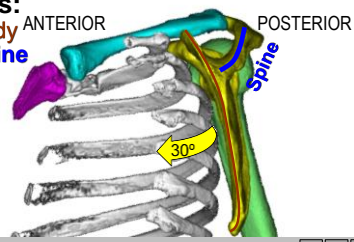
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Scapula: Medial View

Parts:
 > **Body** ANTERIOR
 > **Spine** POSTERIOR



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 Anterior
 Posterior
 CT
 Final Case
 Conclusion

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Upper Extremity Trauma Shoulder

Scapula: Posterior Medial View

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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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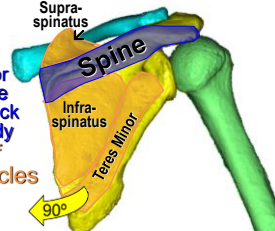
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Scapula: Posterior View

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Radiographs
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 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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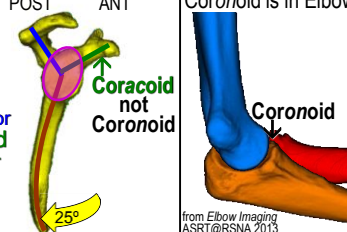
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Scapula: Lateral View

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Radiographs
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 Y & ACJ
 AC Injury
 GH Dislocate
 Anterior
 Posterior
 CT
 Final Case
 Conclusion

“Y-view”

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



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Scapula: Anterior Lateral View

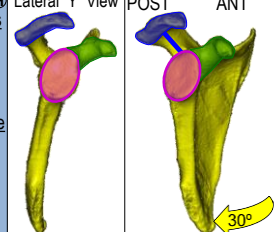
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Radiographs
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Coracoid

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

Acromion

- > **Arises from posterior spine**
- ✓ **Points anterior**



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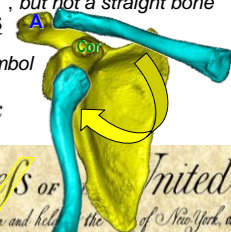
Clavicle: [L] “collarbone”, “key”

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Radiographs
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“Long Bone”, but not a straight bone

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

$\int_a^b f(x) dx$



Congress of the United States
 US Bill of Rights
 begun and held at the City of New York, on Wednesday the fourth of September, one thousand seven hundred and eighty nine

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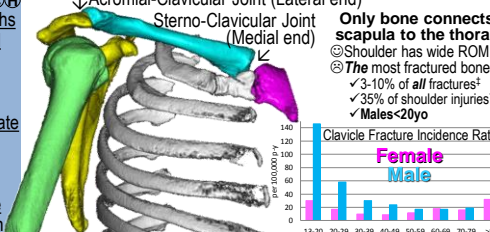
Clavicle: 2 Joints

Bones **©** **C** **H**
Radiographs
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Acromial-Clavicular Joint (Lateral end)
Sterno-Clavicular Joint (Medial end)

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**



Clavicle Fracture Incidence Rate[†]

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Humerus: 1 Head, 2 Necks

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

Lateral view
Anterior view

Surgical Neck
 MOST common site for proximal humeral fractures
 > This is the neck of interest to the Surgeons

Anatomic Neck
 LEAST common site for proximal humeral fractures

Google → Conjoined lambs

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Neer Classification Proximal Humerus Fractures

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

1-Part Fx
 Displaced < 1cm
 Angled < 45°

2-Part Fx
 Angled > 45°

3-Part Fx
 SN: Displaced > 1cm
 GT: Displaced > 1cm

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 Neer CS. Displaced proximal humeral fractures. I. Classification and evaluation. J Bone Joint Surg Am. 1970;52(16):1077-89 14/72

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Humerus: External vs Internal Rotation

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

External Rotation
 Profiles GT

Internal Rotation
 > GT en face

GT profiled

GT en face
 Looks like Ice cream cone
 I = Ice cream
 I = Internal rotation

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Shoulder: 3 Bones & 2 Joints

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

Acromioclavicular Joint

Glenohumeral Joint

AC Joint = "Gliding Joint"

GH Joint = Ball-in-Socket
 = 1/2 Ball
 = 1/2 Socket
 = Shallow Socket

GH Joint is ~40° oblique to AP

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Radiographs: AP view Humerus Int. Rotated

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

Anterior view

AP view

A→P X-Rays

Marty 12yoM

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

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Upper Extremity Trauma Shoulder

Radiographs: Oblique Humerus Ext. Rotated

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

Anterior Medial view

Grashey* view

GHJ

Marty 12yoM

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

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 *1965 Atlas typischer Röntgenbilder vom normalen Menschen p.38-39 [books.google.com] 18/72

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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

Less stuff to penetrate here
Than here

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Boomerang Filter

Bones ©©©
Radiographs
● AP & Obl
● Ax & WP
AC Injury
GH Dislocate
Anterior
Posterior
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Final Case
Conclusion

Sometimes we can see the filter on radiographs

Well exposed ACJ
Well exposed GHJ
Usually we see only the internal radiopaque tracer chain

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Boomerang Filter

ACJ way over-exposed
ACJ now well-exposed

Technologist forget to use boomerang filter
Repeated with boomerang filter in place

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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:

Oblique "Grashey"
Axillary (supine)
West Point (prone)

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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

Coracoid anterior
Articular surface humeral head
Articular surface glenoid
X-Rays

F,K 16yoF

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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

Acromion
ACJ
Articular surface glenoid
Articular surface humeral head
Coracoid (anterior)
X-Rays

F,K 16yoF

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Radiographs: West Point vs Axillary

AP view (upright) QA: No filter
3 metal Mitek suture anchors in Anterior Glenoid
Anterior Glenoid
Bankart Reconstruct
West Point view
S,T 35yoM recurrent anterior shoulder dislocations

Axillary view (supine)
Coracoid (anterior)
Clavicle
Parallelism

Both well show GHJ width/alignment
 > Ax: Anterior glenoid overlaps clavicle
 > WP: Well shows anterior glenoid

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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:

Merrill's Atlas of Radiographic Positioning and Procedures
12 Ed. Vol. 1 ©2012 [Print Replica] [Kindle Edition]

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Upper Extremity Trauma

Radiographs: AC Joints (Bilateral)

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

Without weights
This is what we do at UW

Anatomic alignment of Acromia with lateral ends of Clavicles

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Upper Extremity Trauma Shoulder

Radiographs: AC Joints (Bilateral)

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

We don't use weights at UW

"Weights should be attached to wrists as shown and not held in hands."

Merrill's Atlas of Radiographic Positioning and Procedures
12 Ed. Vol. 1 ©2012 [Print Replica] [Kindle Edition] Fig. 5-55

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Upper Extremity Trauma

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

Rockwood & Green's Fractures in Adults
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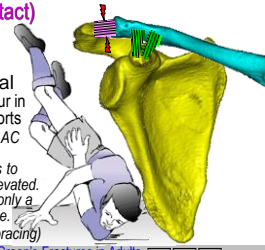
Acromioclavicular Injury: Type 1

Bones (S, C, H)
Radiographs
 AP & Obl
 Ax & WP
 Y & ACJ

AC Lig: Sprain (intact)
CC Lig: Intact
ACJ: Aligned

AC Injury
GH Dislocate
 Anterior
 Posterior
 CT
 Final Case
 Conclusion

✓ 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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Rockwood & Green's Fractures in Adults
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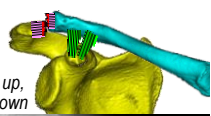
Acromioclavicular Injury: Type 2

Bones (S, C, H)
Radiographs
 AP & Obl
 Ax & WP
 Y & ACJ


AC Lig: Torn
CC Lig: Intact
ACJ: Subluxated

AC Injury
GH Dislocate
 Anterior
 Posterior
 CT
 Final Case
 Conclusion

✓ While clavicle appears displaced up, it's the scapula that's displaced down



Symptomatic **Asymptomatic**



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Rockwood & Green's Fractures in Adults
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Acromioclavicular Injury: Type 3

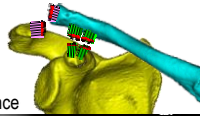

Bones (S, C, H)
Radiographs
 AP & Obl
 Ax & WP
 Y & ACJ

AC Lig: Torn
CC Lig: Torn
ACJ: Dislocated

✓ C→C distance is increased
 less than twice the normal distance

AC Injury
GH Dislocate
 Anterior
 Posterior
 CT
 Final Case
 Conclusion

Symptomatic **Asymptomatic**

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Upper Extremity Trauma Shoulder

Acromioclavicular Injury: Type 5

Bones (S, C, H)
Radiographs
 AP & Obl
 Ax & WP
 Y & ACJ



AC Lig: Torn
CC Lig: Torn
ACJ: Very Dislocated

✓ C→C distance is increased
 more than twice the normal distance

AC Injury
GH Dislocate
 Anterior
 Posterior
 CT
 Final Case
 Conclusion

Deltoid/Trapezius muscles are torn from clavicle

Symptomatic **Asymptomatic**

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Acromioclavicular Injury: Type 4

Bones (S, C, H)
Radiographs
 AP & Obl
 Ax & WP
 Y & ACJ

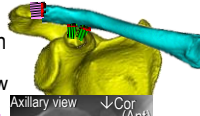
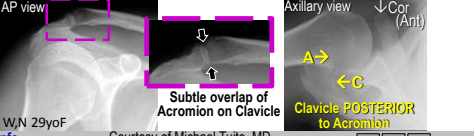
AC Lig: Torn
CC Lig: Torn

✓ Clavicle Posterior to Acromion
 ✓ Hard to see on AP view
 ✓ Need to look at Axillary view

AC Injury
GH Dislocate
 Anterior
 Posterior
 CT
 Final Case
 Conclusion

This type is very rare

Symptomatic **Asymptomatic**

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

W,N 29yoF
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Upper Extremity Trauma Shoulder



Acromioclavicular Injury: Type 6

Bones (S, C, H)
Radiographs
 AP & Obl
 Ax & WP
 Y & ACJ

AC Lig: Torn
CC Lig: Torn

AC Injury
GH Dislocate
 Anterior
 Posterior
 CT
 Final Case
 Conclusion

This type is so rare I've never seen one

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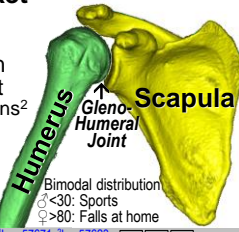
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Upper Extremity Trauma Shoulder

Shoulder: 3 Bones & 2 Joints

Bones ☉☉☉☉
Radiographs
 AP & Obi
 Ax & WP
 Y & ACJ
 AC Injury
 GH Dislocate
 Anterior
 Posterior
 CT
 Final Case
 Conclusion

GHJ: Shallow Socket
 > Glenoid covers only ~25% humeral head¹
 ☉ 360° range of motion
 ☉ **Most dislocated joint**
 ✓ 45% of ALL dislocations²
 ~70,000/year in US³



Shoulder Dislocation Incidence Rate

Age Group	Male	Female
0-9	0	0
10-19	0	0
20-29	0	0
30-39	0	0
40-49	0	0
50-59	0	0
60-69	0	0
70-79	0	0
80-89	0	0
>90	0	0


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

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Shoulder Range of Motion

Bones ☉☉☉☉
Radiographs
 AP & Obi
 Ax & WP
 Y & ACJ
 AC Injury
 GH Dislocate
 Anterior
 Posterior
 CT
 Final Case
 Conclusion

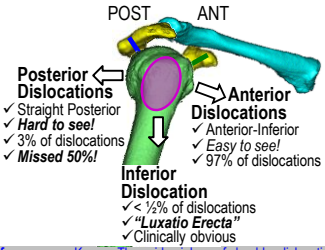


www.schreibman.info Nature v498 483-6 27 June 2013
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Upper Extremity Trauma Shoulder

Gleno-Humeral Dislocations

Bones ☉☉☉☉
Radiographs
 AP & Obi
 Ax & WP
 Y & ACJ
 AC Injury
 GH Dislocate
 Anterior
 Posterior
 CT
 Final Case
 Conclusion



Posterior Dislocations
 ✓ Straight Posterior
 ✓ Hard to see!
 ✓ 3% of dislocations
 ✓ Missed 50%!

Anterior Dislocations
 ✓ Anterior-Inferior
 ✓ Easy to see!
 ✓ 97% of dislocations

Inferior Dislocation
 ✓ < 1/2% of dislocations
 ✓ "Luxatio Erecta"
 ✓ Clinically obvious

3 Limbs:
 ✓ Body
 ✓ Inferior
 ✓ Coracoid
 ✓ Anterior
 ✓ Spine
 ✓ Posterior

✓ Glenoid
✓ Shallow Socket


www.schreibman.info Krener: The epidemiology of shoulder dislocations. Arch Orthop Trauma Surg. 1989;108:288-90. 39/72
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Upper Extremity Trauma Shoulder

GH Dislocations: Inferior

Bones ☉☉☉☉
Radiographs
 AP & Obi
 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"

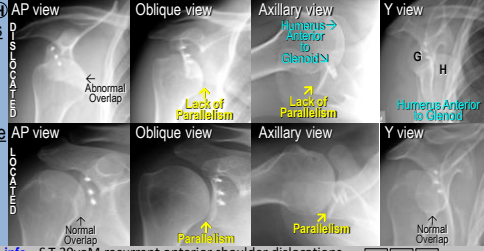


www.schreibman.info B,T 40yoM 1 hour later after reduction in ED
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Upper Extremity Trauma Shoulder

GH Dislocations: Anterior

Bones ☉☉☉☉
Radiographs
 AP & Obi
 Ax & WP
 Y & ACJ
 AC Injury
 GH Dislocate
 Anterior
 Posterior
 CT
 Final Case
 Conclusion



AP view: Abnormal Overlap

Oblique view: Lack of Parallelism

Axillary view: Humerus Anterior to Glenoid, Lack of Parallelism

Y view: Humerus Anterior to Glenoid, Normal Overlap

Normal Overlap: Parallelism


www.schreibman.info S,T 39yoM recurrent anterior shoulder dislocations 41/72
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Upper Extremity Trauma Shoulder

GH Dislocations: Subcoracoid

Bones ☉☉☉☉
Radiographs
 AP & Obi
 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
 2/3 Anterior Dislocations are subcoracoid



AP view: Cor, H

Oblique view: Cor, H

Y view: Cor, H

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Upper Extremity Trauma: Shoulder

Upper Extremity Trauma Shoulder

GH Dislocations: Subglenoid

Bones (S, C, H)
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
 1/3 Anterior Dislocations are **subglenoid**

AP view Oblique view Axillary view

www.schreibman.info YC 90yoF
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Upper Extremity Trauma Shoulder

GH Dislocations: Anterior

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

2 Very rare types (I've never seen either...)
 > Subclavicular > Intrathoracic

www.schreibman.info www.radiologyassistant.nl Courtesy of Michael Tuite, MD
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Upper Extremity Trauma Shoulder

GH Dislocations: Anterior

Bones (S, C, H)
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=2/3, Subglenoid=1/3
 ✓ Subclavicular, Intrathoracic, Luxatio Erecta = all rare

Can have characteristic fractures:
 > Humeral Head (**Hill-Sachs**)
 ✓ 40-90% single disloc. ~100% recurrent dislocations
 > Anterior Glenoid (**Bony Bankart**)

www.schreibman.info Rockwood & Green [Kinote Edition] Loc 57895
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Upper Extremity Trauma Shoulder

GH Dislocations: Hill-Sachs

Bones (S, C, H)
Radiographs
 AP & Obl
 Ax & WP
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 Final Case
 Conclusion

AP view Oblique view Axillary view **Hill-Sachs**

Abnormal Overlap Lack of Parallelism H-S G

Normal Overlap Parallelism H-S G

Posterior Humeral Head impacted on Anterior Glenoid
 > Creating wedged fracture in the postero-superolateral humeral head

Hill-Sachs Defect

www.schreibman.info P,D 24yoF Hill, Sachs: The Grooved Defect of the Humeral Head, Radiology 1940: 35:690-700
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Upper Extremity Trauma Shoulder

Mechanism

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

www.schreibman.info Bankart: The Pathology and Treatment of Recurrent Dislocation of the Shoulder. JBJS 1938 v26 p23-9
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Upper Extremity Trauma Shoulder

GH Dislocations: Bankart Fx

Bones (S, C, H)
Radiographs
 AP & Obl
 Ax & WP
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 Anterior
 Posterior
 CT
 Final Case
 Conclusion

H,D 35yoM P,C 32yoM

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Upper Extremity Trauma: Shoulder

Upper Extremity Trauma Shoulder

Bankart: Often best seen on WP

Bones Oblique view Axillary view Axillary view: Clavicle overlaps anterior glenoid West Point view

Radiographs AP & Obl Ax & WP Y & ACJ AC Injury GH Dislocate

Anterior Posterior CT Final Case Conclusion

No fracture seen

West Point view: Well shows anterior glenoid

E,H 20yoM

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Upper Extremity Trauma Shoulder

Dislocations: Anterior v Posterior

Bones Anterior Dislocations (97%) Posterior Dislocations (3%)

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% Electrocuting
 Internal Rotators overwhelm weaker External Rotators

W,F 19yoM Recurrent S,C 58yoF Bike v Car

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Upper Extremity Trauma Shoulder

Posterior Dislocation Clues: 1

Humerus Stuck in Internal Rotation

Bones Radiographs AP & Obl Ax & WP Y & ACJ AC Injury GH Dislocate

Anterior Posterior CT Final Case Conclusion

GT en face GT en face

Humeral Head is in Internal Rotation Humeral Head still is in Internal Rotation

Int Rot Ext Rot 58y e v

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Upper Extremity Trauma Shoulder

Posterior Dislocation Clues: 2

Lack of Parallelism on Oblique View

Bones Radiographs AP & Obl Ax & WP Y & ACJ AC Injury GH Dislocate

Anterior Posterior CT Final Case Conclusion

Dislocated Relocated

Lack of Parallelism Parallelism

Articular surface humeral head Articular surface glenoid

S,C 58yoF Bike v Car

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Posterior Dislocation Clues: 3!

Look at the Axillary/WP View!

Bones Radiographs Oblique AP West Point! (glenoid) (subscap) (acromioclav) ↓

AC Injury GH Dislocate

Anterior Posterior CT Final Case Conclusion

Lack of Parallelism Humeral Head stuck in Internal Rotation

Humeral Head Posterior to Glenoid!

H G H ↓

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Upper Extremity Trauma Shoulder

Posterior Dislocation Clues: Bonus

Trough Line Sign (Reverse Hill-Sachs)

Bones Radiographs AP West Point

AC Injury GH Dislocate

Anterior Posterior CT Final Case Conclusion

Anterior Dislocation: AP
 ✓ Anterior Glenoid impacts into
 ✓ Posterior Humerus
 ✓ "Hill-Sachs"

Posterior Dislocation:
 ✓ Posterior Glenoid impacts into
 ✓ Anterior Humerus
 ✓ Trough Line Sign

Axial CT (after relocation) ↓ Biceps ↓ LT ↓

← TLS → TLS

AJR 1978; 130: 945-950

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Upper Extremity Trauma: Shoulder page 10 of 12

Upper Extremity Trauma Shoulder

Shoulder Exams at UW DOR

Bones ©C®
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

www.schreibman.info This is actual research I did for this talk
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Upper Extremity Trauma Shoulder

Shoulder: What to Order When

Bones ©C®
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

www.schreibman.info *Lee & Rosas AJR online 2010 v195 n3 Video Article
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Upper Extremity Trauma Shoulder

Optimizing Bone CT: General

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

- Optimize Patient Positioning**
 - ✓ Try to center the bone
 - ✓ Get other bones/metal out of scanning FOV
- Optimize Scanning Technique**
 - ✓ Thin slices, 50% overlap
 - ✓ Use small focal spot, small display FOV
- Optimize Reformats**
 - ✓ 2D: Angle slices relative to ANATOMY
 - ✓ 3D: Rotate & Segment

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Upper Extremity Trauma Shoulder

Optimizing Bone CT: Shoulder

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

Shrug UP ipsilateral
Shrug DOWN contralateral
Scooch patient over

Gets contralateral shoulder out of scan FOV, minimizing streak artifacts from that side

CT: AP Scout S:A 66yoM
"Schreibman Shrug"

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Upper Extremity Trauma Shoulder

Optimizing Bone CT: Shoulder

- 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!**

Gets metal contralateral shoulder out of scan FOV
ABER keeps metal contralateral shoulder within the scan FOV

CT: AP Scout S:A 66yoM
"Schreibman Shrug"

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Upper Extremity Trauma Shoulder

Optimizing Bone CT: General

- Optimize Scanning Technique**

(This is what my physicist tells me..)

 - 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: page 11 of 12 Shoulder

Upper Extremity Trauma Shoulder

GE CT Scanner mA Limits		140 kV	120 kV	100 kV	80 kV	What kV to use?	
Bones [®] CT [®] H Radiographs AP & ObI Ax & WP Y & ACJ AC Injury GH Dislocate Anterior Posterior CT Final Case Conclusion	Scanner Name	Scan FOV					
	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
		Revolution Evo & Optima CT660	Small Focal Spot	10 - 335	10 - 335	10 - 310	10 - 300
		LightSpeed 16, & LightSpeed 8	Large Focal Spot	515	560	480	400
			Small Focal Spot	10 - 170	10 - 200	10 - 240	10 - 300
			Large Focal Spot	380	440	420	400
			Small Focal Spot	10 - 170	10 - 200	10 - 240	10 - 300

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

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Upper Extremity Trauma Shoulder

Optimizing Bone CT: General

Bones[®]CT[®]H
Radiographs
AP & ObI
Ax & WP
Y & ACJ
AC Injury
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Posterior
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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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Upper Extremity Trauma Shoulder

Optimizing Bone CT: General

Bones[®]CT[®]H
Radiographs
AP & ObI
Ax & WP
Y & ACJ
AC Injury
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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 ≈ 1/2mm

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Upper Extremity Trauma Shoulder

Optimizing Bone CT: Shoulder

Bones[®]CT[®]H
Radiographs
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Conclusion

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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Upper Extremity Trauma Shoulder

Optimizing Bone CT: Shoulder

Bones[®]CT[®]H
Radiographs
AP & ObI
Ax & WP
Y & ACJ
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Conclusion

3) Optimize Reformats

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

Overly aggressive shrugs:
Angle axial reformats

Coronal slices angled perpendicular to GHJ

Sagittal slices angled parallel to GHJ

CT: Axial image through GHJ

Slices should not be coronal to the table

Also, all these annotations should be turned off

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Upper Extremity Trauma Shoulder

Optimizing Bone CT: Shoulder

Bones[®]CT[®]H
Radiographs
AP & ObI
Ax & WP
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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 page 12 of 12

Upper Extremity Trauma Shoulder

One final case...

Triceps Spur
Elbow Laceration

Anterior Dislocation
✓ Subcoracoid

Surgical Neck Fracture
✓ Angulated > 45°
✓ 2-Part Fracture (at least)

GT Fx

Direct trauma was to elbow Indirect trauma was to shoulder

CT
Final Case
Conclusion

www.schreibman.info R,D 58yoM: Cleaning gutters, fell from 6ft ladder. Fell on elbow, shoulder pain

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Upper Extremity Trauma Shoulder

Multiple Views...

AP: Relocated

Cor-View (Ant)

AP: Dislocated

Axillary: Dislocated

Axillary: Relocated

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Upper Extremity Trauma Shoulder

CT: 2D Reformats

AP: Relocated 16:05

CT: Axial slice through GHJ

CT: Coronal Reformat (Perpendicular to GHJ)

AP: CT scout 17:39

Bankart Fx

CT: Sagittal Reformat (Parallel to GHJ)

Coracoid Fx

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Upper Extremity Trauma Shoulder

CT: 3D Reformats

Bones (S) (C) (R)

Radiographs
AP & Obli
Ax & WP
Y & ACJ

AC Injury
GH Dislocate
Anterior
Posterior

CT
Final Case
Conclusion

Scapula only

Coracoid

Bankart Fx

Sagittal Reformat (Parallel to GHJ)

Coronal Reformat (Perpendicular to GHJ)

Humerus only

Post ORIF

www.schreibman.info R,D 58yoM: Cleaning gutters, fell from 6ft ladder. Fell on elbow, shoulder pain

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Upper Extremity Trauma Shoulder

Goal: Better 3-D Understanding of Shoulder

Bones (S) (C) (R)

Radiographs
AP & Obli
Ax & WP
Y & ACJ

AC Injury
GH Dislocate
Anterior
Posterior

CT
Final Case
Conclusion

Objectives:

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

Three Easily Missed Dislocations:

- Every Elbow, look for Radial Head dislocation
- Every Shoulder, look for Posterior dislocation
- Every Foot, look for Lisfranc dislocation

www.schreibman.info Can download this and all of my lectures in various formats

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Upper Extremity Trauma Shoulder

Questions?

Bones (S) (C) (R)

Radiographs
AP & Obli
Ax & WP
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Anterior
Posterior

CT
Final Case
Conclusion

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