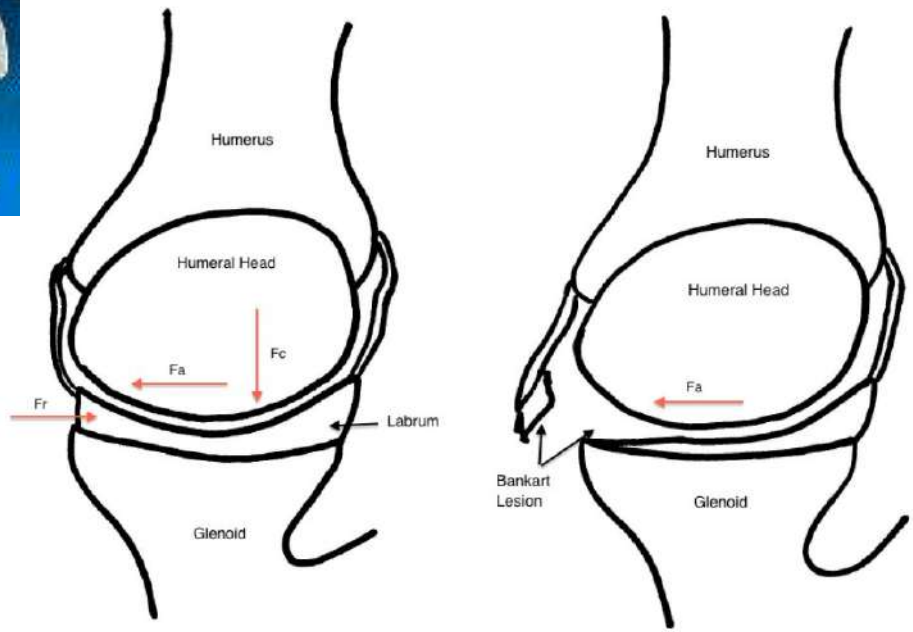


Figure 1-7. Glenohumeral Joint Concavity-Compression Effect.

Failed Bankart and Bone loss

The relationship between bone loss and failure of Bankart repair was first noted in a 1978 report by Rowe and colleagues.

Burkhart and DeBeer demonstrated that isolated arthroscopic Bankart repair has a significantly higher failure rate in the setting of anterior bone loss in contact athletes.

Traumatic Glenohumeral Bone Defects and Their Relationship to Failure of Arthroscopic Bankart Repairs: Significance of the Inverted-Pear Glenoid and the Humeral Engaging Hill-Sachs Lesion

Stephen S. Burkhart, M.D., and Joe F. De Beer, M.D.

EVALUATION OF BONE LOSS IN COMPLEX SHOULDER INSTABILITY

TARGET ORTHO

HILL SACHS LESION

The earliest description appeared in 1861 by Flowers, but it was not until 1940 when Hill and Sachs published a concise review that the lesion adopted their names!

Incidence of bone loss

- Glenoid bone loss is extremely common and present in atleast 50-95% of cases with recurrent GHI.
- Humeral head bone loss occurs in about 93% of patients with recurrent GHI.
- Hill Sachs bone lesion occurs simultaneously with glenoid bone loss in upto 62% of patients with recurrent GHI.

MULTIPLE EPISODES

FACTORS RELATED TO FREQUENT DISLOCATIONS OR

MULTIPLE EPISODES

- Young Aged
- Return to contact or collision sports
- Hyperlaxity
- Failed soft tissue procedure (Bankart)

GAGEY's HYPERABDUCTION TEST

Evaluation of Bone Loss

Suspect Bone Loss

Quantify (%Age) Bone Loss

Access Location/ Area

Clues from History

- High-energy mechanism of injury
- Arm was abducted (≥70 ^{0}) and extended (≥30 ^{0}) at time of initial dislocation
- Patient reports that most instability occurs in midrange of motion (20 ^{0}-60 ^{0} of abduction)
- Patient notes progressive ease of instability
- Prolonged history of instability
- Mechanical symptoms such as catching and locking

Physical examination

- Shoulder apprehension test is positive in midranges of abduction (30^0-90^0) and lesser amounts of external rotation
- Anterior translation of humeral head over glenoid rim is reproducible during instability testing

Quantification of Bone Loss

Glenoid — **Humeral Head**

ANATOMY

Modalities used

- Radiography (x rays)
- CT
- MRI
- Arthroscopy

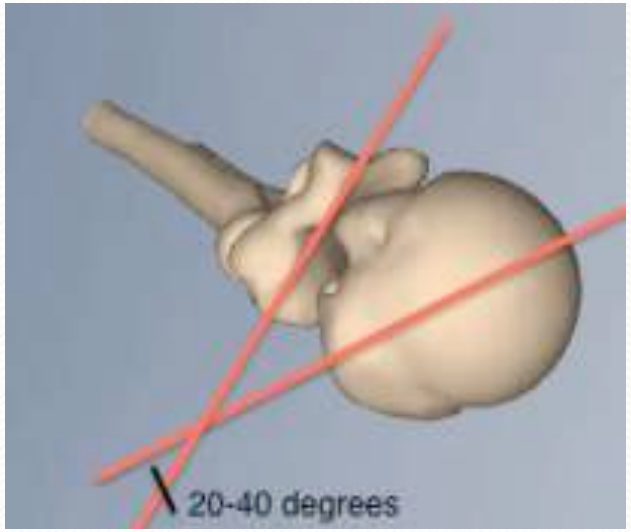
Anatomy

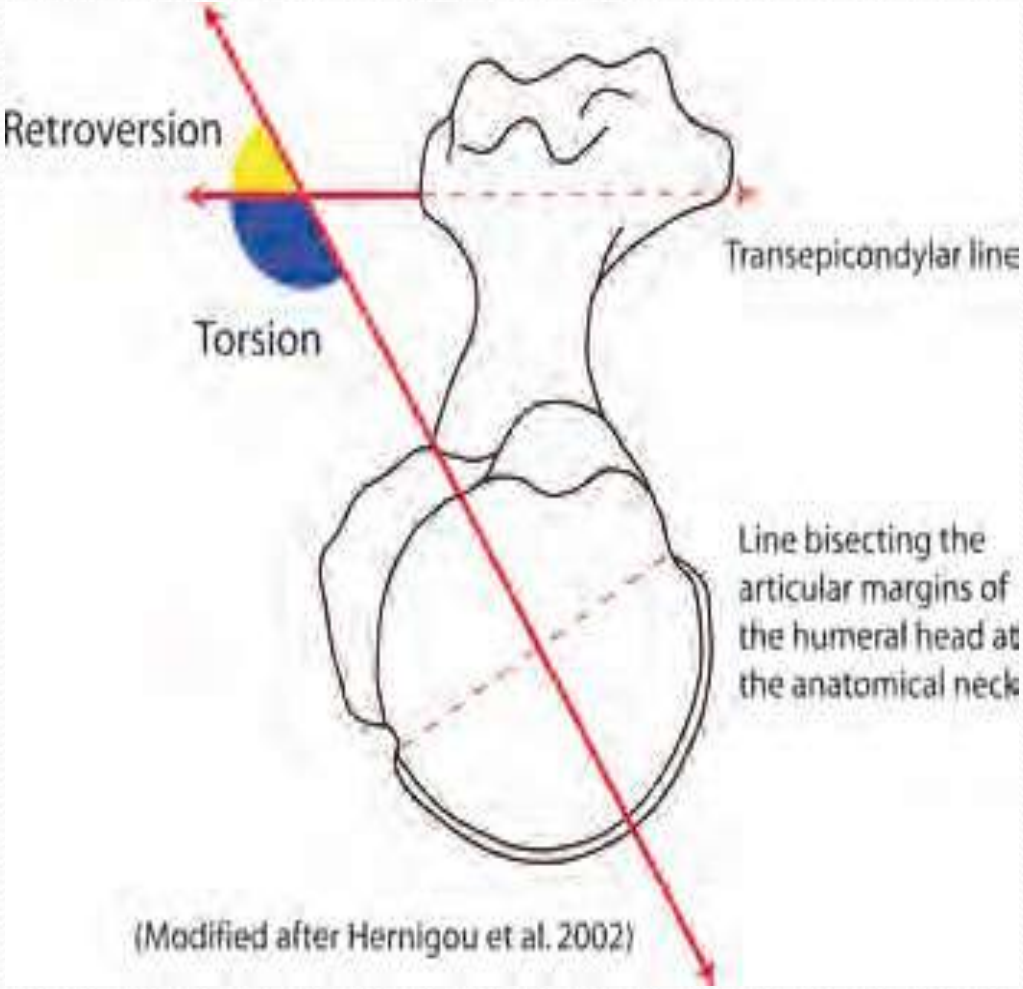
Humeral head

average diameter is 43 mm.

retroverted 30°
(from transepicondylar axis of the distal humerus)

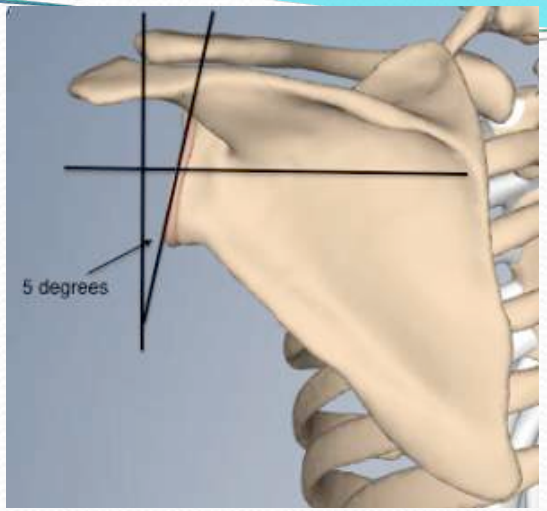
articular surface inclined upward 130° from the shaft

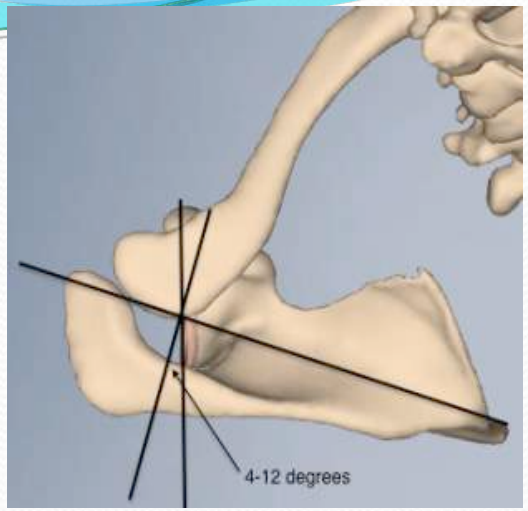




INCLINATION AND VERSION

Glenoid

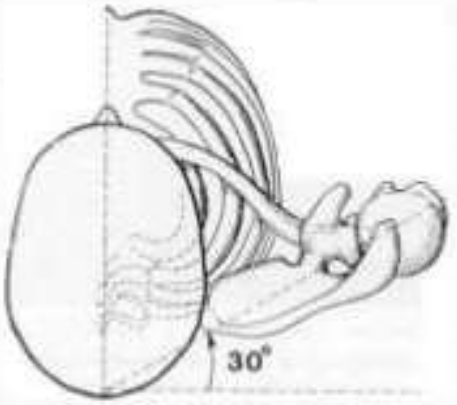




pear-shaped surface

average upward tilt of 5°

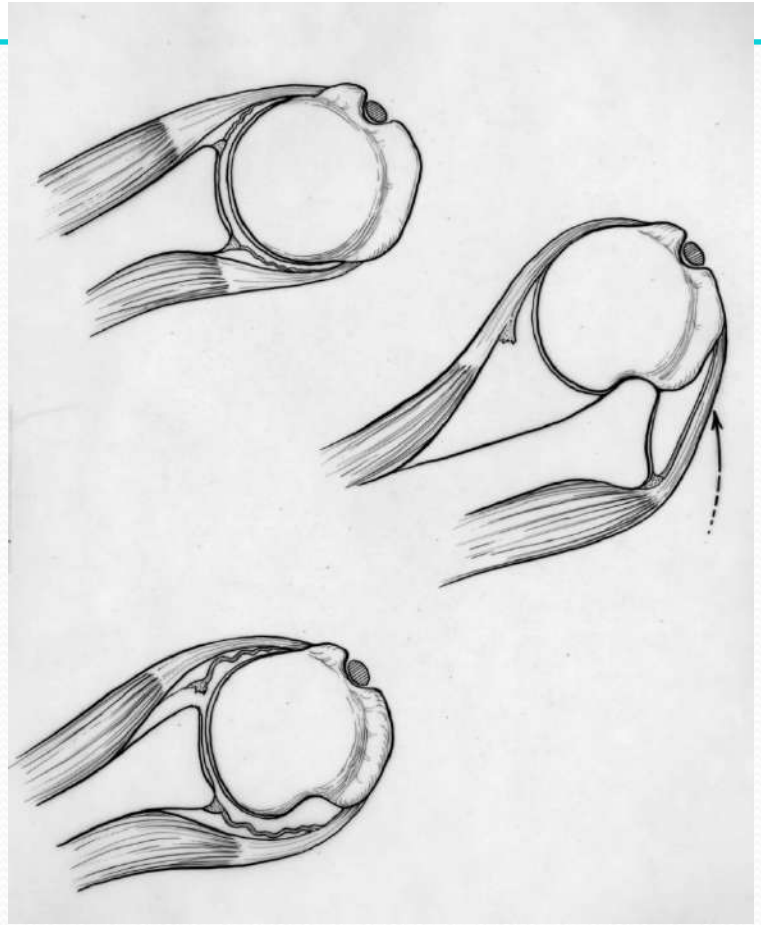
average version is 7° of retroversion (10 retro to 10 ante) in relation to the axis of the scapular



average depth of the glenoid in the anterior/posterior direction is 2.5mm compared to 9mm in the superior/inferior direction, explains, in part, the reason for minimum stability in the anterior/posterior direction.

anterior-to-posterior dimension of the glenoid at the level of the bare spot is around 24-26 mm.

Glenoid bone loss



X rays

- After dislocation, the standard of care is to obtain orthogonal anteroposterior and axillary views of the shoulder.
- This is a very accurate way to determine the adequacy of reduction, but typically underestimates anterior-inferior bone loss.

X rays

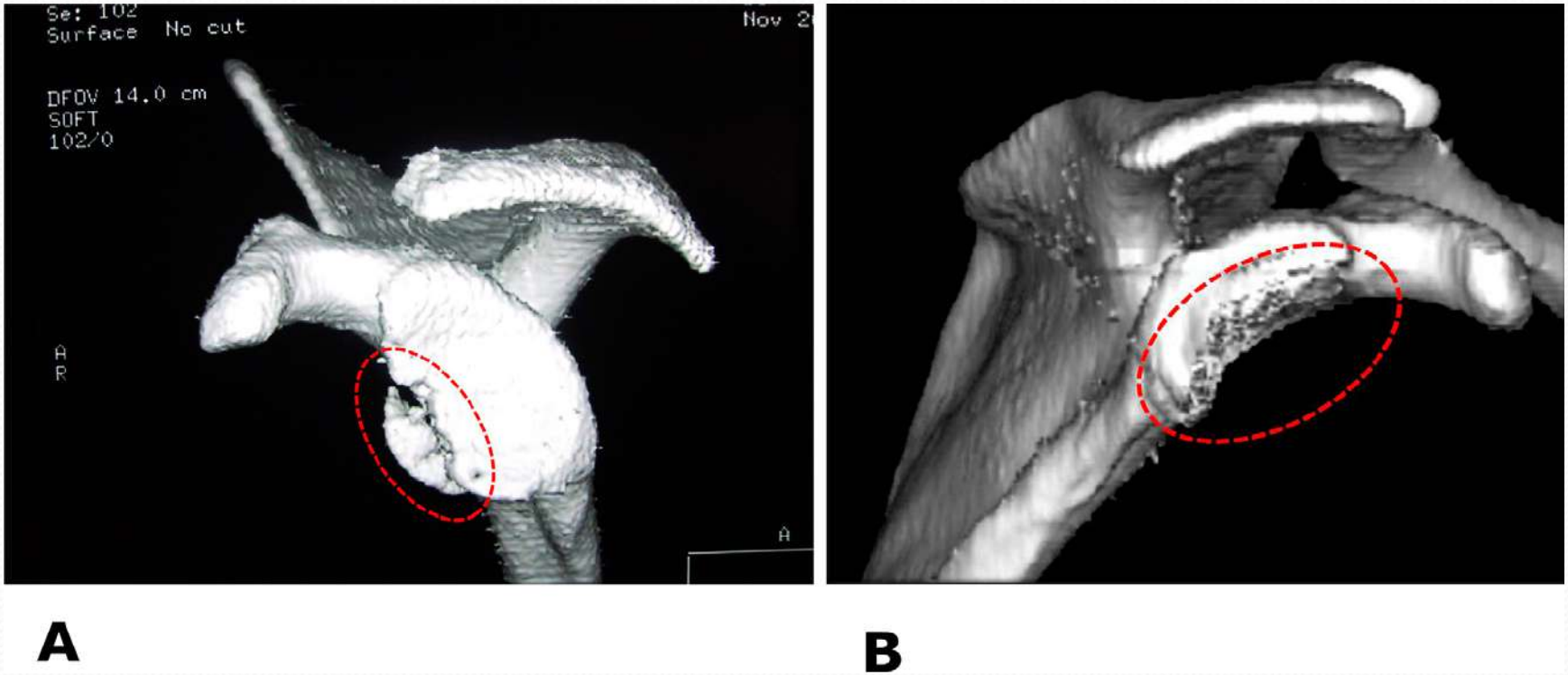
- The most useful radiographic views for glenoid bone loss are:

❖The West point view
❖Apical oblique(Garth) view
❖Bernageau view

But these X-rays can not quantify the degree of bone loss.

CT Scan

- CT is the standard for elucidating glenoid bone loss because it offers unparalleled delineation of complex anatomy.
- 3-D CT is considered as the gold standard because it allows the digital subtraction of humeral head from images of the glenohumeral complex.
- It provides information not only about the extent and magnitude of bone loss but also about the type of bone loss i.e. whether it is due to acute #, partial attritional loss or complete attritional loss.



Glenoid bone loss seen on a three-dimensional computed tomography reconstruction. Bone loss can be either acute (A) or chronic (B)

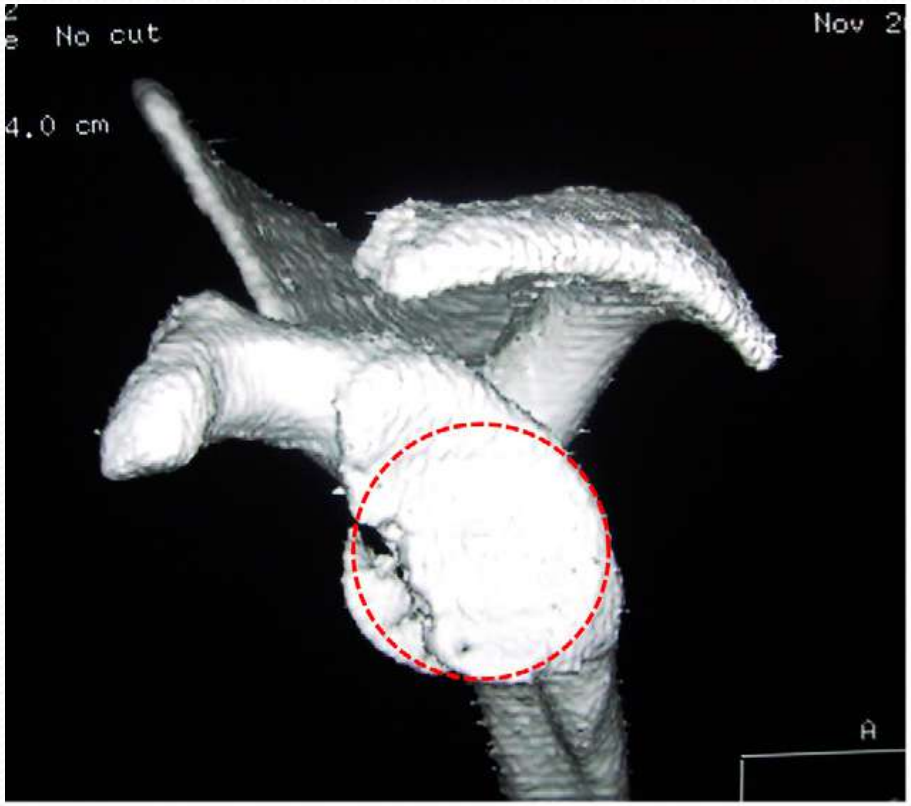
Indications for Obtaining a Computed Tomography

- Radiograph or MRI evidence of Bone loss
- High Energy Trauma
- History of multiple dislocations
- History of failed stabilization procedure
- Dislocation after trivial trauma (initial episode) or little provocation
- Instability in midranges of motion
- Inferior instability
- History of difficult reduction

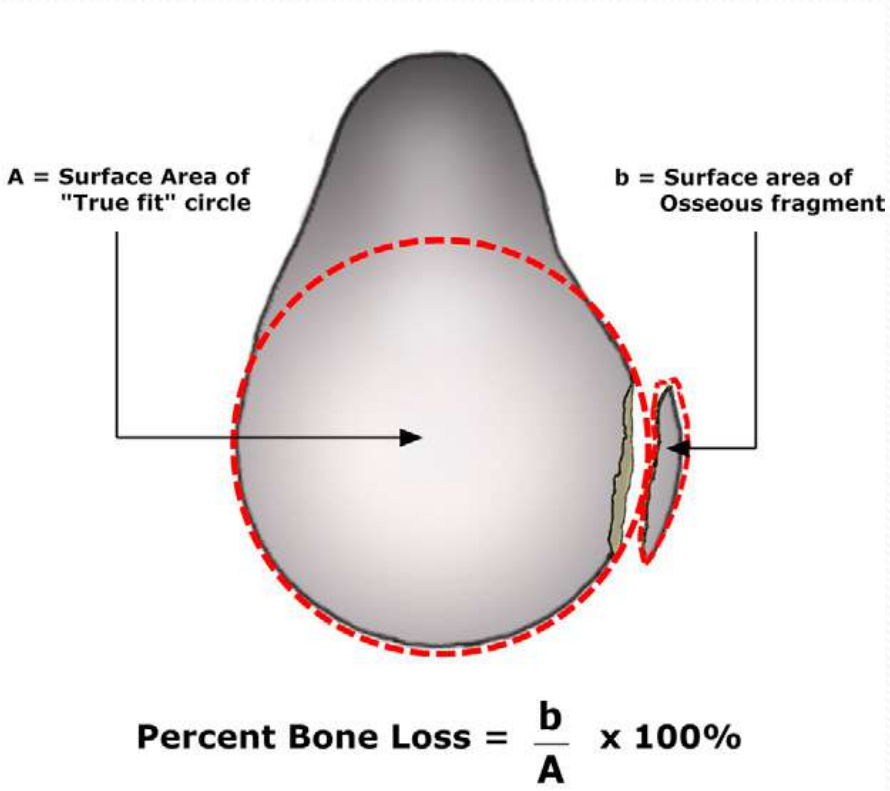
Methods of quantifying bone loss on CT Scan

- Surface area method (Pico method)
- Linear measurement method
- Glenoid index
- Length of osseous fragment
- De Filippo method

Surface area /Pico method

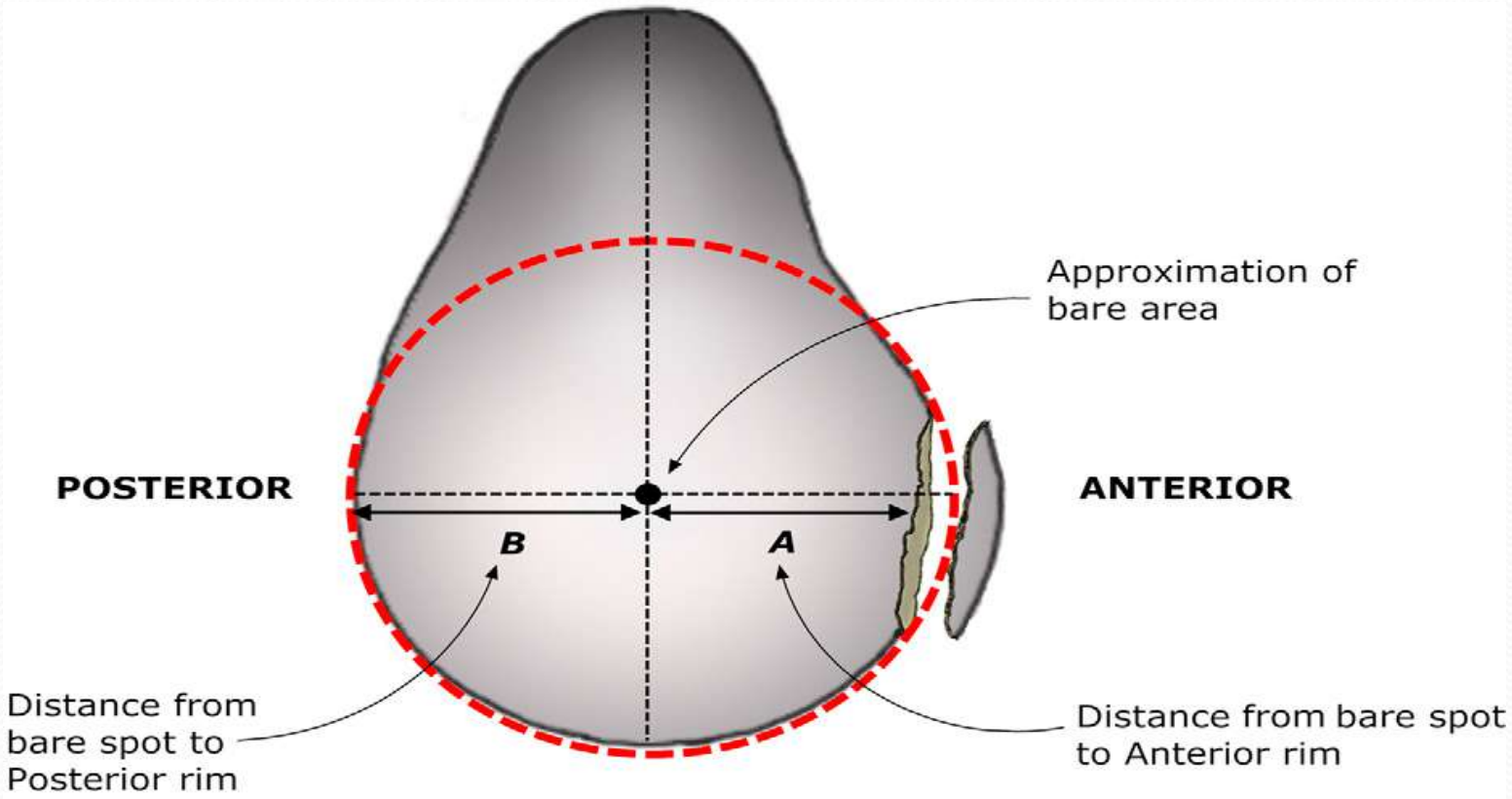


A



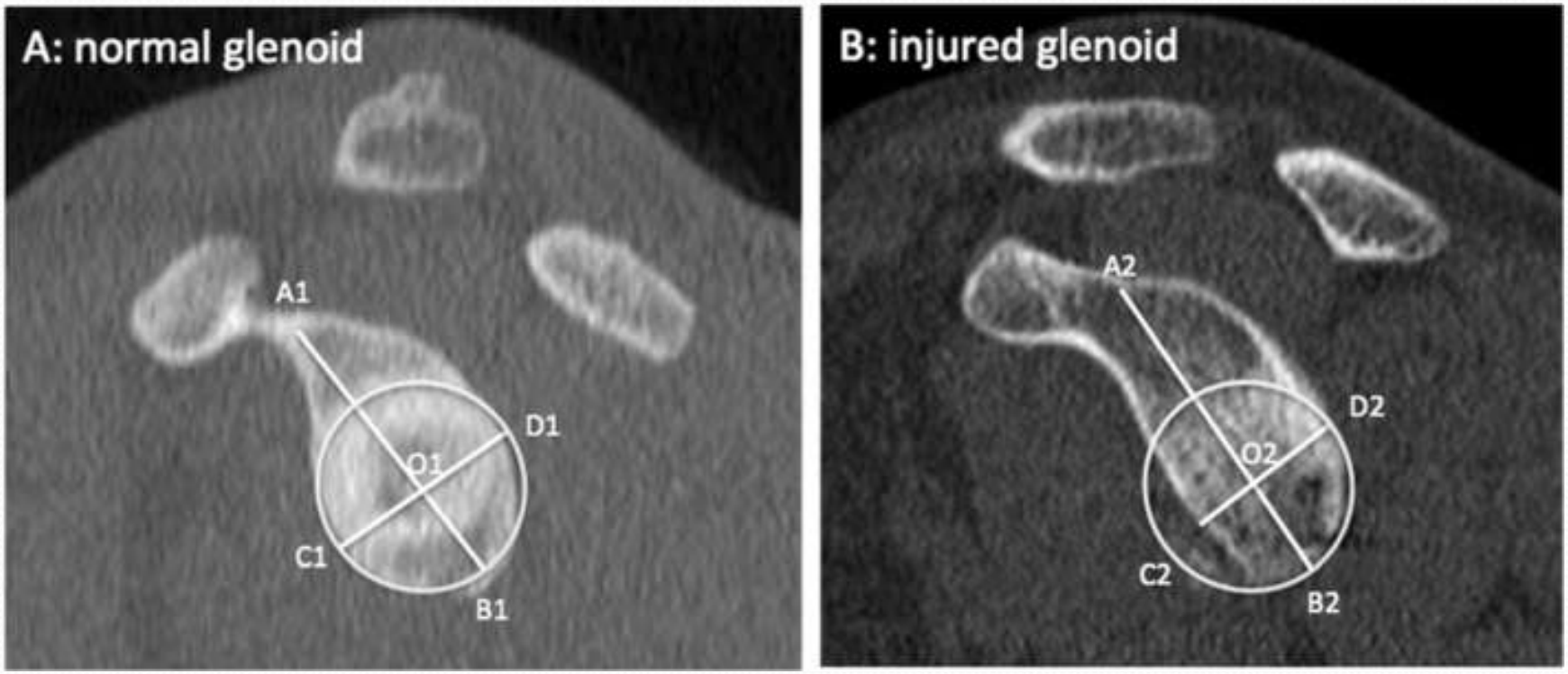
B

Linear Measurement Method



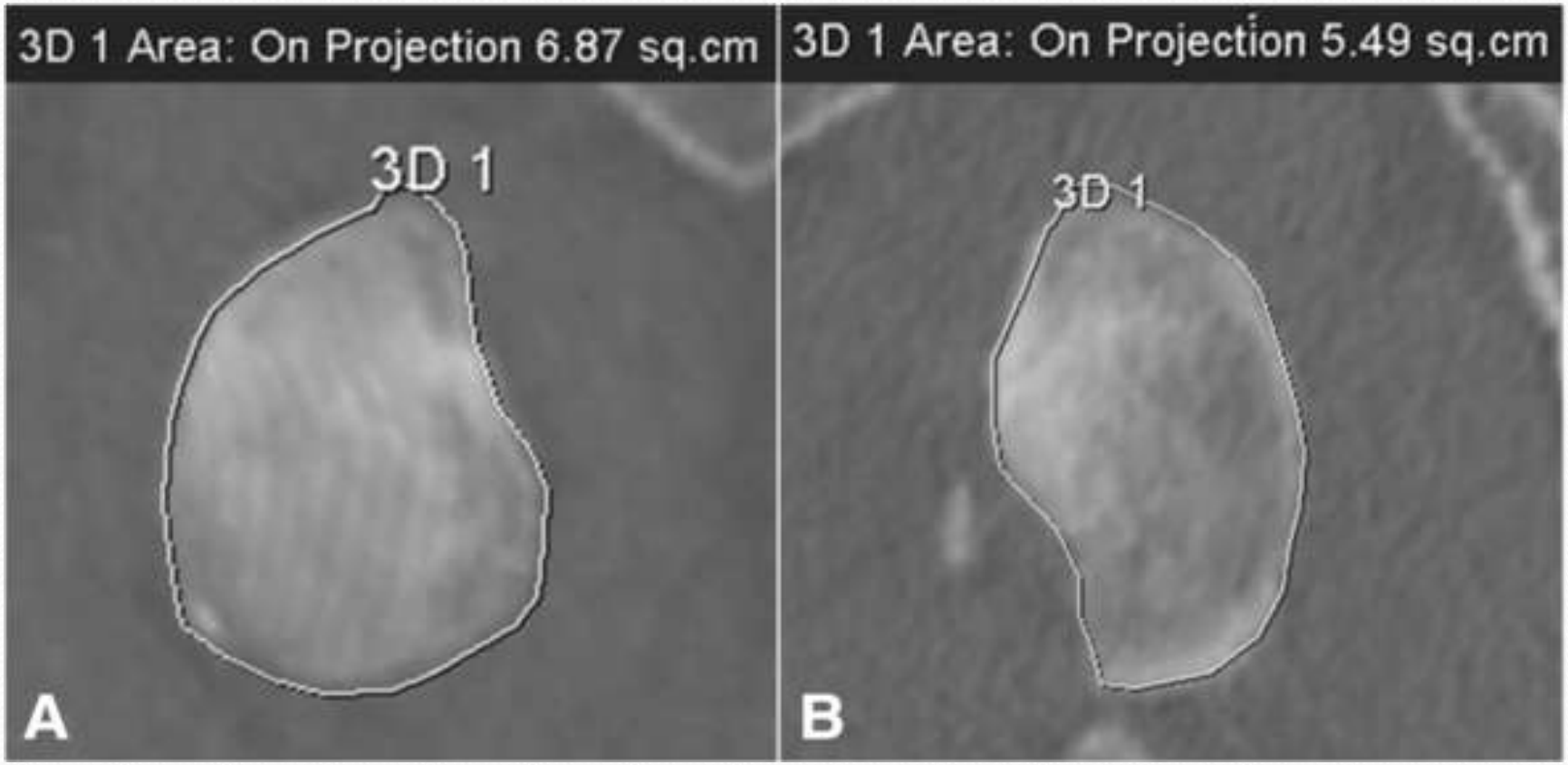
$$\text{Percent Bone Loss} = \frac{(B-A)}{2\times B} \times 100\%$$

Glenoid Index



Glenoid Index. The Glenoid Index is calculated from injured width/ normal width. Significant if less than 75%.

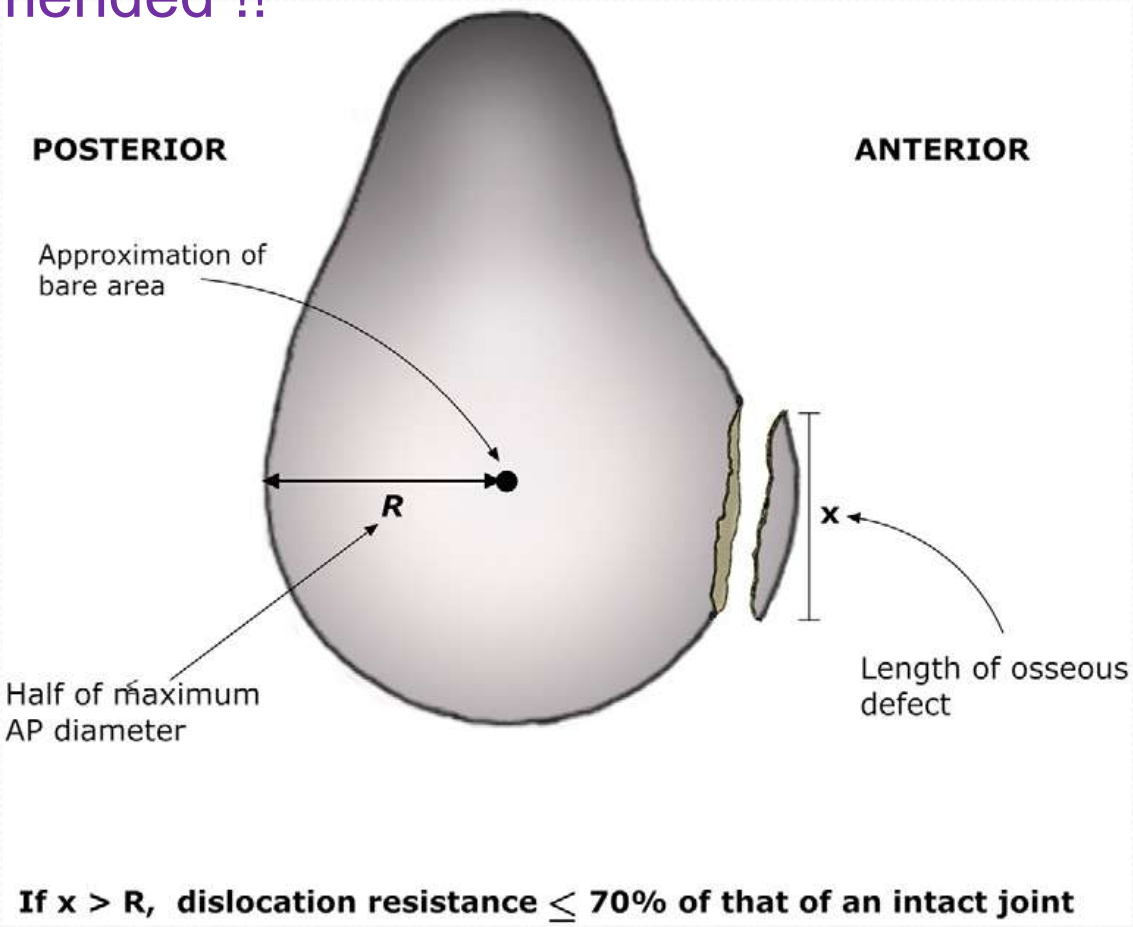
De Fillipo Method



Glenoid bone loss is calculated using CT curved MPR. Normal right glenoid (a), left glenoid with deficiency (b)

Length of Osseous Fragment

If the length of the defect is greater than the radius then bone grafting is recommended !!



If x > R, dislocation resistance $\leq$ 70% of that of an intact joint

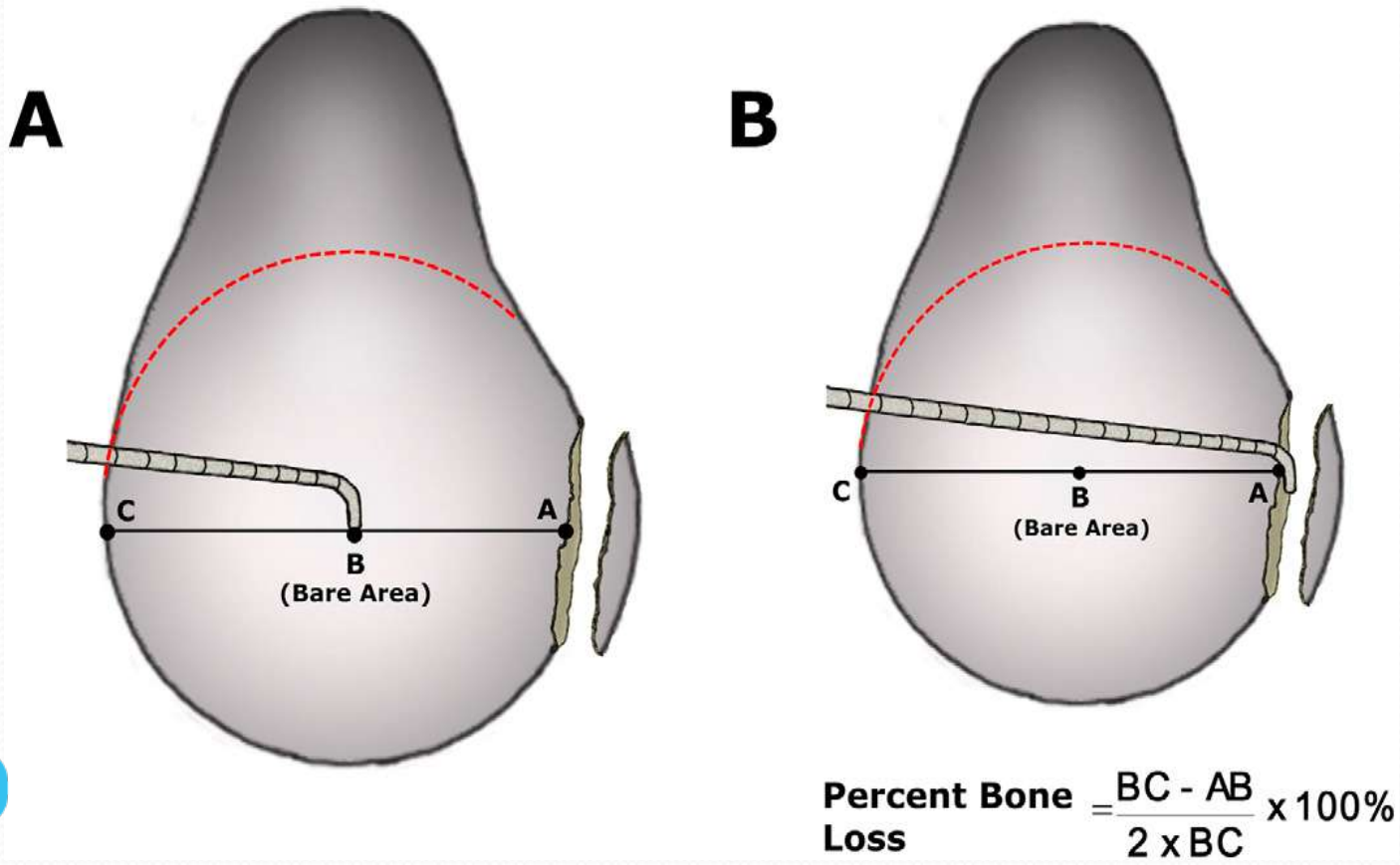
No consensus though !!

A recent review of imaging methods for quantifying bone loss found the Glenoid Index and Pico methods to be the most accurate and reliable forms of measurement !!

Burkhart and Lo

Arthroscopy

Glenoid bone loss is measured by the use of glenoid bare spot method.



ARTHROSCOPY

CT Scan

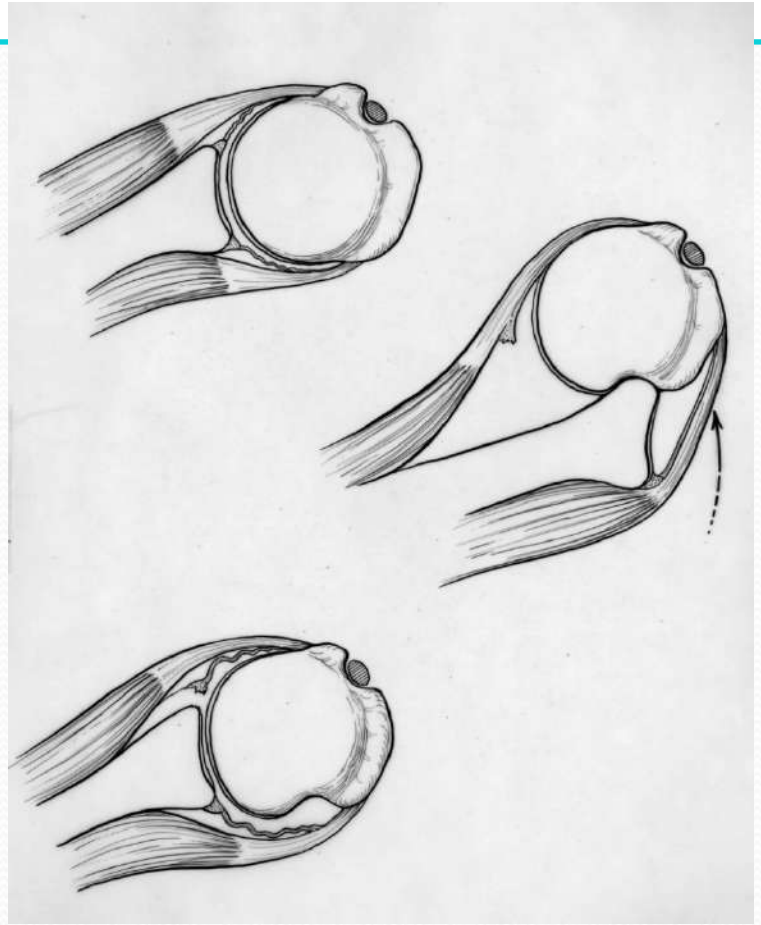
It has been shown on CT that glenoid bare spot is 1.4 mm anterior to the true center point, a finding that implies that the CT SCAN overestimate bone loss.

Categories of Glenoid bone loss

- Mild bone loss: less than 15%
- Moderate bone loss: 15%-25%
- Severe bone loss: greater than 25%

Itoi et al. (2000) (33) performed a cadaveric study looking at the stability provided with a standard Bankart repair in the setting of increasing glenoid defects. They found that once a critical defect value of 21% of the width of the glenoid was surpassed, that an isolated Bankart repair was insufficient in restoring stability and that alternative procedures to address the glenoid defect would be required.

Humeral bone loss

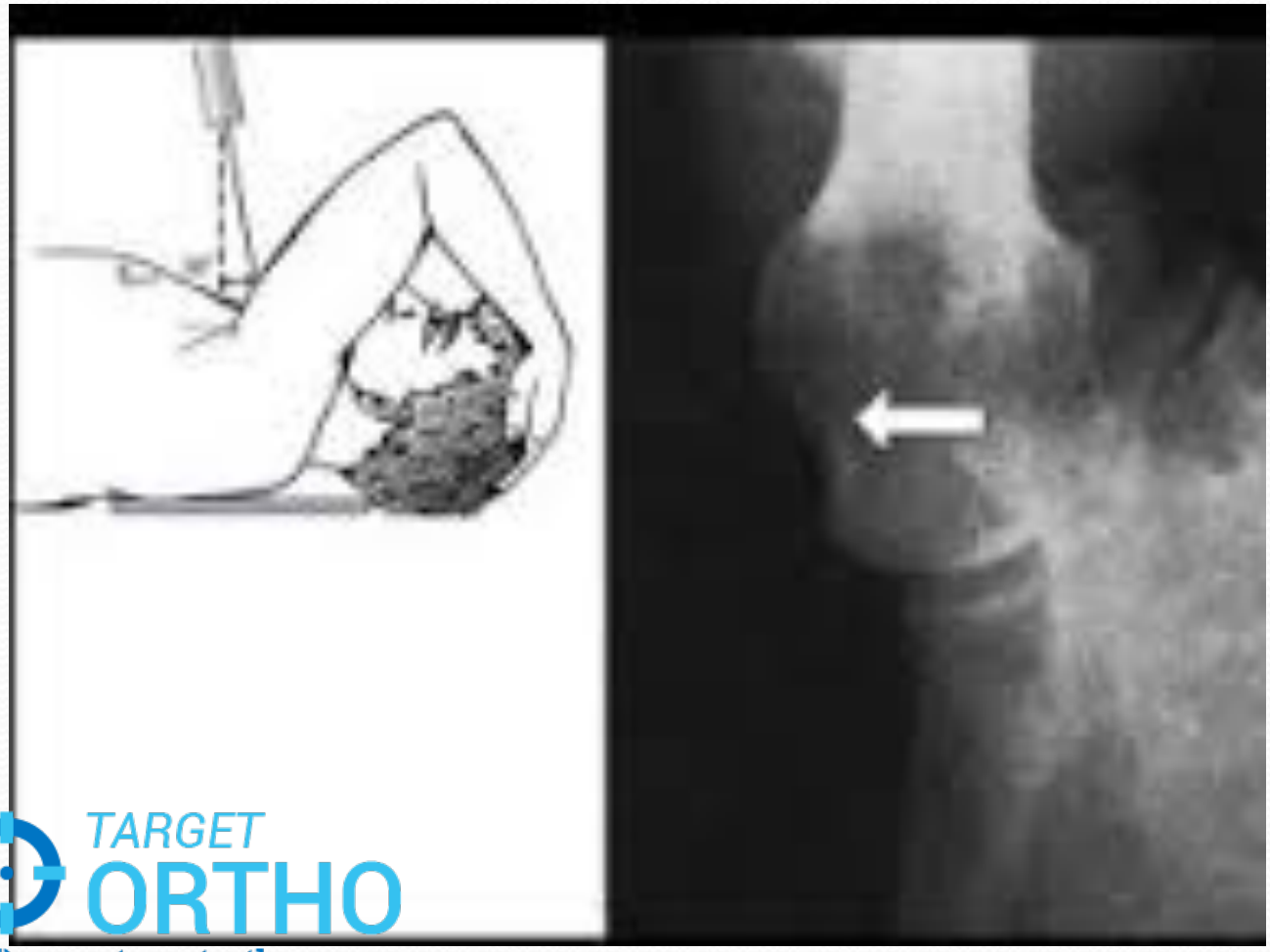


X rays to access humeral bone loss

- Stryker notch view
- AP view in internal rotation
- Garth view
- Bernageau view

Internal rotation brings the Hill-Sachs lesion into profile and away from the bony metaphysis, which may obscure it on standard AP radiographs.

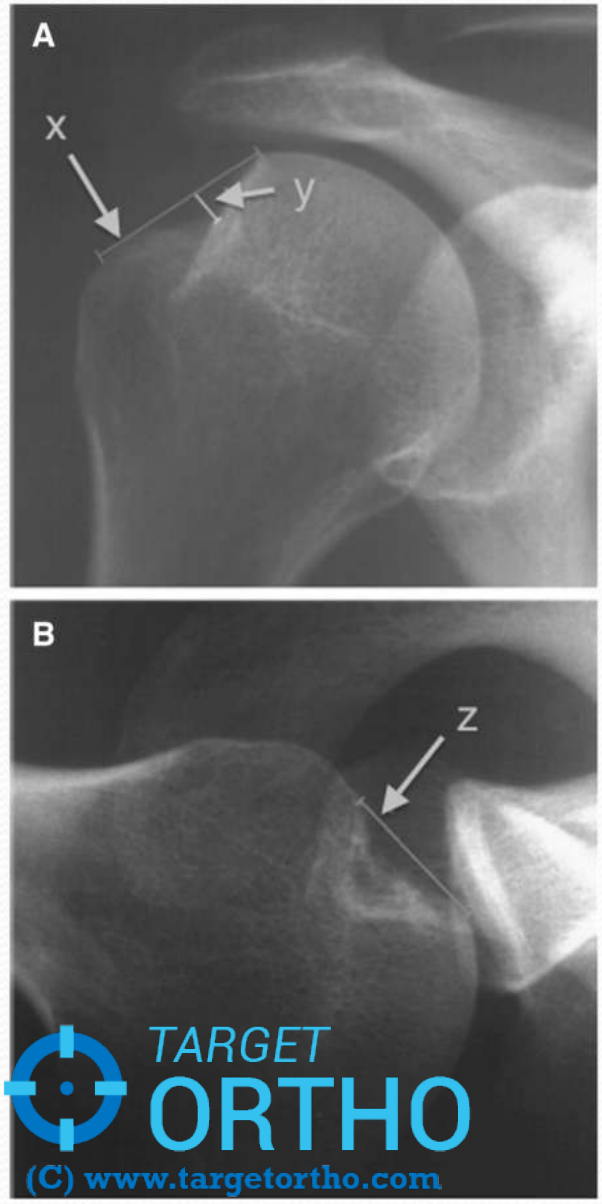
Stryker notch view



Quantifying humeral head bone loss

X rays

- In contrast to glenoid bone loss, radiographs has been shown to be useful in quantifying humeral bone loss.
- Methods used are:
  - Hill Sachs quotient
  - Hill Sachs defect depth AND humeral head radius; RATIO method



Hill Sachs Quotient

a) True AP x-ray of the humerus with the shoulder in 60° internal rotation to measure the width (x) and depth (y) of the lesion.

b) Bernageau profile view to measure the length (z) of the lesion.

The Hill-Sachs Quotient is calculated by multiplying x, y and z.

Grade: I <1.5 ; II 1.5-2.5 ; III > 2.5

Ratio method

Humeral head depth: radius ratio (d/R).

On a true AP x-ray with internal rotation, a circle template is fit to the contour of the articular surface of the humeral head and the depth of Hill-Sachs bone loss is measured.

Significant if >20%

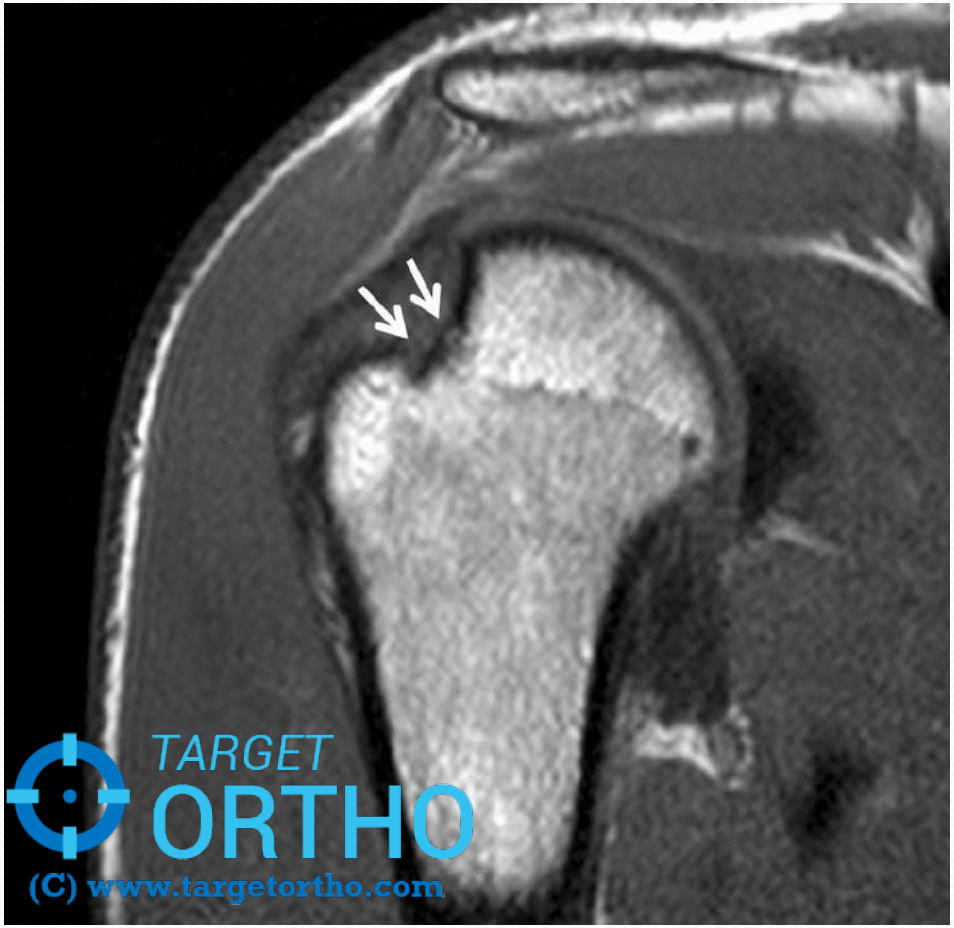
MRI

CT Scan

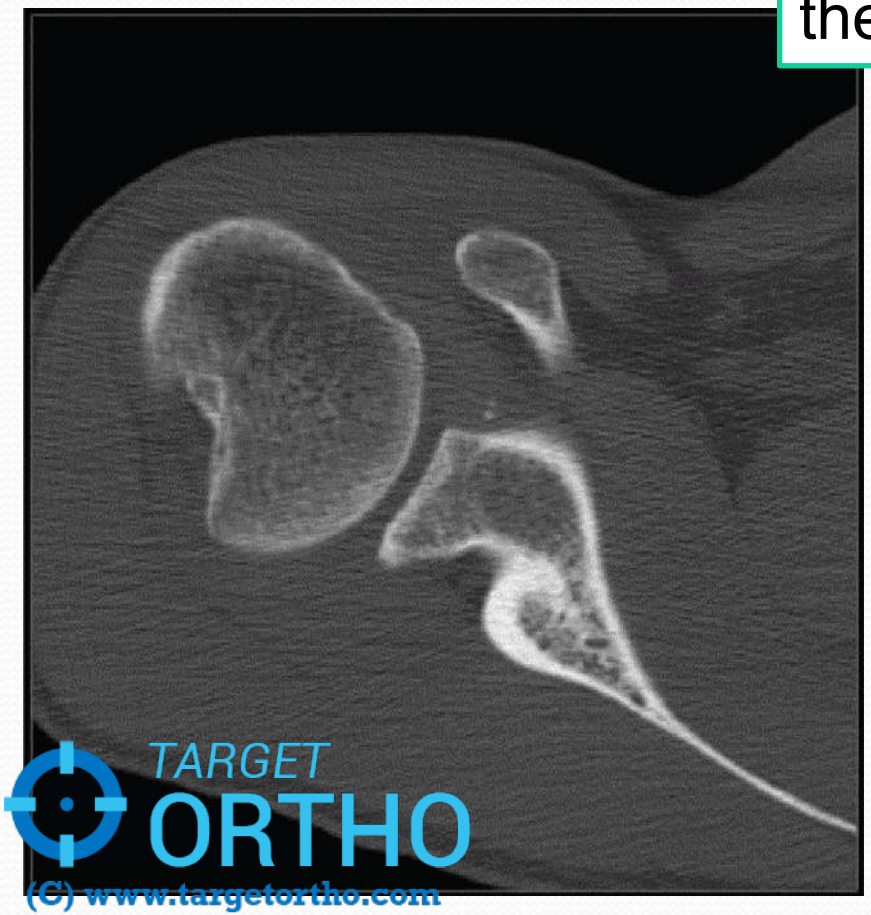
Can quantify DEPTH, WIDTH, VOLUME and access LOCATION very accurately !!

100 % sensitivity BUT Poor corelation with size measured on CT or Arthroscopy

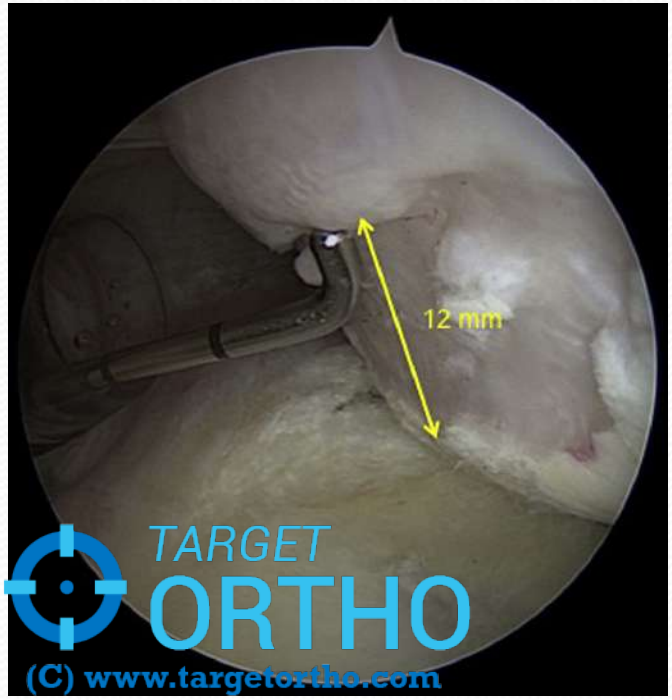
MRI



On an axial image, the size of the wedge-shaped lesion is determined as a percentage of the circular intact humeral head.



Arthroscopy



- Arthroscopy allows the surgeon to accurately and dynamically determine the clinical relevance of a humeral head compression fracture.
- Viewing from a standard posterior portal, the humerus is manually abducted and externally rotated while visualizing the glenohumeral articulation. This establishes whether the Hill-Sachs lesion is of adequate size and orientation to “engage” the glenoid.

Stephen S. Burkhart, M.D., and Joe F. De Beer, M.D.
Arthroscopy: The Journal of Arthroscopic and Related Surgery, Vol 16, No 7 (October), 2000

Burkhart and De Beer recognized that one of the risk factors for failure of arthroscopic stabilization was based on the anatomic relation of the bone loss affecting the humeral head and the glenoid in critical positions.

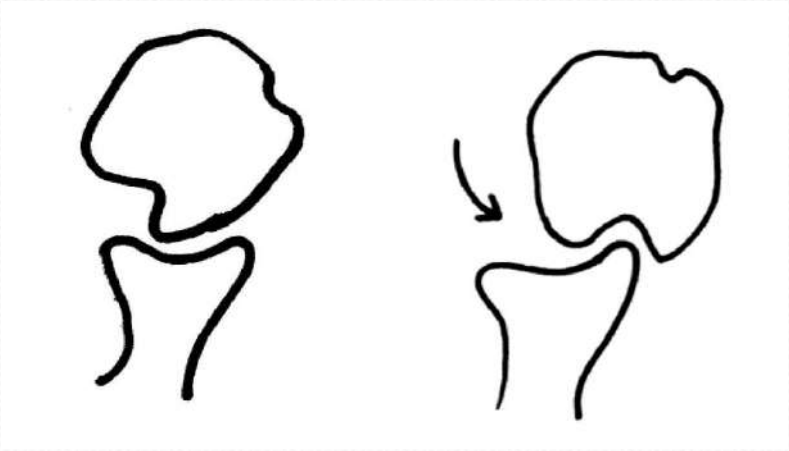
They introduced the concept of "significant bone loss."

Stephen S. Burkhart, M.D., and Joe F. De Beer, M.D.
Arthroscopy: The Journal of Arthroscopic and Related Surgery,
Vol 16, No 7 (October), 2000

They defined a significant glenoid bone defect as one in which the arthroscopic appearance of the glenoid, when viewed from a superior-to-inferior perspective, was an inverted pear (refers to bone loss of 25-30%).

On the humeral side, they defined a significant bone defect to be an engaging Hill-Sachs lesion, oriented in such a way that it engaged the anterior glenoid in a position of athletic function (90 degrees of abduction combined with external rotation of approximately 90 degrees).

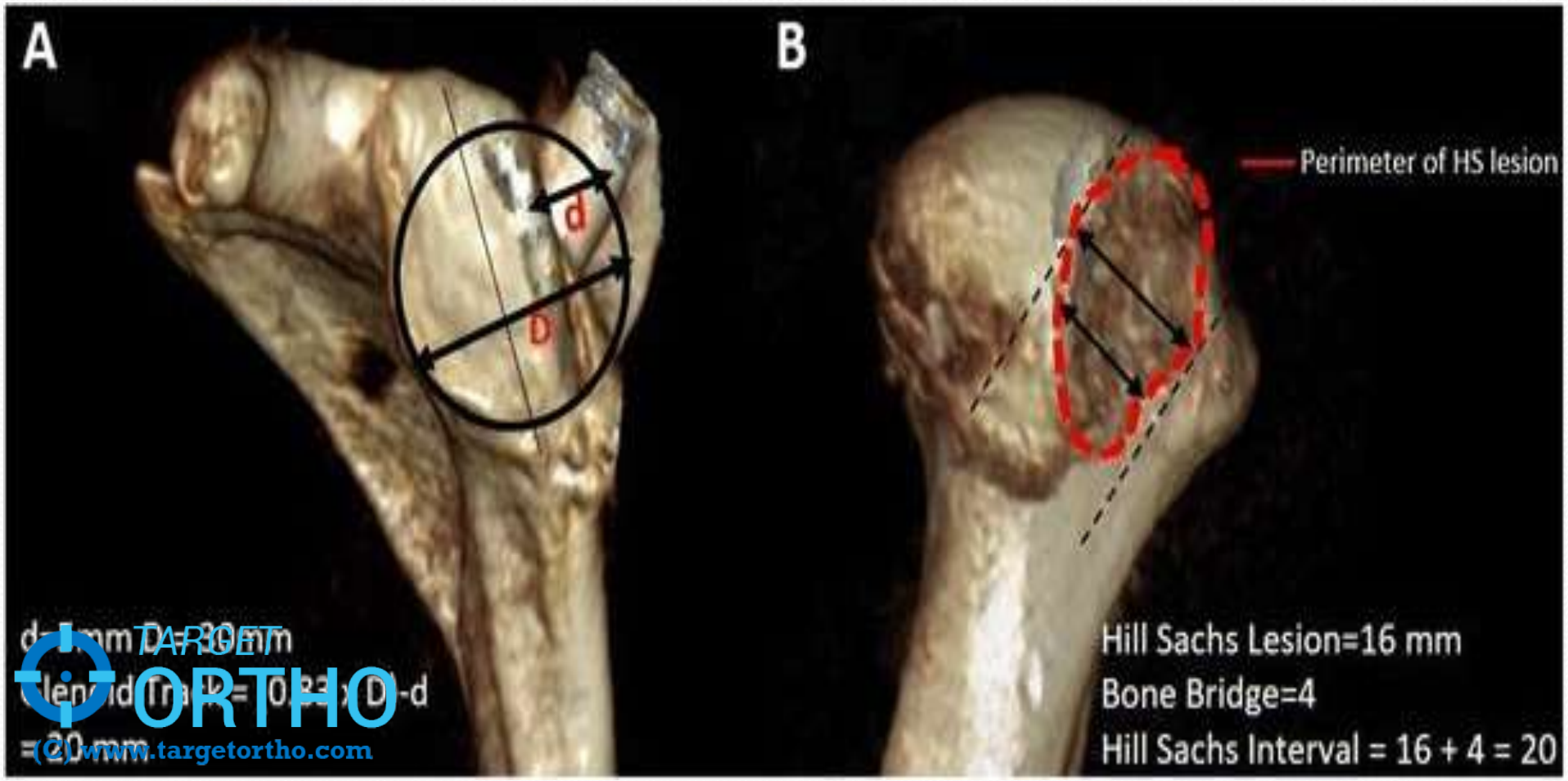
The term ‘engage’, described by Burkhart and De Beer, simply means that in certain arm positions, mostly abduction and external rotation, the axis of the Hill-Sachs lesion will match that of the anterior glenoid rim, allowing the humeral head to translate anteriorly over the glenoid rim as the defect ‘engages’ the rim.



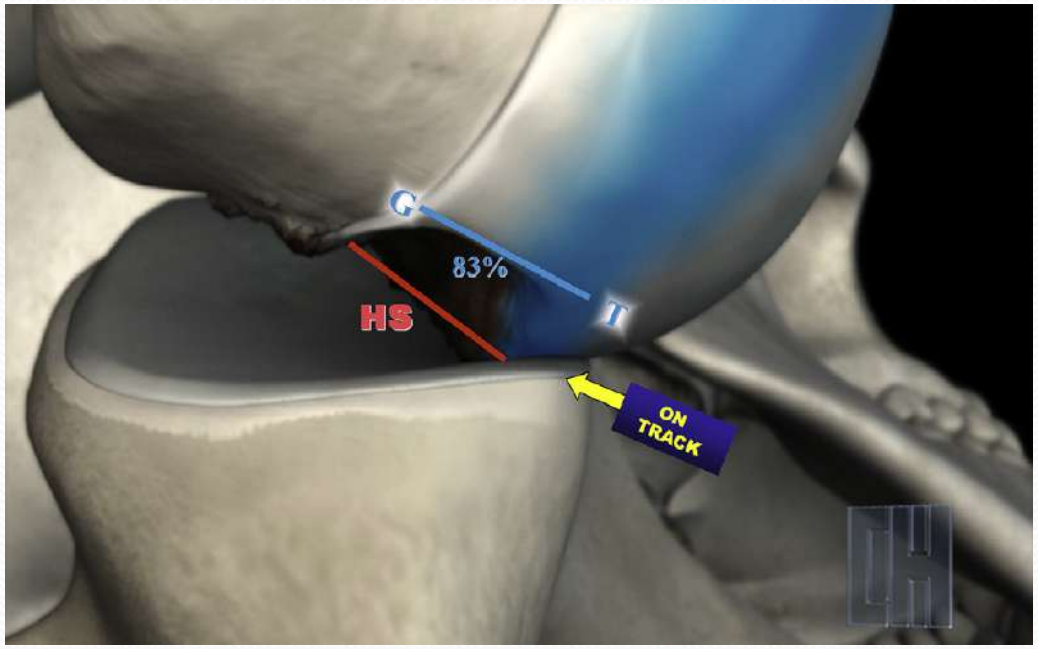
Bipolar lesions

Evolving Concept of Bipolar Bone Loss and the Hill-Sachs Lesion: From "Engaging/Non-Engaging" Lesion to "On-Track/ Off-Track" Lesion.

Giovanni Di Giacomo, M.D., Eiji Itoi, M.D., Ph.D., and Stephen S. Burkhart, M.D.



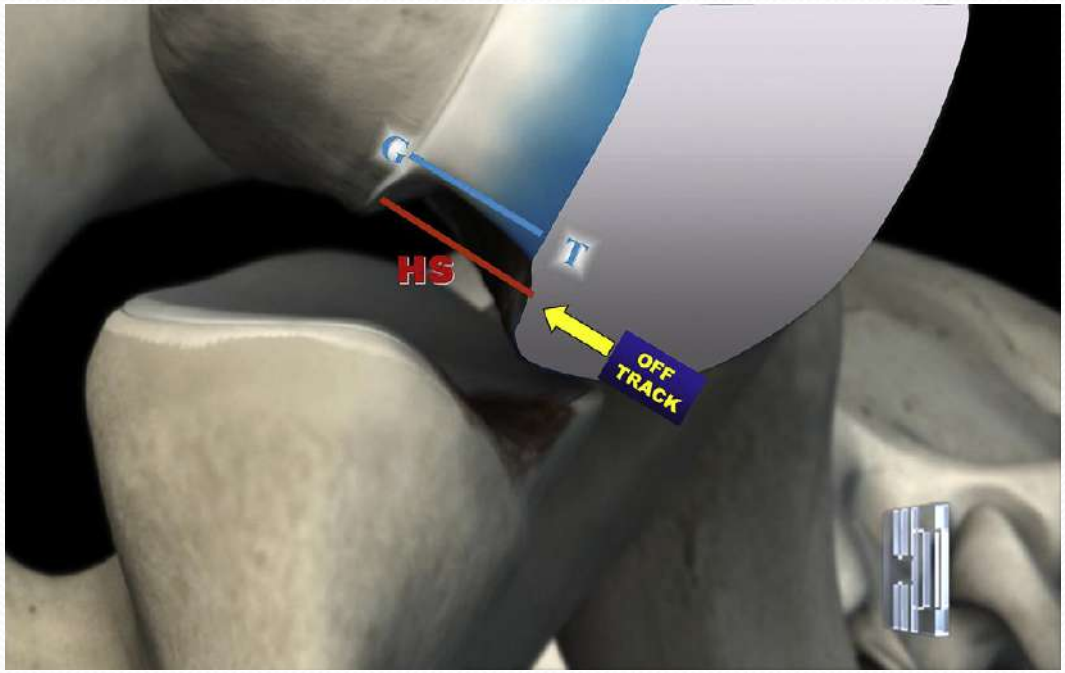
On track/ Non engaging Hill Sachs



Glenohumeral joint in abduction and external rotation.

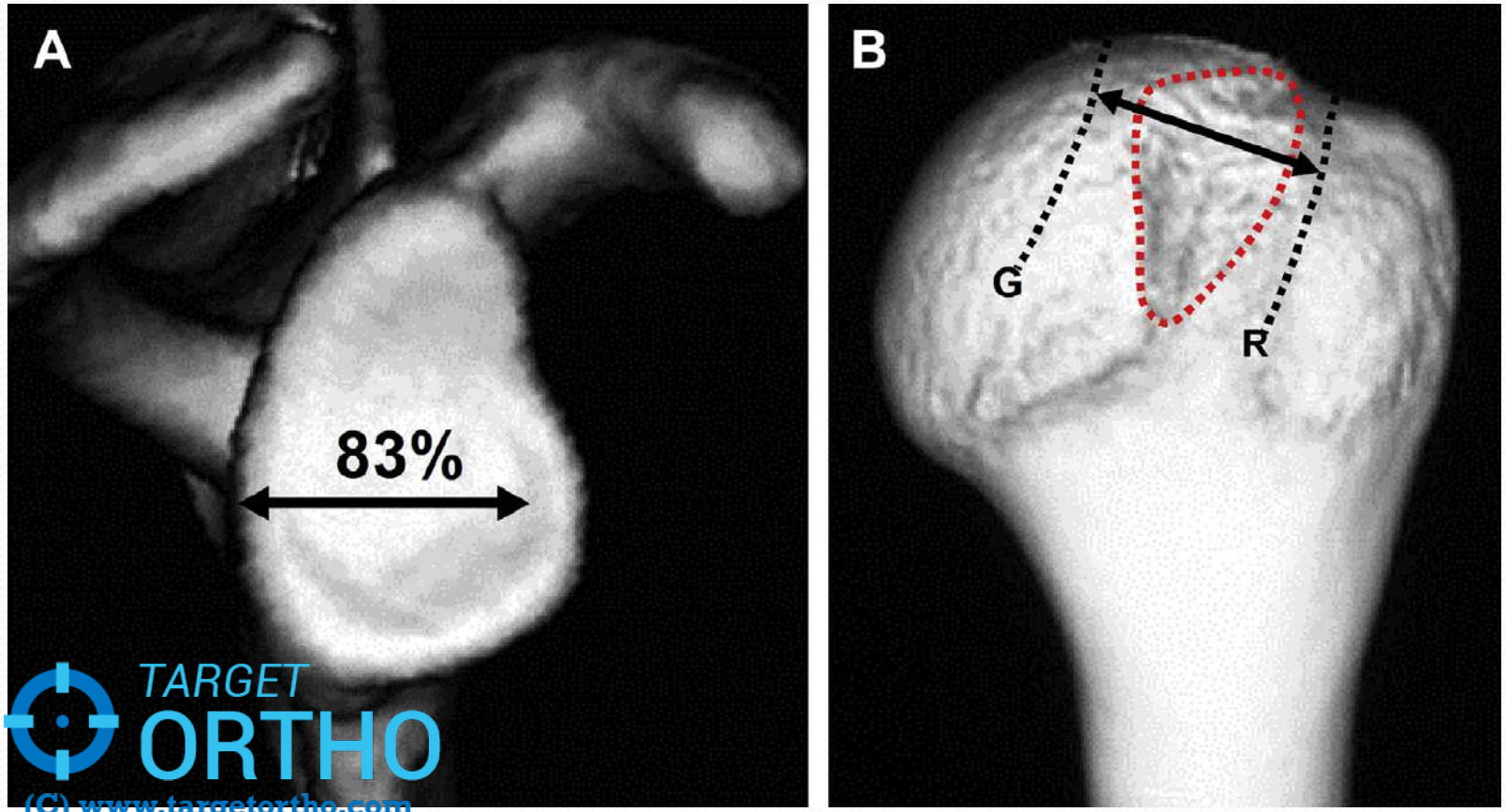
If the Hill-Sachs lesion (HS) is within the medial margin of the glenoid track (G-T), there is still glenoid track support for bone stability (on-track Hill-Sachs lesion). This implies that intrinsic stability can be shared between the Bankart repair and bone support.

Off track/ Engaging Hill Sachs



Glenohumeral joint in abduction and external rotation in shoulder with glenoid defect and Hill-Sachs lesion (HS) (bipolar bone loss).

The Hill-Sachs lesion extends medial to the medial margin of the glenoid track (G-T), with loss of bone support at the anterior glenoid rim (off-track Hill-Sachs lesion).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83%
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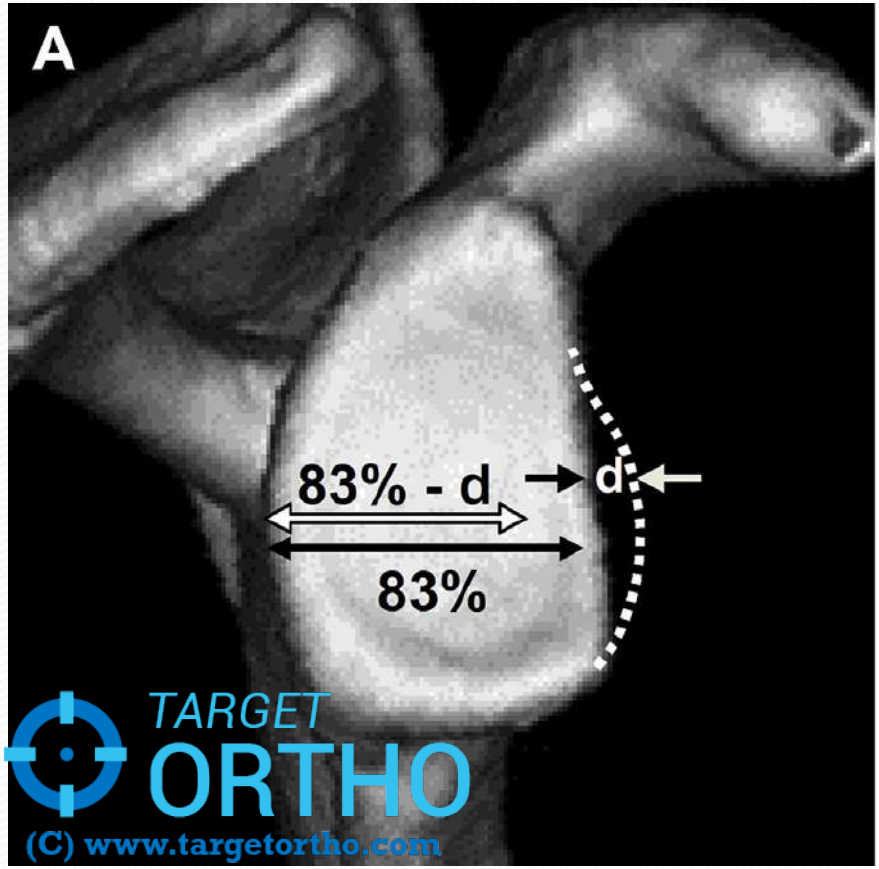
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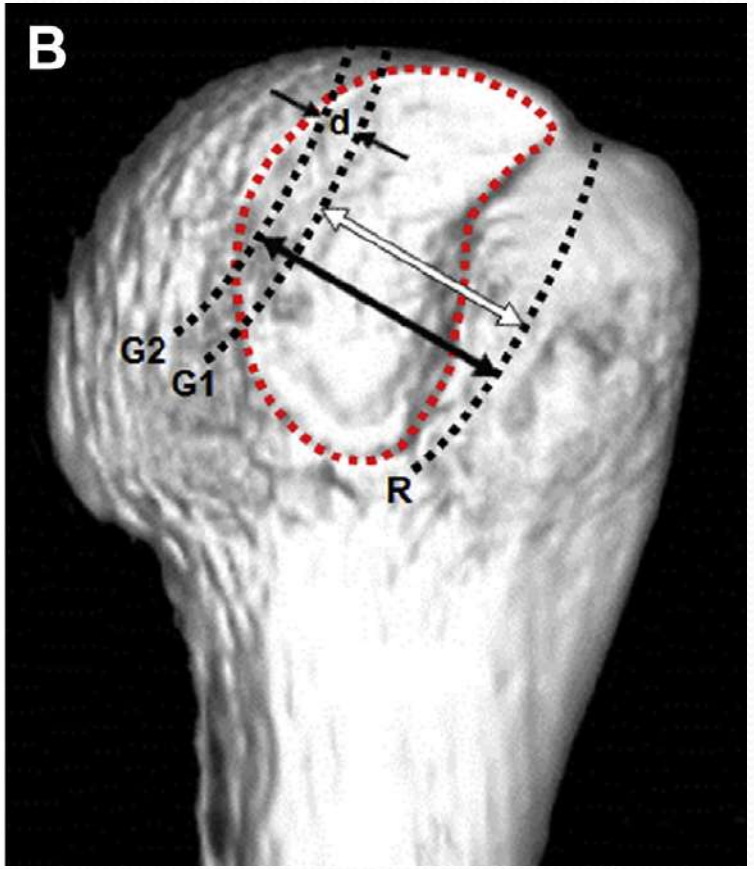
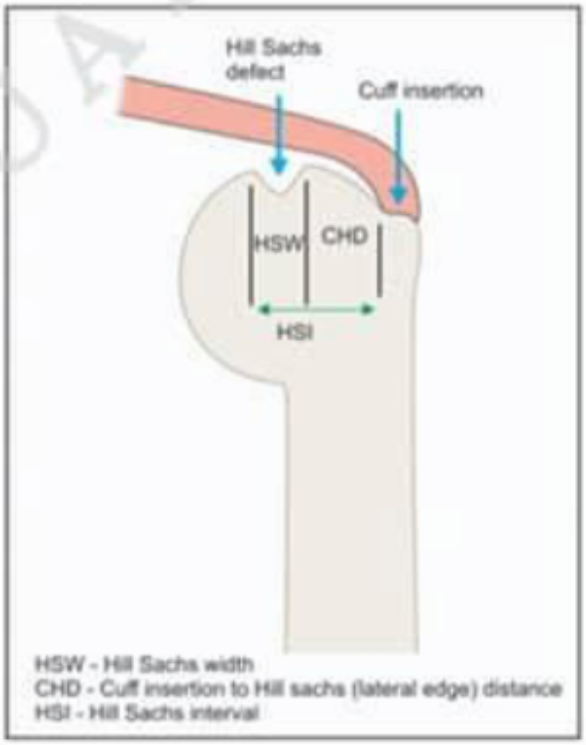
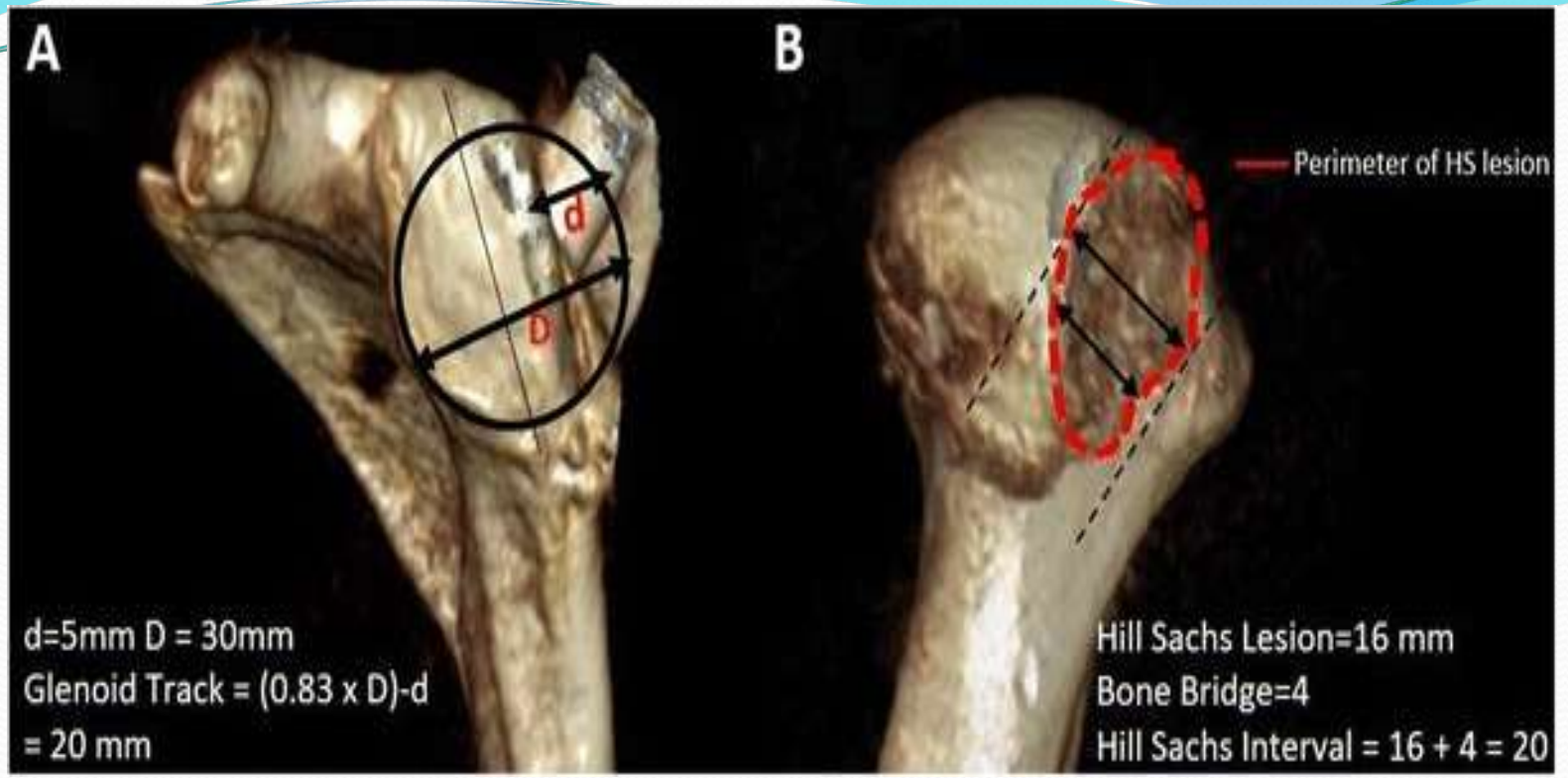

B
d
G2
G1
R

THANKS

1. Glenoid track (GT)= 83%(0.83) of glenoid width minus glenoid width loss
2. Hill sachs lesion width (HSW)
3. Distance of lateral edge of Hill Sachs from medial edge of rotator cuff insertion (CHD)
4. Hill Sachs interval (HSI)= HSW+CHD (2+3)



If HSI>GT, then the Hill Sachs is labelled as "off track" otherwise it is labelled a "on track"



- (a) Glenoid track (GT) formula where D = diameter of the inferior glenoid and d = the width of the anterior glenoid bone loss. (b) Hill-Sachs interval (HSI) formula, the sum of the width of the HS lesion and the width of the bone bridge between the rotator cuff attachments and the lateral aspect of the HS lesion. If HSI > GT, the HS is off-track or engaging. If HSI < GT, the HS is on track, or non-engaging

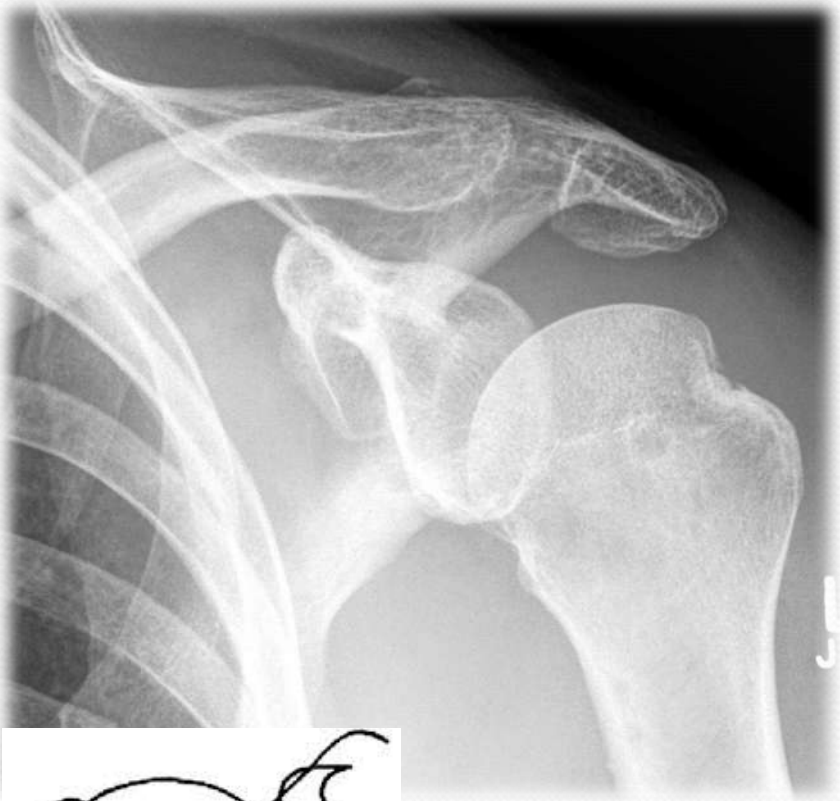
Instability Severity Index Score

JBJS 2007

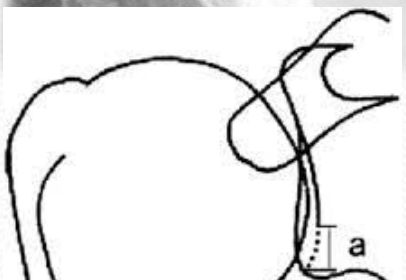
Boileau et al. stated that there is no simple method to identify patients in whom recurrent instability will develop after arthroscopic Bankart.

The following risk factors were identified:

1. Patient age under 20 years at the time of surgery;
2. Involvement in competitive or contact sports or those involving forced overhead activity;
3. Shoulder hyperlaxity;
4. A Hill-Sachs lesion present on an anteroposterior radiograph of the shoulder in external rotation and/or
5. Loss of the sclerotic inferior glenoid contour.



External rotation of more than 85° with the arm at the side demonstrates anterior shoulder hyperlaxity.



Instability severity index score is based on a pre-operative **Questionnaire, Clinical examination, and Radiographs**

Prognostic factors	Points
Age at surgery (yrs)	
≤ 20	2
> 20	0
Degree of sport participation (pre-operative)	
Competitive	2
Recreational or none	0
Type of sport (pre-operative)	
Contact or forced overhead	1
Other	0
Shoulder hyperlaxity	
Shoulder hyperlaxity (anterior or inferior)	1
Normal laxity	0
Hill-Sachs on AP* radiograph	
Visible in external rotation	2
Not visible in external rotation	0
Glenoid loss of contour on AP radiograph	
Loss of contour	2
No lesion	0
	Total (points) 10

Instability Severity Index Score

IMPLICATIONS

Patients with a score of 6 points or less have an acceptable recurrence risk of 10%, and are therefore potentially good candidates for Bankarts repair.

By contrast, those patients with > 6 have an unacceptable recurrence risk of 70% and should be advised to undergo bony procedures (e.g. Latarjet procedure).

Ignored in the Scoring

- Location of bone loss
- Quantification of bone loss