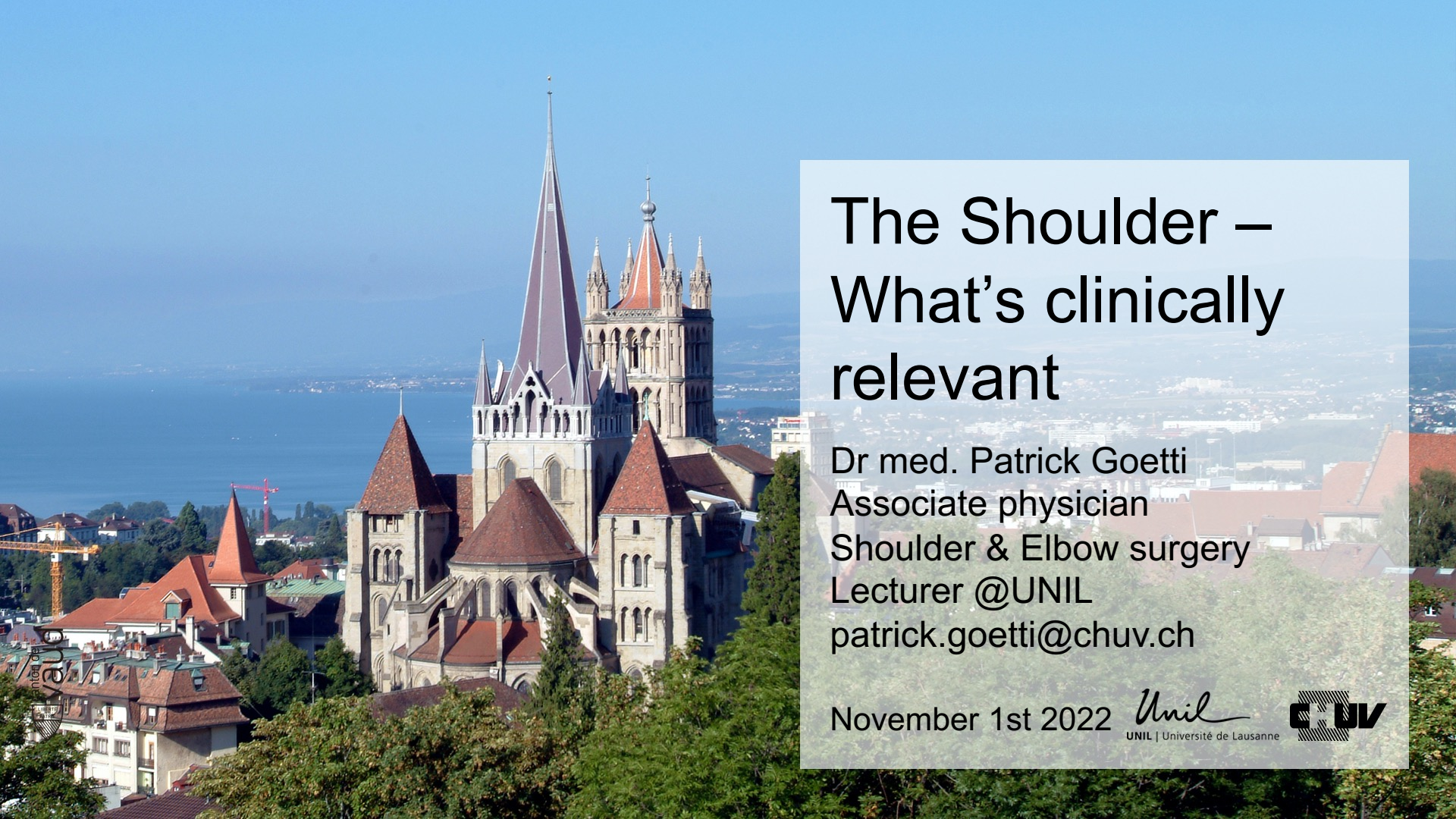




The Shoulder – What's clinically relevant

Dr med. Patrick Goetti
Associate physician
Shoulder & Elbow surgery
Lecturer @UNIL
patrick.goetti@chuv.ch

November 1st 2022

Unil
UNIL | Université de Lausanne

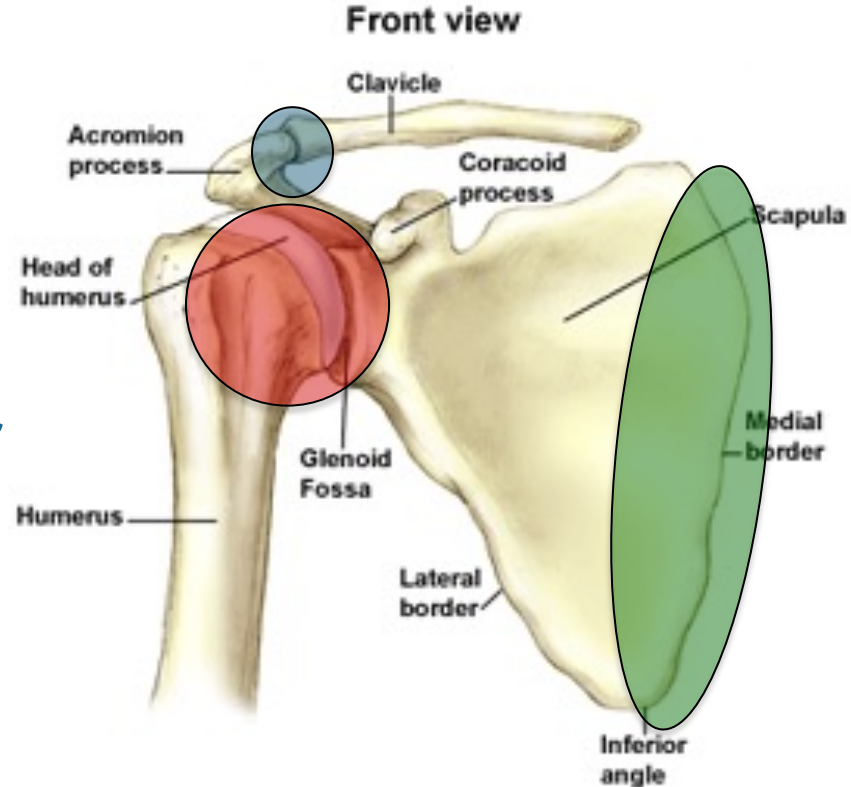


Overview of the next 45 min

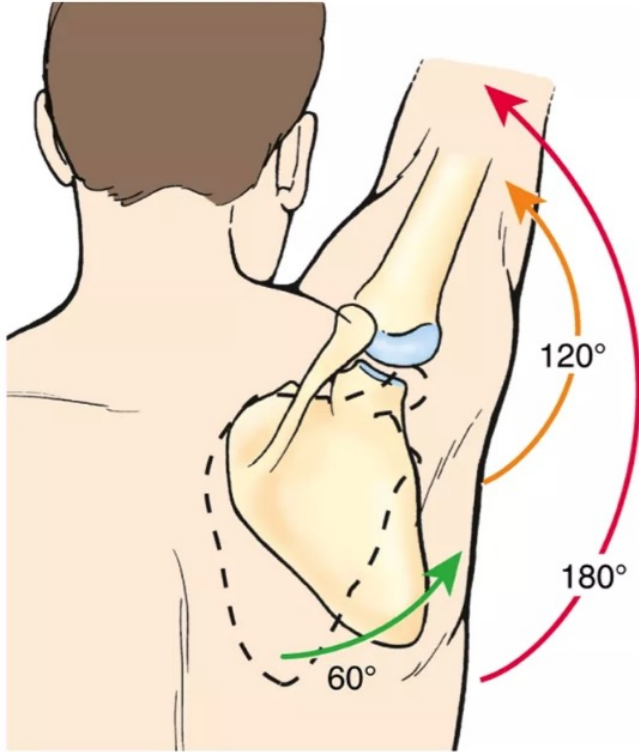
- Basic **biomechanical** knowledge of the shoulder joint
- Common **pathologic conditions** that lead to shoulder joint replacement
- Different **types of shoulder replacement**
- The role of **3D planning** in shoulder surgery

The Shoulder: three joints in one!

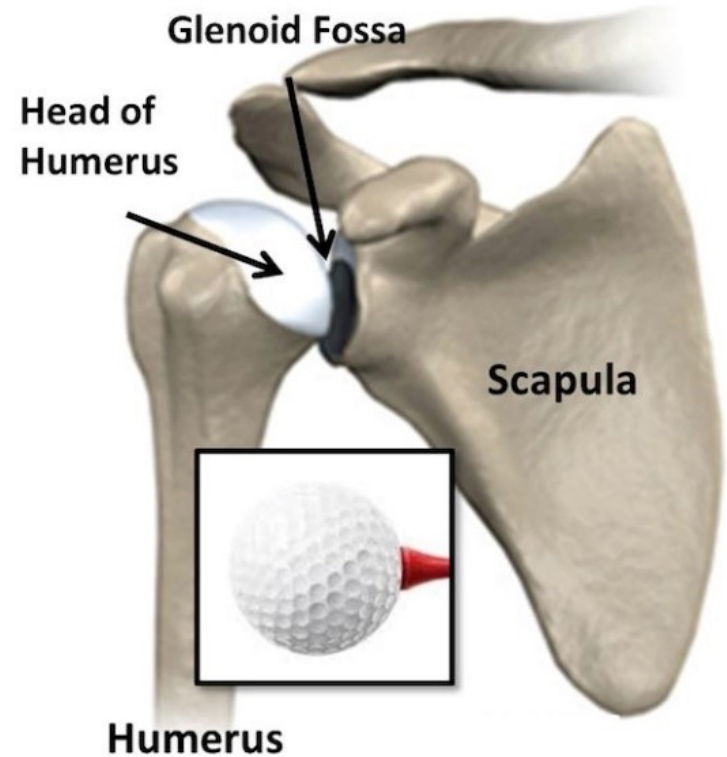
- 3 articulations
 - Gleno-humeral
 - Acromio-clavicular
 - Omo-thoracic



Joint with the highest range of motion

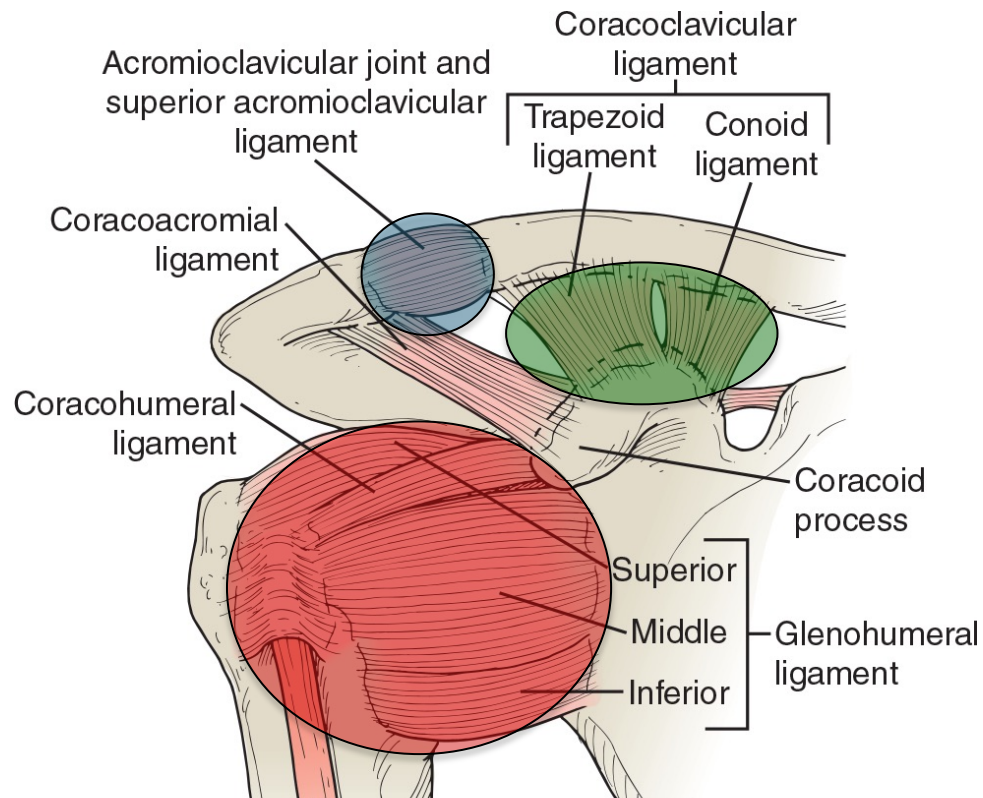


Ball and socket joint : prone to instability



Ligaments = static stabilizers

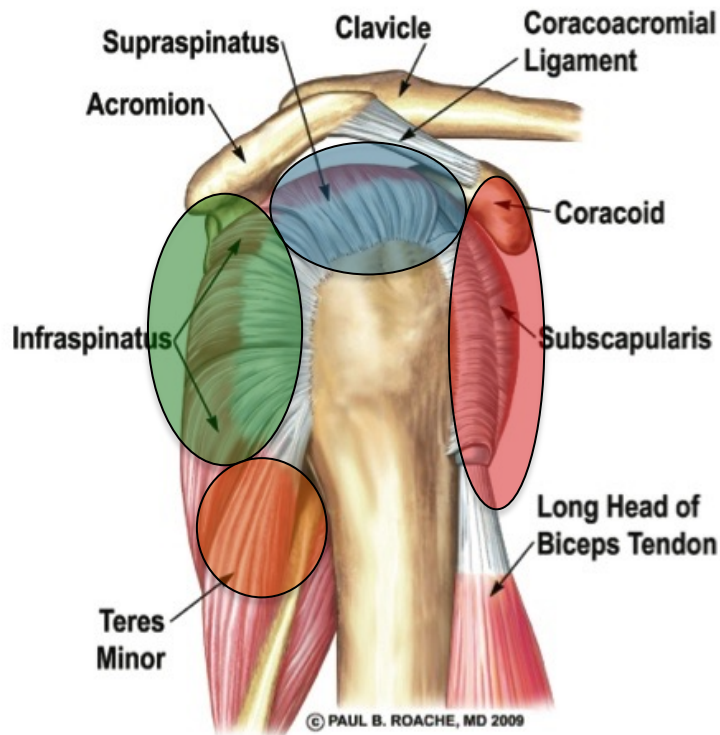
- Gléno-humérale
- Acromio-claviculaire
- Coraco-claviculaire



The rotator cuff = dynamic stabilizer

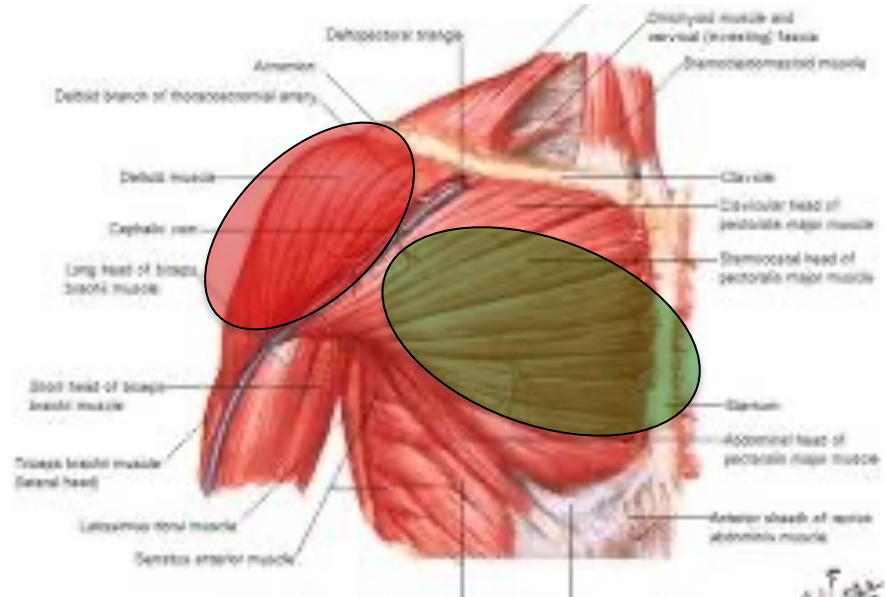
The rotator cuff

- Subscapularis
- Supraspinatus
- Infraspinatus
- Teres minor

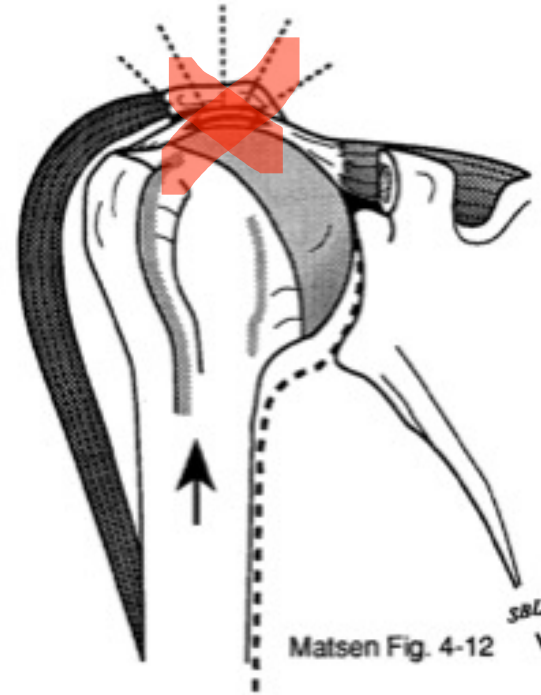
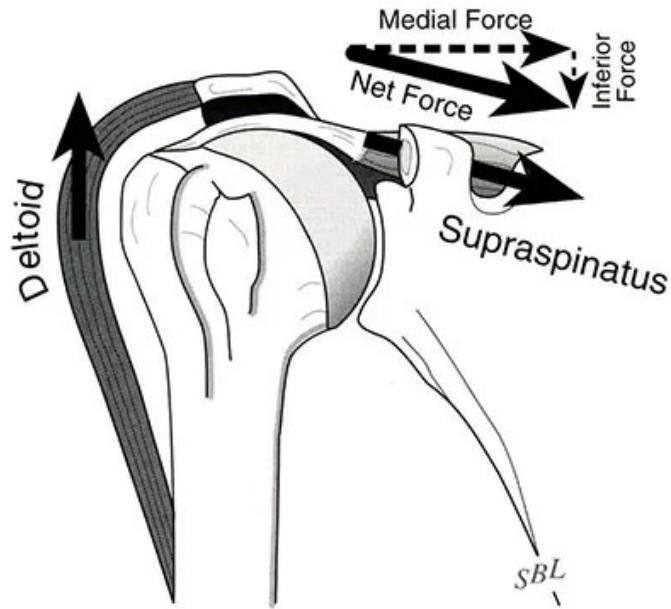


The big muscles = power house

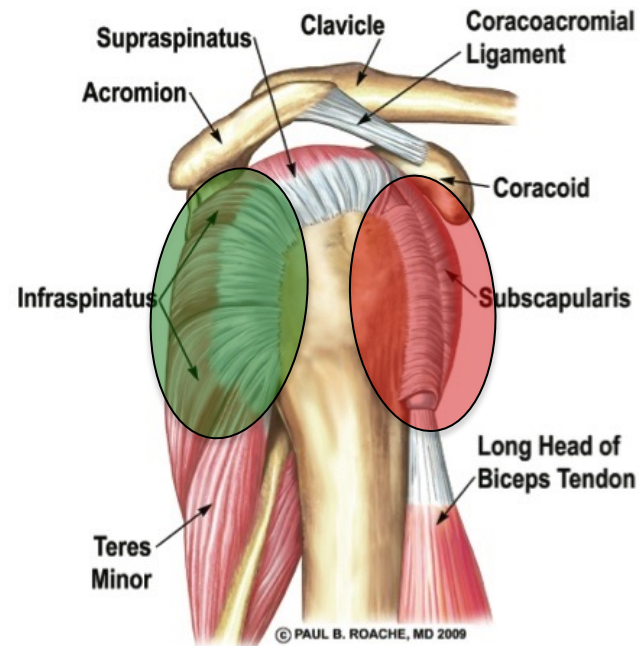
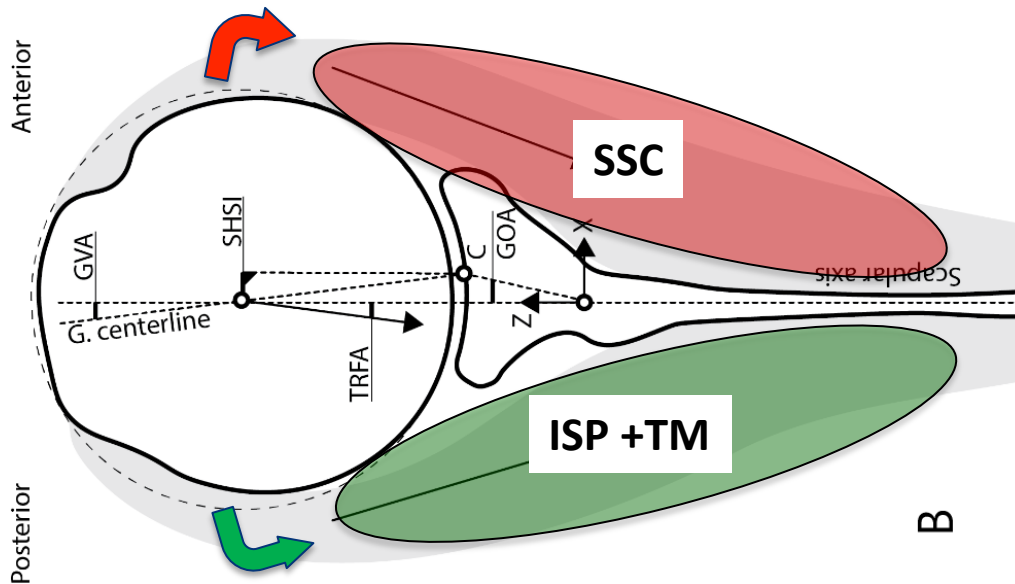
- Deltoid
- Pectoralis major



The physiologic state: vertical force couples



The physiologic state: horizontal force couples



If you want further insights

Shoulder & Elbow

EOR | VOLUME 5 | AUGUST 2020

DOI: 10.1302/2058-5241.5.200006

www.efortopenreviews.org



EFORT open reviews

Shoulder biomechanics in normal and selected pathological conditions

Patrick Goetti¹

Patrick J. Denard²

Philippe Collin³

Mohamed Ibrahim⁴

Pierre Hoffmeyer⁵

Alexandre Lädermann^{6,7,8}

- Shoulder dislocation
- Conservative surgery
- Rotator cuff
- Stiffness
- Adhesive capsulitis



Open access



Let's focus on shoulder arthroplasty

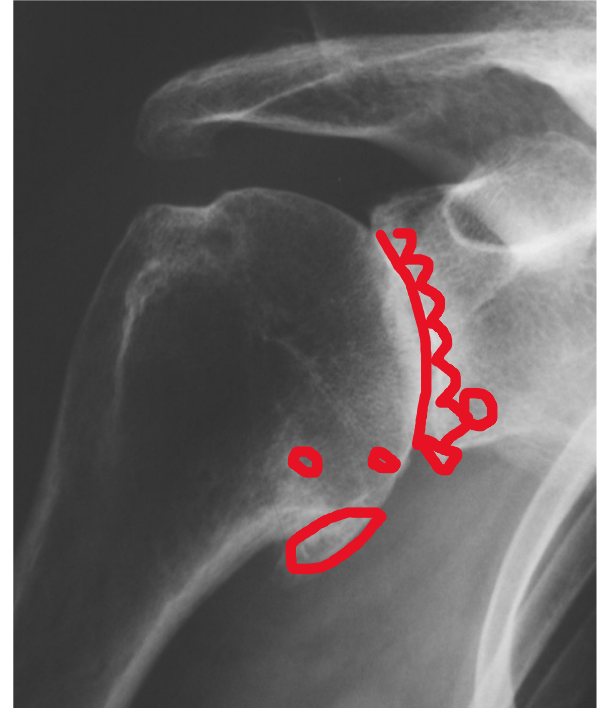
What are the common indications leading to shoulder joint replacements

- Primary osteoarthritis (OA)
- Secondary OA
- Irreparable rotator cuff tears w. pseudoparalysis
- Fractures

Primary osteoarthritis (OA)

Key features on X-ray

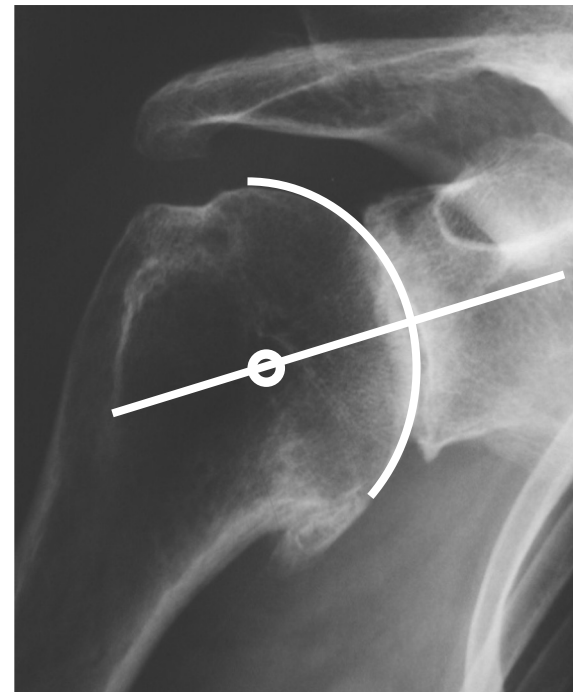
1. Joint space narrowing
2. Subchondral sclerosis
3. Bone cysts
4. Osteophytes



Primary osteoarthritis (OA)

Clinical features:

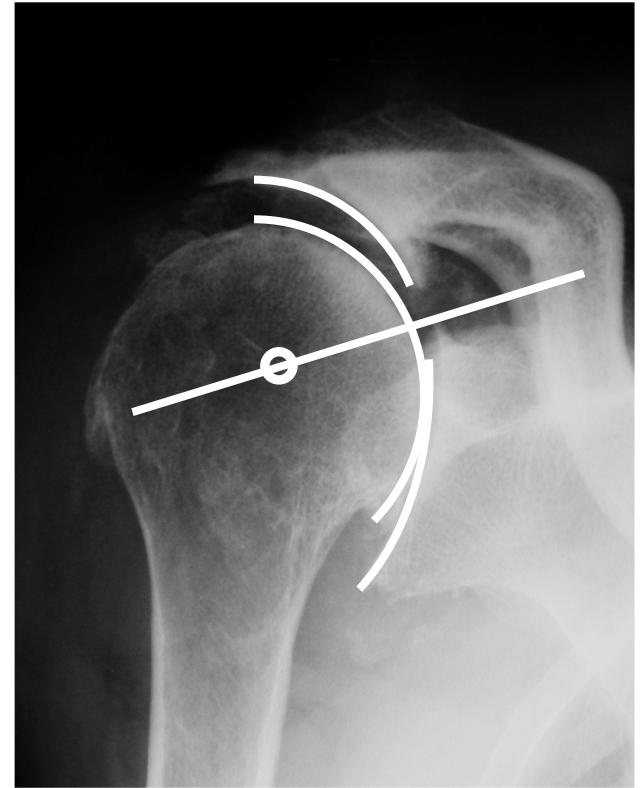
- Pain
- ROM↓ = stiffness
- Muscle function +/- N
- Joint +/- centered
- Cartilage wear



Secondary osteoarthritis (OA)

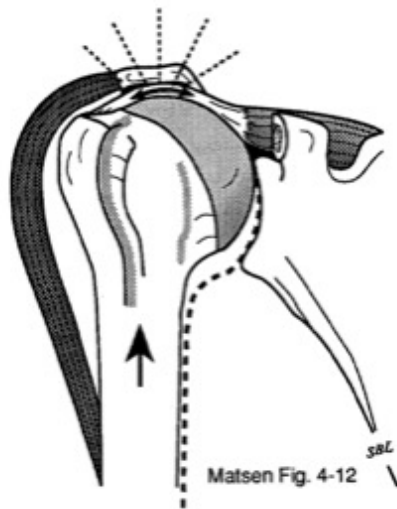
Clinical features:

- Pain
- ROM↓ = stiffness
- Muscle function altered
 - Rotator cuff failure
- Joint no more centered
 - Vertical imbalance
- Cartilage wear

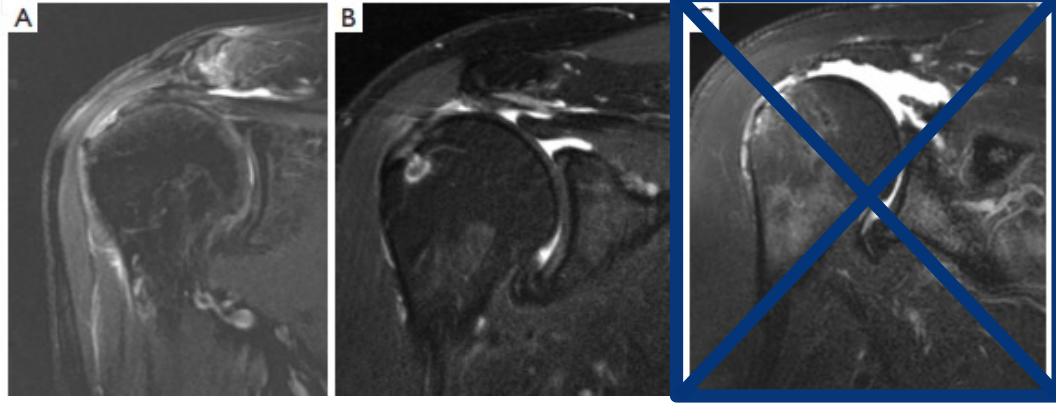


Pseudoparalysis – vertical force couple imbalance

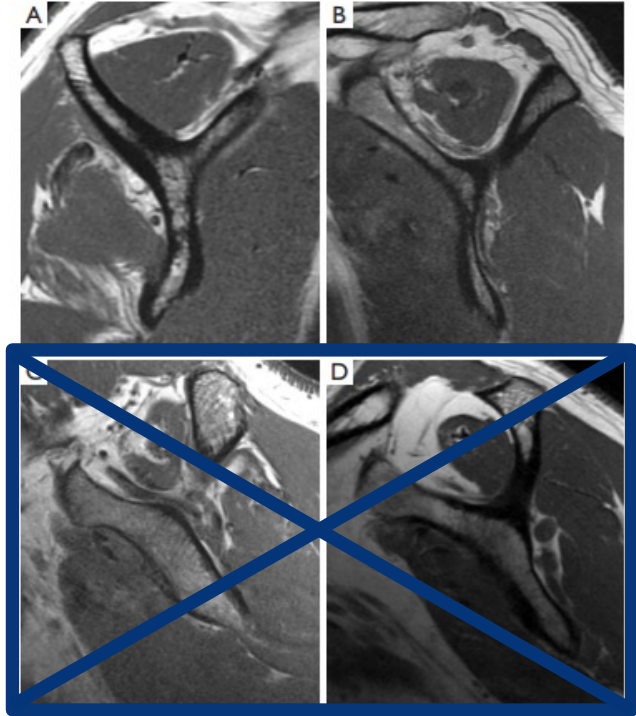
No active motion
Preserved passive motion



The irreparable rotator cuff



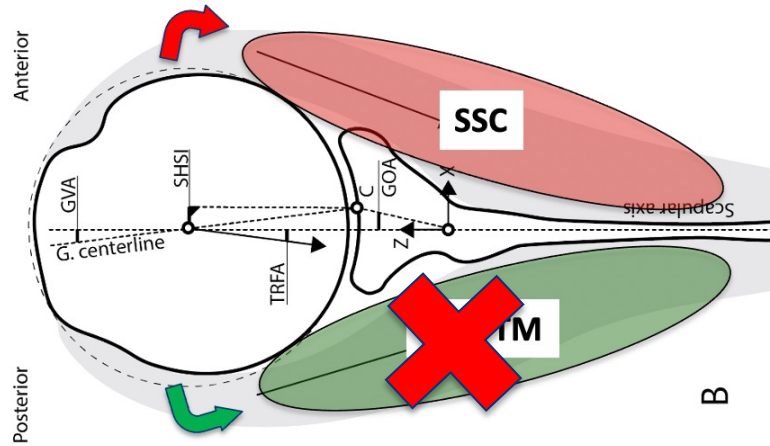
Patte D. Clin Orthop Relat Res 1990



Goutallier D CORR 1994 Fuchs B. JSES 1999

Irreparable rotator cuff

Horizontal force couple imbalance



Secondary osteoarthritis (OA)

Inflammatory process

Synovial (capsular
inflammation)

Progressive joint destruction

Bone loss

Rhumatoid arthritis



Avascular necrosis (AVN)

Loss of sphericity = collapse

Glenoid intact (in early stages)

Intact cuff

Pain is very present

Etiology

- Blood supply is altered
- OH, steroids, post-fracture



Fractures

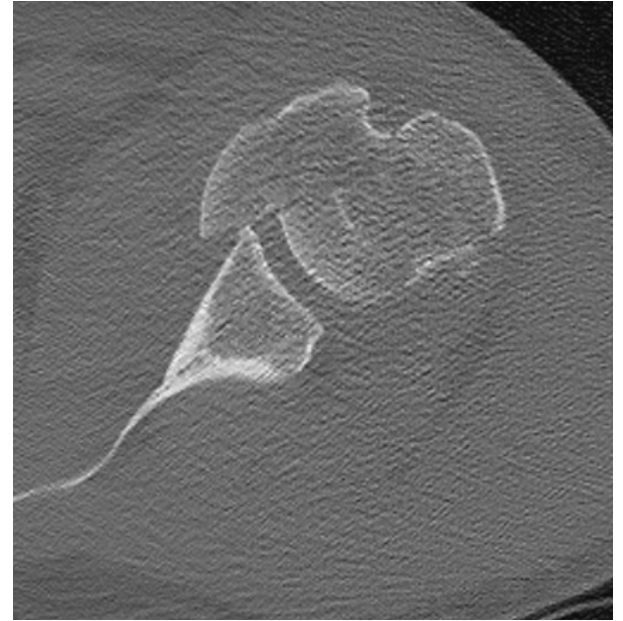
Poor bone quality

- Elderly patient

Fracture dislocation

- Head ischemia
- Risk of AVN +++

Head split, not amenable to reposition



What are the options

Hemiarthroplasty



Anatomic TSA

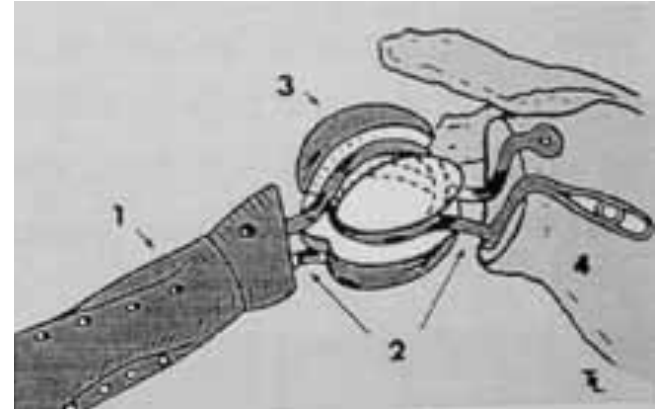
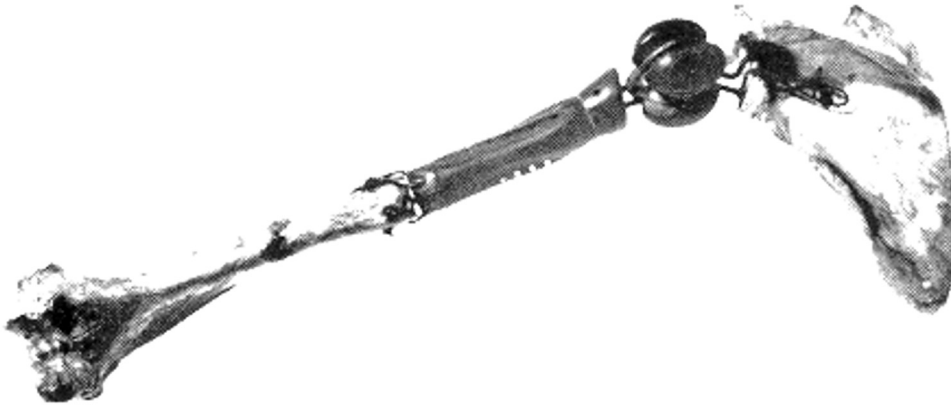


Reverse shoulder arthroplasty

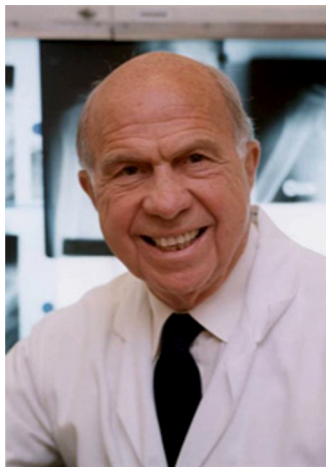


Historical background

Jules Emile PEAN 1893



Charles Neer



1955 Charles Neer II

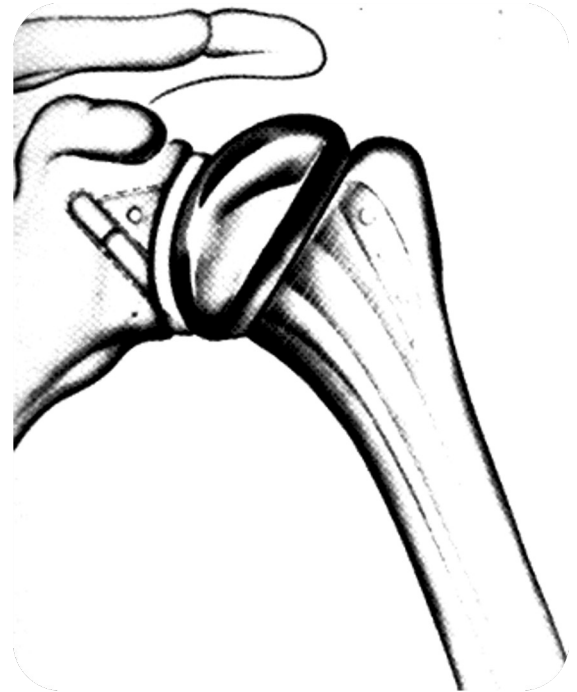
Proximal humerus
arthroplasty
-> pain control



Neer I vitallium prosthesis

Charles Neer

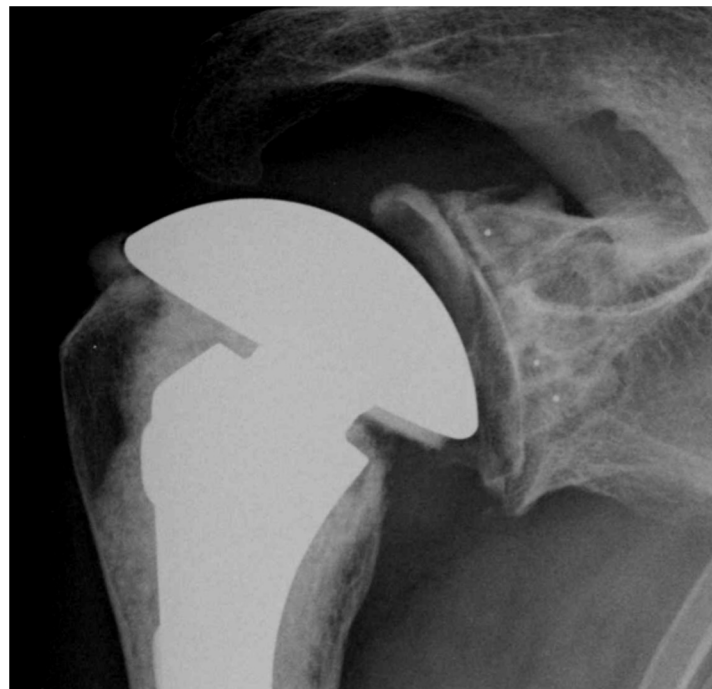
In 1973 – the modern
Total Shoulder Arthroplasty (TSA)
Chrome-cobalt - humerus
Polyethylene - glenoid



Charles Neer

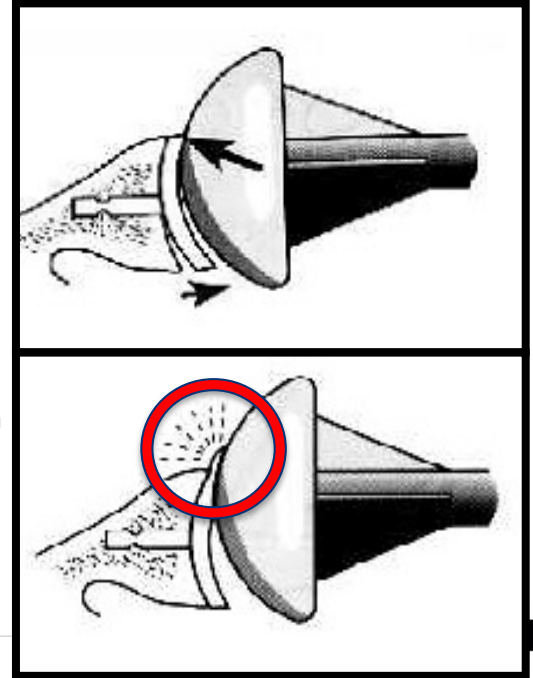
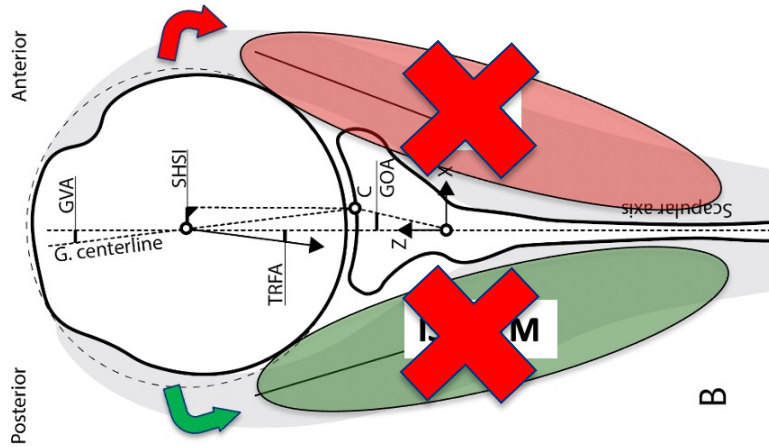
First lesson learned was:

TSA with no functional cuff
= high rate of glenoid component
failure



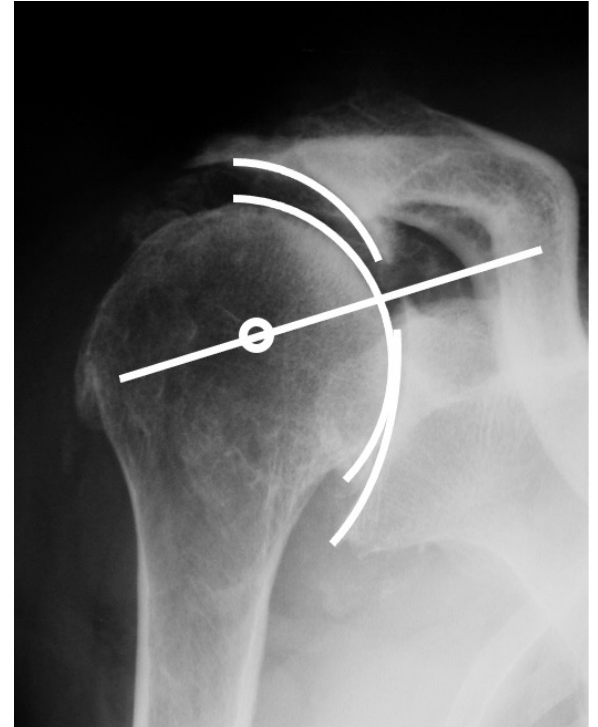
The “rocking horse” phenomena

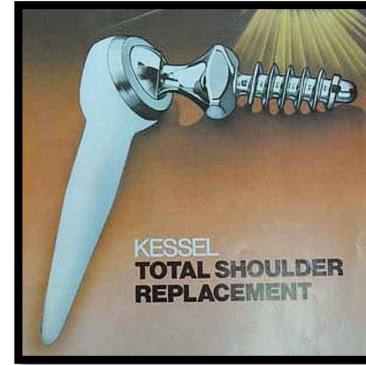
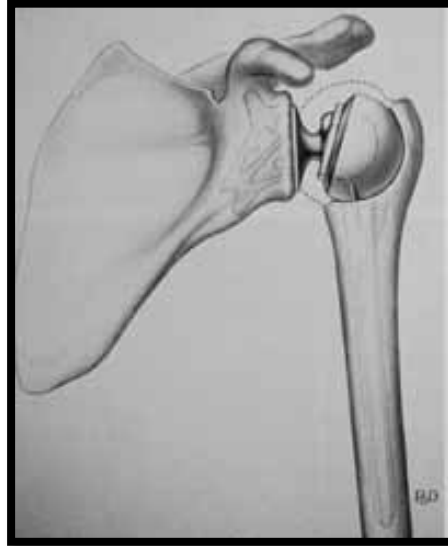
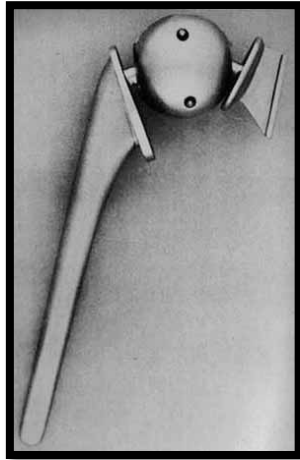
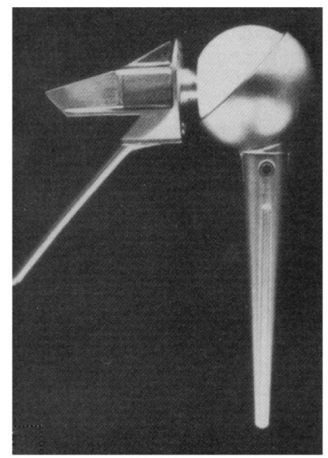
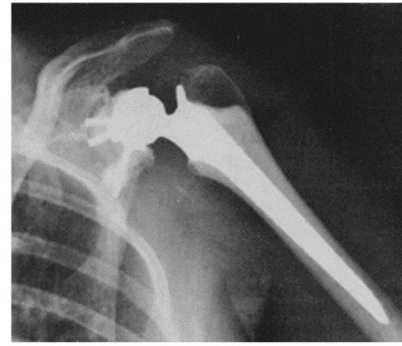
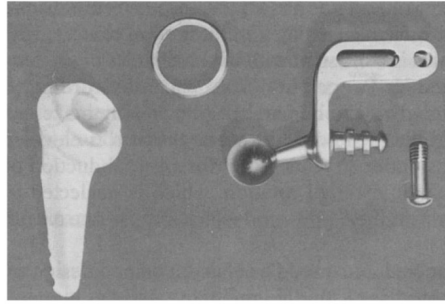
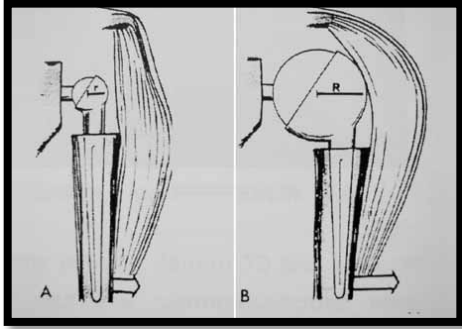
Edge-loading of humeral head on anterosuperior rim of the glenoid component (Franklin et al., 1988).



But wait, you told us the cuff can be ruptured

There was a need for a solution that works without the rotator cuff

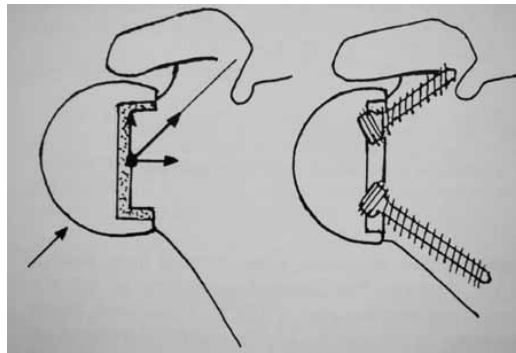




Lot of failures but finally a brilliant idea

1985: Paul Grammont

1. Semi-constraint design
2. Reversing “normal” anatomy
3. Center of sphere at or within the glenoid bone-implant interface
4. Center of rotation medialized and distalized



Biomechanical benefit

- Fixed center of rotation (fulcrum)
- Conversion of upward-directed force of deltoid into a rotatory movement

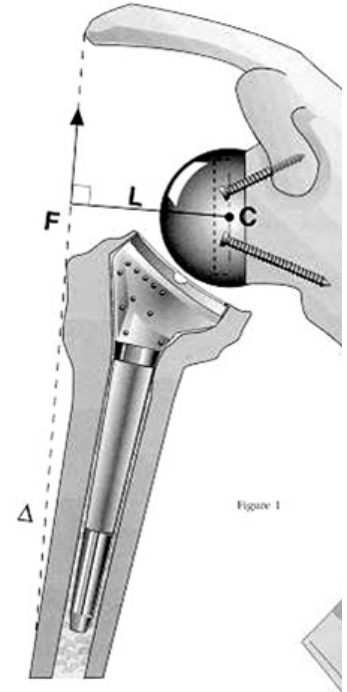
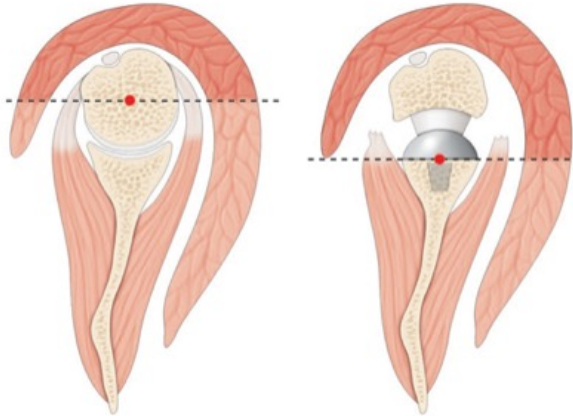
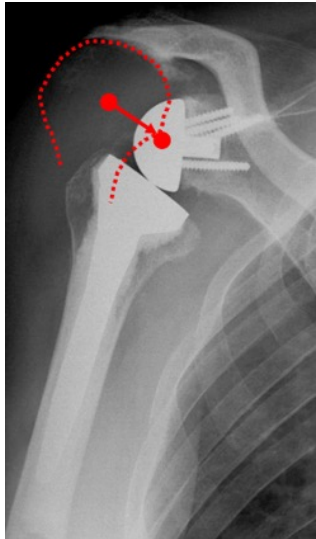


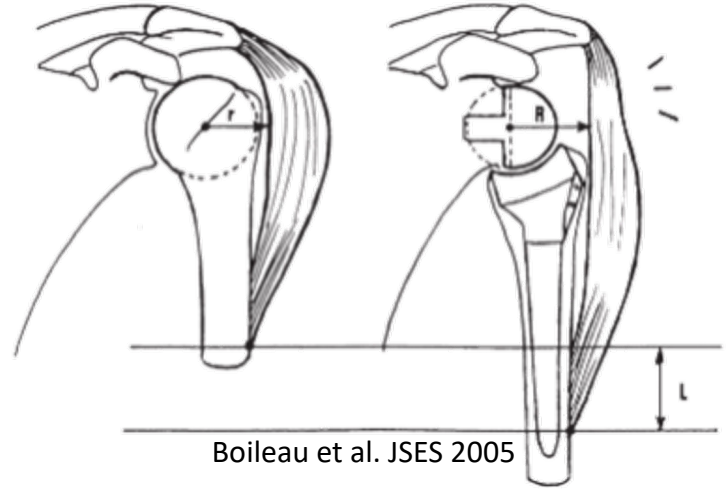
Figure 1

How does it work

Center of rotation medialized
→ increased deltoid lever arm



Goetti et al. EOR 2021



Boileau et al. JSES 2005

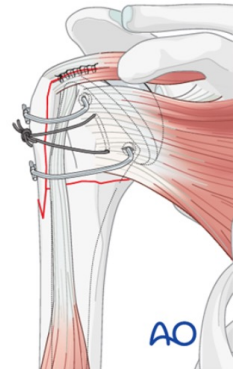
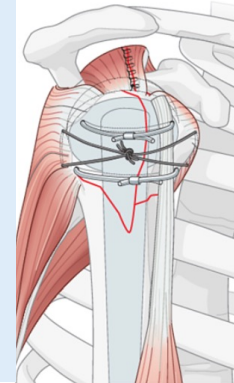
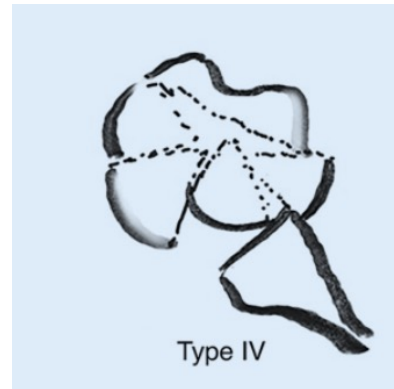
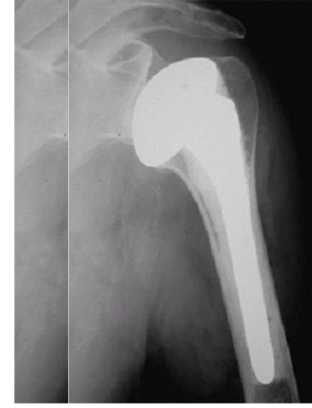
Center of rotation distalized
→ increased deltoid tension

So how to chose the best option?



Hemiarthroplasty

- AVN
- Non rebuildable articular surface in the young patient



Anatomic total shoulder arthroplasty

- Primary OA with intact cuff



Reverse shoulder arthroplasty

- Cuff Tear Arthropathy
- Massive cuff tear with pseudoparalysis
- Proximal humeral fracture in the elderly
- Rheumatoid arthritis

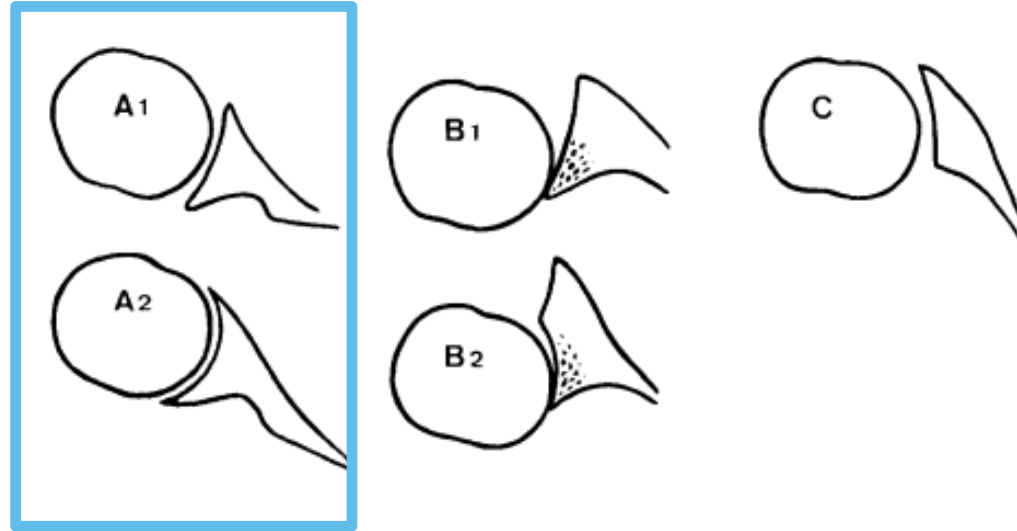


Everything is said?

- It might be a little bit more complicated
- Let's first get back to primary OA

Walch classification

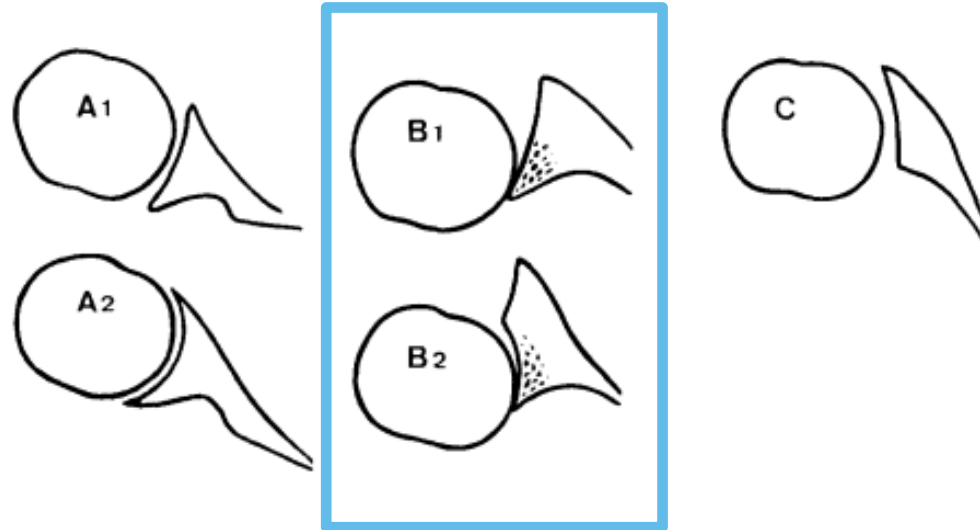
Fig. 2. Different morphologic types of the glenoid in primary glenohumeral osteoarthritis (see text).



Glenoid Erosion

Walch classification

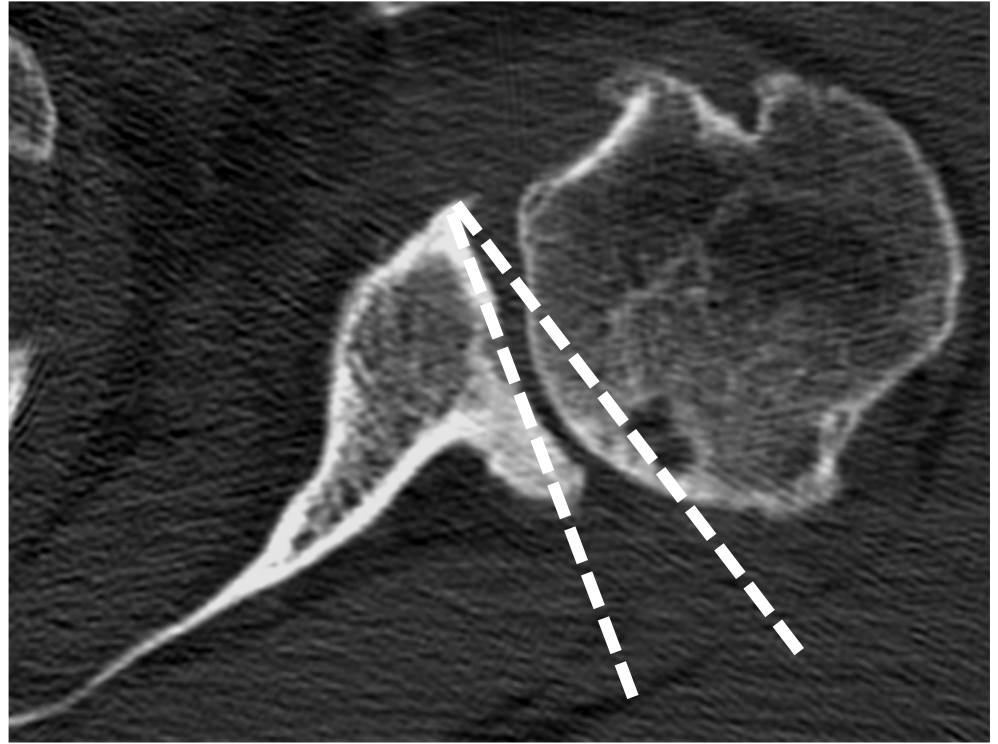
Fig. 2. Different morphologic types of the glenoid in primary glenohumeral osteoarthritis (see text).



Subluxation

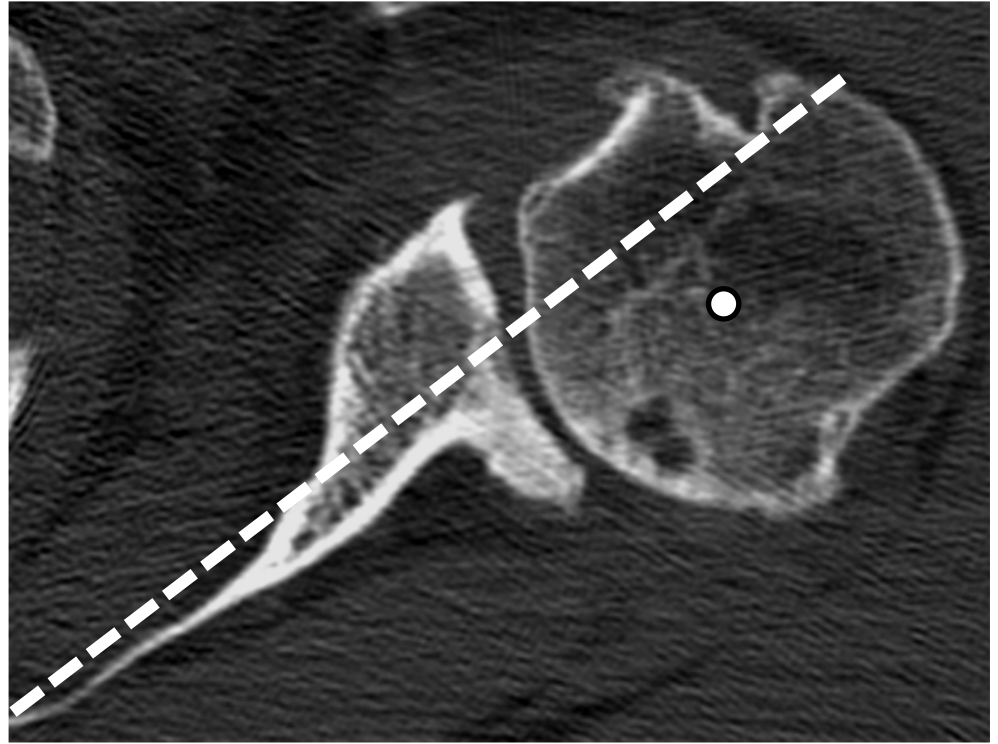
Asymmetric glenoid wear in primary OA

Glenoid version
 $>15^\circ$



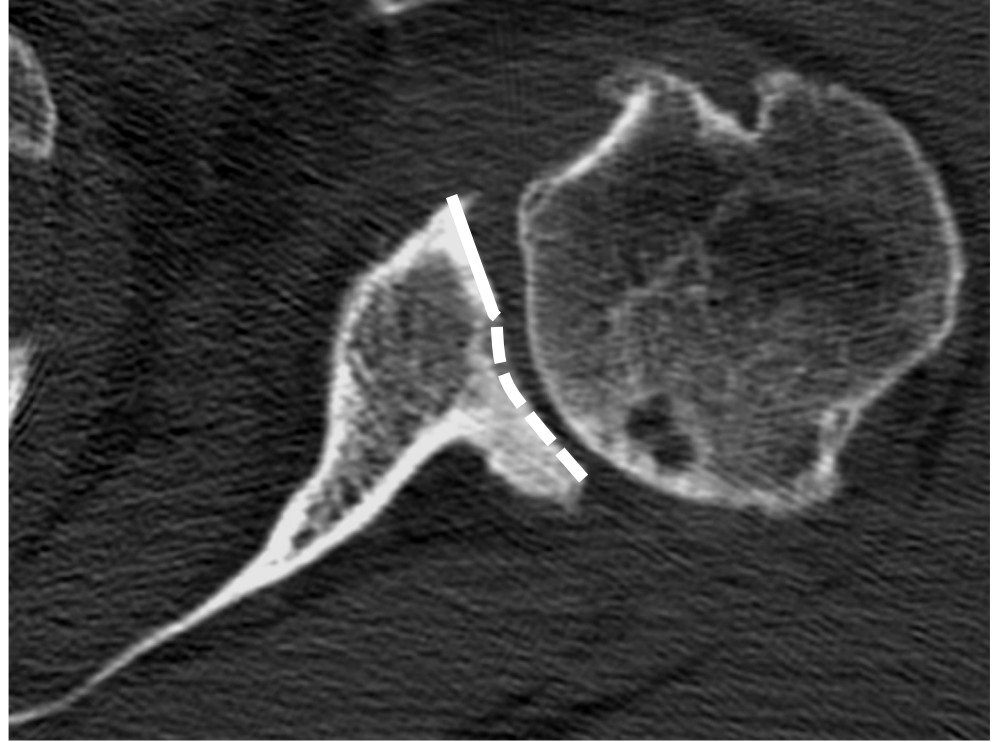
Asymmetric glenoid wear in primary OA

Humeral Head
Subluxation



Asymmetric glenoid wear in primary OA

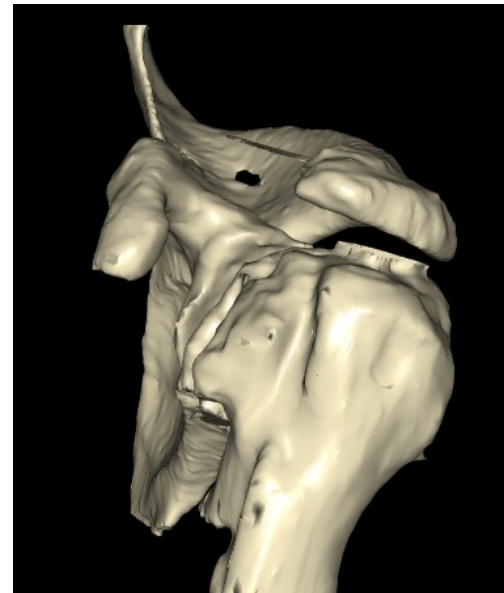
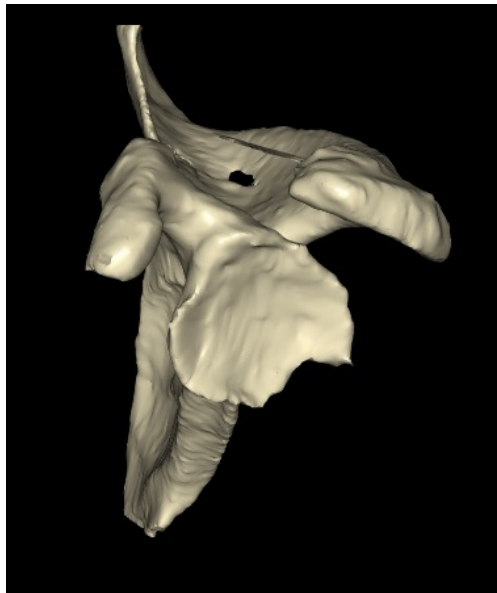
Posterior glenoid erosion



As we learned horizontal instability is relevant to avoid aseptic glenoid loosening

Reality in 3D

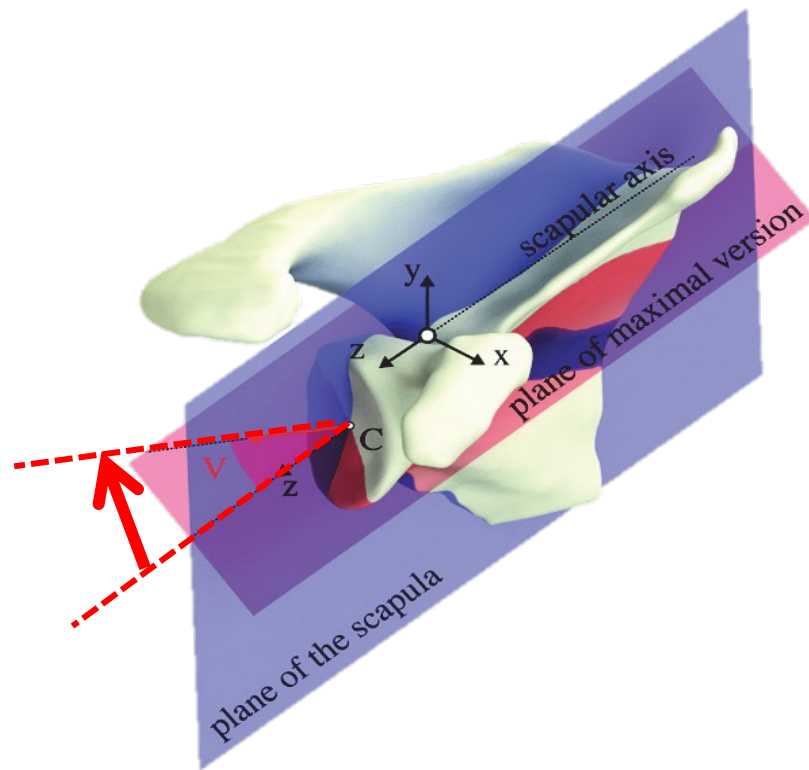
Asymmetric wear and deformity is a mix between horizontal and vertical!



The benefit of 3D measurements

Version

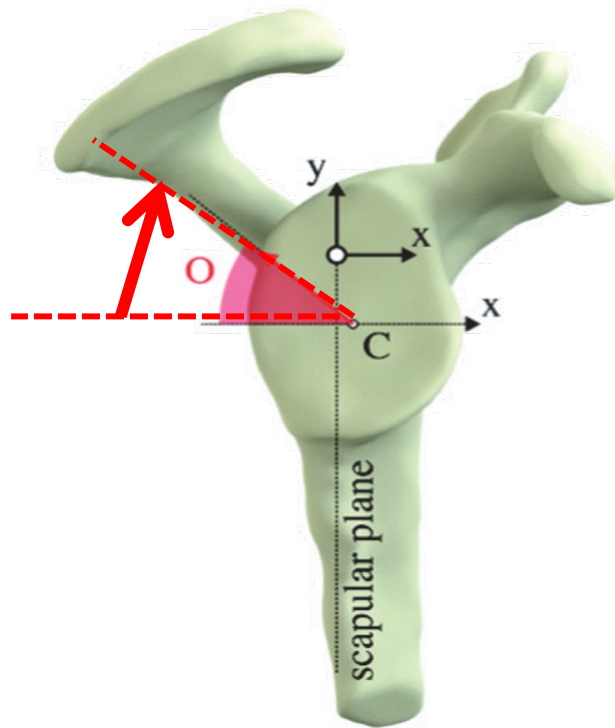
- Plane of maximal version
- $\neq$ horizontal plane



The benefit of 3D measurements

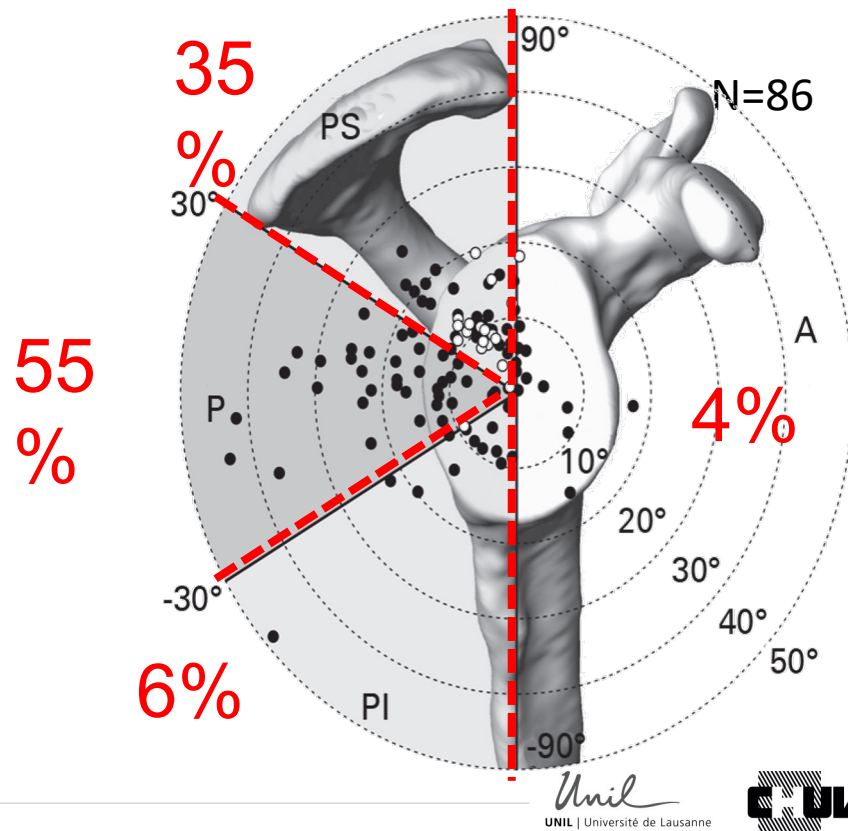
Orientation

- To define the direction of maximal version



The benefit of 3D measurements

- 3D distribution of glenoid erosion in primary OA

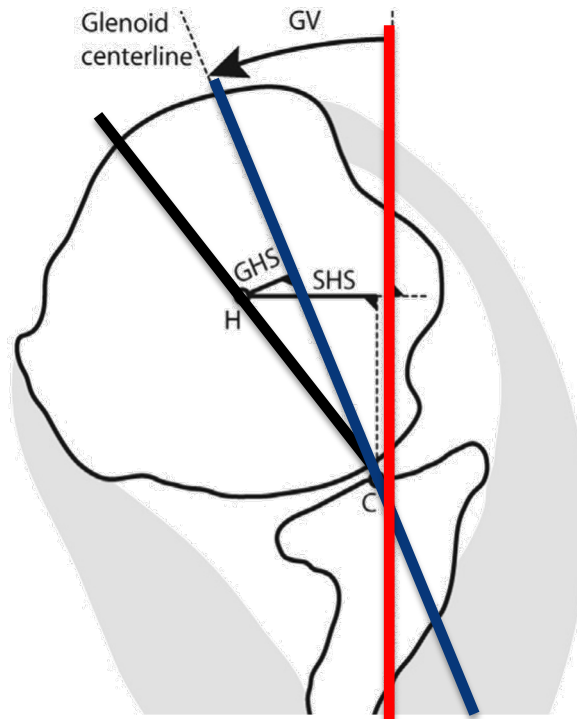


The benefit of 3D measurements

Gleno-humeral (GHS)

Scapulo-humeral subluxation (SHS)

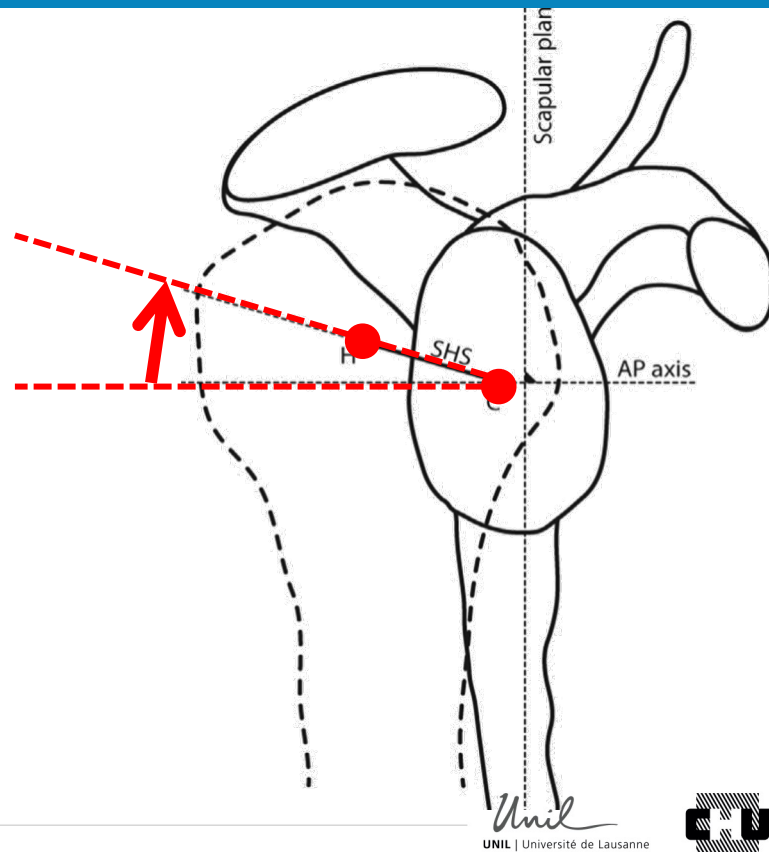
Plane of maximal subluxation



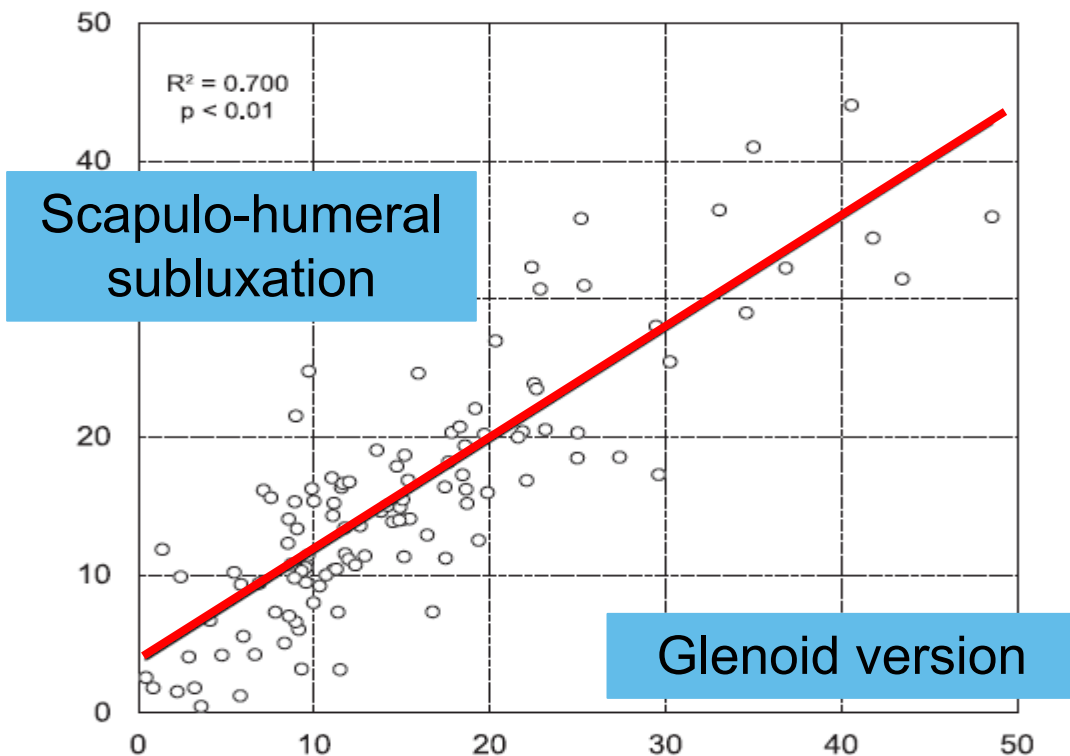
The benefit of 3D measurements

Orientation

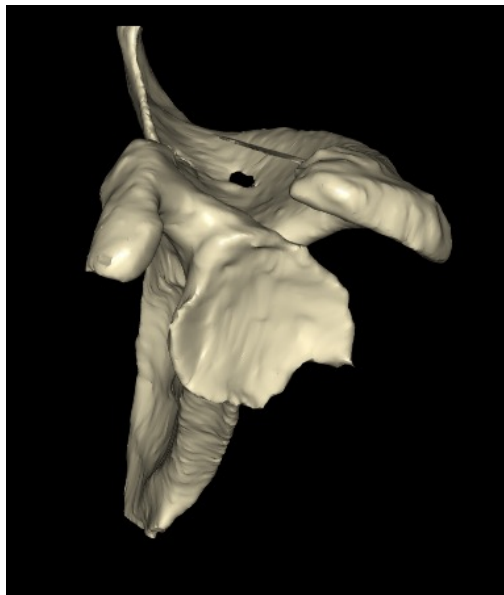
To define the direction of maximal subluxation



The benefit of 3D measurements



Impact on surgical planning



GV, SHS and HHS all impact glenoid component loosening!

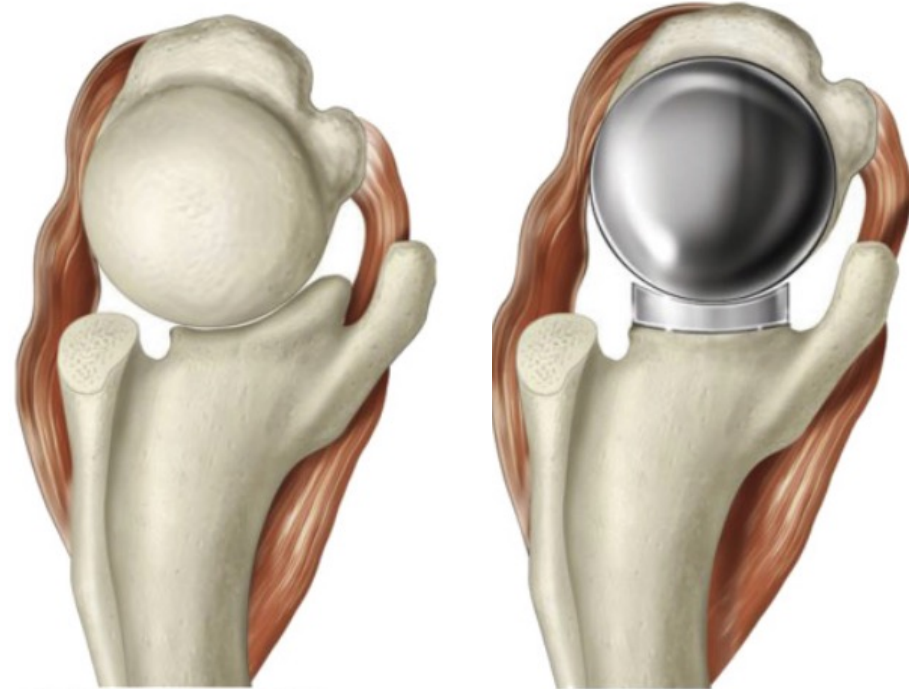
So the goal of aTSA is to correct towards values of Walch type A glenoids

The quickest way to fix a problem is not always the best way to go!

High sided reaming



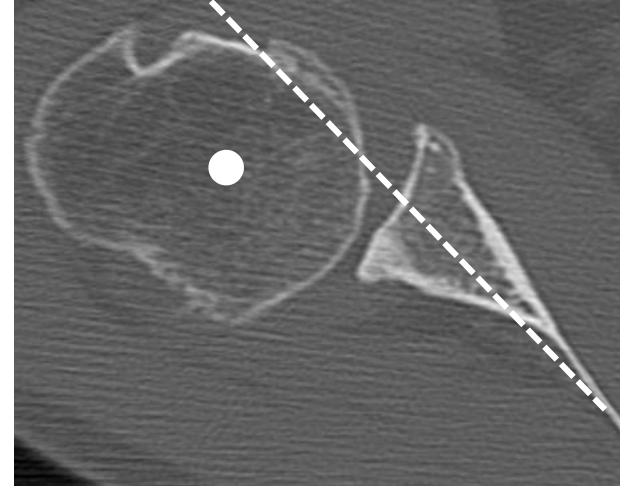
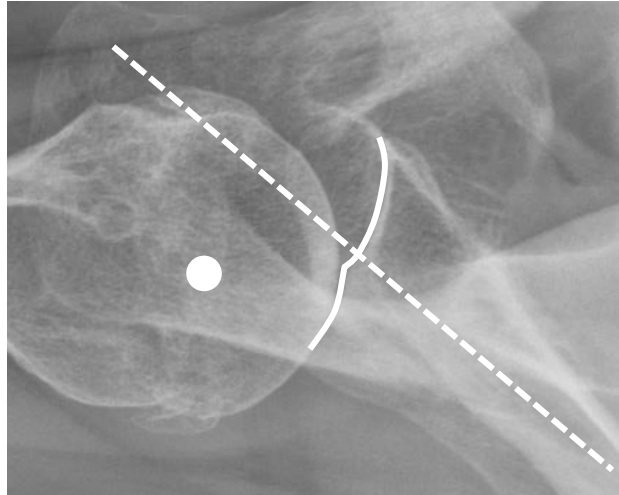
Denard et al, JSES 2013



Grey et al, JSES 2020

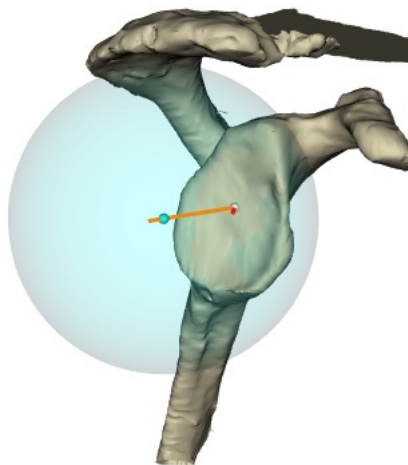
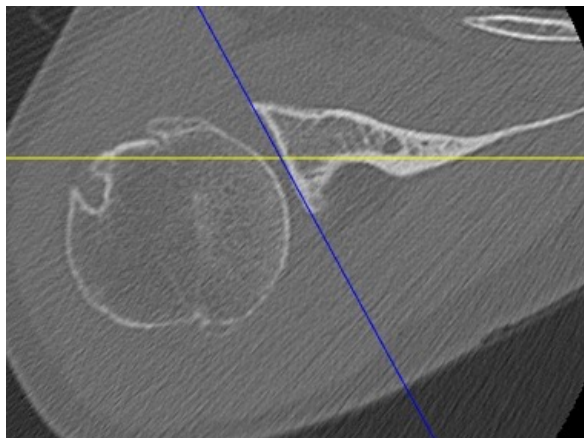
Technology might help us?

“B2” glenoid



Precise preoperative planning

“B2” glenoid



Subluxation (%)

91

POST

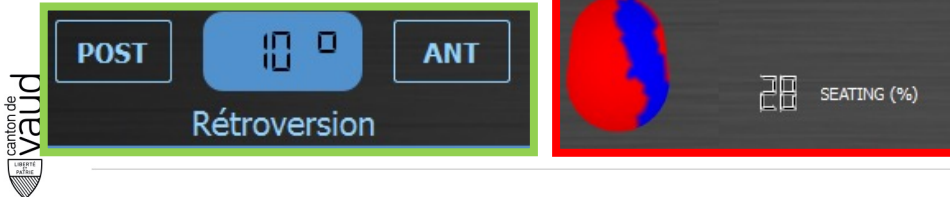
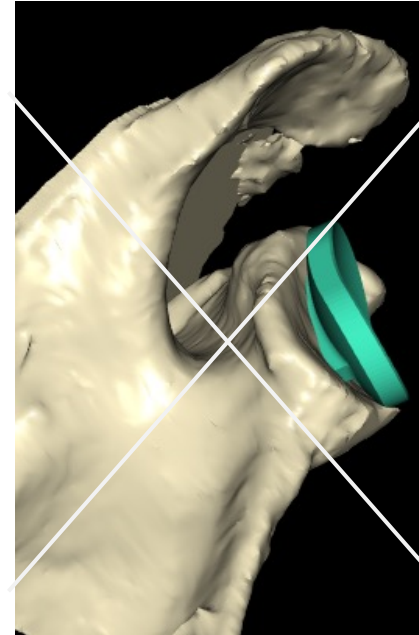
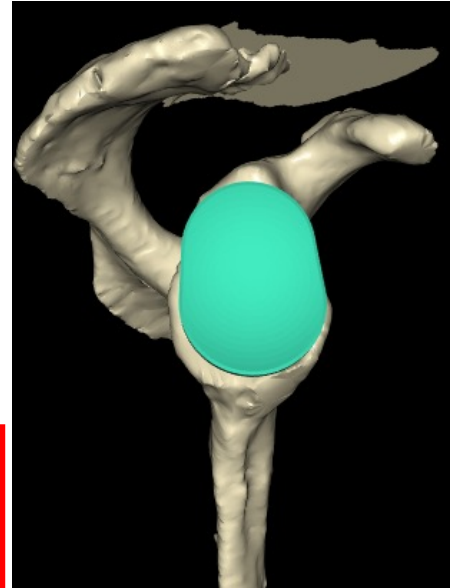
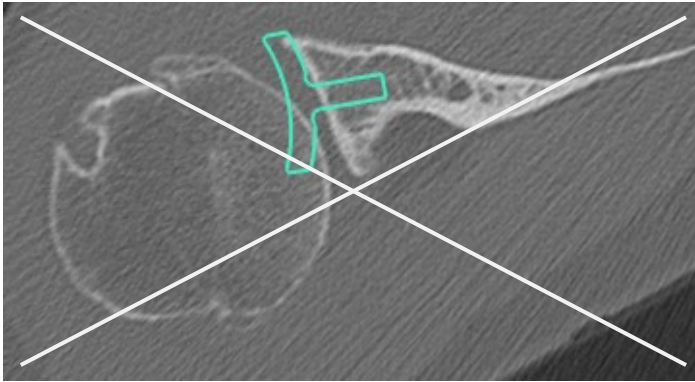
26 °

ANT

Rétroversion

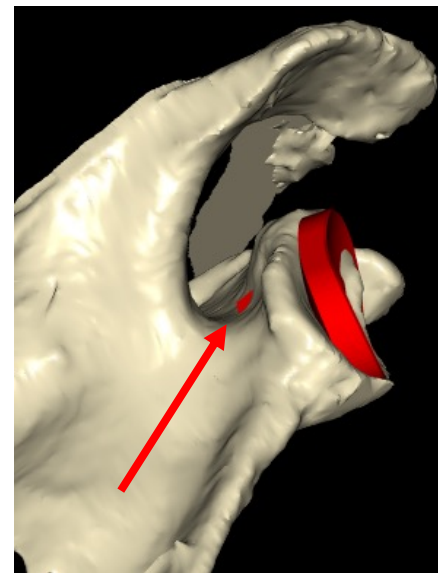
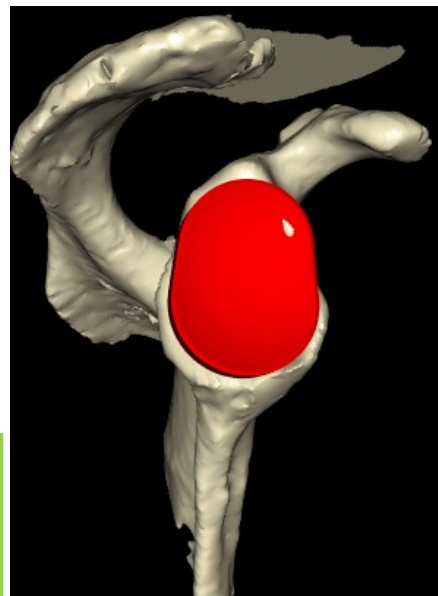
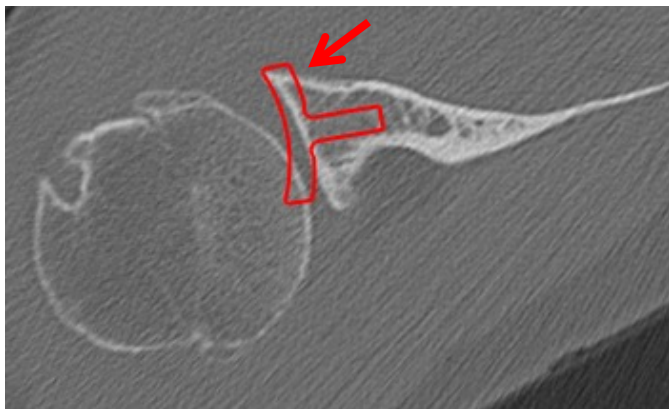
Understanding the associated problems

➔ Bad glenoid seating



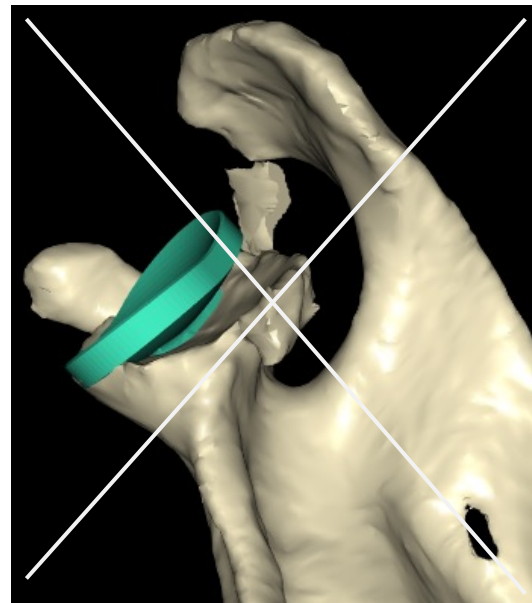
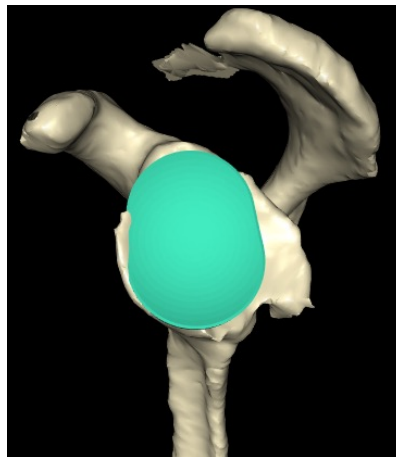
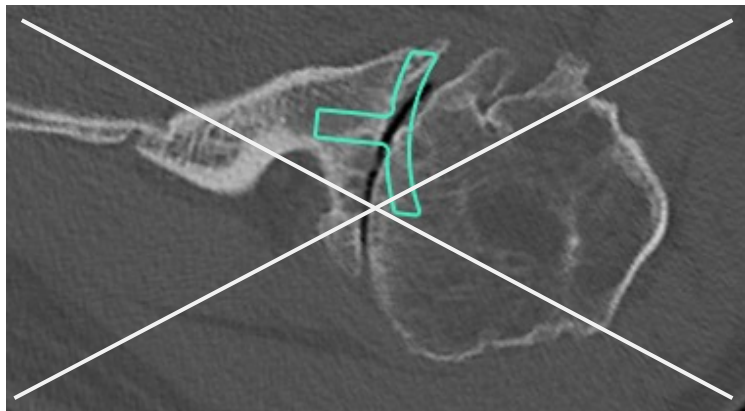
Maybe achieving a compromise?

→ Assymetric glenoid reaming



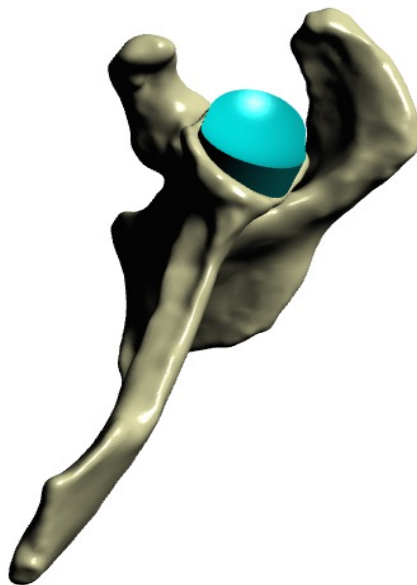
Maybe achieving a compromise?

→ Bad glenoid seating



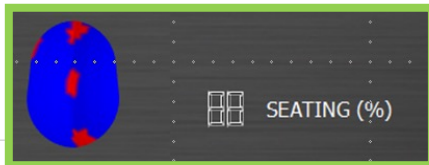
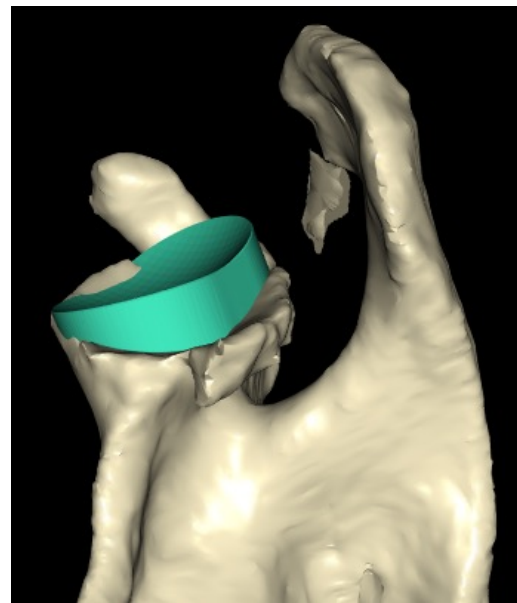
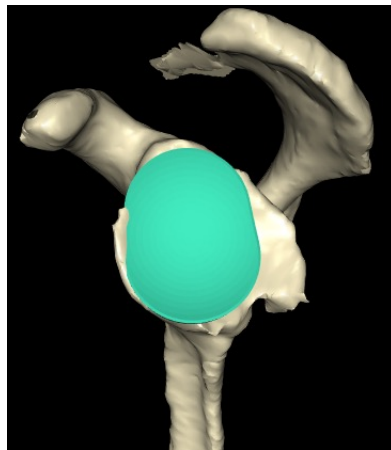
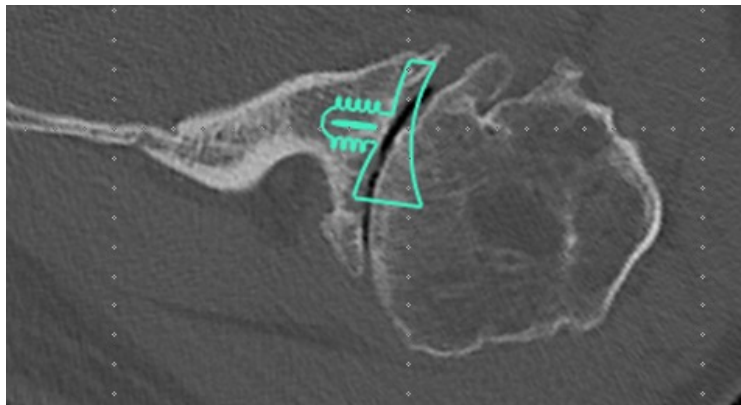
Using implant that correct posterior erosion?

TSA with augmented glenoid implants



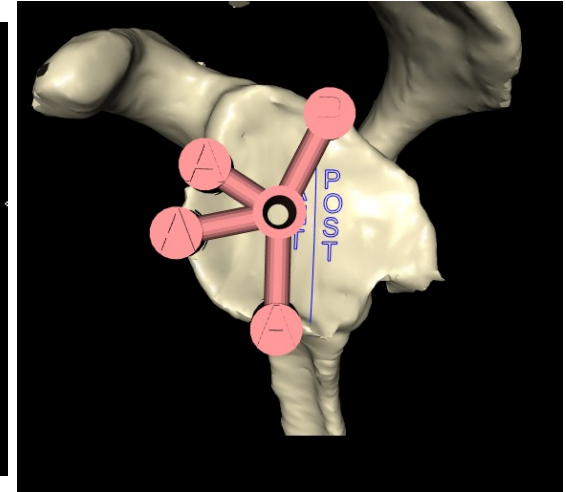
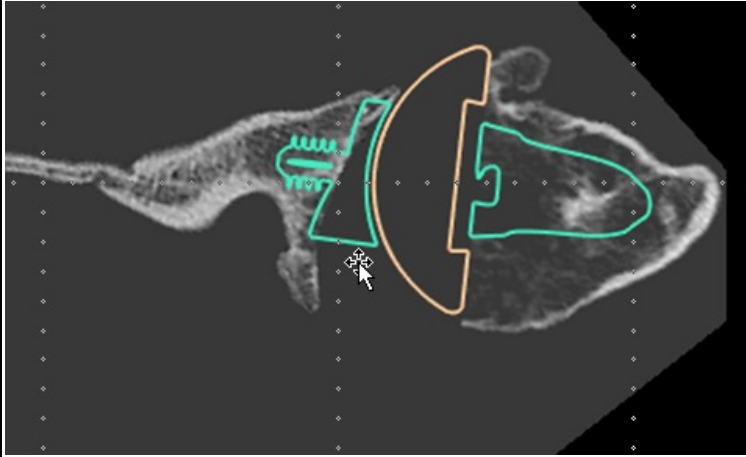
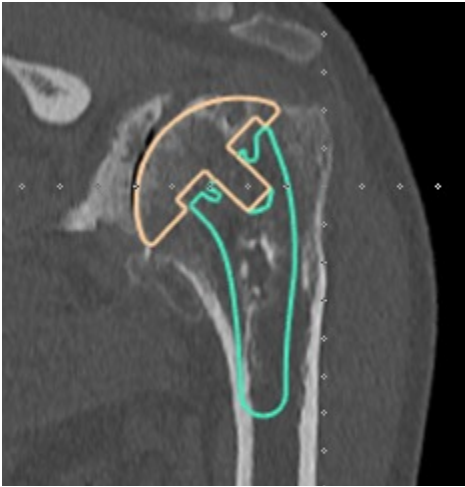
Using implant that correct posterior erosion?

→ Augmented glenoid



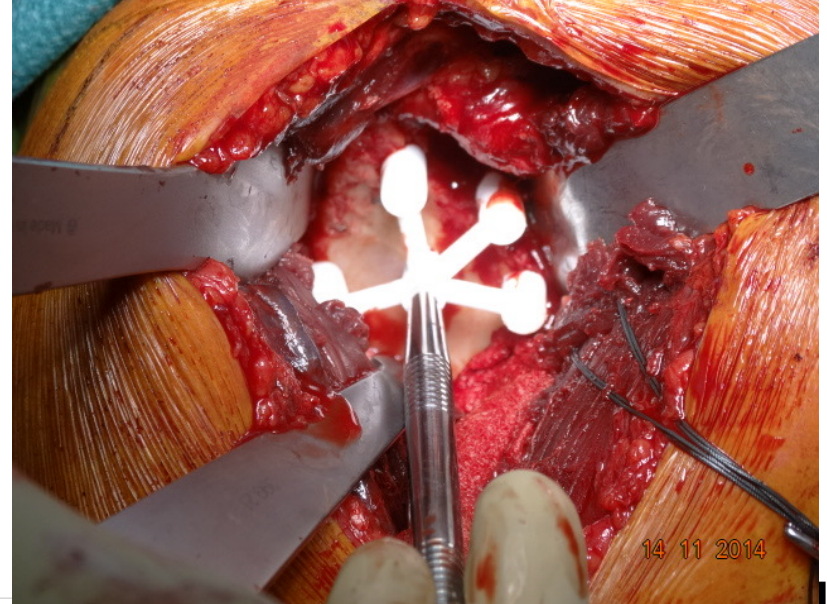
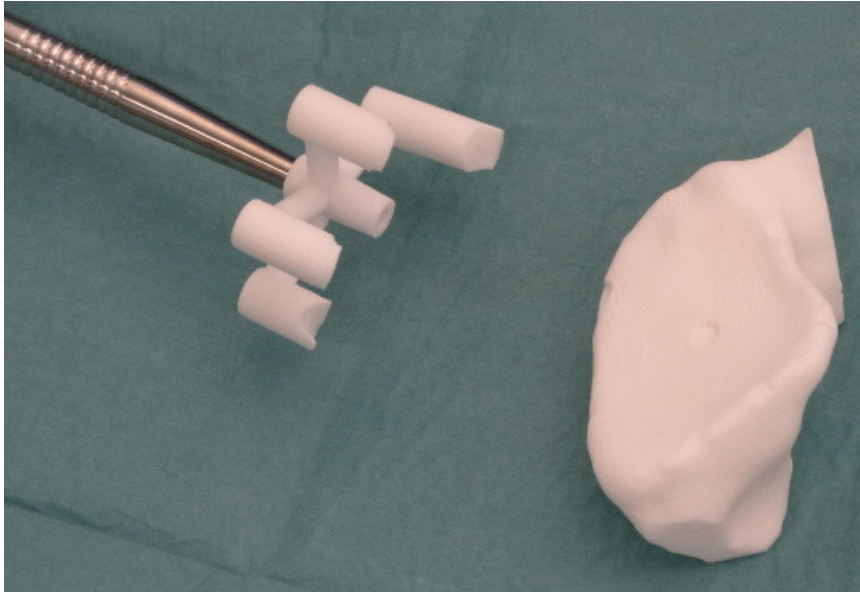
And with the help of 3D printing reproducing the plan!

→ Augmented glenoid + PSI positioning



And with the help of 3D printing reproducing the plan!

➔ Patient specific instrumentation



Posterior augmented glenoid implants

TSA with augmented glenoid implants

➔ *“Potential to improve the outcome”*

Stephens et al, JBJSA 2015

➔ *“Only biomechanical or early clinical results”*

Hsu et al, JSES 2013

➔ *“Excellent outcomes at 50 months”*

Grey et al, JSES 2020

And with the help of 3D printing reproducing the plan!

TSA with augmented glenoid implants: the solution?

Our experience on 10 cases with 5 year follow-up

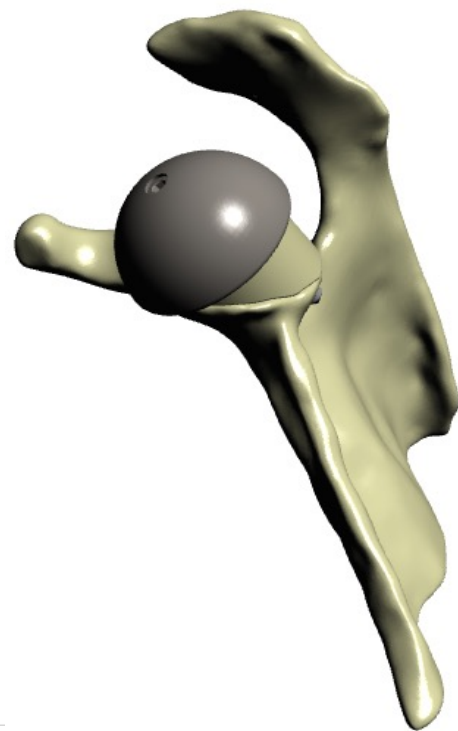
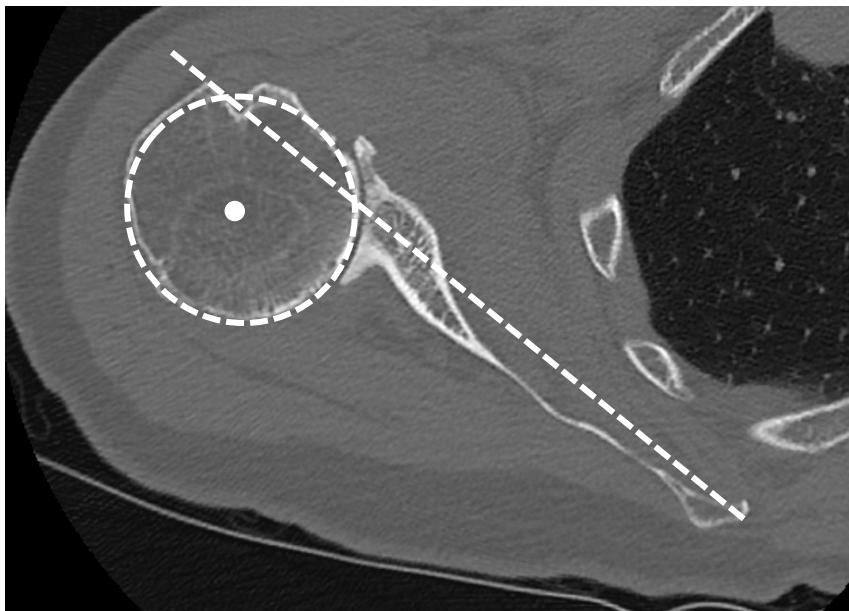
- Effective correction of GV and HHS

BUT

- 50% of glenoid loosening 😞

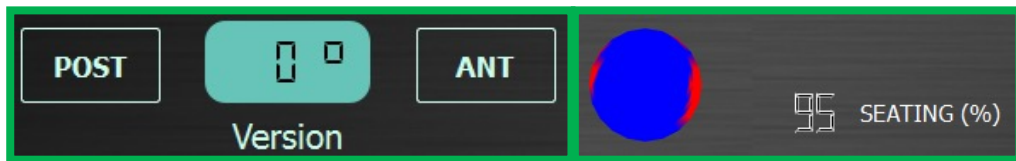
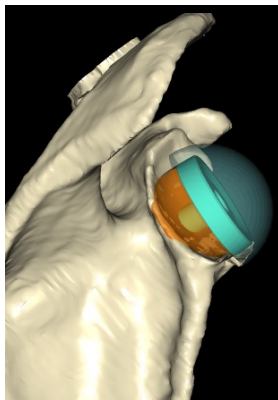
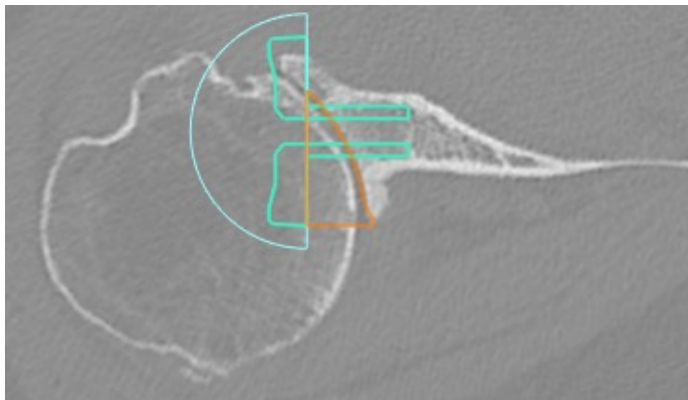
So is there another alternative?

Reverse shoulder arthroplasty?



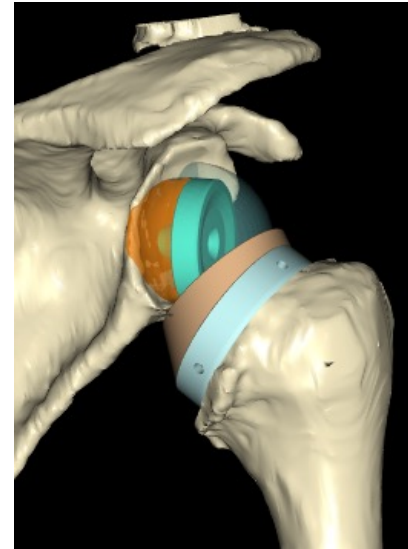
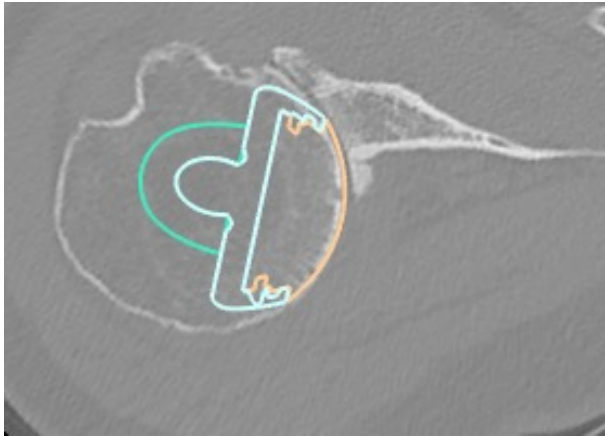
Augmented reverse baseplate

➔ Bone grafting or metallic augments of the glenoid



Augmented reverse baseplate

➔ Bone grafting of the glenoid



Augmented reverse baseplate

RSA:

- *“With or without bone graft”*
- *“Excellent outcome with posterior augmented baseplate”*

Virk et al, JSES 2020

- *“Excellent clinical outcomes”*

Mizuno et al, JBJSA 2013

- *“Less complications than TSA”*

Gallusser et al, OTSR 2014

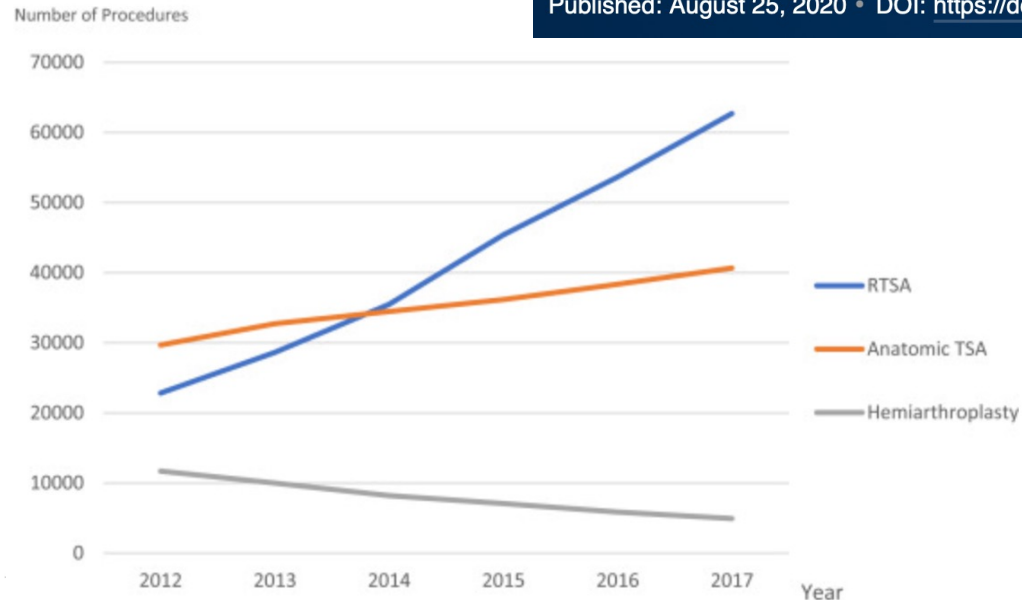
Reversomania!

JOURNAL OF SHOULDER AND ELBOW SURGERY

Increasing incidence of primary reverse and anatomic total shoulder arthroplasty in the United States

Matthew J. Best, MD • Keith T. Aziz, MD • John H. Wilckens, MD • Edward G. McFarland, MD • Uma Srikumaran, MD

Published: August 25, 2020 • DOI: <https://doi.org/10.1016/j.jse.2020.08.010> •  Check for updates



If you want further insights

Shoulder & Elbow

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Biomechanics of anatomic and reverse shoulder arthroplasty

Patrick Goetti¹

Patrick J. Denard²

Philippe Collin³

Mohamed Ibrahim⁴

Adrien Mazzolari⁵

Alexandre Lädermann⁵⁻⁷

- Anatomic and Reverse Shoulder arthroplasty



Open access



Aknowlegment

Thank you to the head of department :

Pr Alain Farron



and Alex Terrier



For their work and dedication to the field of
shoulder arthroplasty

And for the baseline of this presentation!