Shoulder Arthroplasty

Jaime Candal Couto

Osteoarthritis

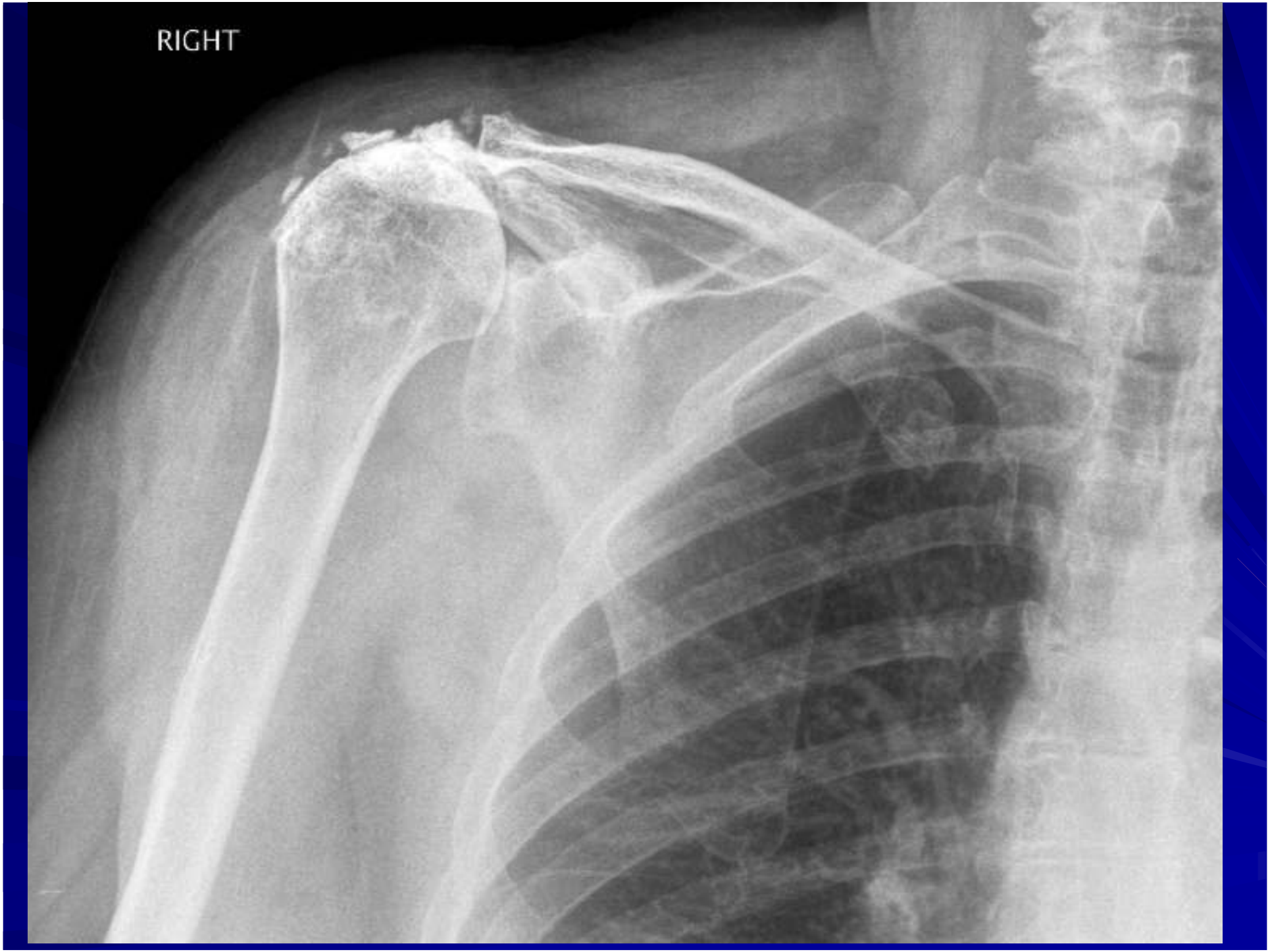
- "Improvement of self assessed health status after TSR (Total Shoulder Replacement) is comparable to that of Total Hip replacement and C
  Artery Bypass Graft"
  - ***Boorman et al, JSES 2003***

Patient

Surgeon

Prosthesis


R
LD


RIGHT


R


L
SG

1:The surgeon

Shoulder arthroplasty: incidence
(100.000 population/year)

- US: **21.55**
- New Zealand: **4.2**
- UK: **3.6**
- Norway: **2.8** (1994) - **4.7** (2005)

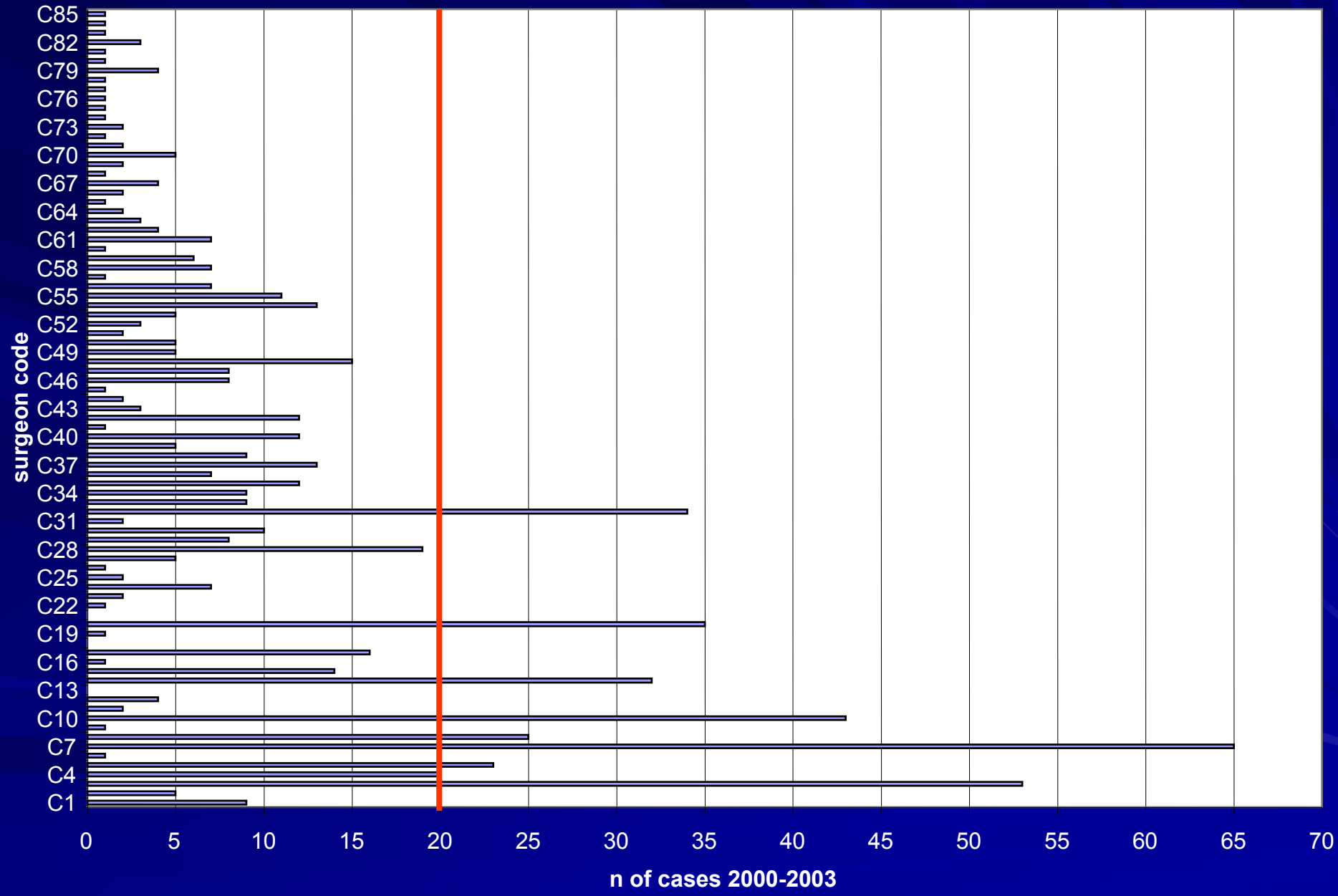
100-150 prosthesis / year

New Zealand Shoulder Arthroplasty register

- 3 m population
- 160 orthopaedic surgeons
- 4 years 2000-2003
- 686 primary prosthesis

J Candal-Couto, BOA 2005

Surgeons workload: Shoulder arthroplasty cases/4 years



THE OXFORD SHOULDER SCORE (OSS)

- 12 questions; score 1(best)-5(worst)

1. Worst pain from shoulder
2. Trouble with dressing
3. Trouble with transport
4. Using a knife and fork
5. Doing household shopping alone
6. Carrying a tray of food
7. Brushing/combing hair
8. Usual level of shoulder pain
9. Hanging clothes in wardrobe
10. Washing under both arms
11. Work interference due to pain
12. Pain in bed at night

- Excellent: 12-18
- Good: 19-26
- Fair: 27-36
- Poor: 37-60

Dawson J, Fitzpatrick R, Carr A. JBone Joint Surg Br. 1996 Jul;78(4):593-600.

SURGEON'S WORKLOAD & Oxford Shoulder Score (12-60)

J Candal-Couto, BOA 2005

ALL CASES	High volume surgeon	Low volume surgeon
Number of cases	221	224
Mean score	23.8	26.4 *p= 0.0038*

Outcome (%)

•Excellent	34.3 %	27.6 %
•Good	30.3 %	28.9%
•Fair	24.5 %	23.9%
•Poor	10.7 %	19.4%

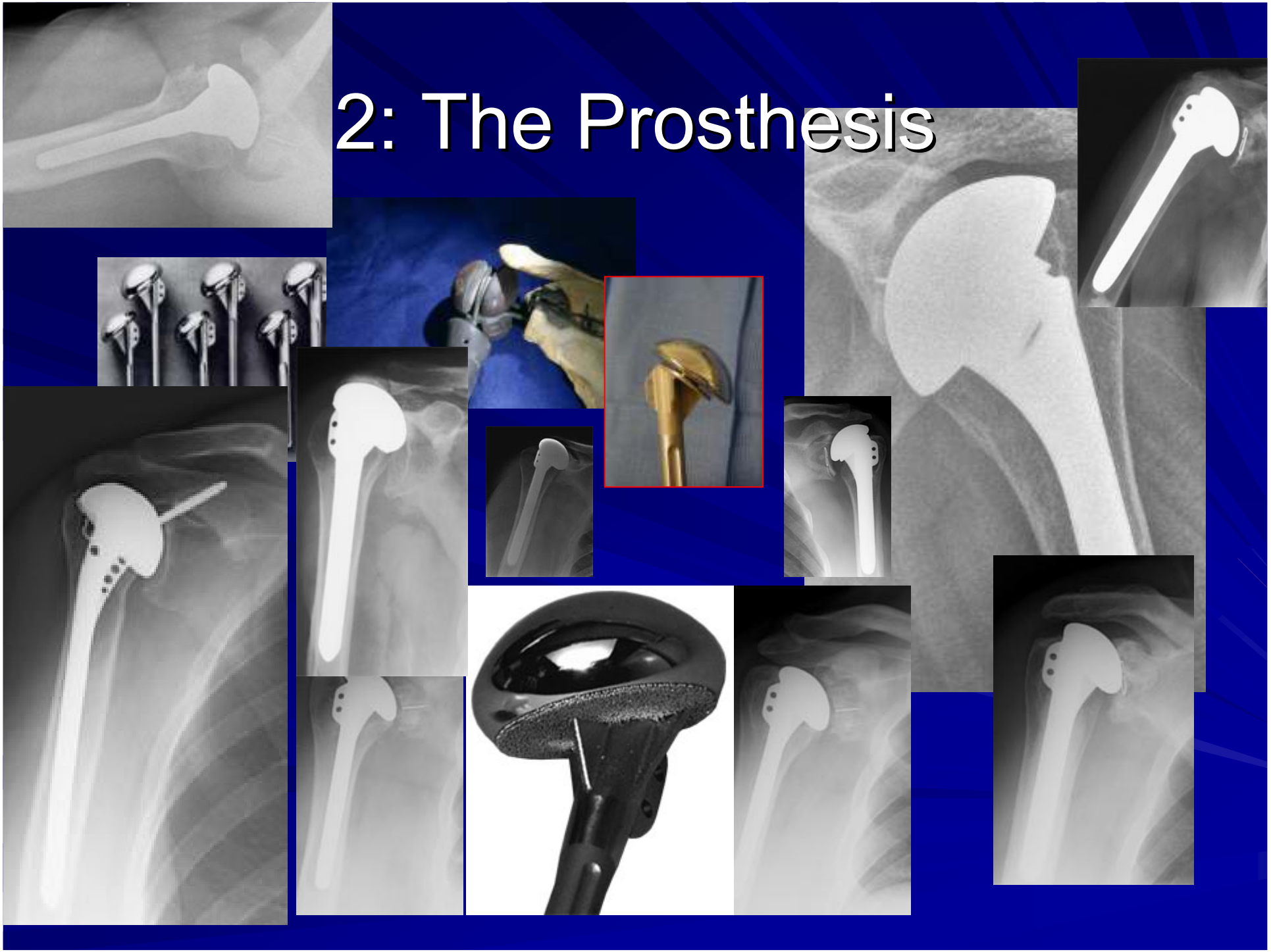
p<0.0001

Surgeons who do >5 cases per year also have…

- Lower complication rates
- Lower Mortality
- Shorter Hospital Stay

- ***Jain at al, JBJS-A 2004***
- ***Hammond et al,JBJS-A 2003***

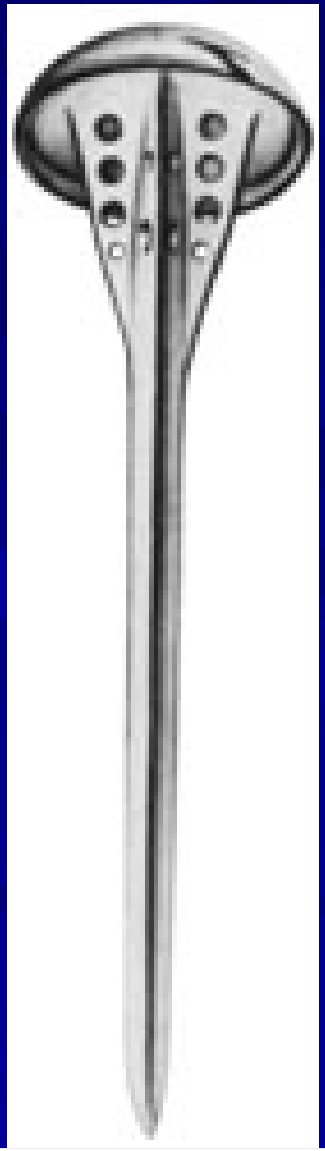
2: The Prosthesis



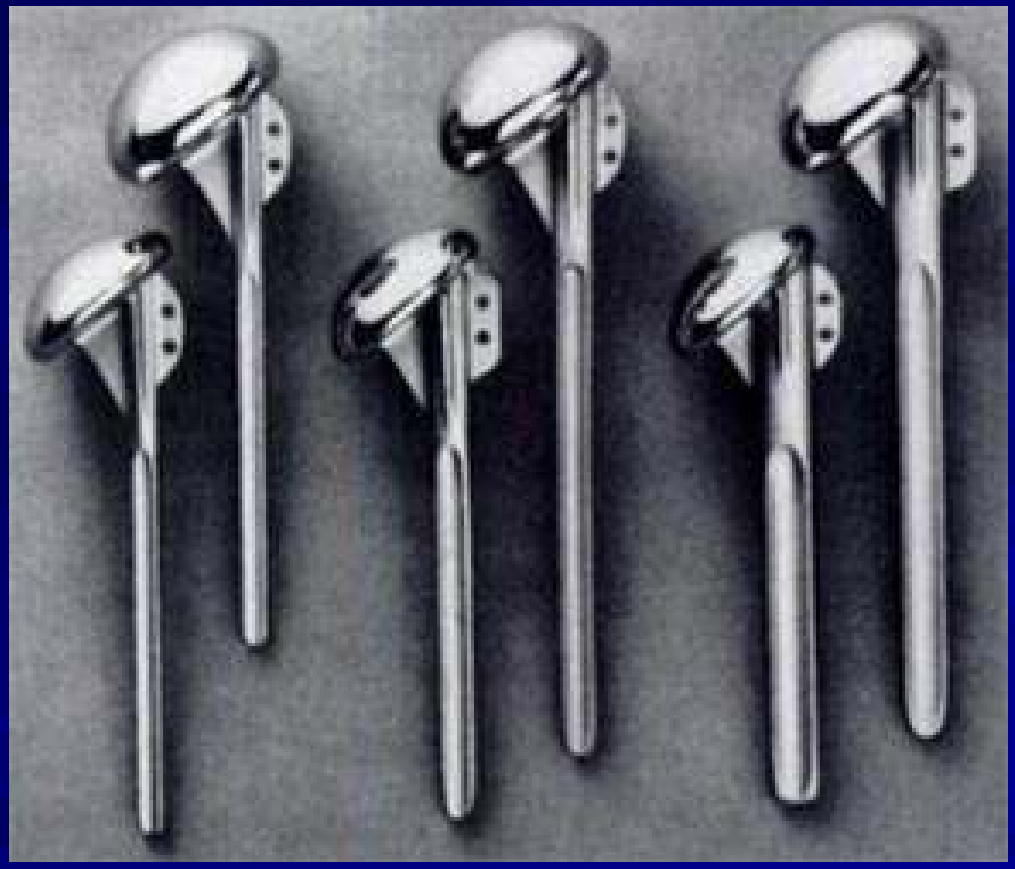
Shoulder arthroplasty: historical background.

Pean, 1893

1951 Neer's Vitalim prosthesis

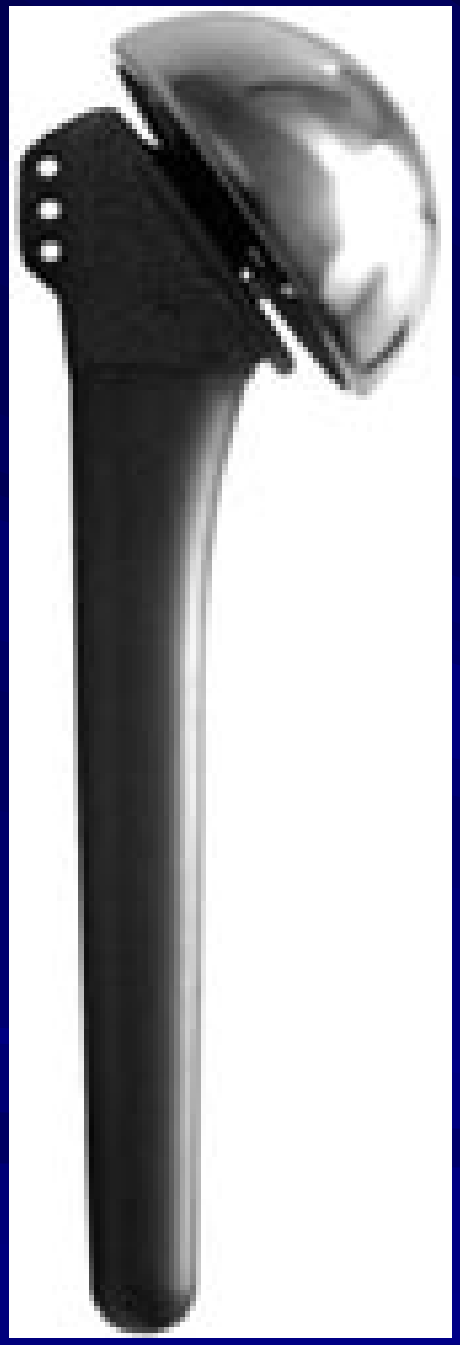


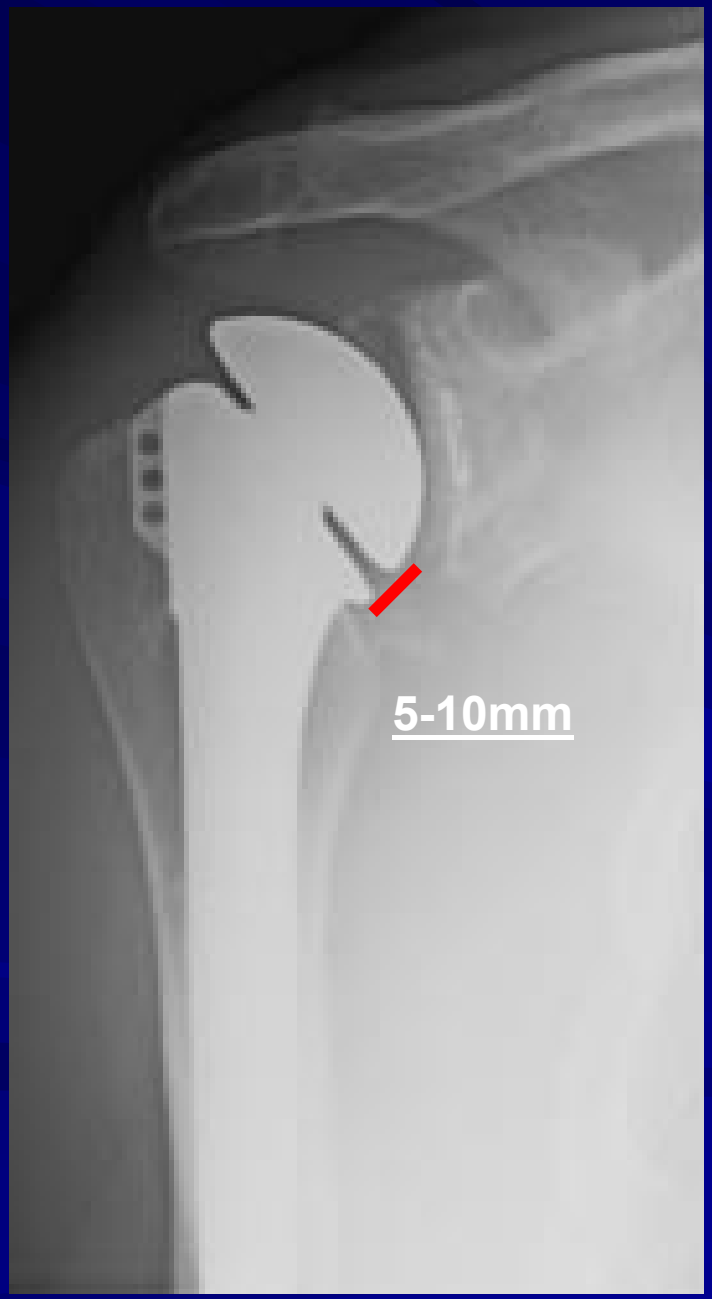
1970's Neer Total Shouder



Neer, et al, JBJS 1982

Humeral Stem
Second Generation: 1980's





5-10mm

Anatomy of the humerus and prosthetic design

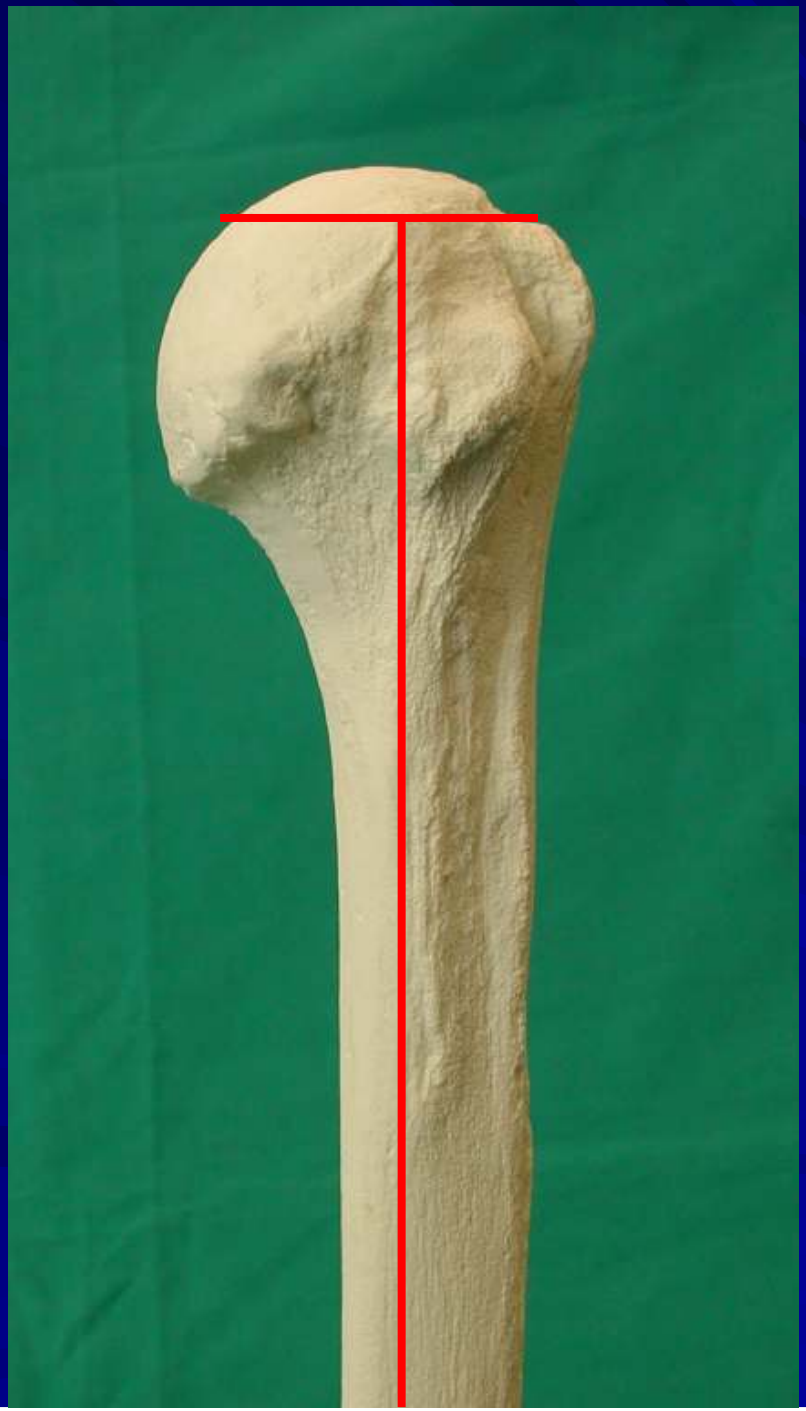
- Surprisingly not Studied in detail till 90's!
- Normal proximal Humeral anatomy Highly variable
- Variability between individuals and also right & Left

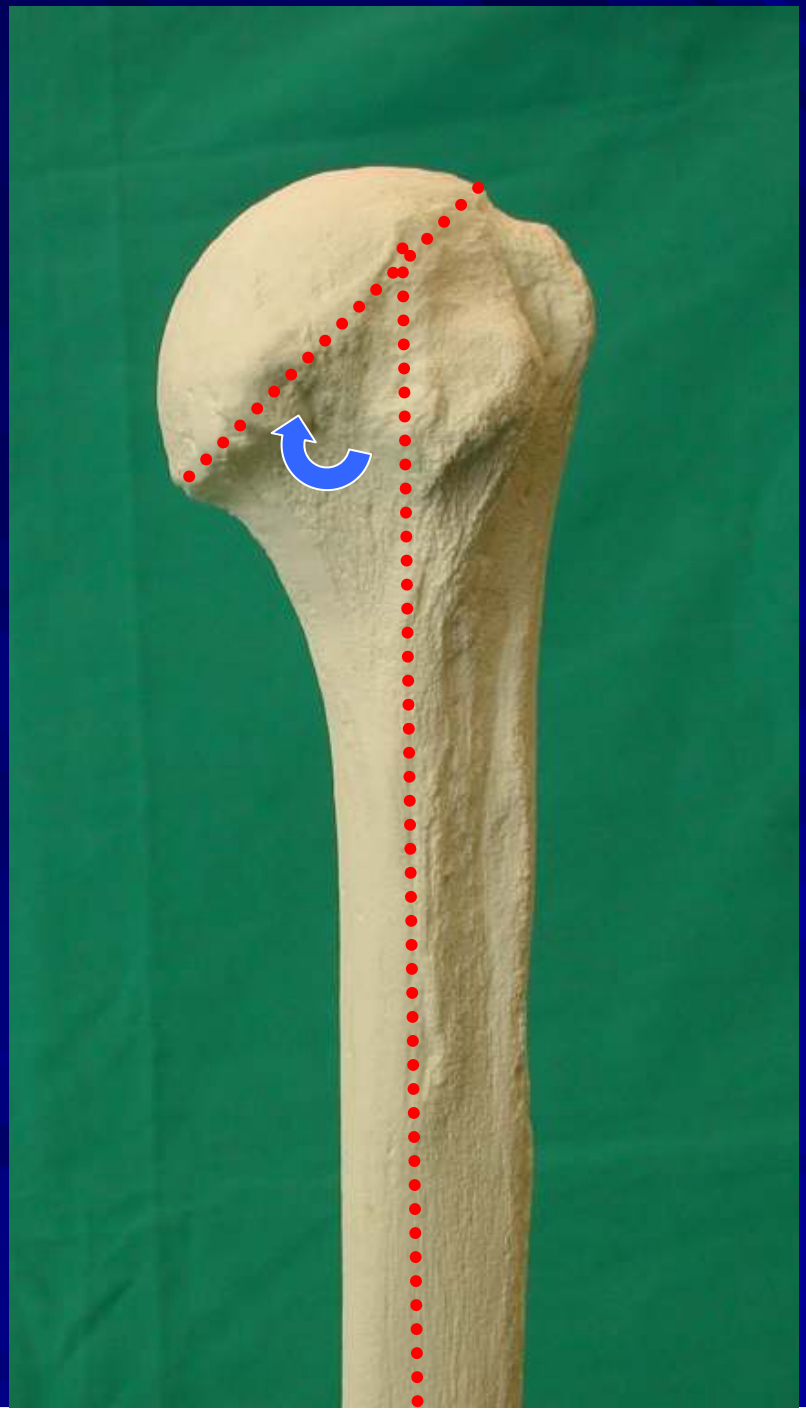
Basic Concepts: Normal anatomy

- Head-Shaft angle
- Retroversion
- Offset
- Radius of Curvature and height height

Basic concepts: Implant Considerations

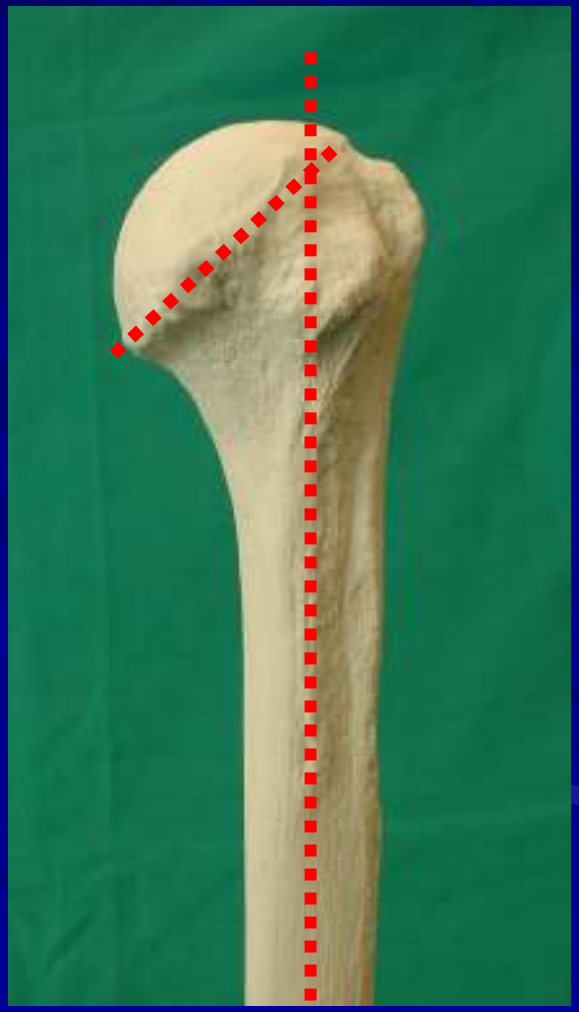
- Humeral head size
- Humeral Head osteotomy
- Head-Stem relationship

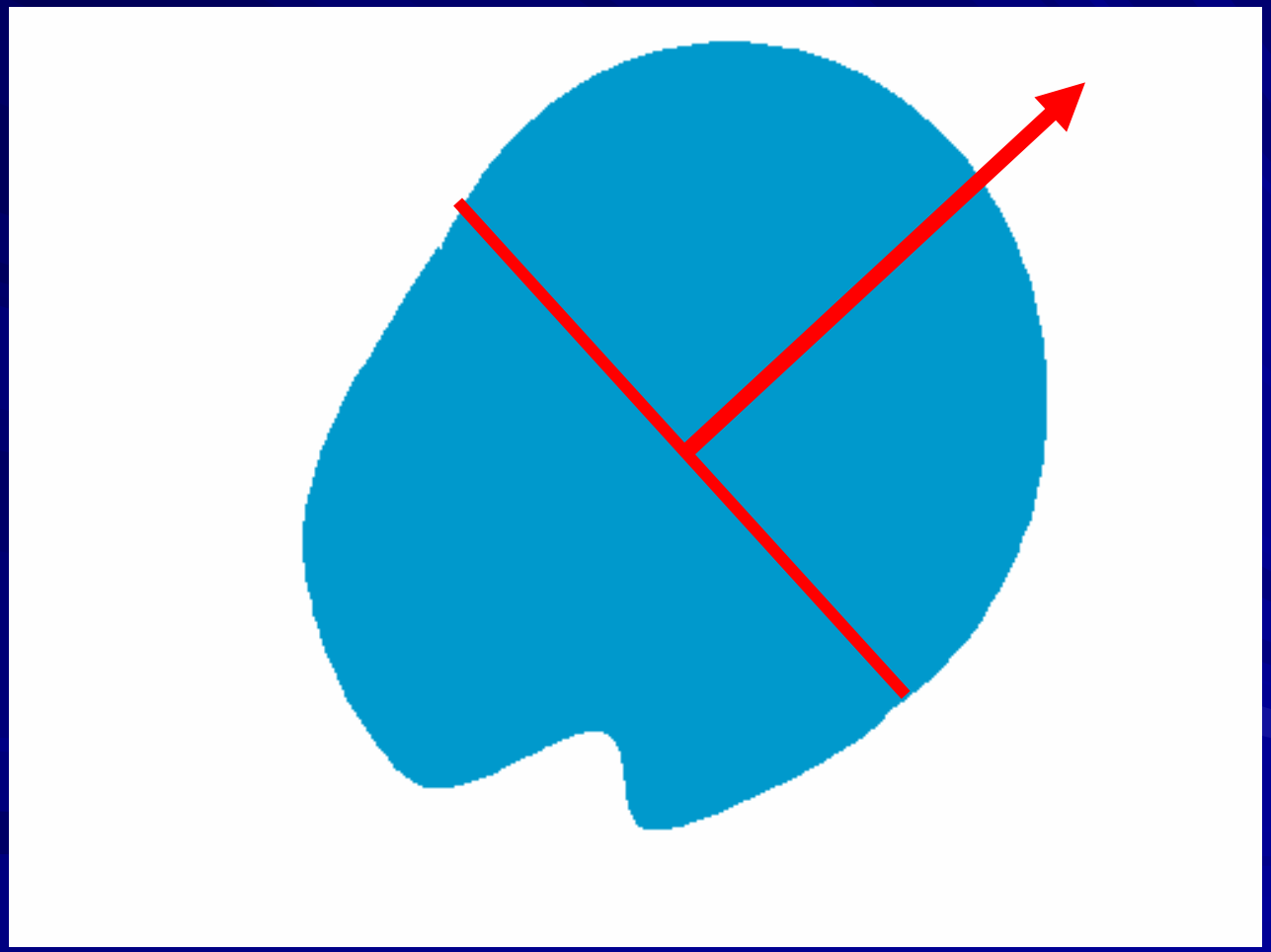


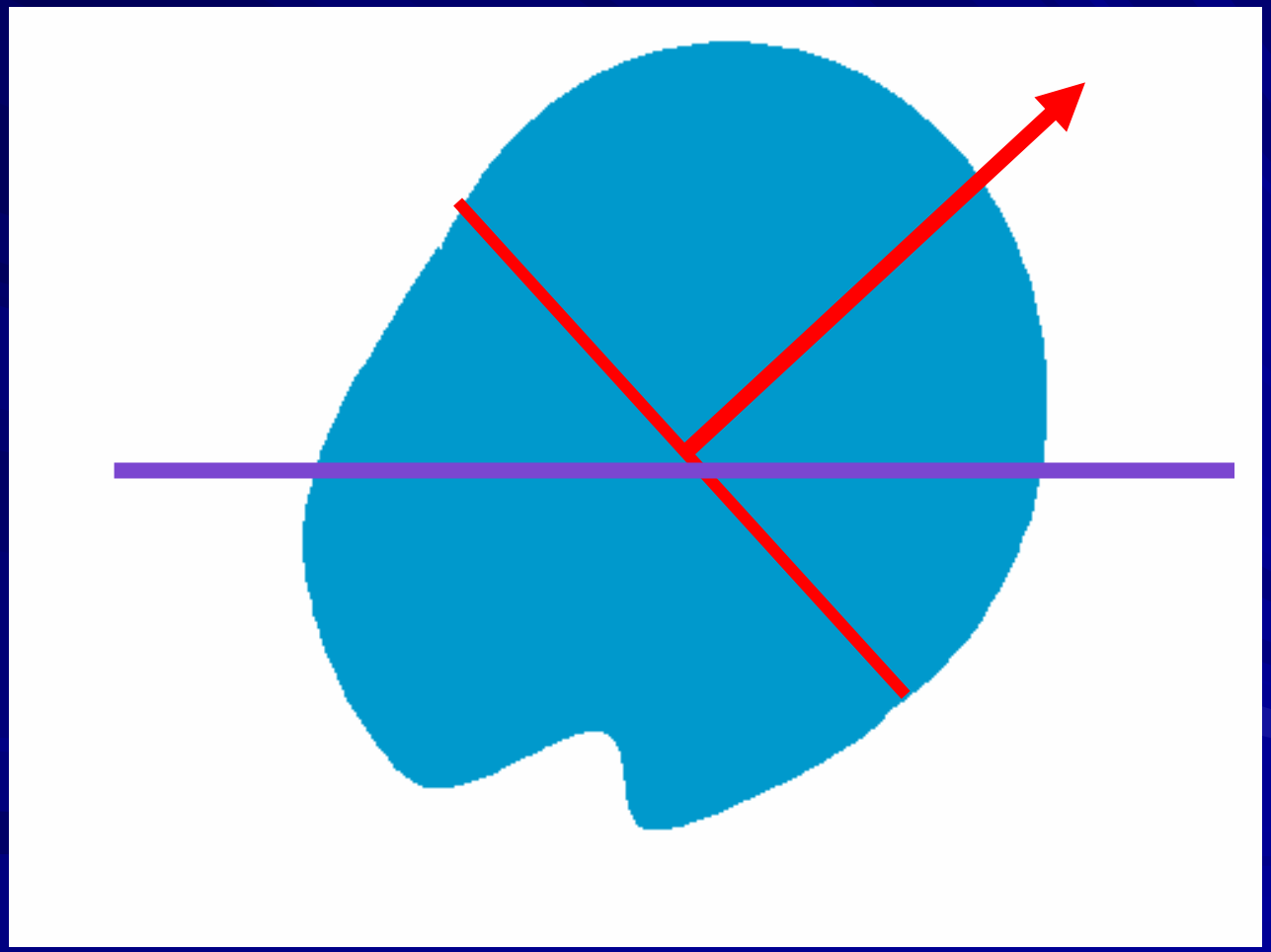


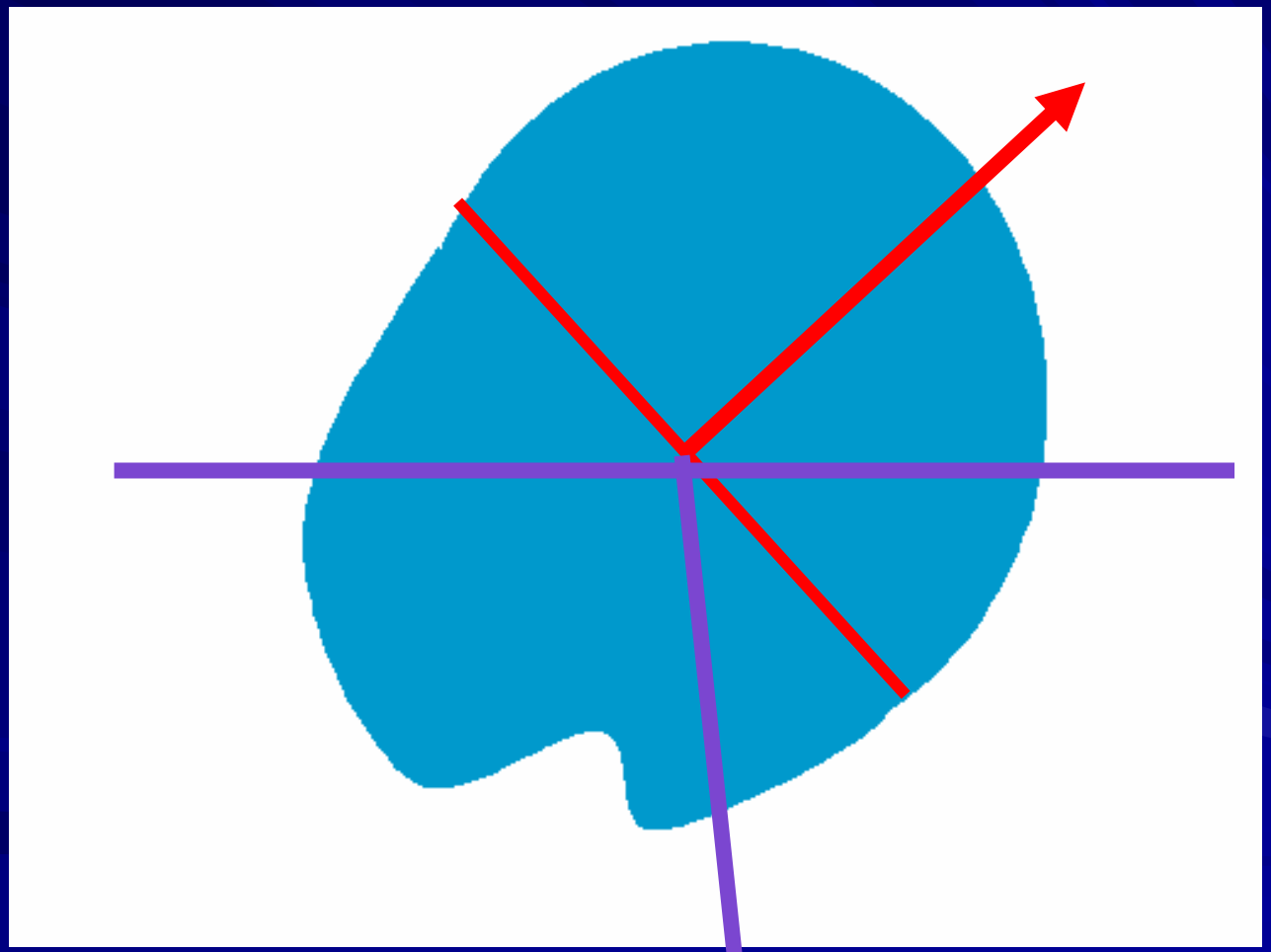
1: Head – Shaft Angle

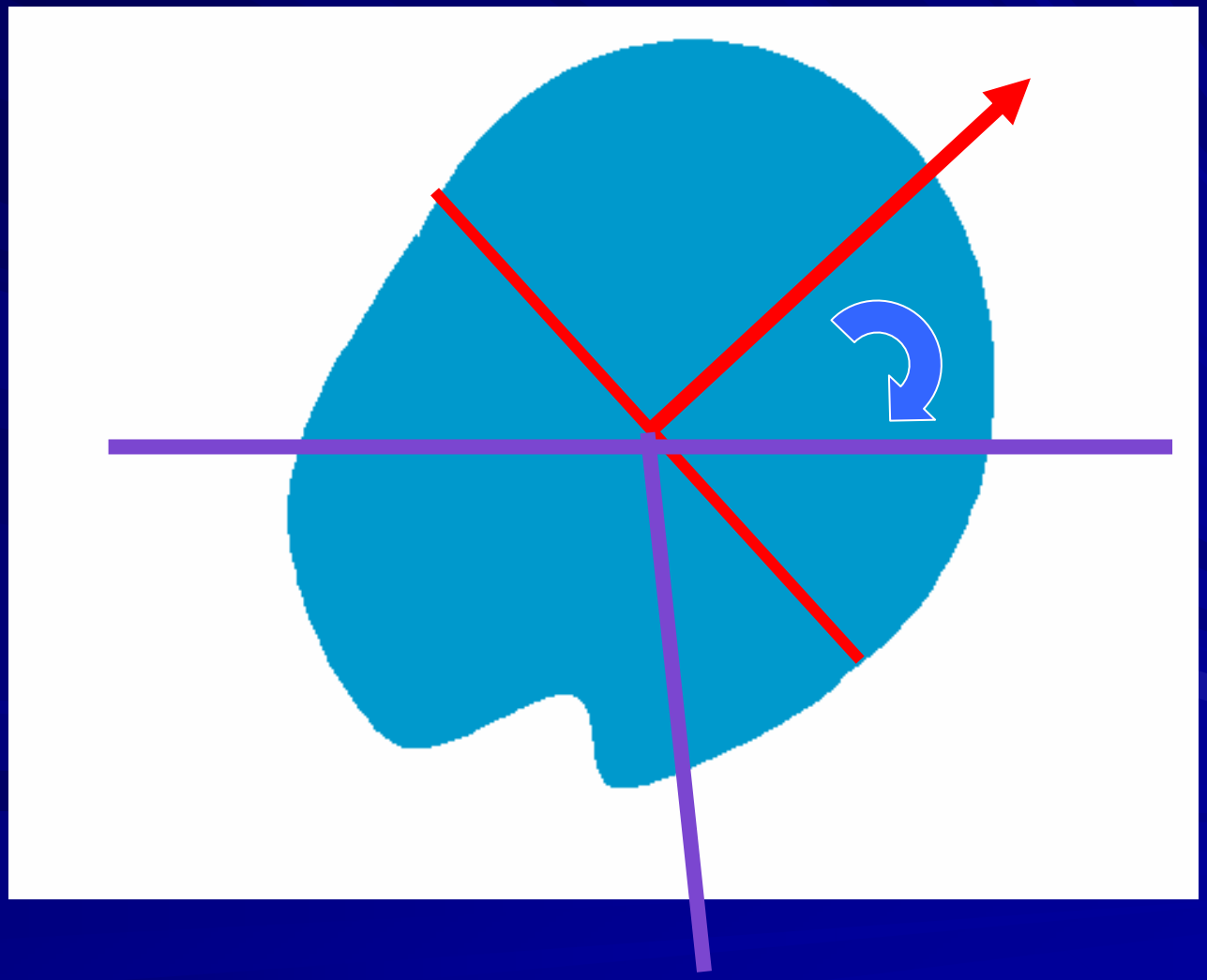
- Difficult measurement
  - Base of articular surface is a plane not a line
  - Humeral shaft is tubular
- **Range 30^0-55^0**

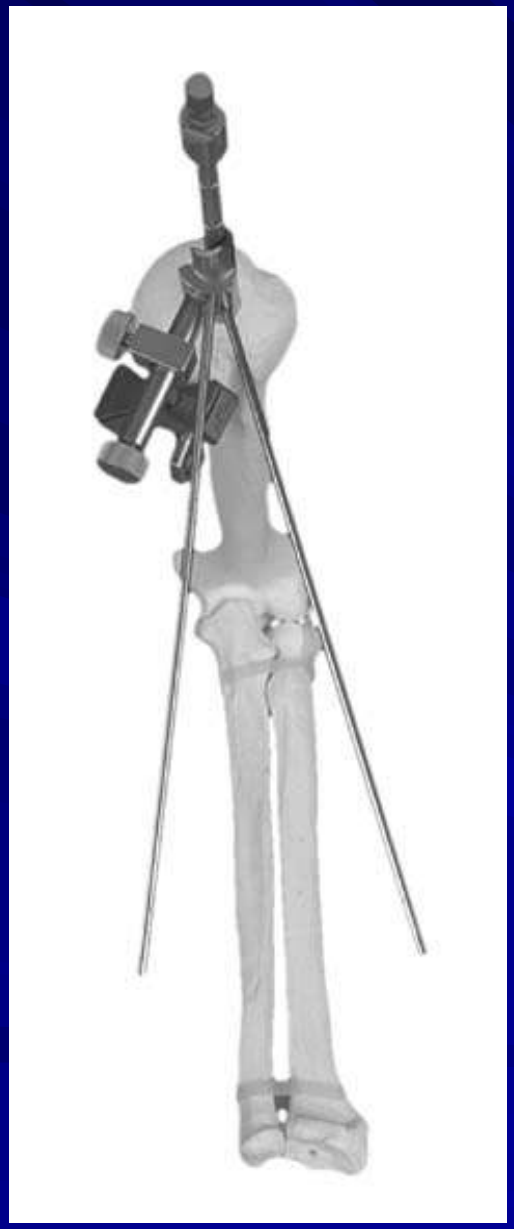






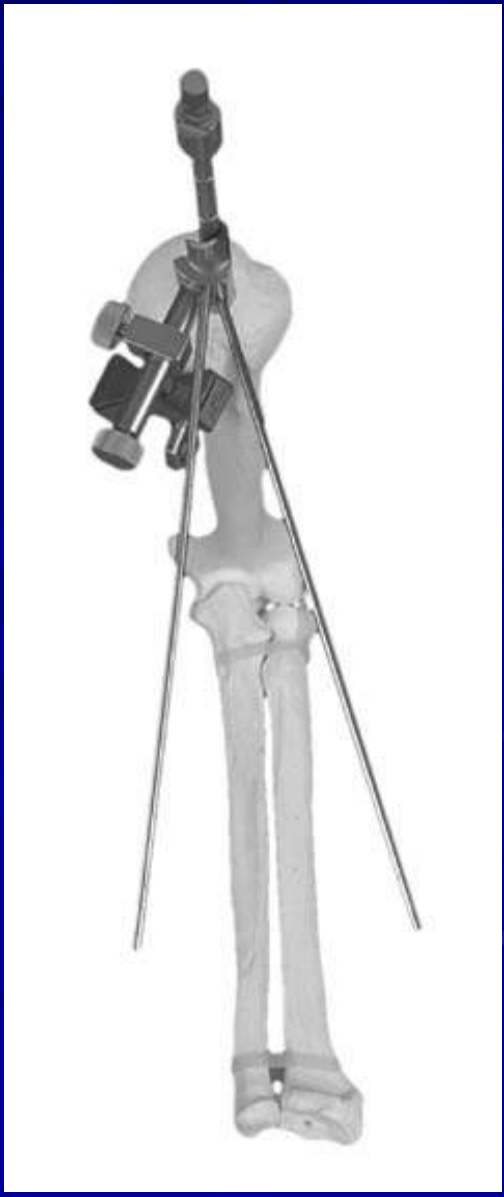


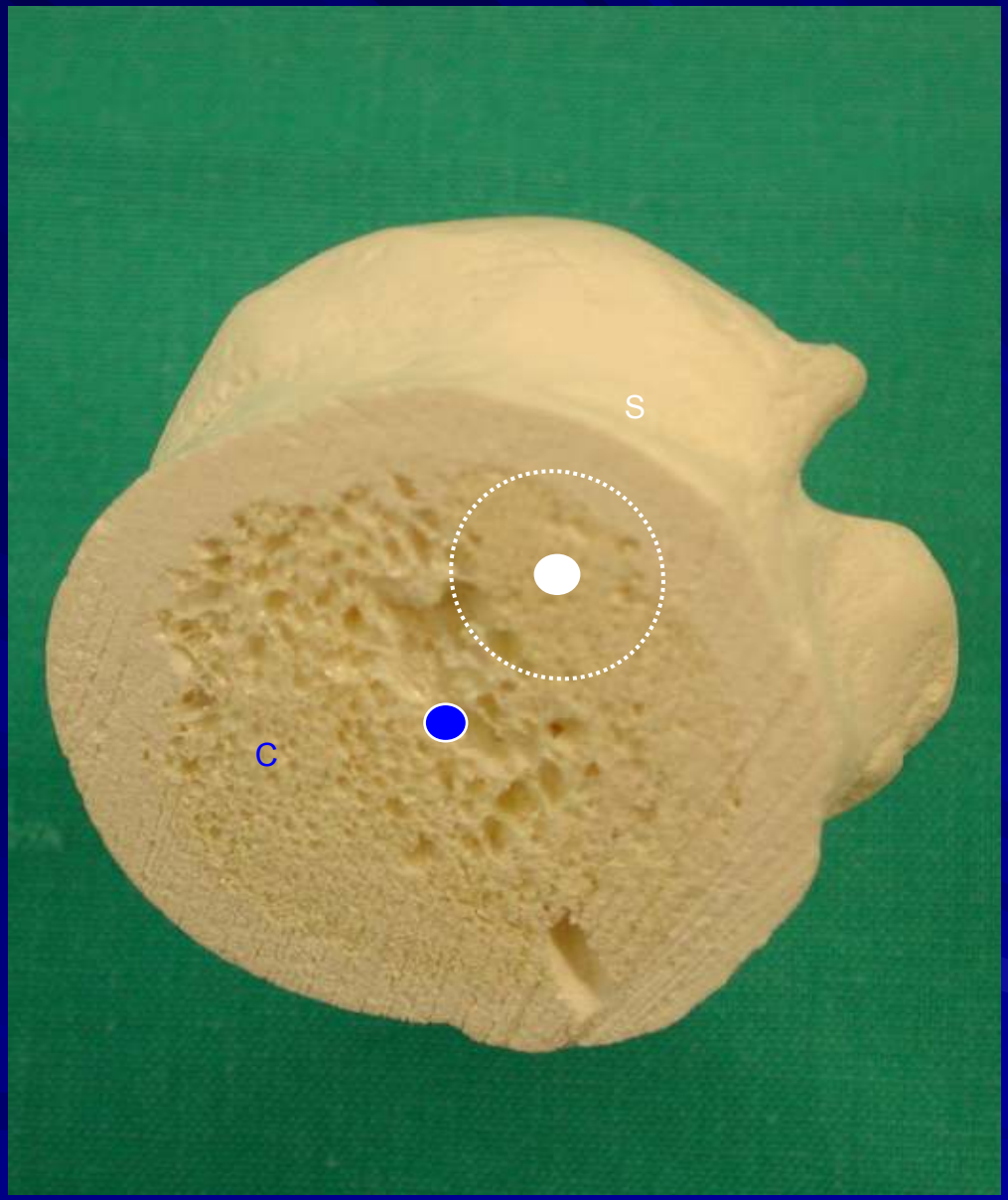




2: Retroversion

- Markedly variable
- **RANGE 0^0 - 55^0**

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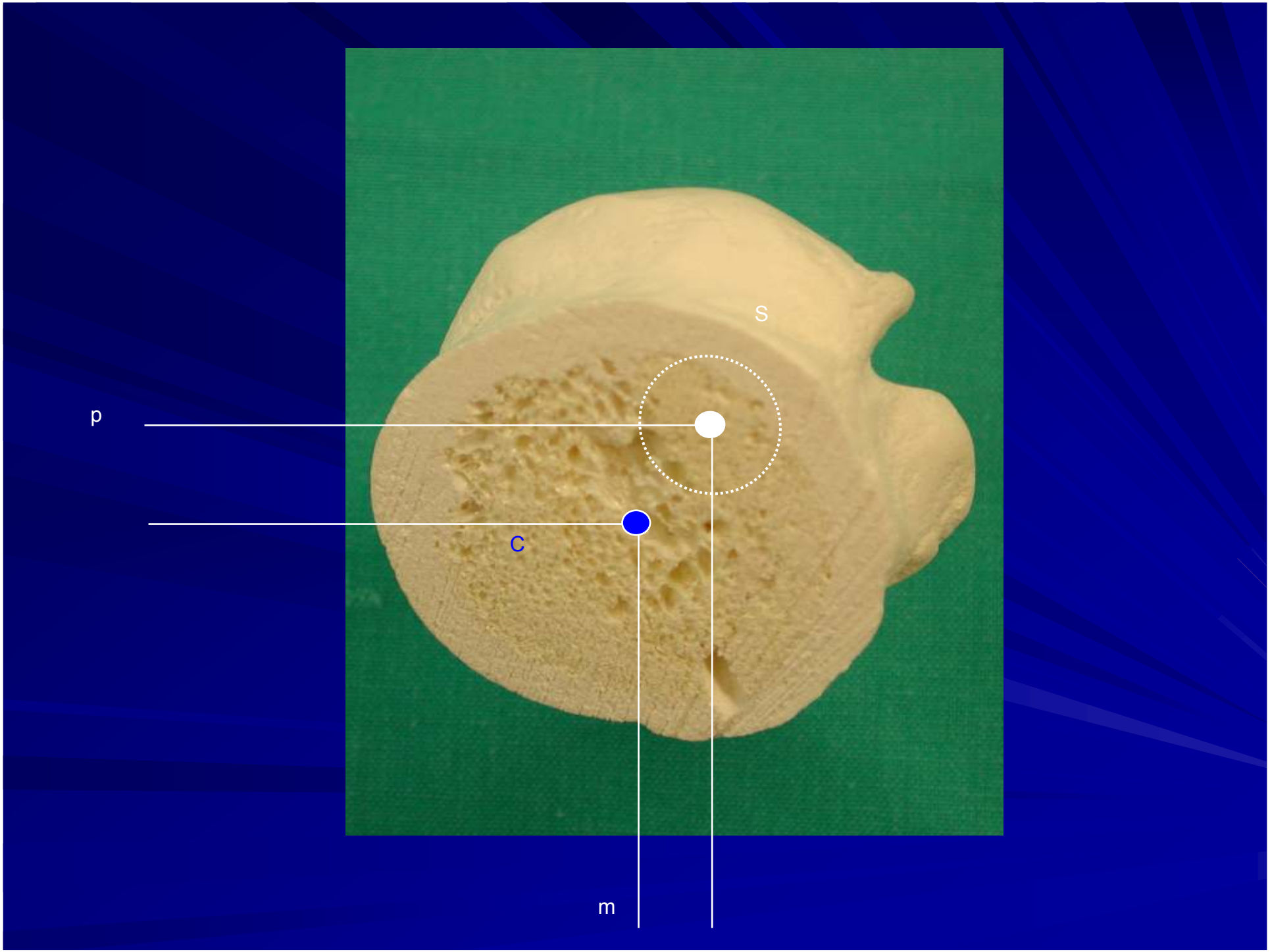
C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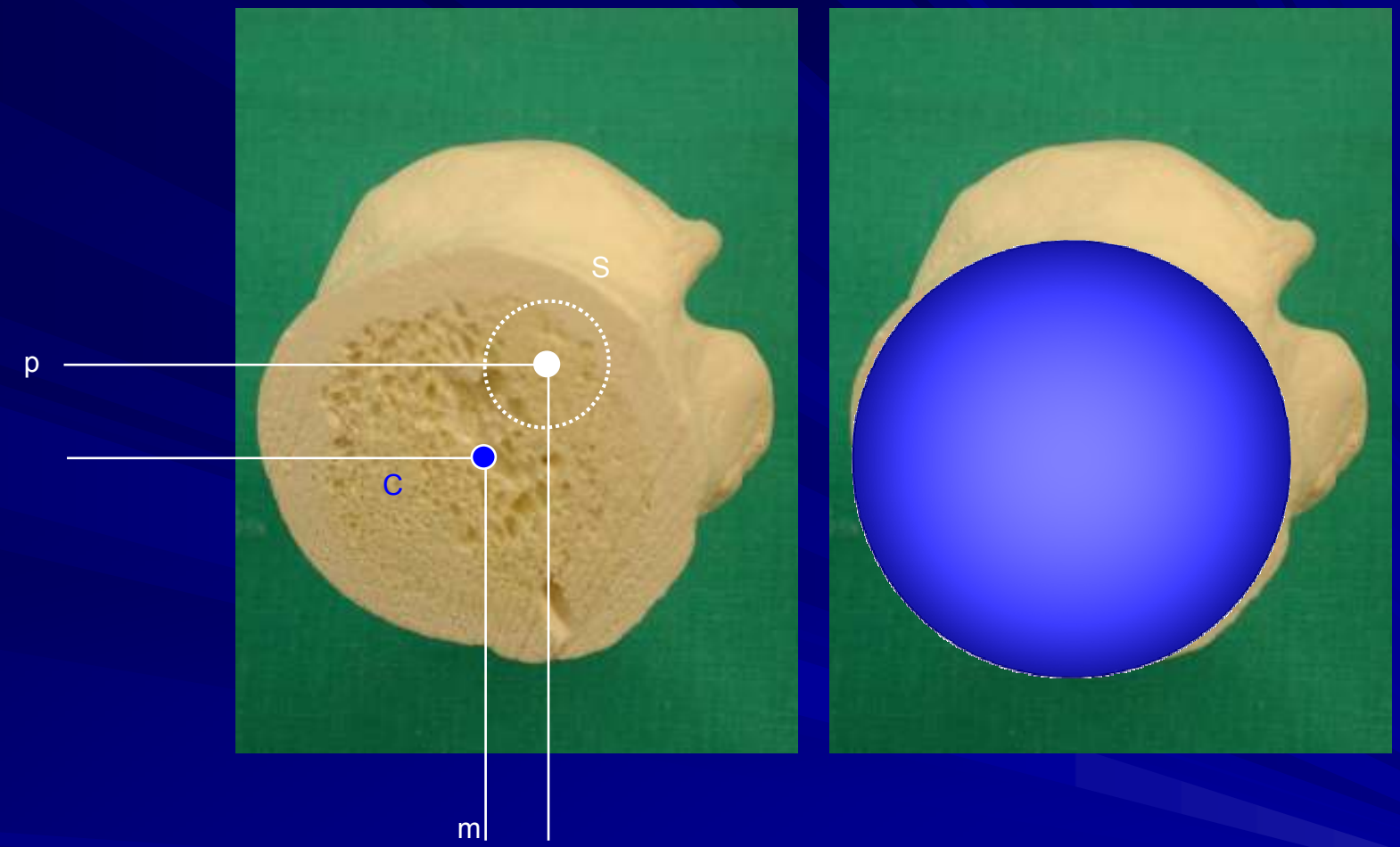
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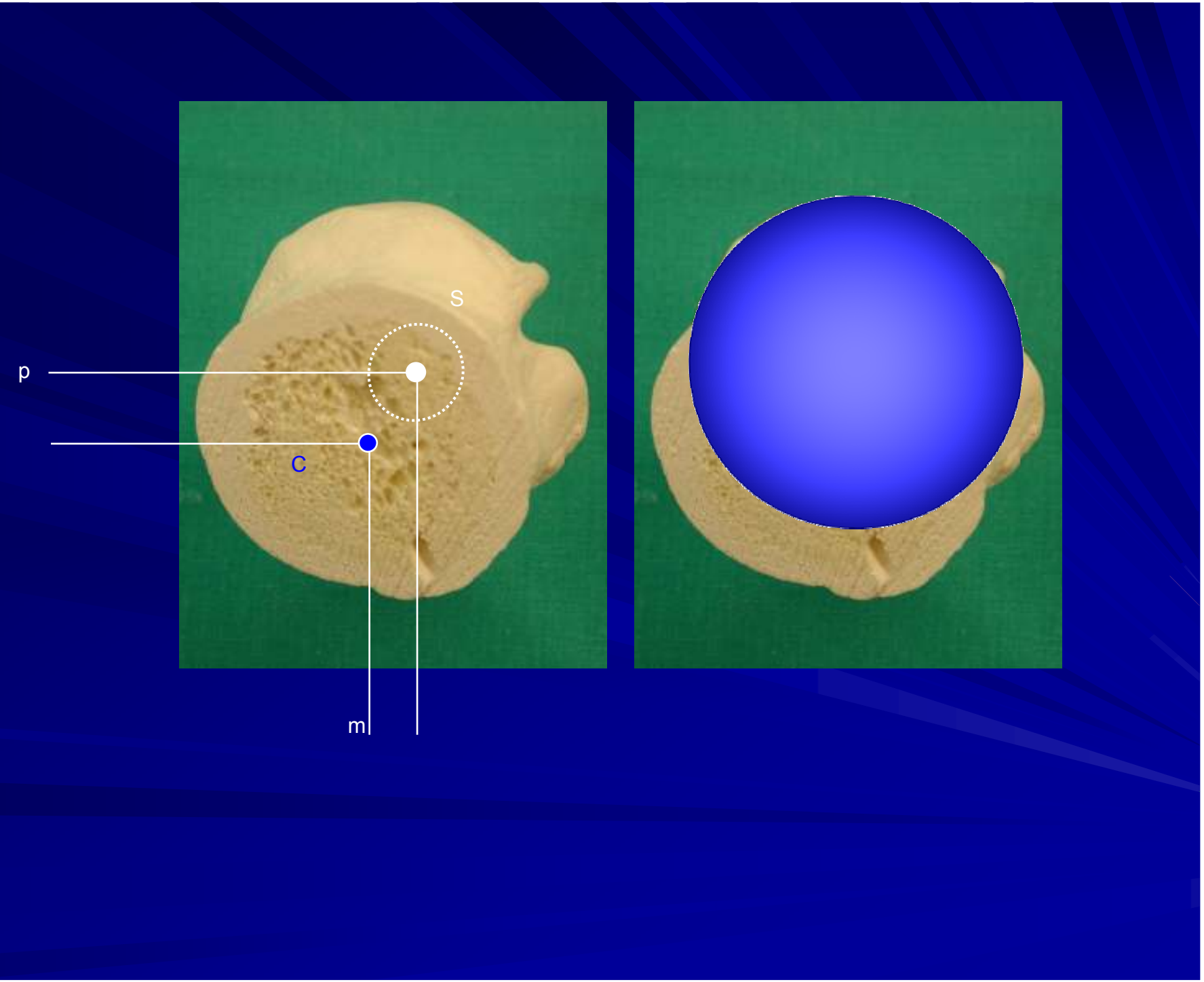
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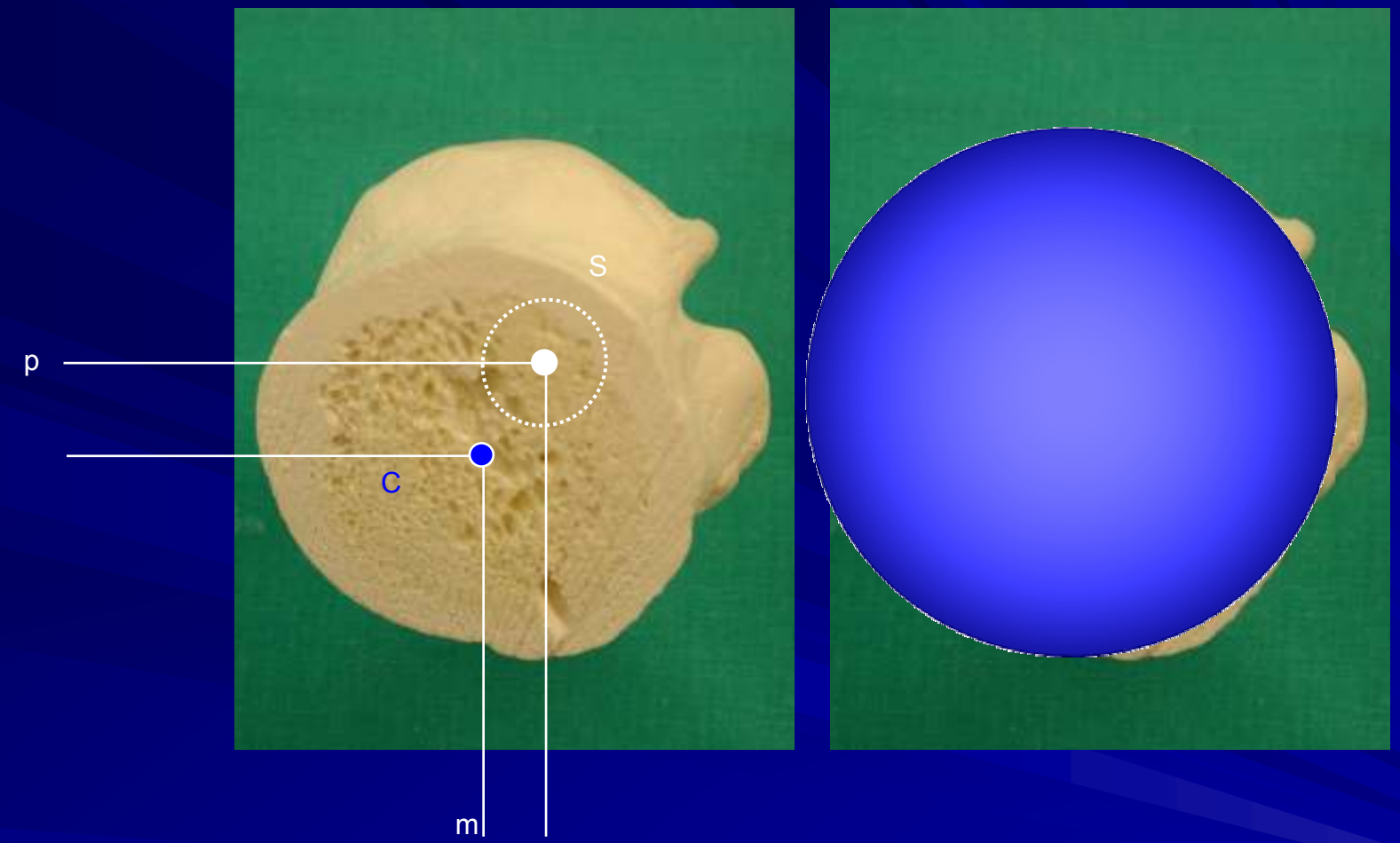
S
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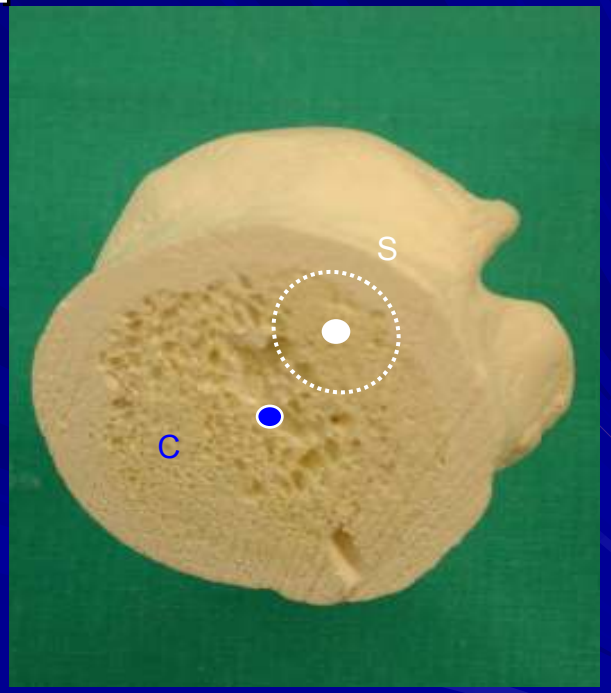
m

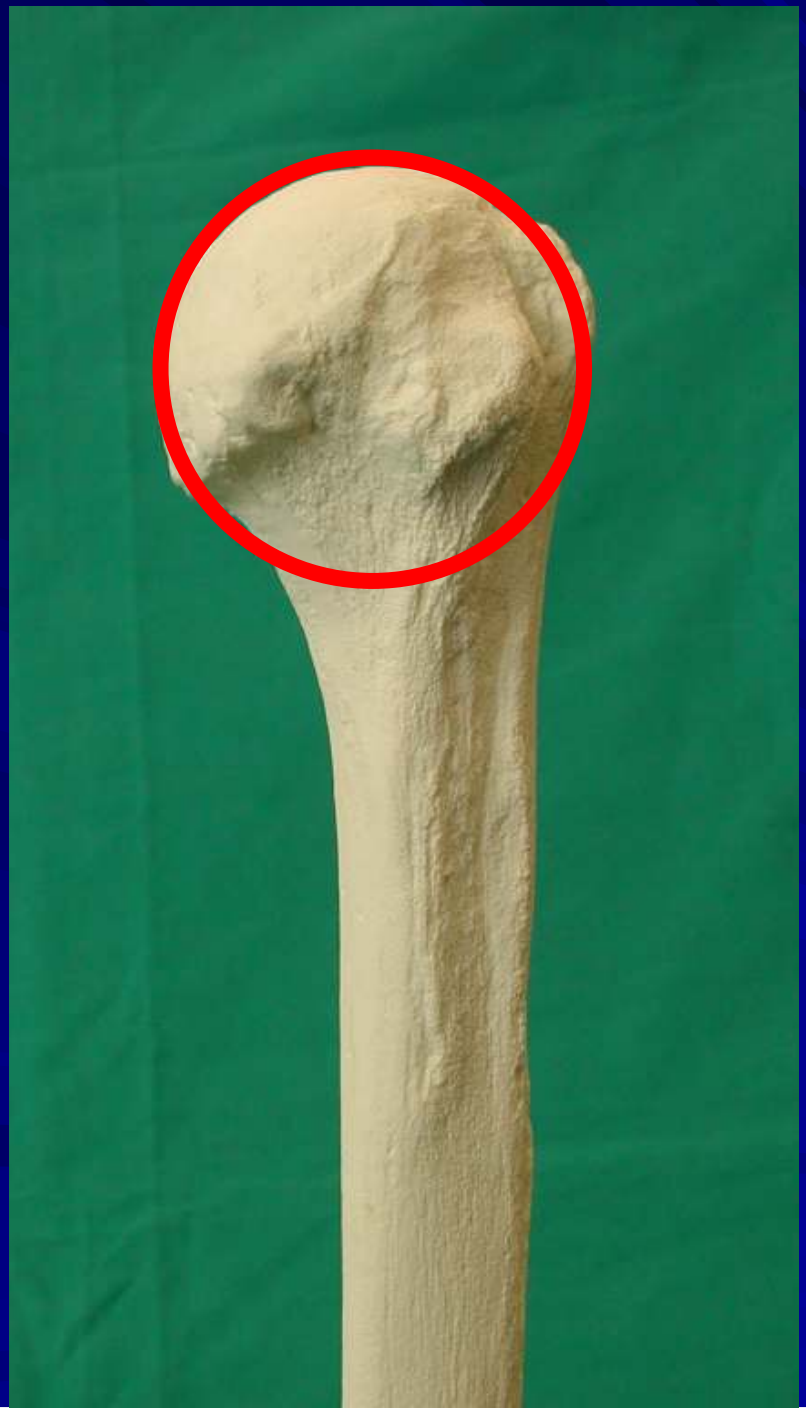
3: Offset

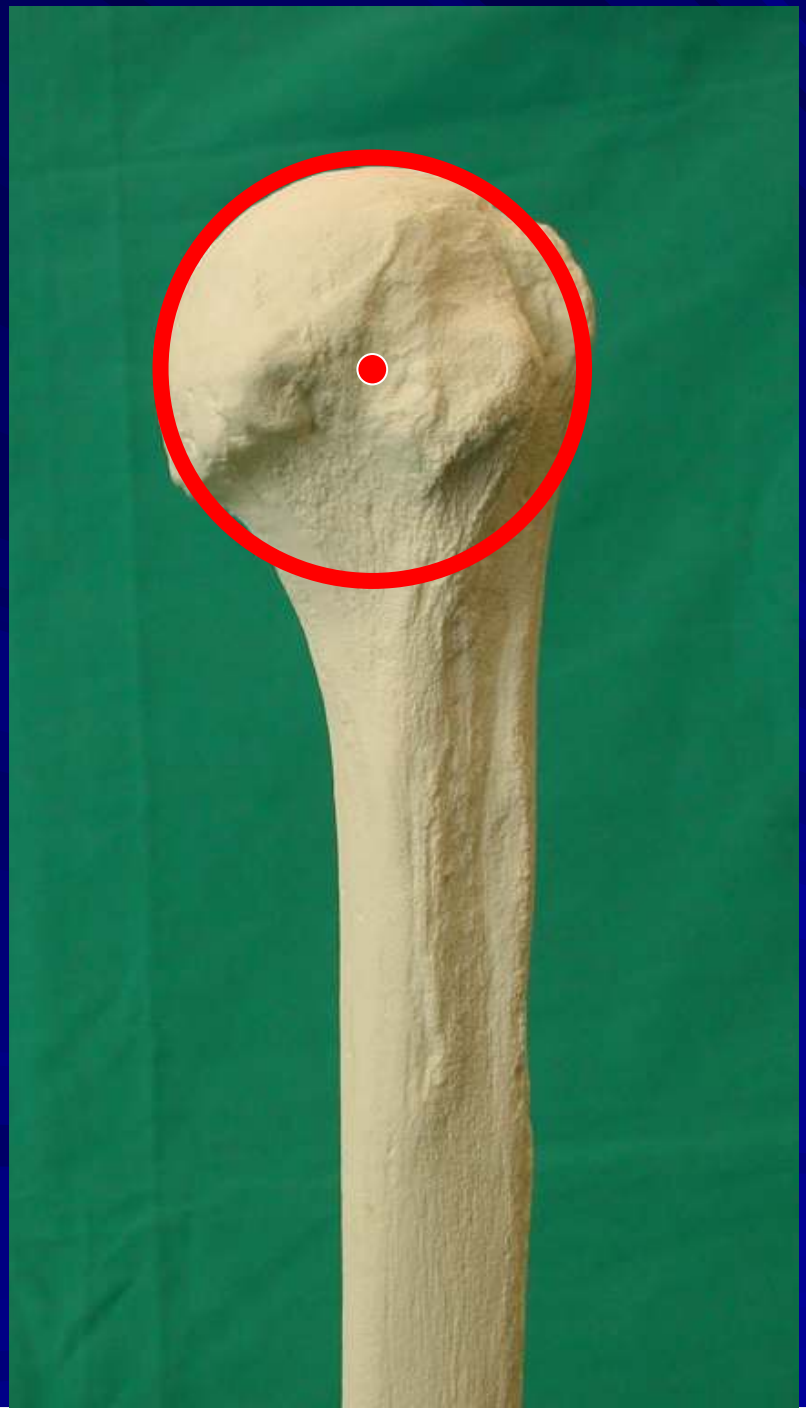
- Distance of Center of rotation to central axis of humeral canal
- CORONAL:

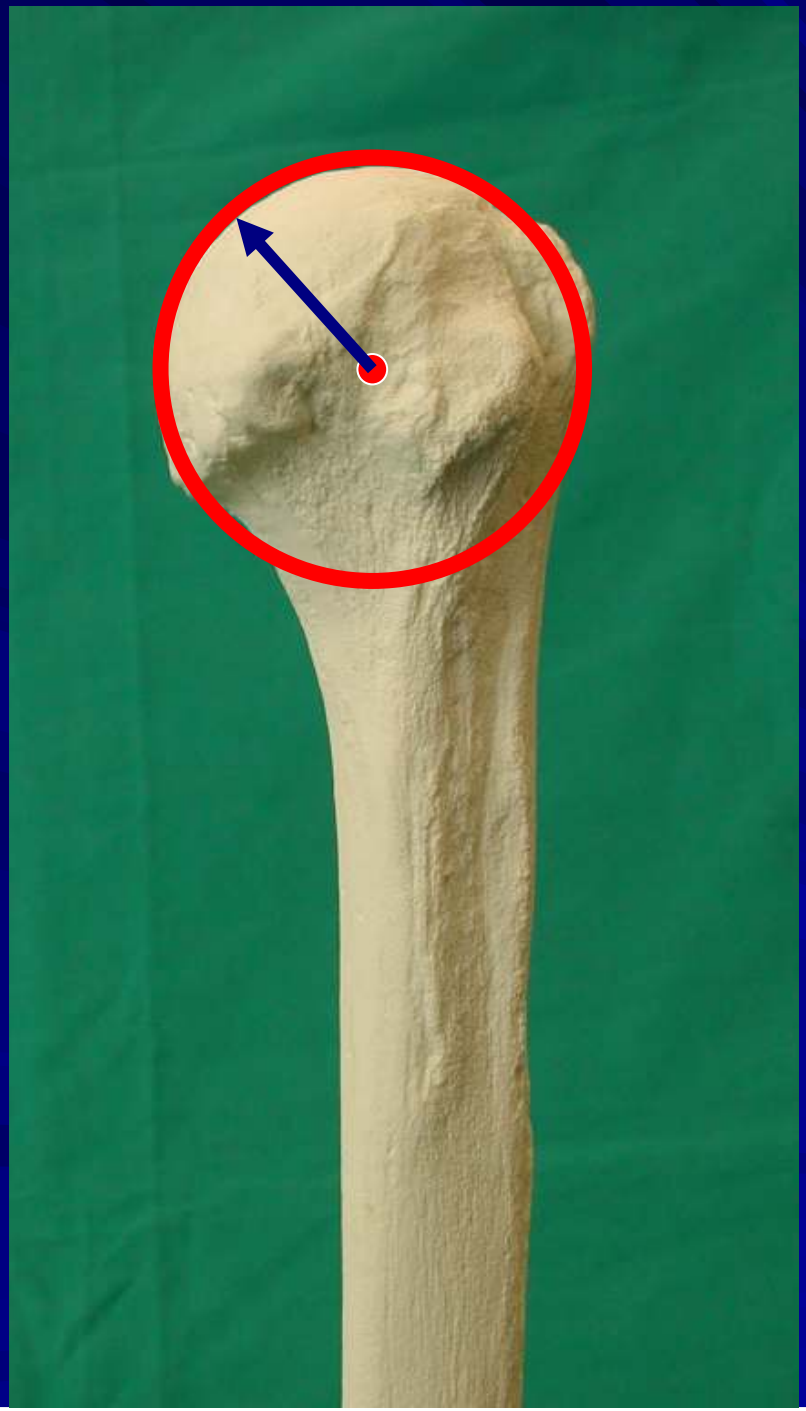
  4 to 14 mm MEDIAL
- SAGGITAL:

  -2 to 10mm POSTERIOR

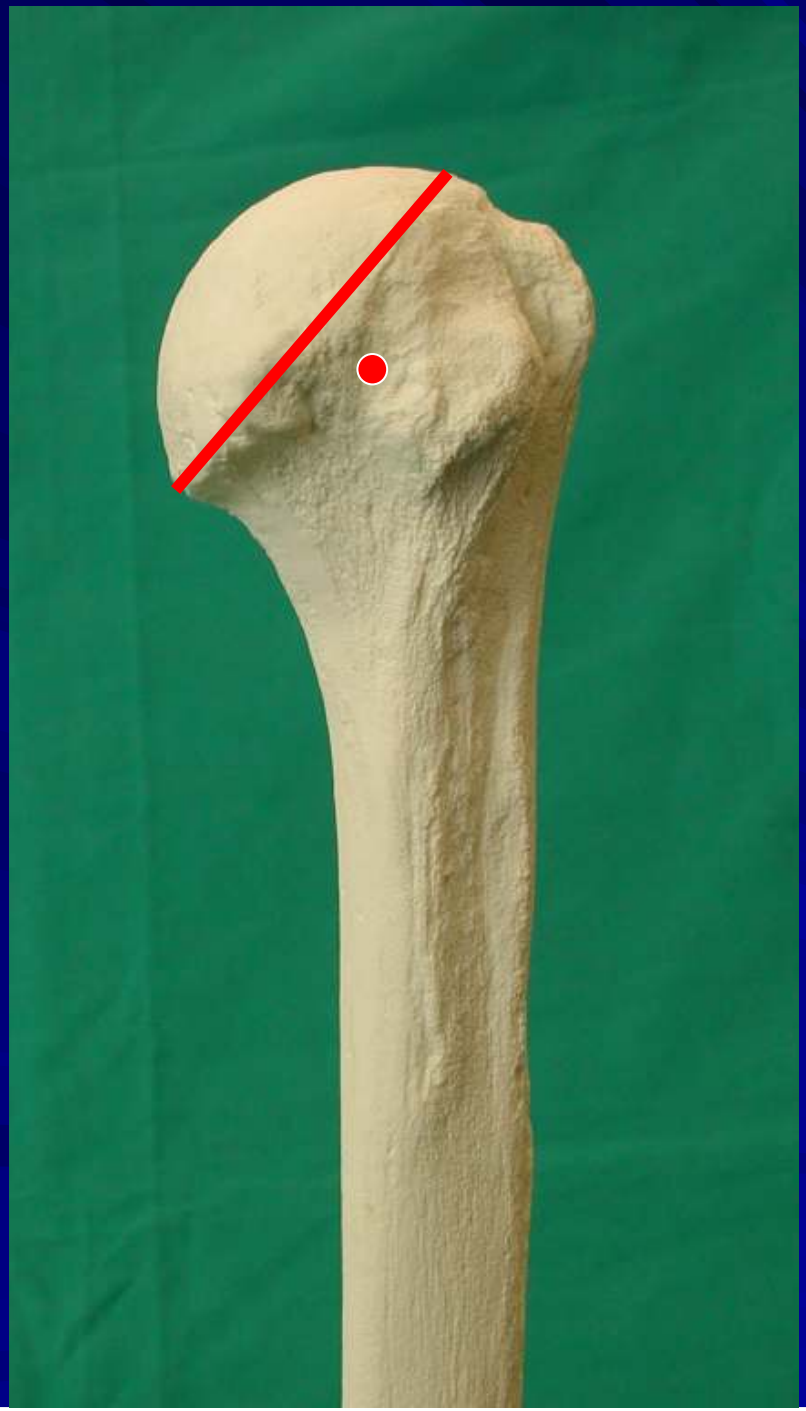


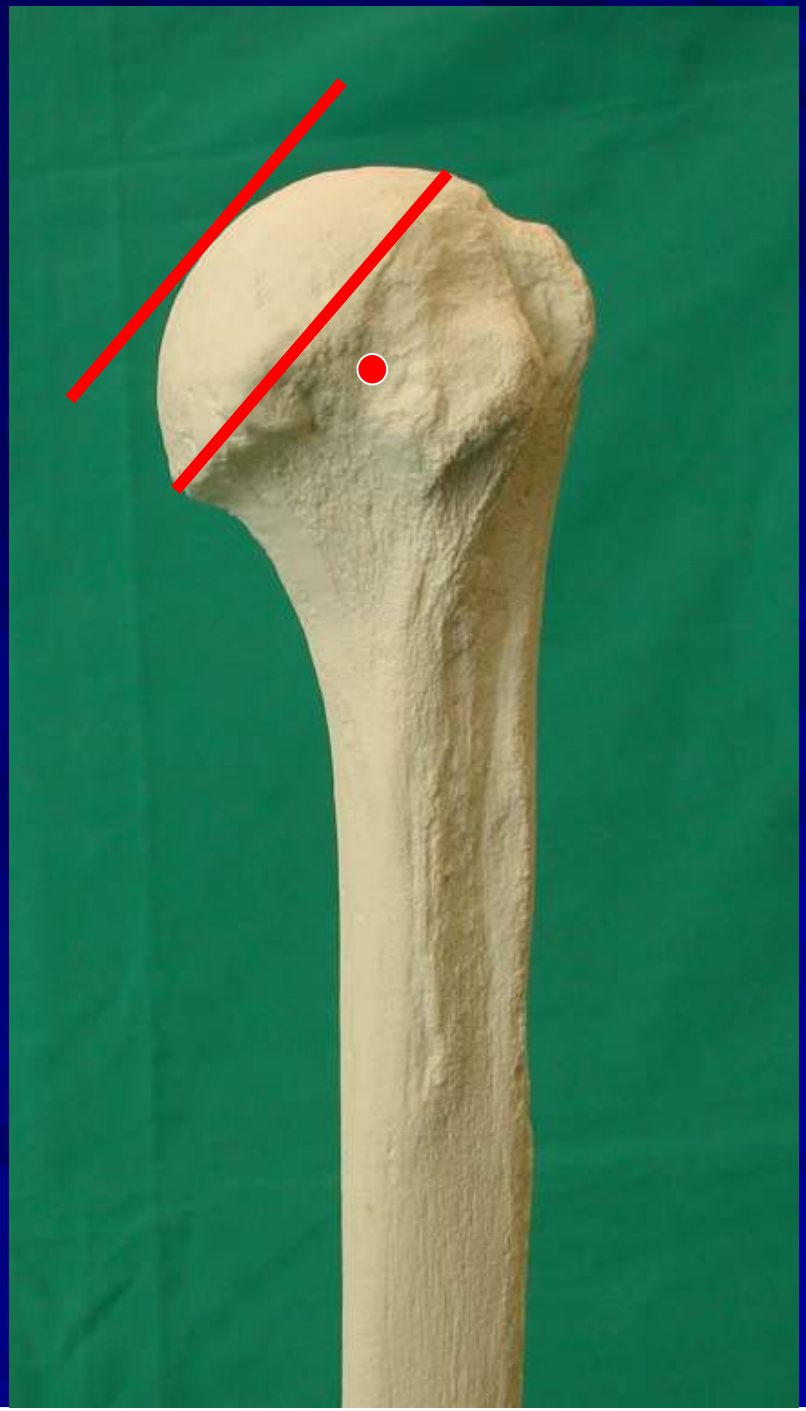


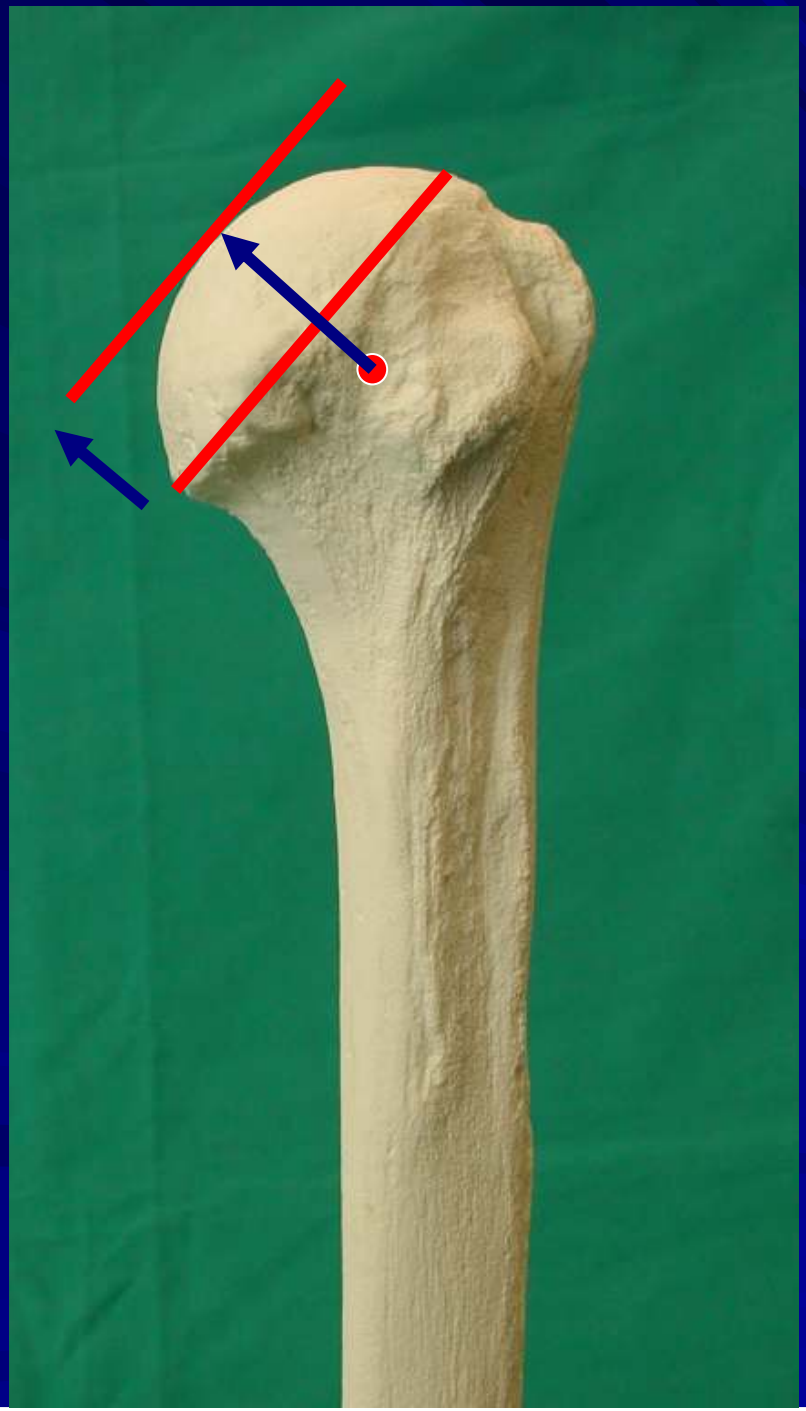




Radius of Curvature
20-30mm

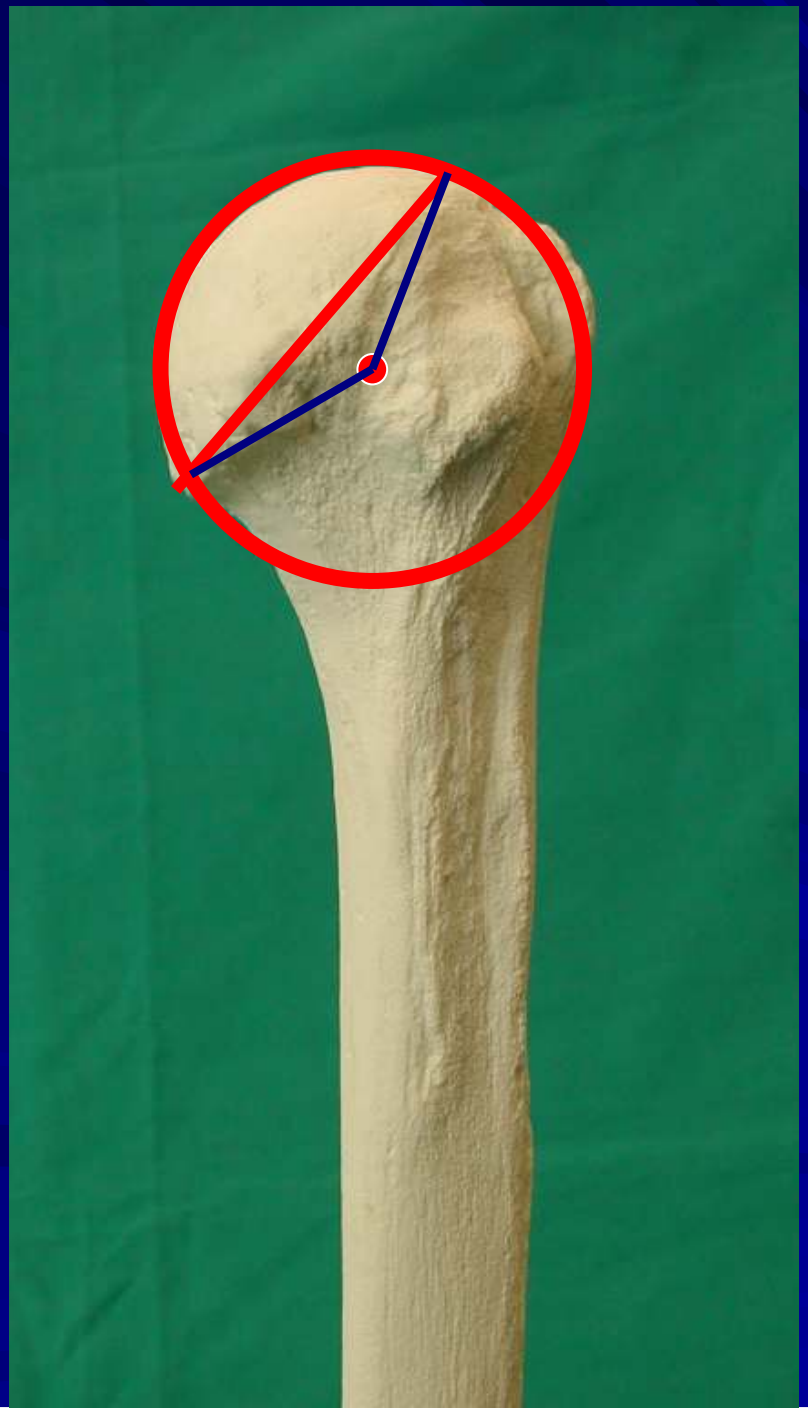






Head Height

¾ of RC

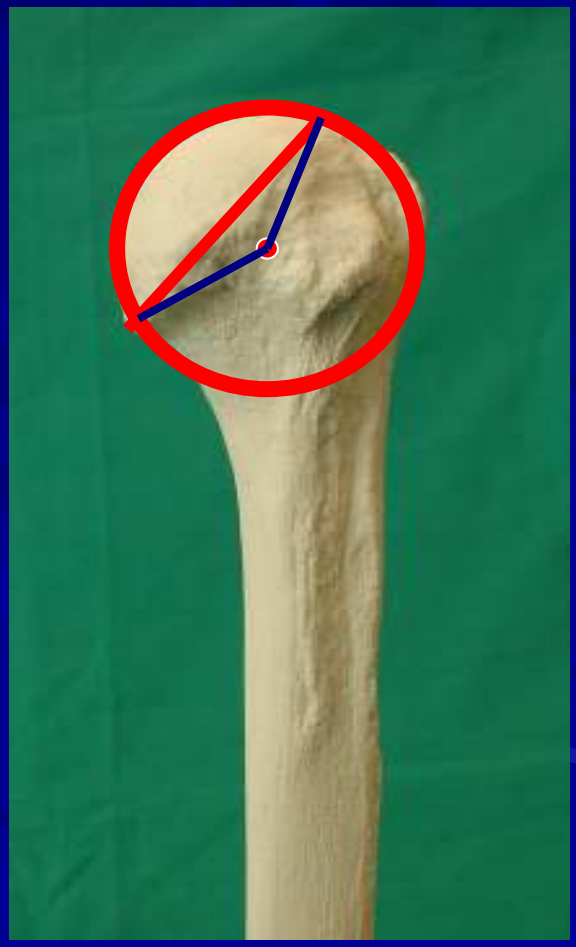


Surface Arc

150°

4: Radius of Curvature and Head Height

- Radius of Curvature (RC):
  - 20-30mm
- Head Height: always ¾ of RC
- Surface Arc 150^0

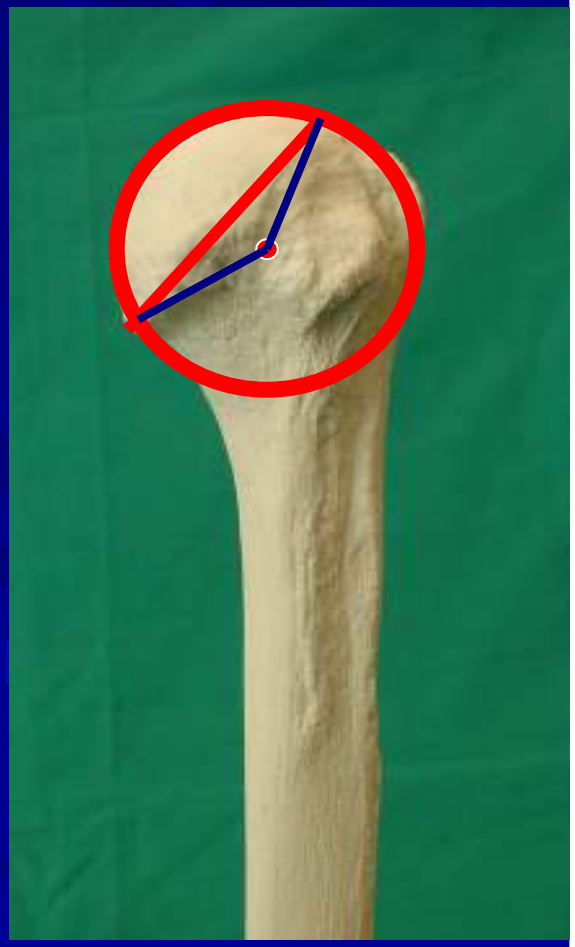


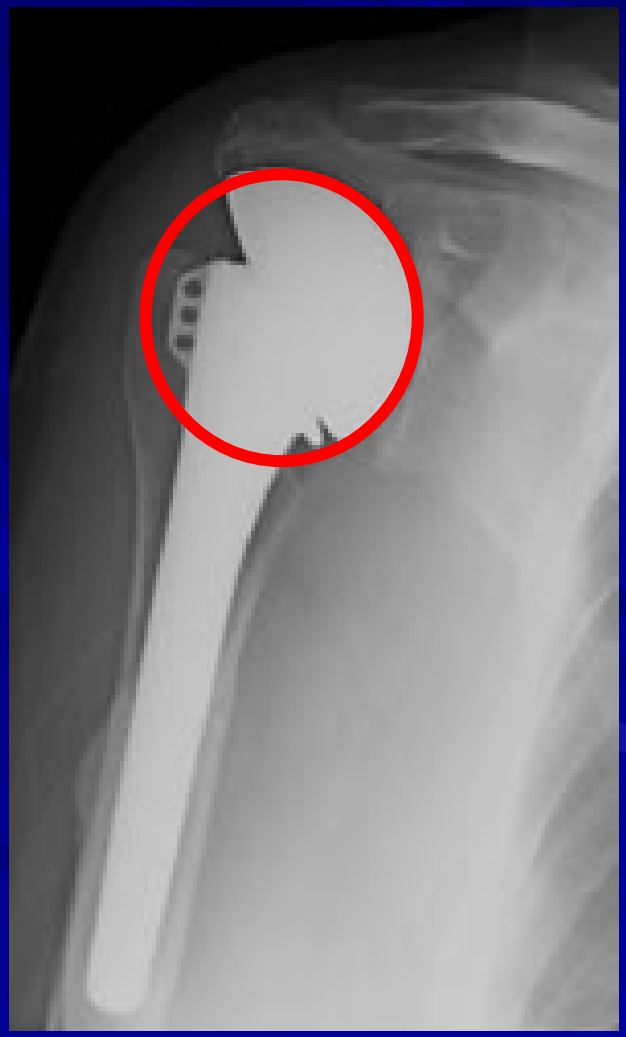
Implant Considerations

- Head Size
- Head-Stem Relationship
- Osteotomy

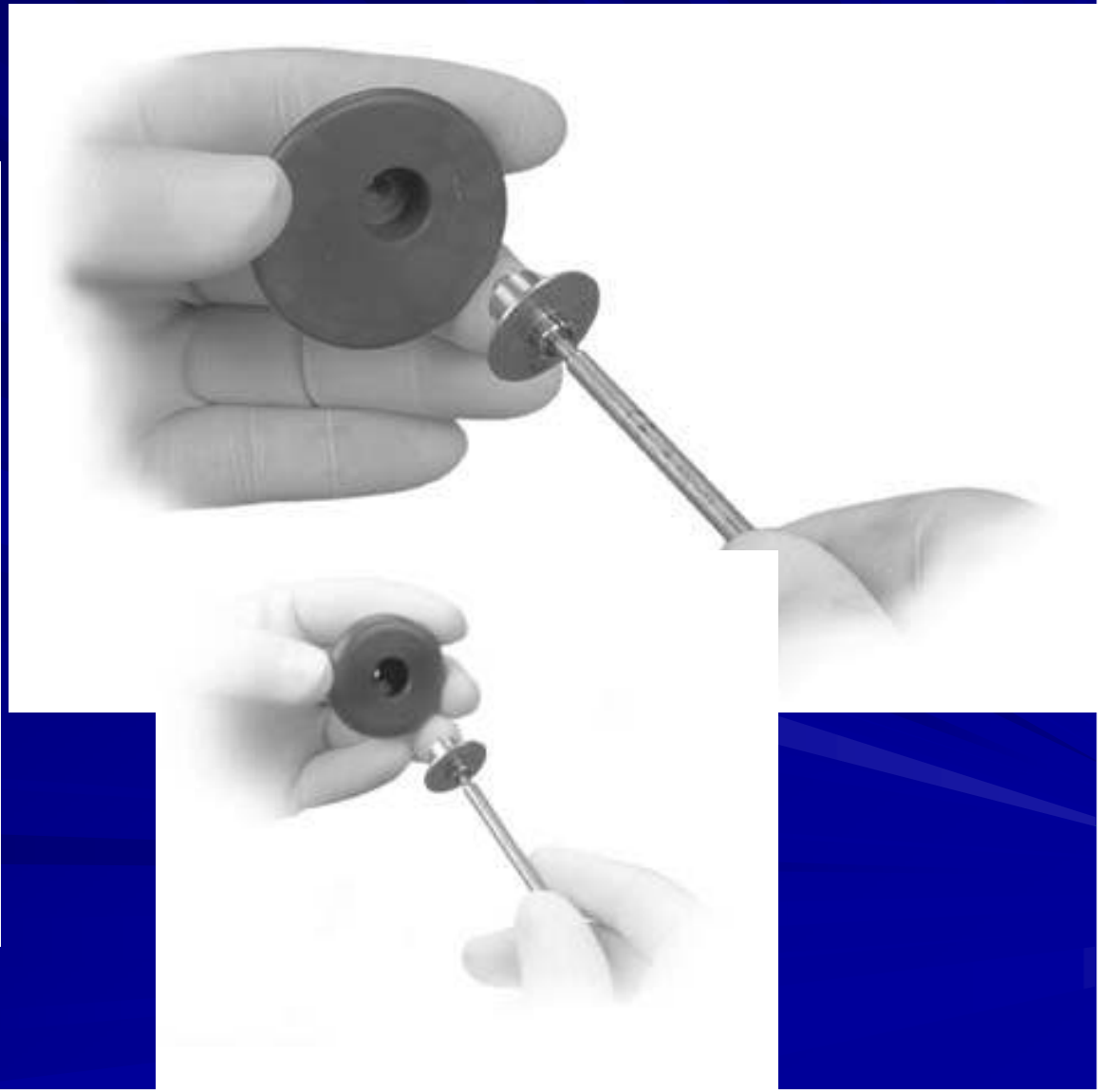
1:Head Size

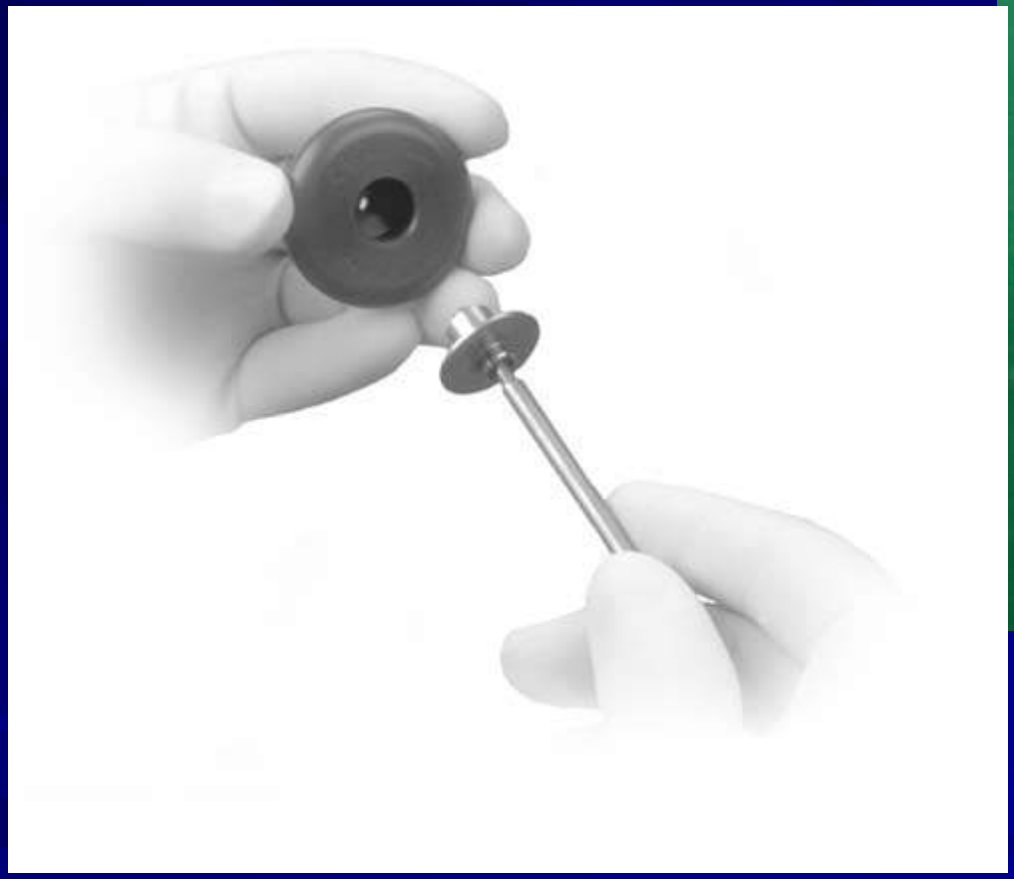
- Too small or too large will change centre of rotation and alter dynamics of Rotator cuff
- Joint “Stuffed” vs “Slack”
- Surface Arc affected
- Mechanical Impingement
  - Tuberosity-Acromium
  - Humeral head-glenoid

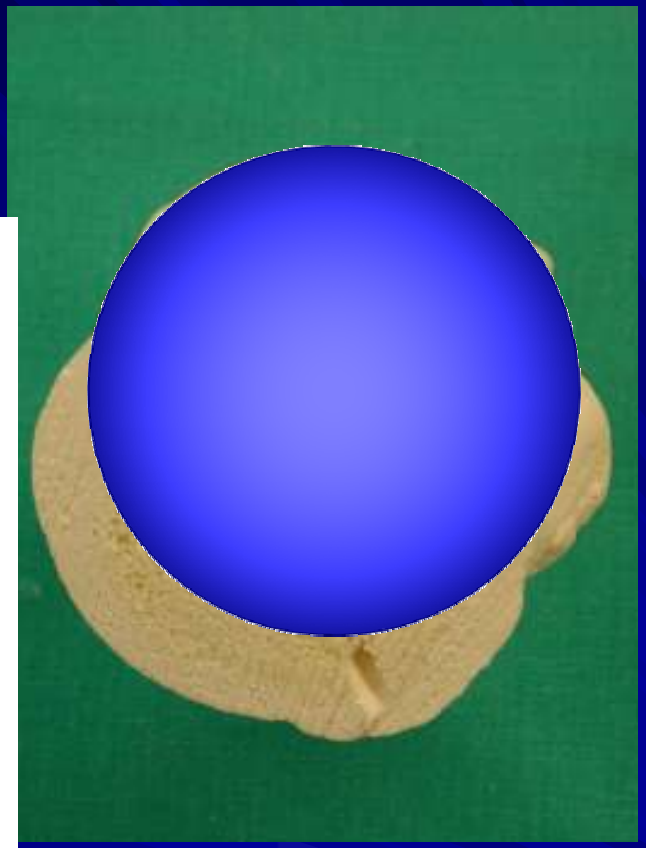


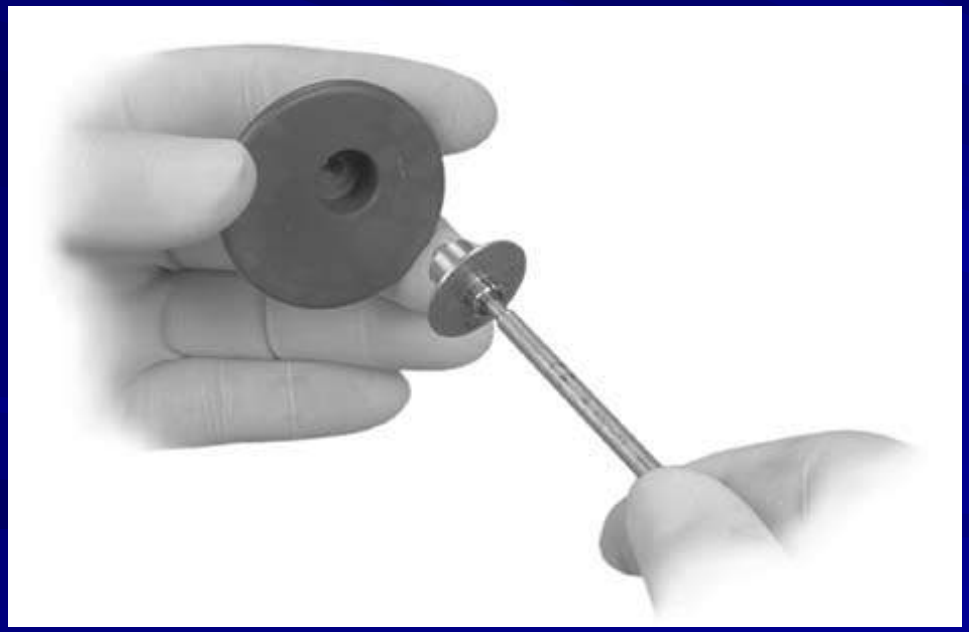


2:Head Stem relationship: Offset










12
3

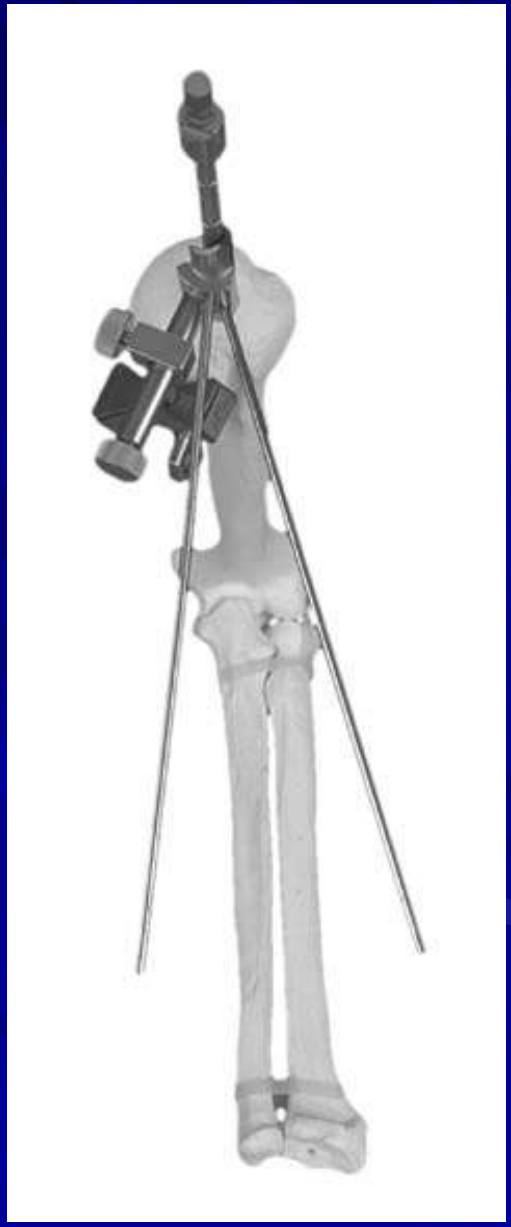

12
3
6
MAX

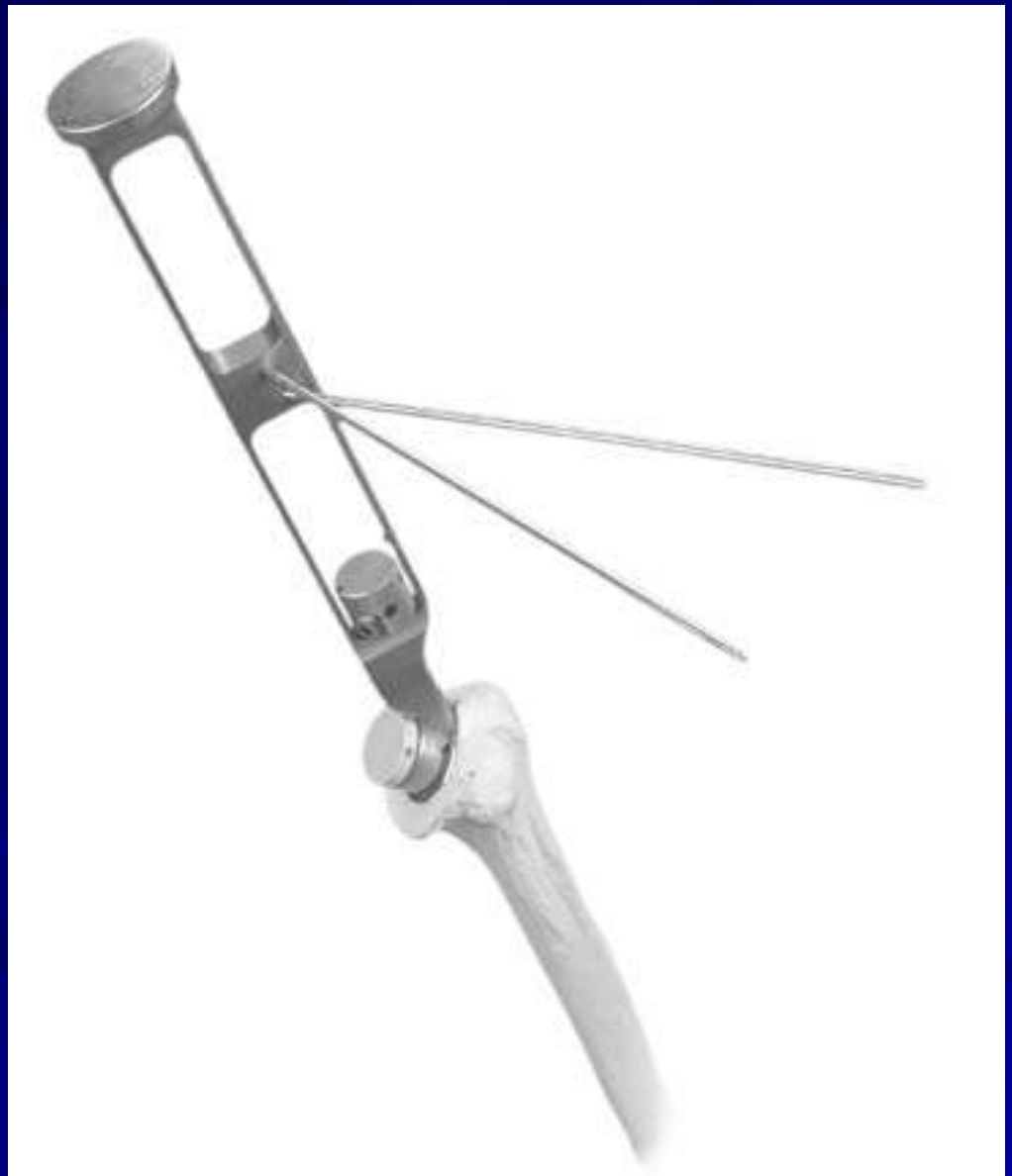
3:Humeral Head Osteotomy

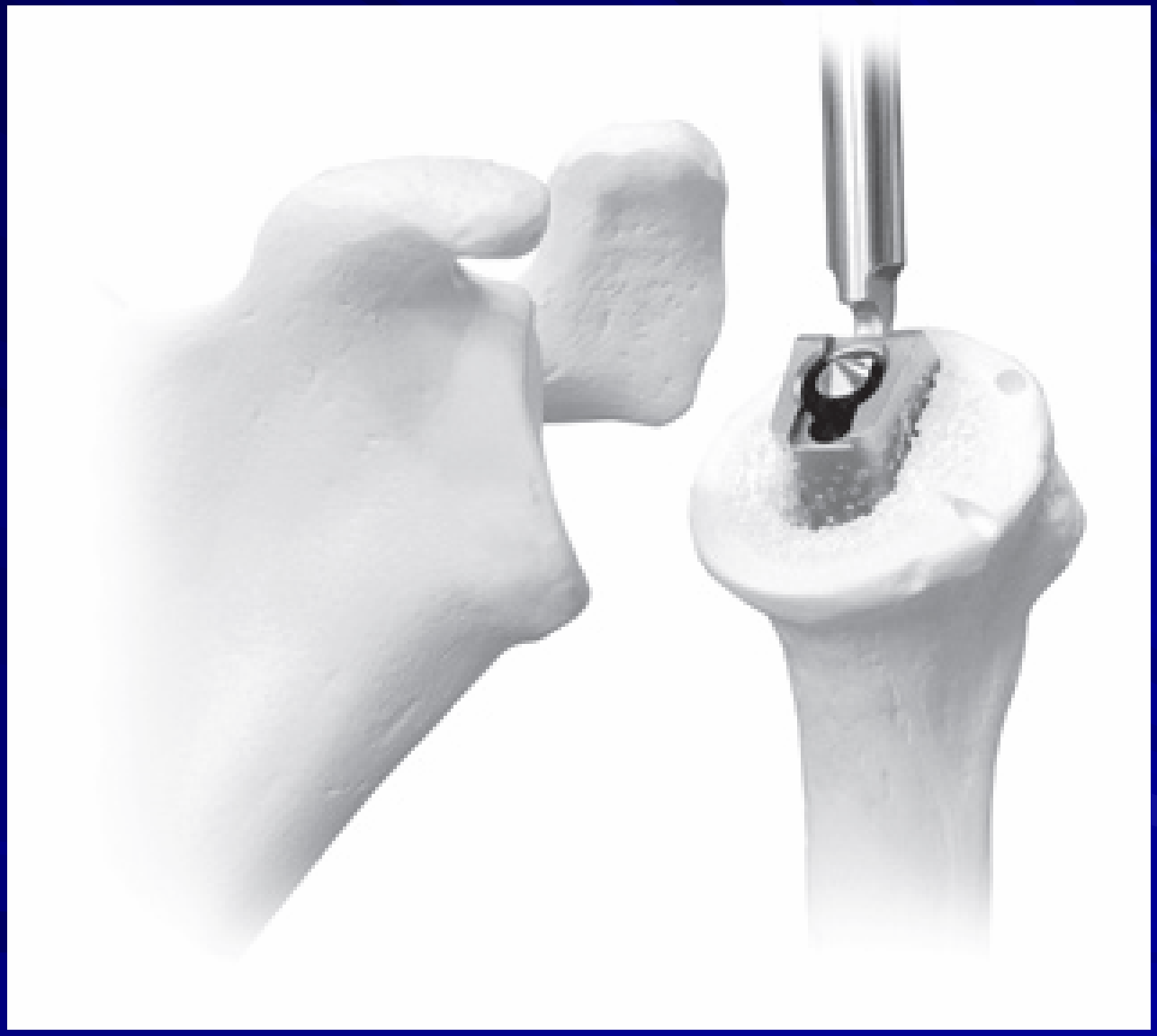
- 2 different philosophies:
  - Cut the bone to match the prosthesis
    - Eg: Bigliani-Flatow (Zimmer)
  - Cut the bone anatomically and adjust the prosthesis to match the osteotomy
    - Eg: Anatomical Prosthesis (Zimmer)

- Fixed neck-shaft angle

- Adjust to retroversion





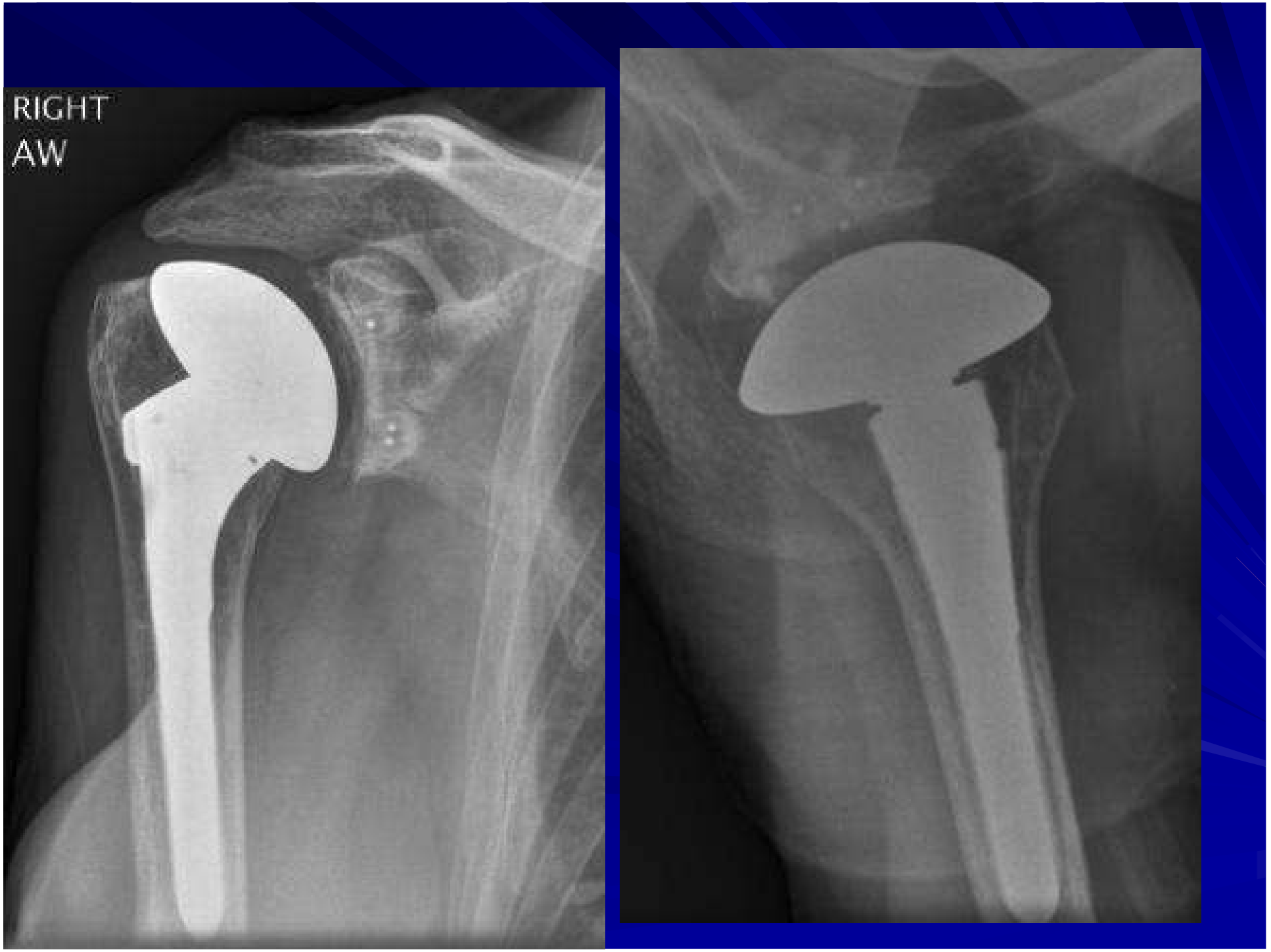


"3rd Generation" & Anatomical Humeral Prosthesis

- Aim to recreate normal anatomy
  - Restore/maintain dynamics of rotator cuff
  - Avoid impingement
- Modular heads
  - Height
  - Diameter
  - Offset
- Anatomical 3 dimensional variable angle

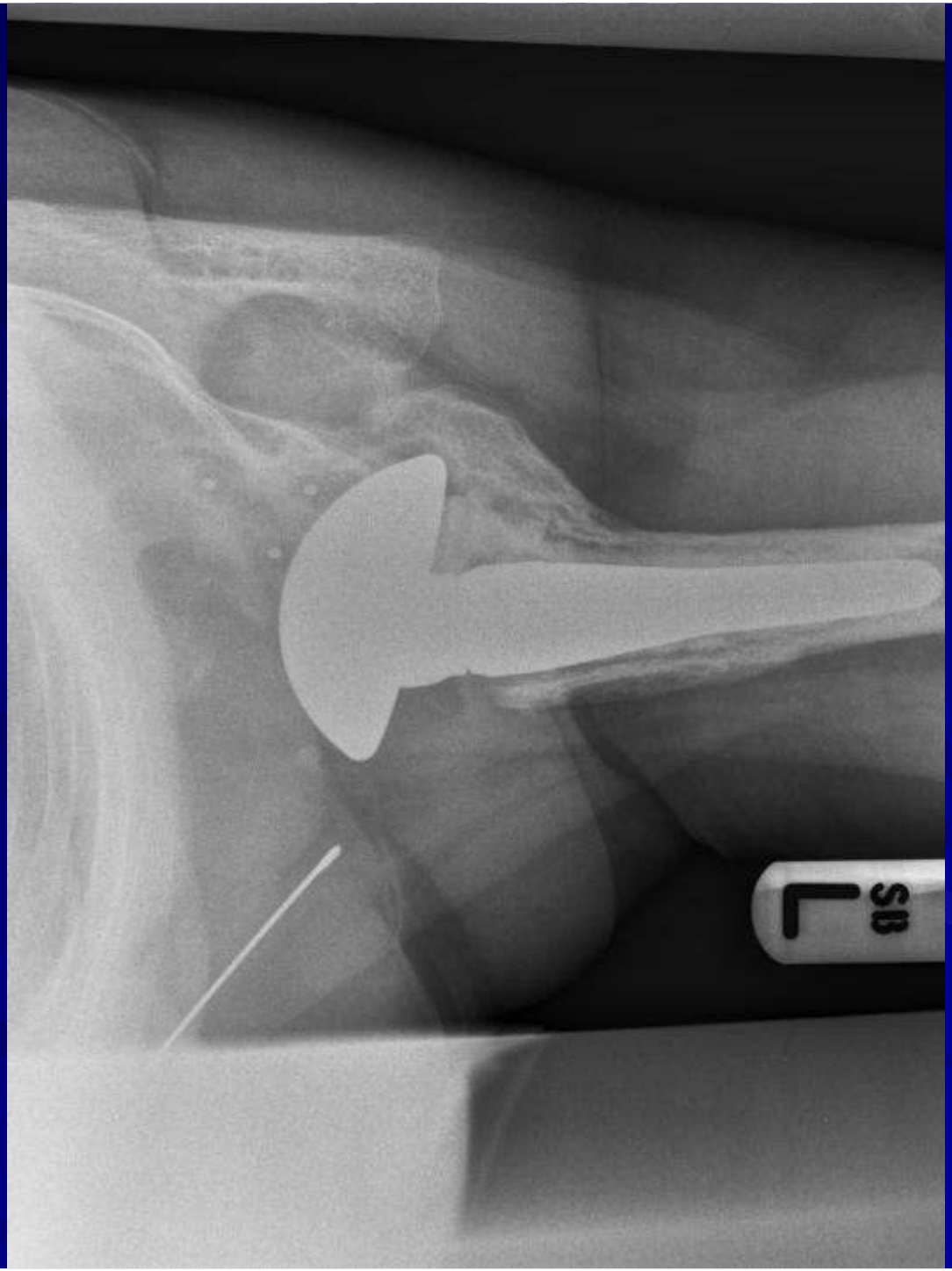
HUMERAL STEMMED COMPONENTS

- 3RD GENERATION/ ANATOMICAL DESIGNS
  - Logical
  - Superior results in laboratory
  - Technically much easier and reliable to reproduce normal anatomy
  - Very good short term-medium term clinical results
    - ***Godeneche et al, JSES 2002***
    - ***Phahler et al, Act Chir Belg, 2009***


RIGHT
AW

Severe avascular necrosis


LEFT
NM


R

Patient

Surgeon

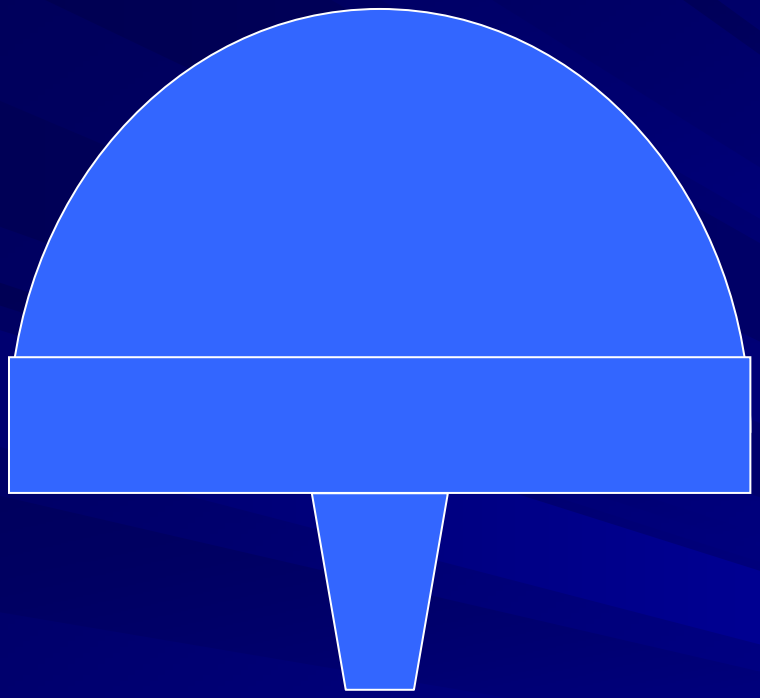
Prosthesis

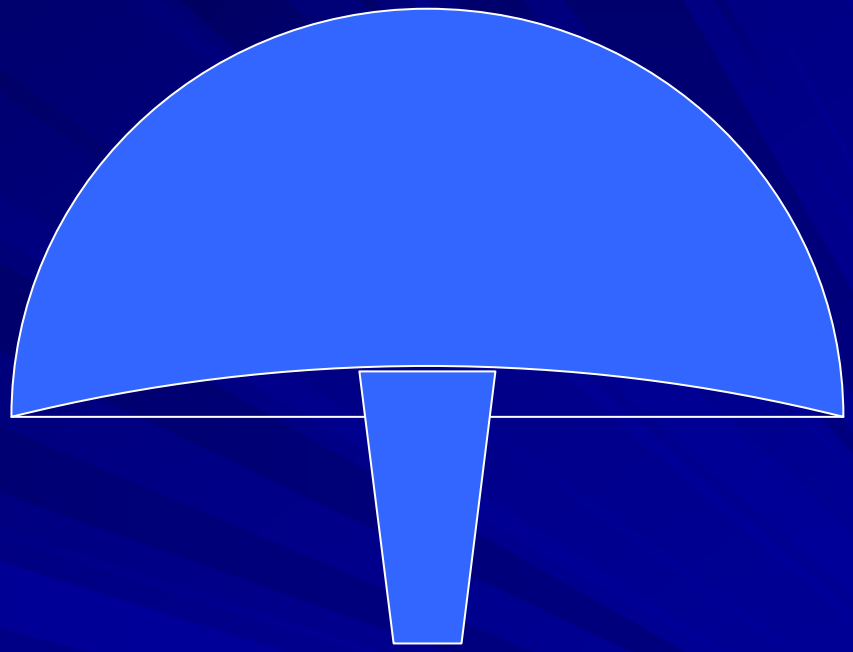
The humeral Component: a different approach…

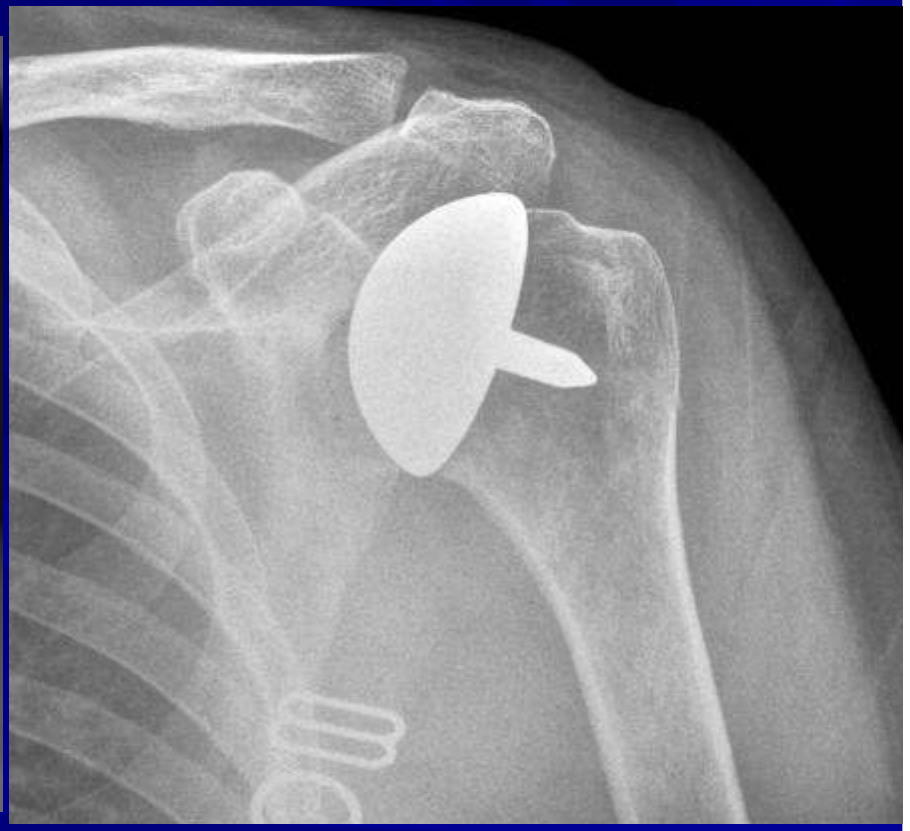
RESURFACING ARTHROPLASTY

- Historically early loosening.
- Copeland prosthesis: satisfactory 10 year results
  - HA coating + design avoid loosening
    - ***Levy & Copeland, JSES ,2004***

2 designs

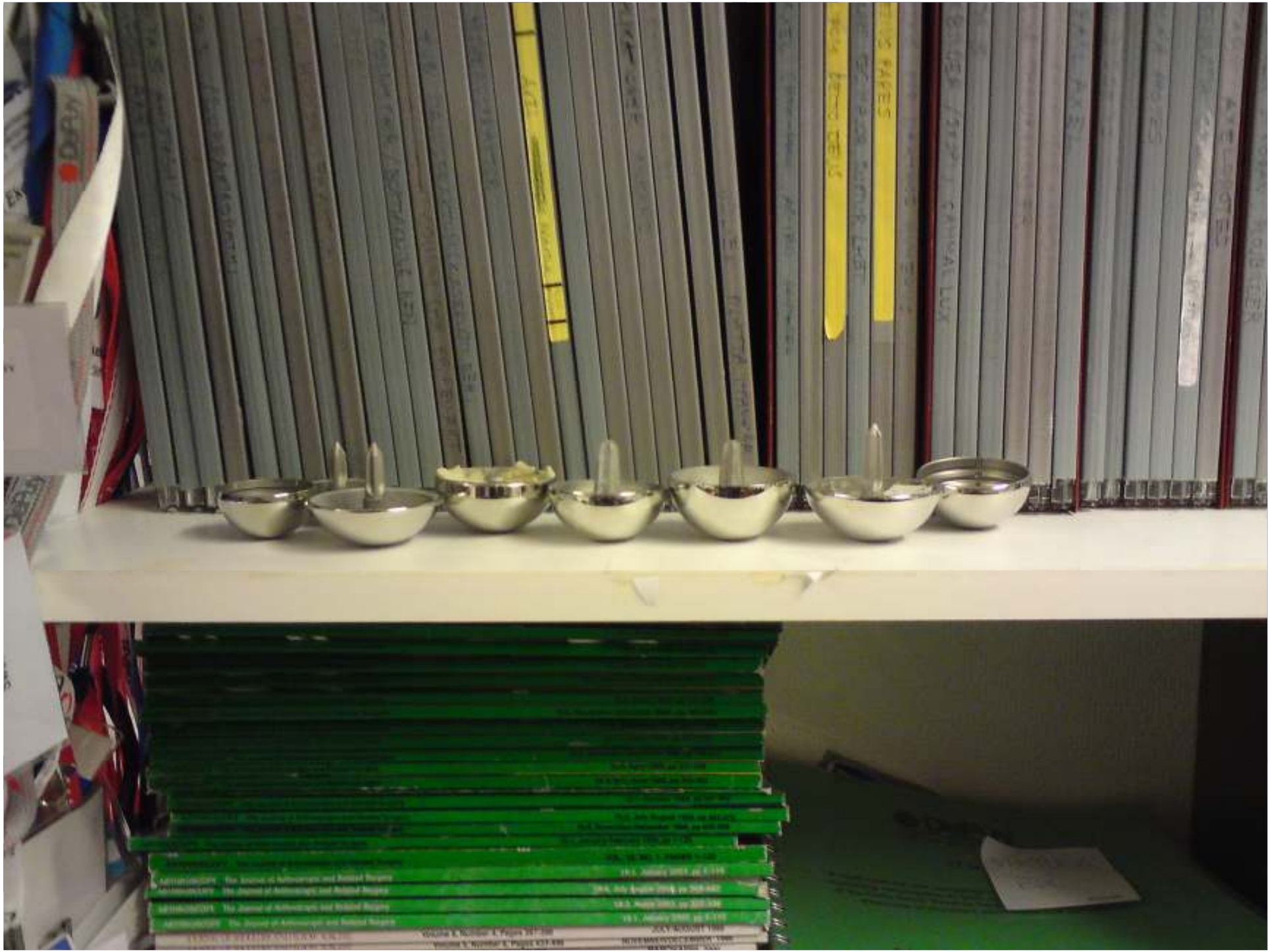






Copeland's resurfacing

- Widespread use in the UK
- Succesful and reliable 10 year results
- Joint "overstuffing" causes problems



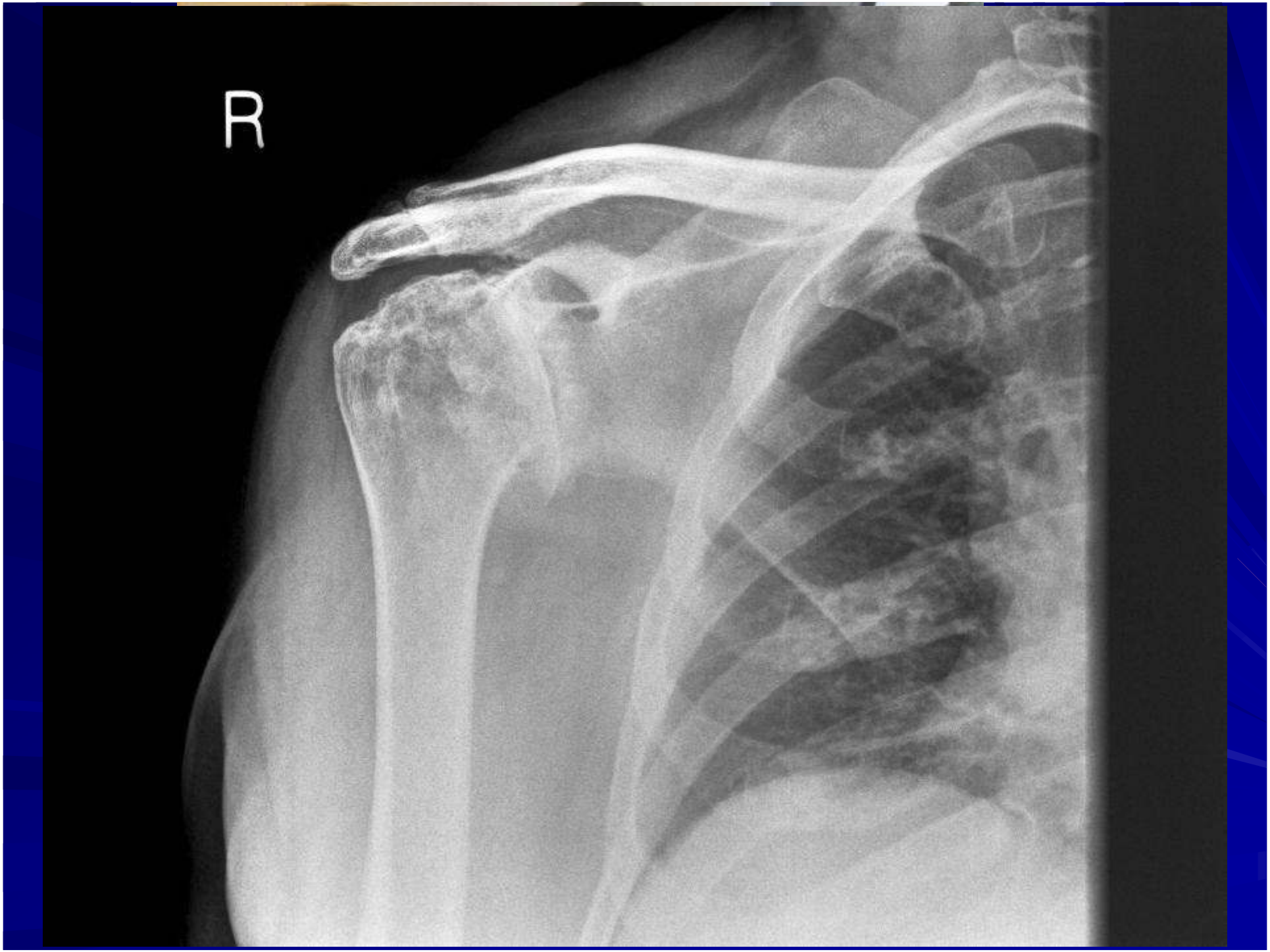
My experience

- 36 prosthesis
- 8 rheumatoid
- 2 cuff arthropathy
- 26 OA
- 34 satisfied
- 2 glenoid erosion-1revised
- 1 early infection
- 1 late infection-revised
- ? No loosening


RIGHT


AM/LH
L

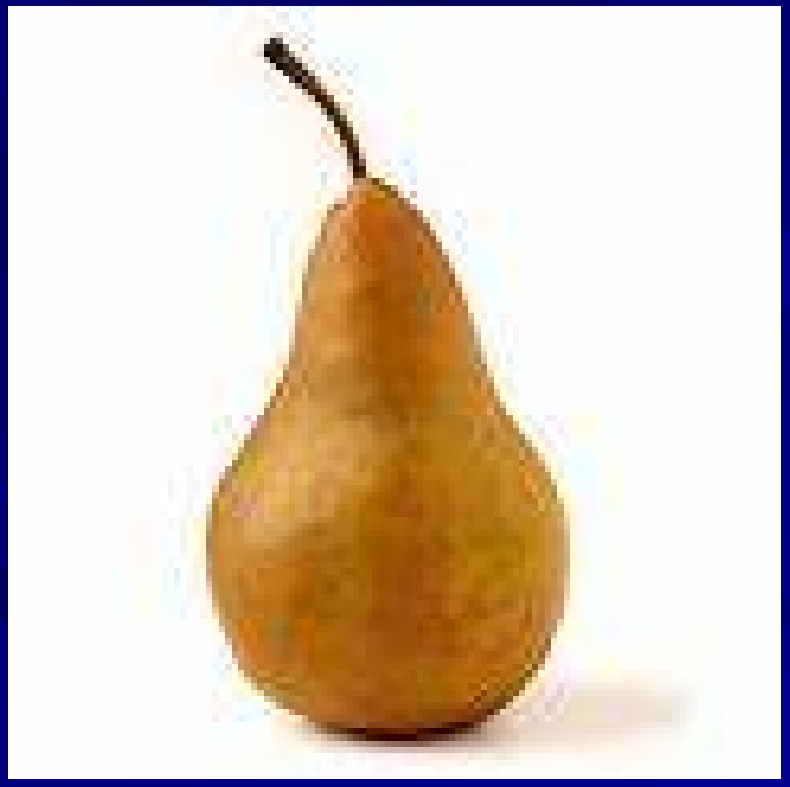

LD
R


R


R
AW

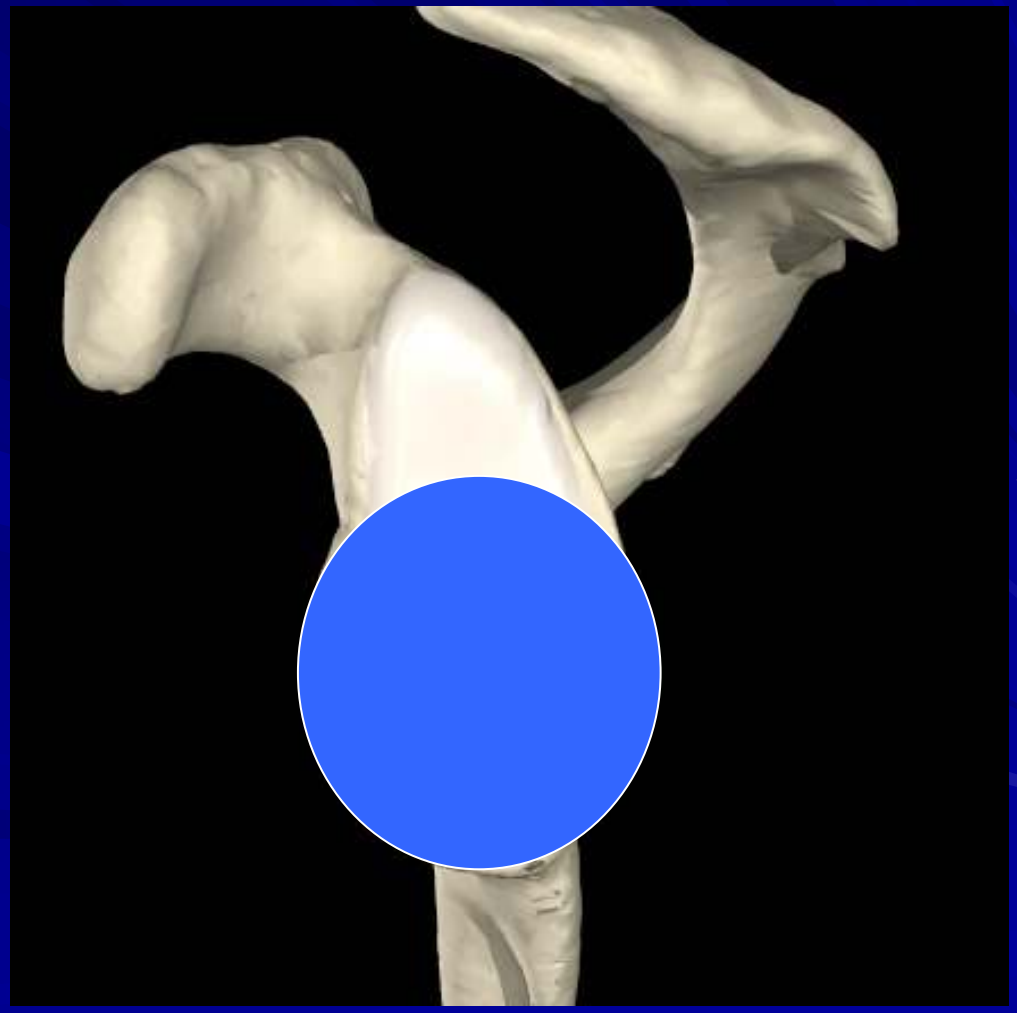
The Glenoid

- anatomy



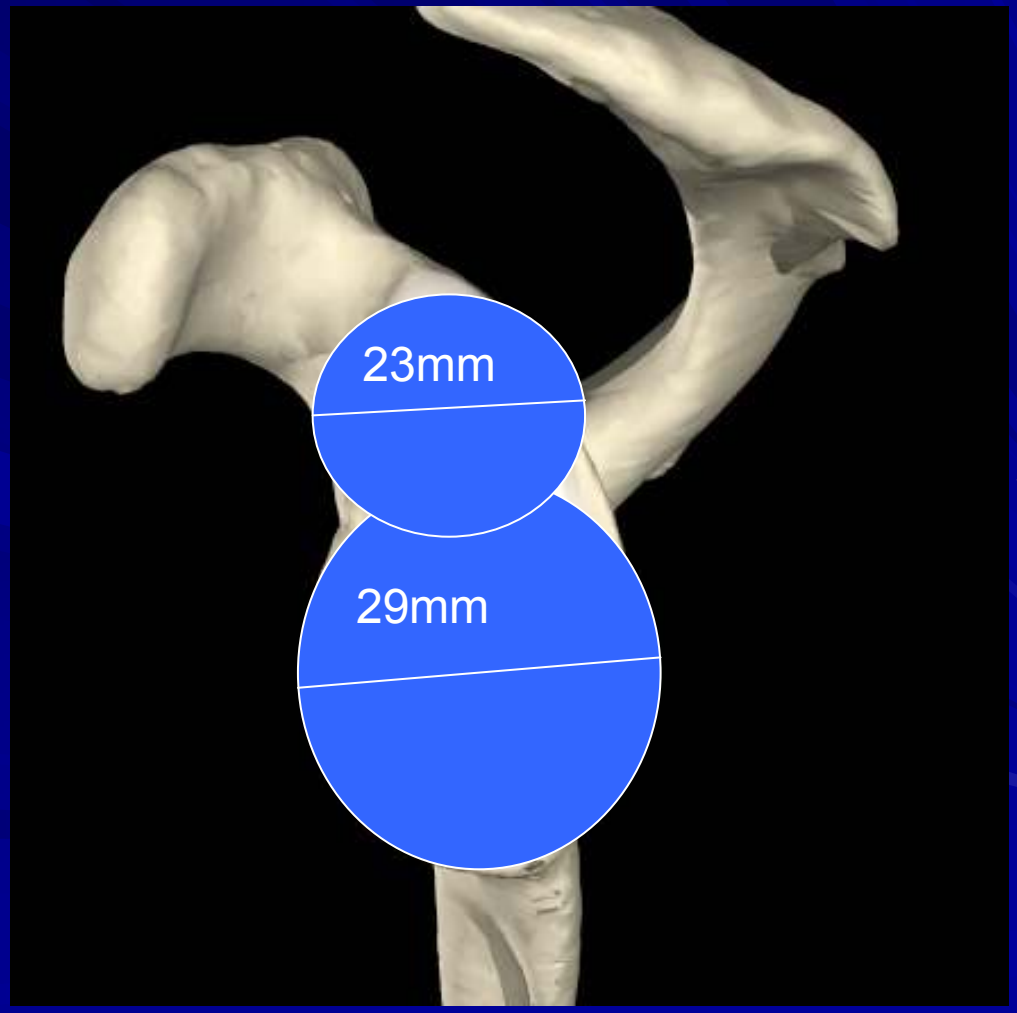
The Glenoid

- anatomy

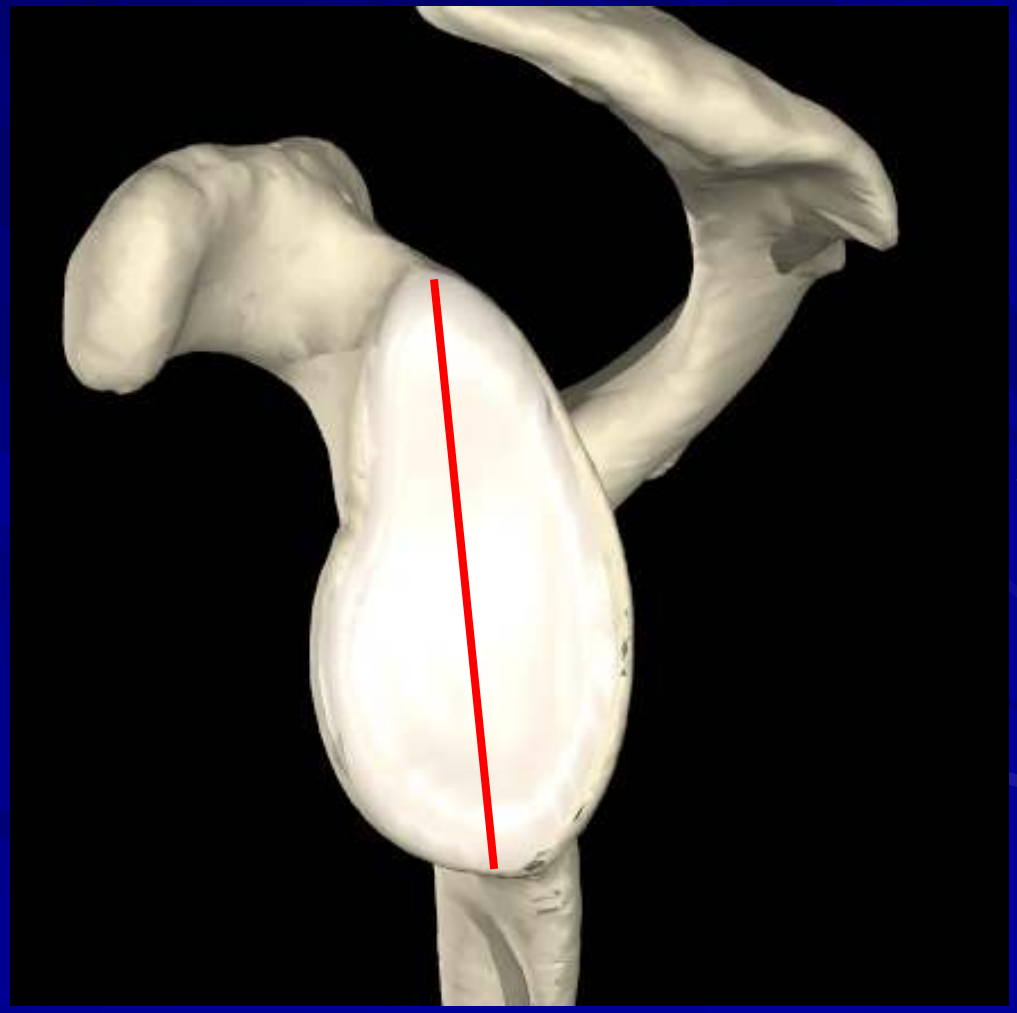


The Glenoid

- Upper: 23mm
  - (18-30)
- Lower 29mm
  - (21-35)

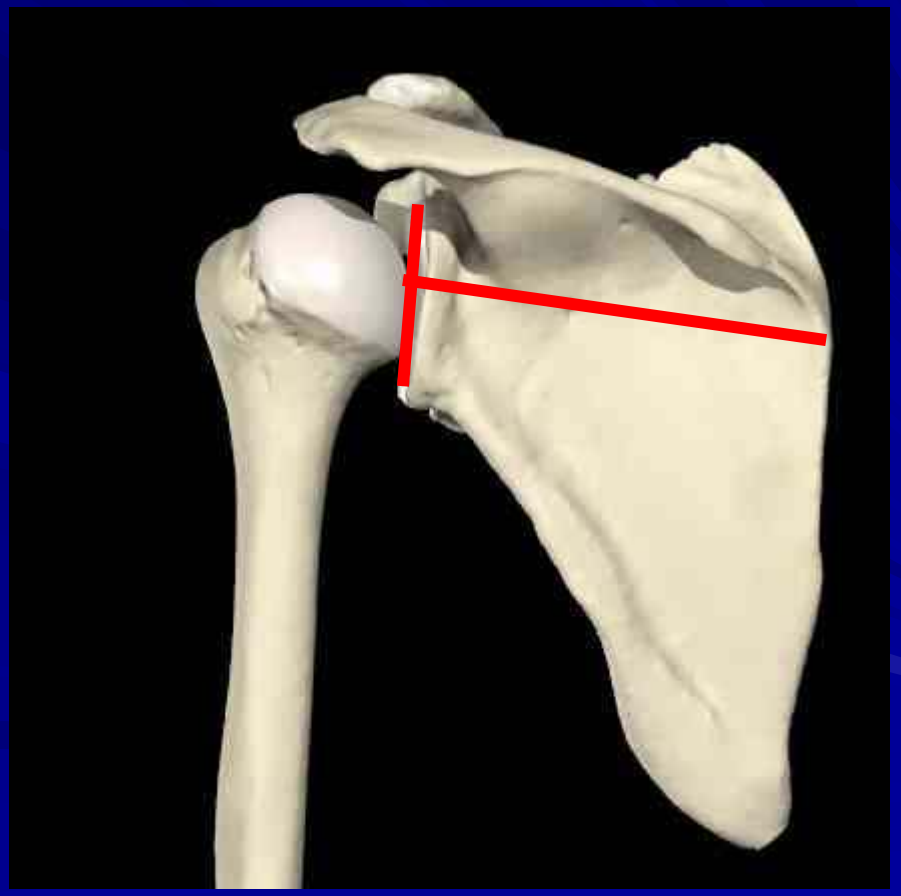


- 37.9mm
- 31.2-50.1mm

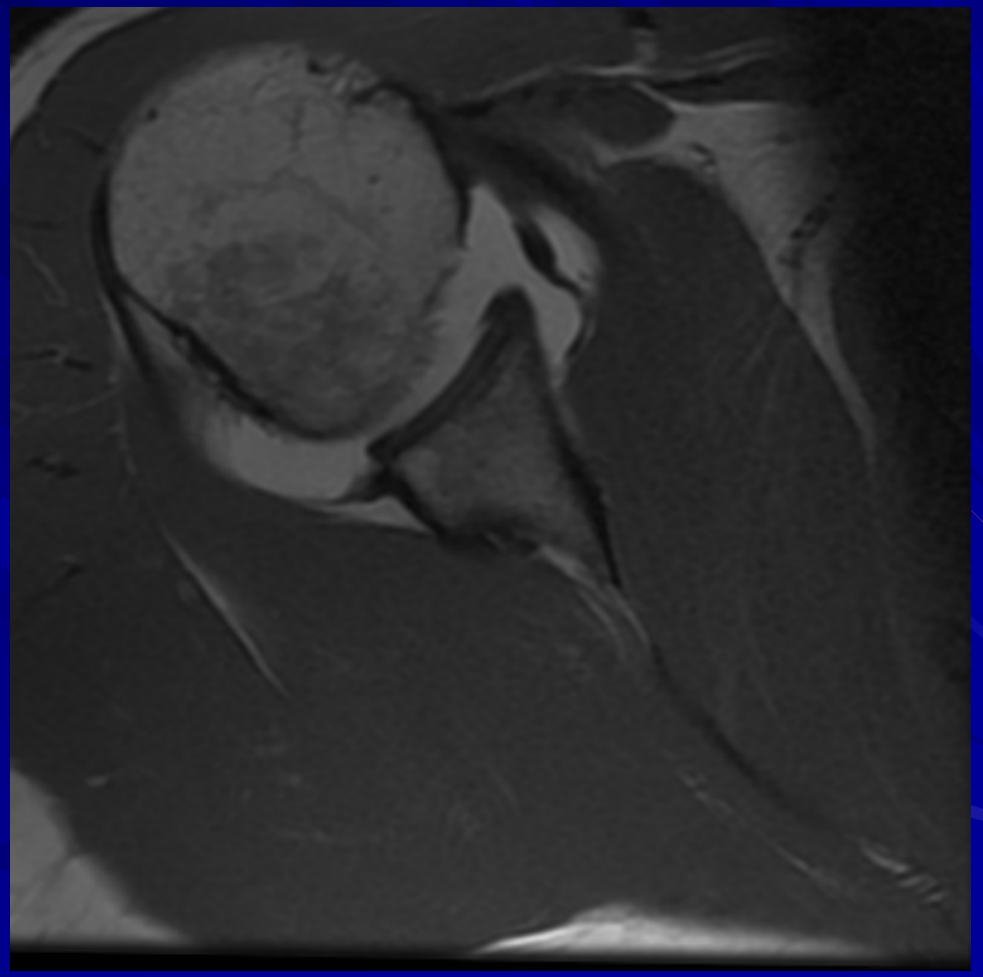


Glenoid inclination

- Superior incline 4°

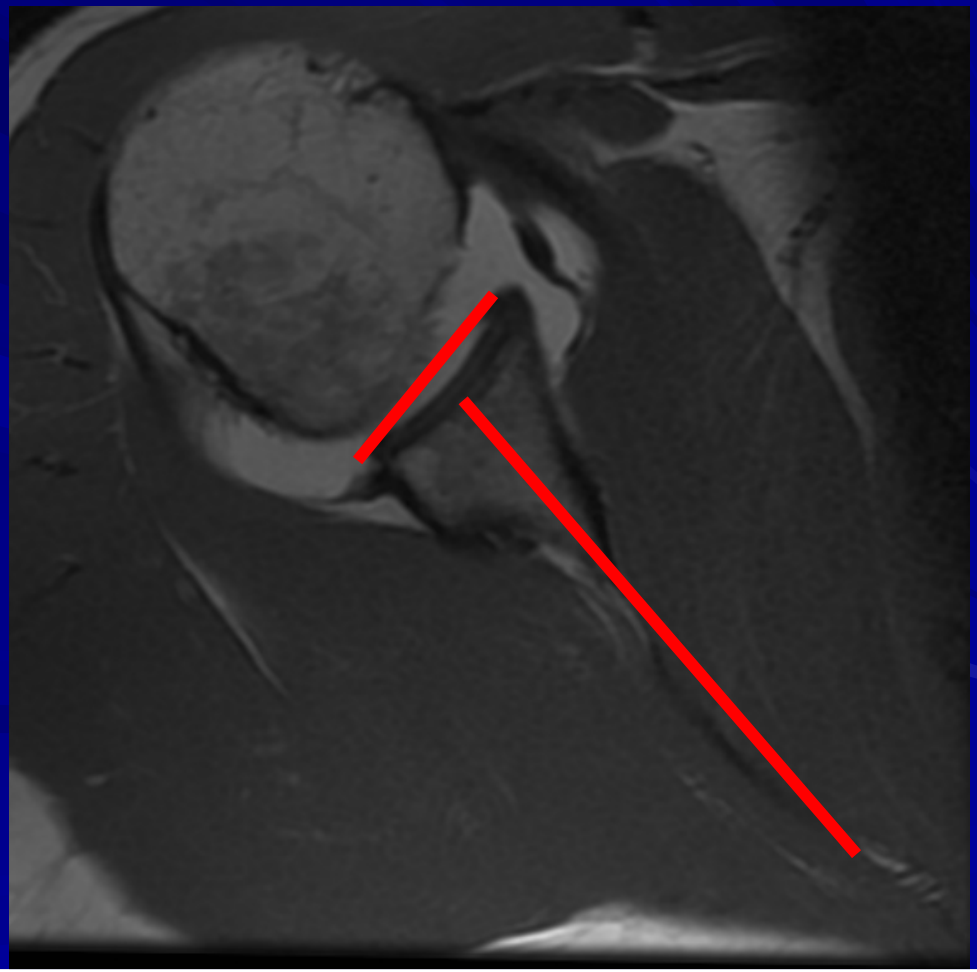


Glenoid version



Glenoid version

- 2° anteversion-9° retroversion

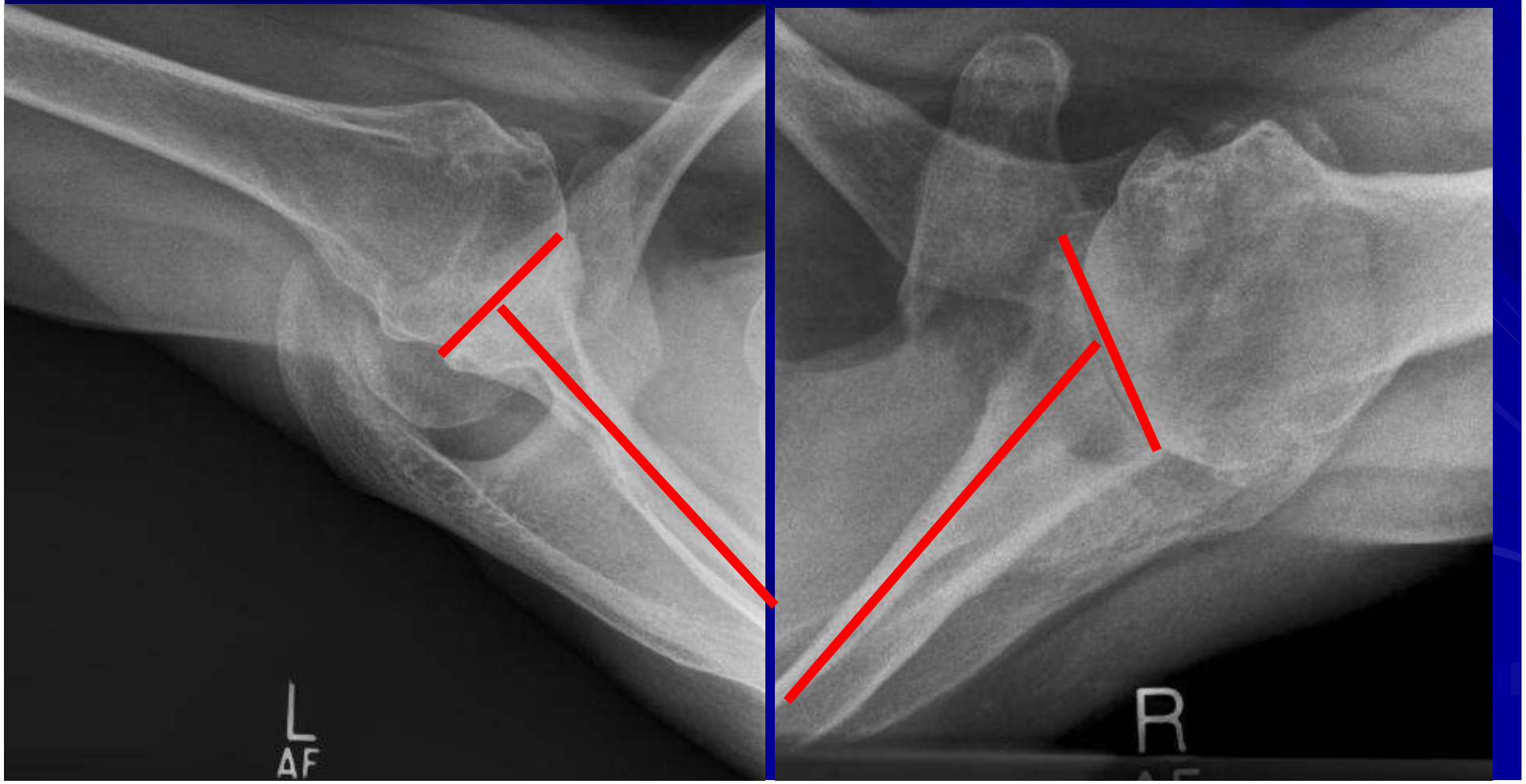


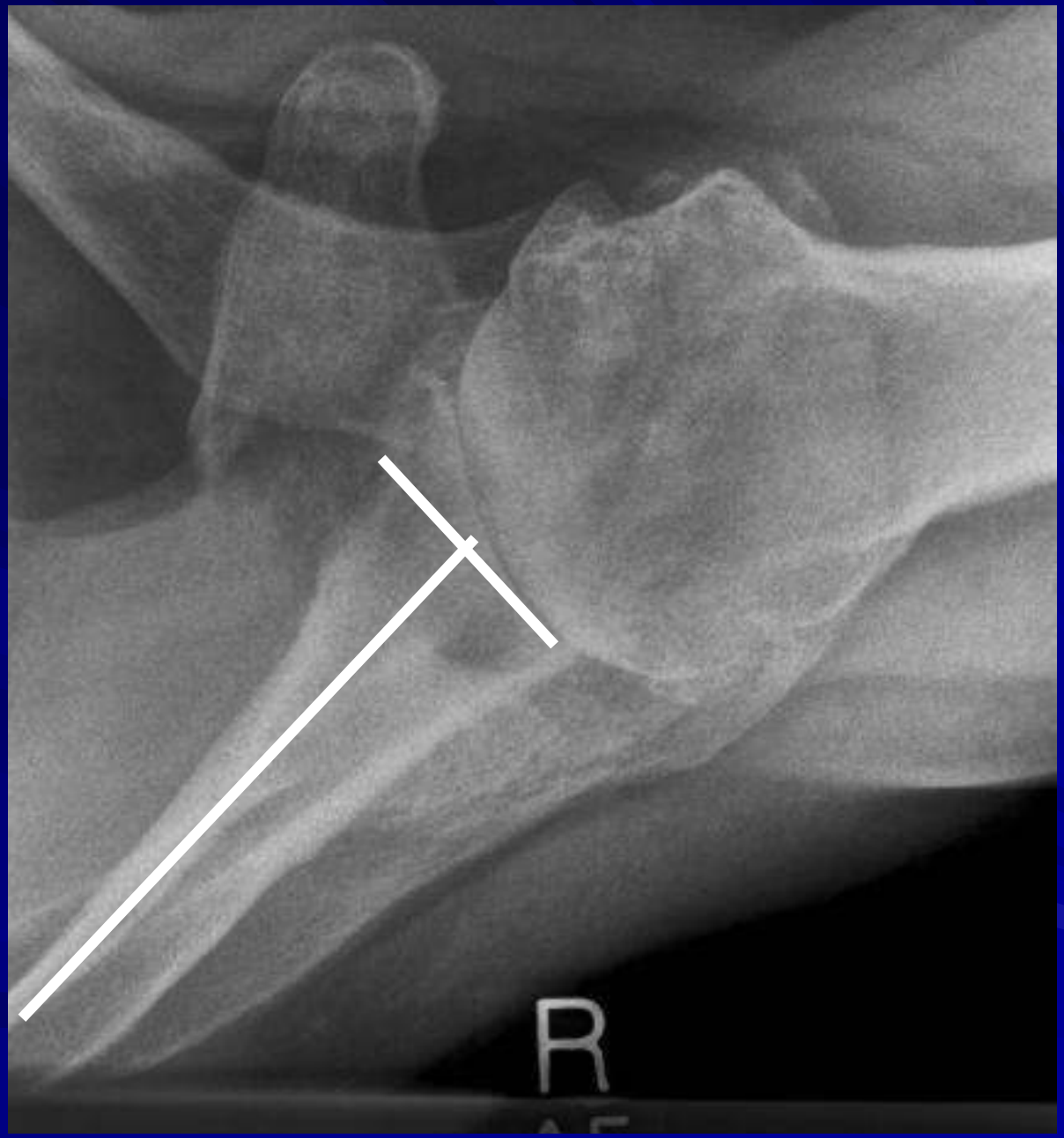
Basic concepts

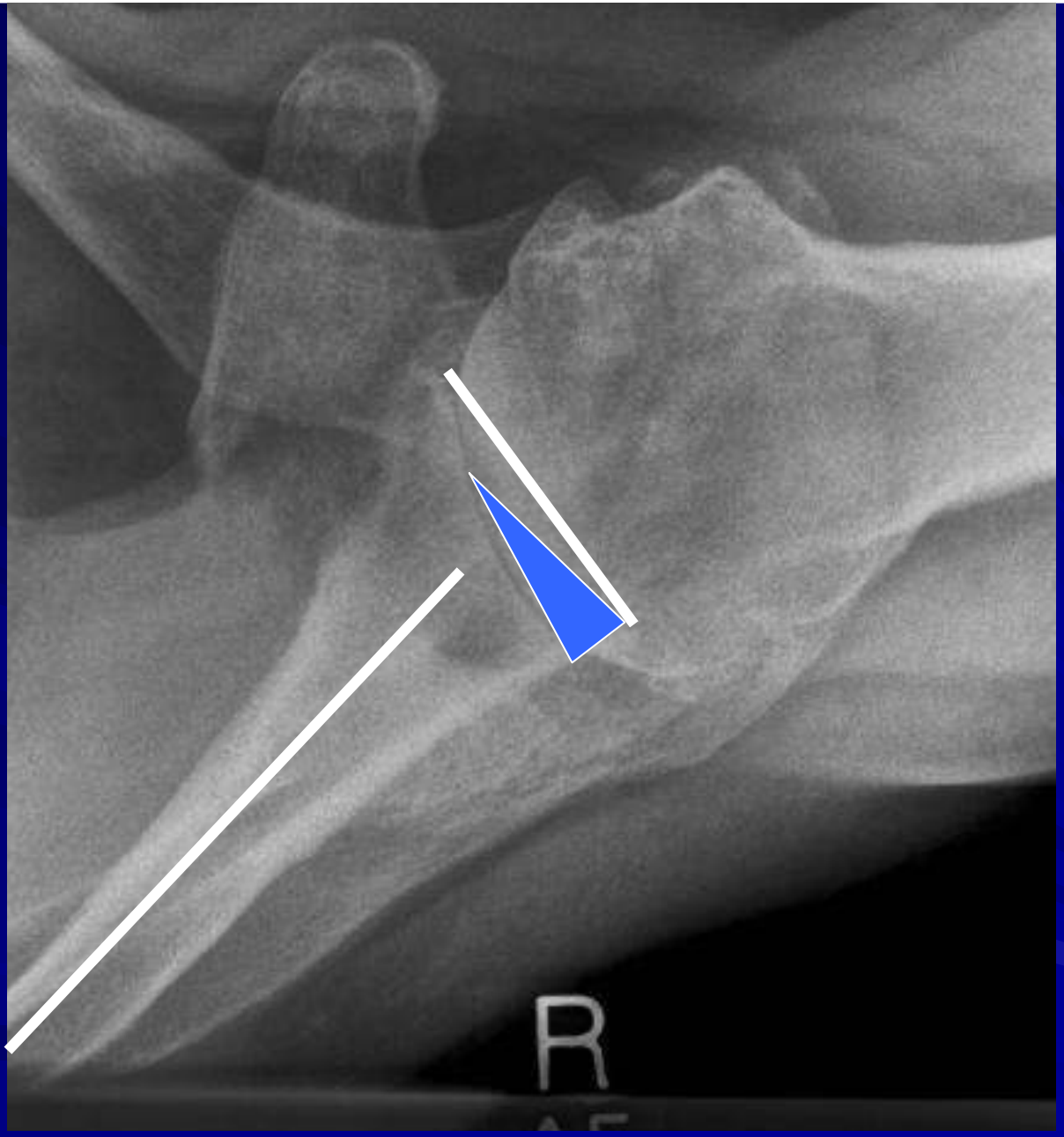
- Glenoid erosion/wear
- Radial missmatch
- Componnt design

1:Posterior glenoid erosion in OA

Posterior glenoid erosion in OA

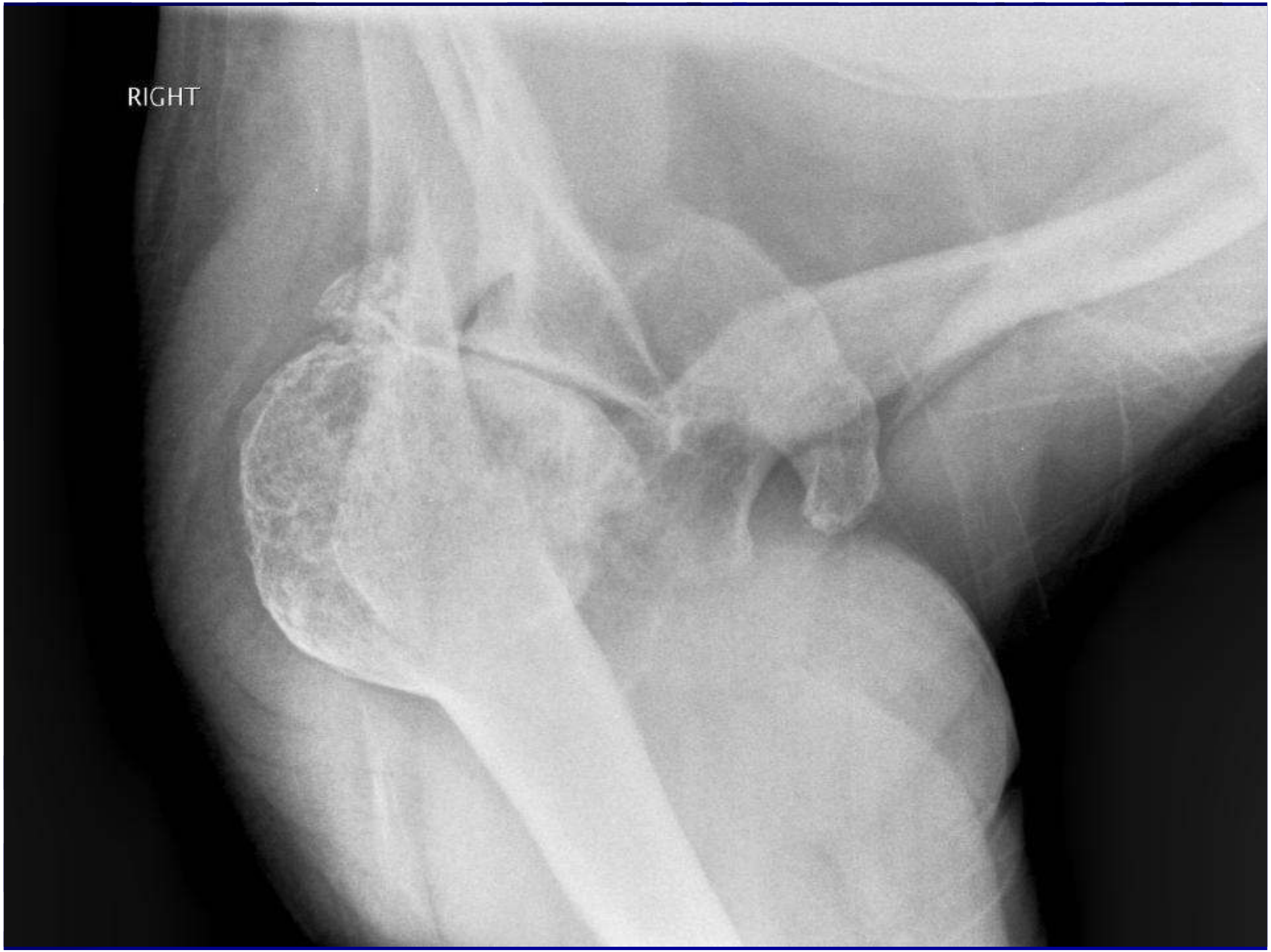



R

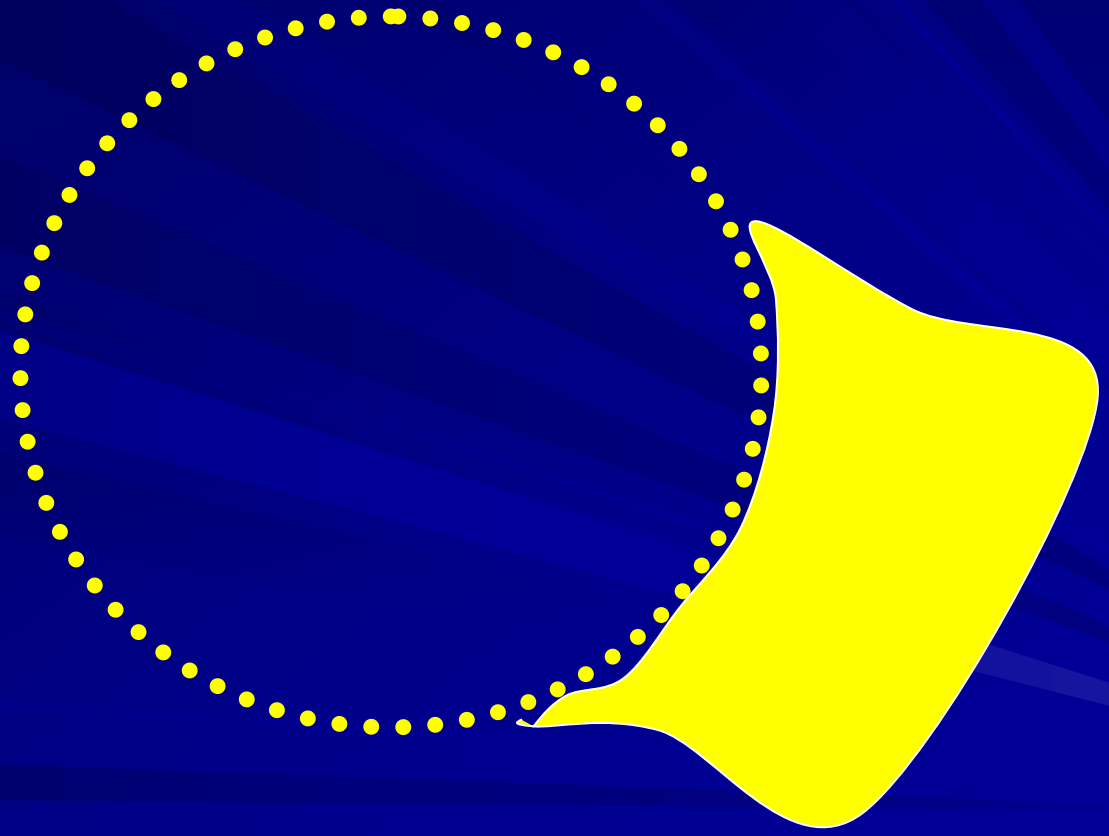

R

Glenoid wear

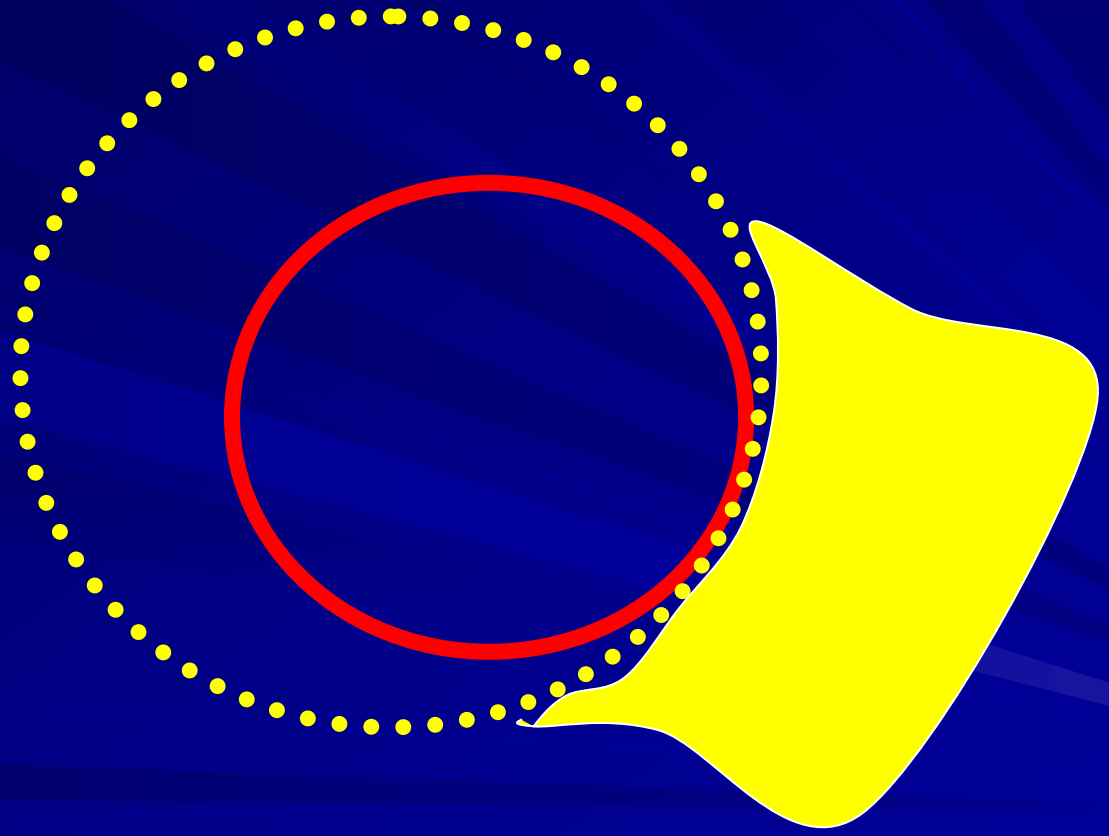
- Eccentric reaming to correct >10^{o} will make the glenoid surface significantly smaller and compromise arc of motion
- Grafting may compromise fixation of glenoid component


RIGHT

“Radial Mismatch”



“Radial Mismatch”



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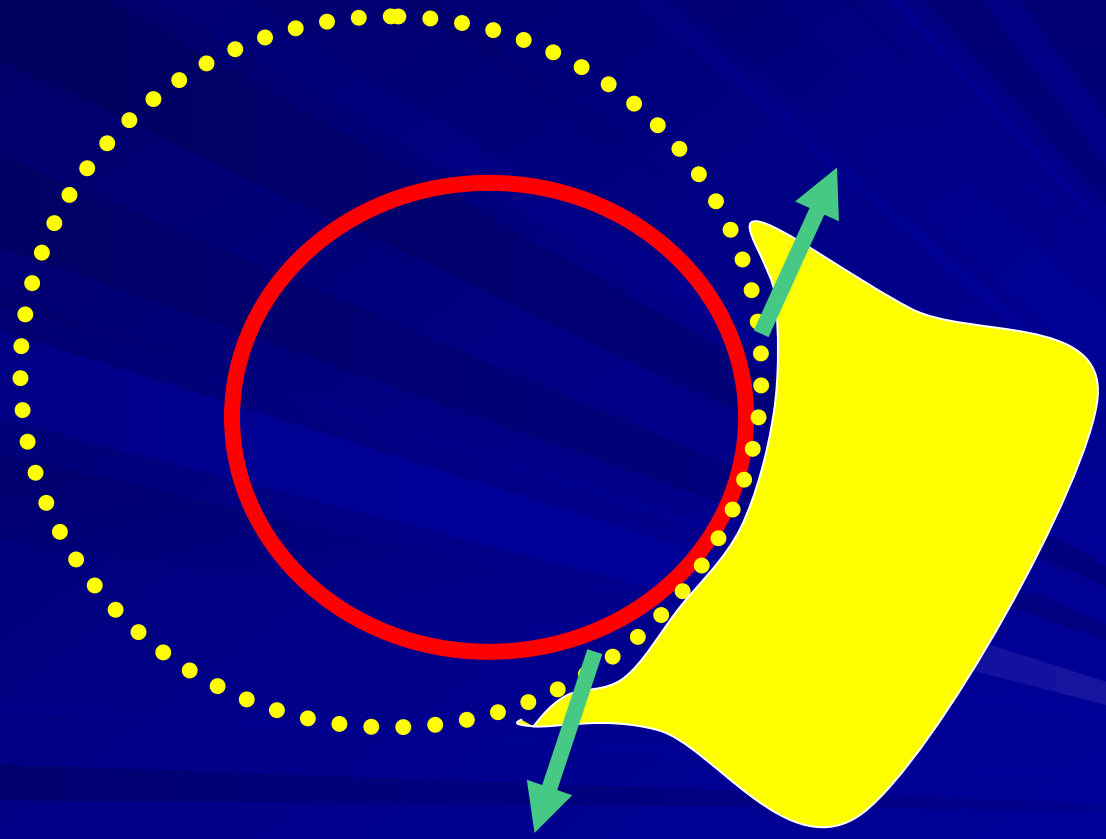

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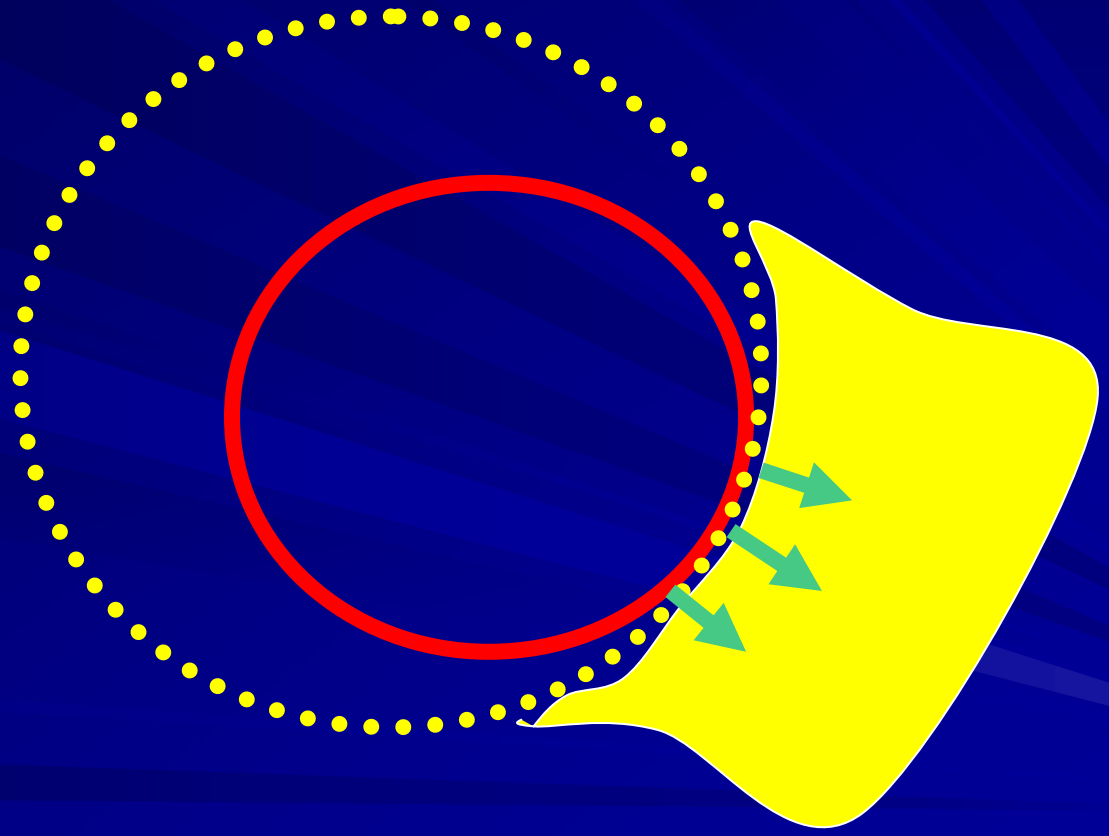

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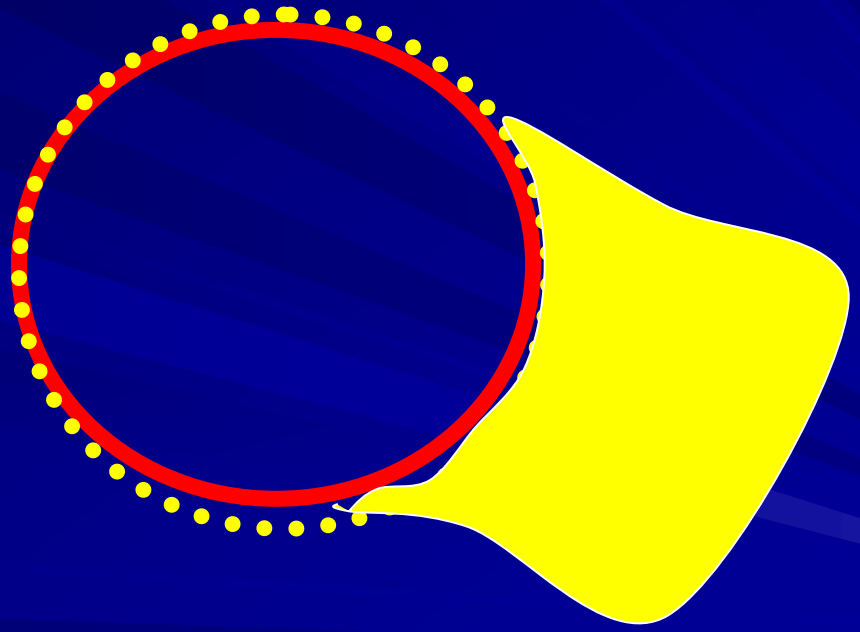
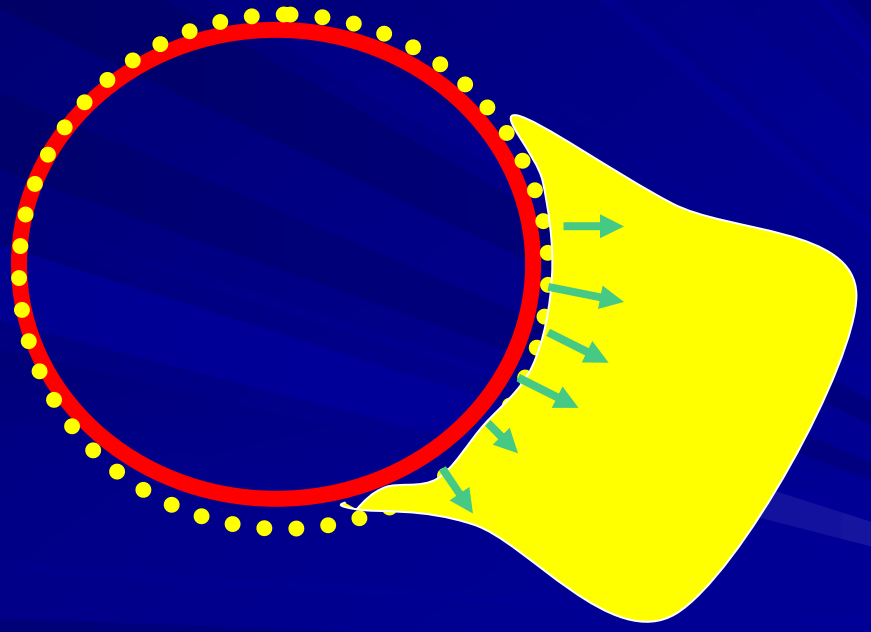


“Radial Mismatch”



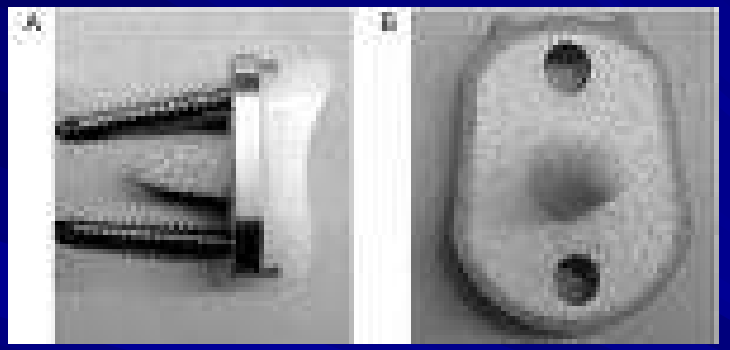
“Radial Mismatch”

Conformity vs “Radial Mismatch”

- Physiological translation
- Cadaveric studies : 4mm mismatch best replicates normal glenohumeral kinematics
  - ***Karduna et al, JBJS A 1997***
- Clinically, **mismatch of 6-7mm** provides best clinical outcome with low incidence of post operative radiolucent lines
  - ***Walch et al, JBJS A 2002***

3 Glenoid component Designs and methods of fixation

- Endless number invented & abandoned!
- Modern glenoids: Areas of recent controversy
  - Cemented / uncemented /hybrid
  - All plastic / metal-back
  - Keeled / peg fixation
  - Flat back / curved back

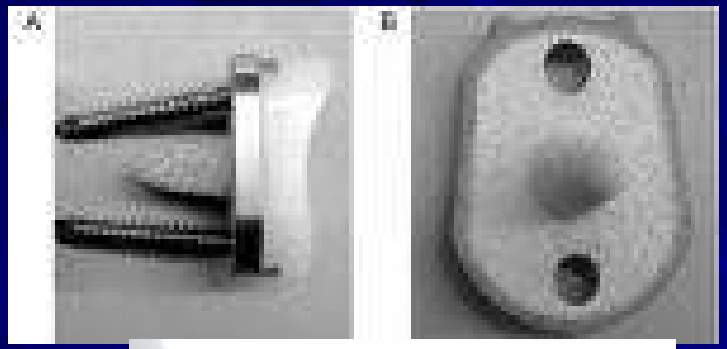


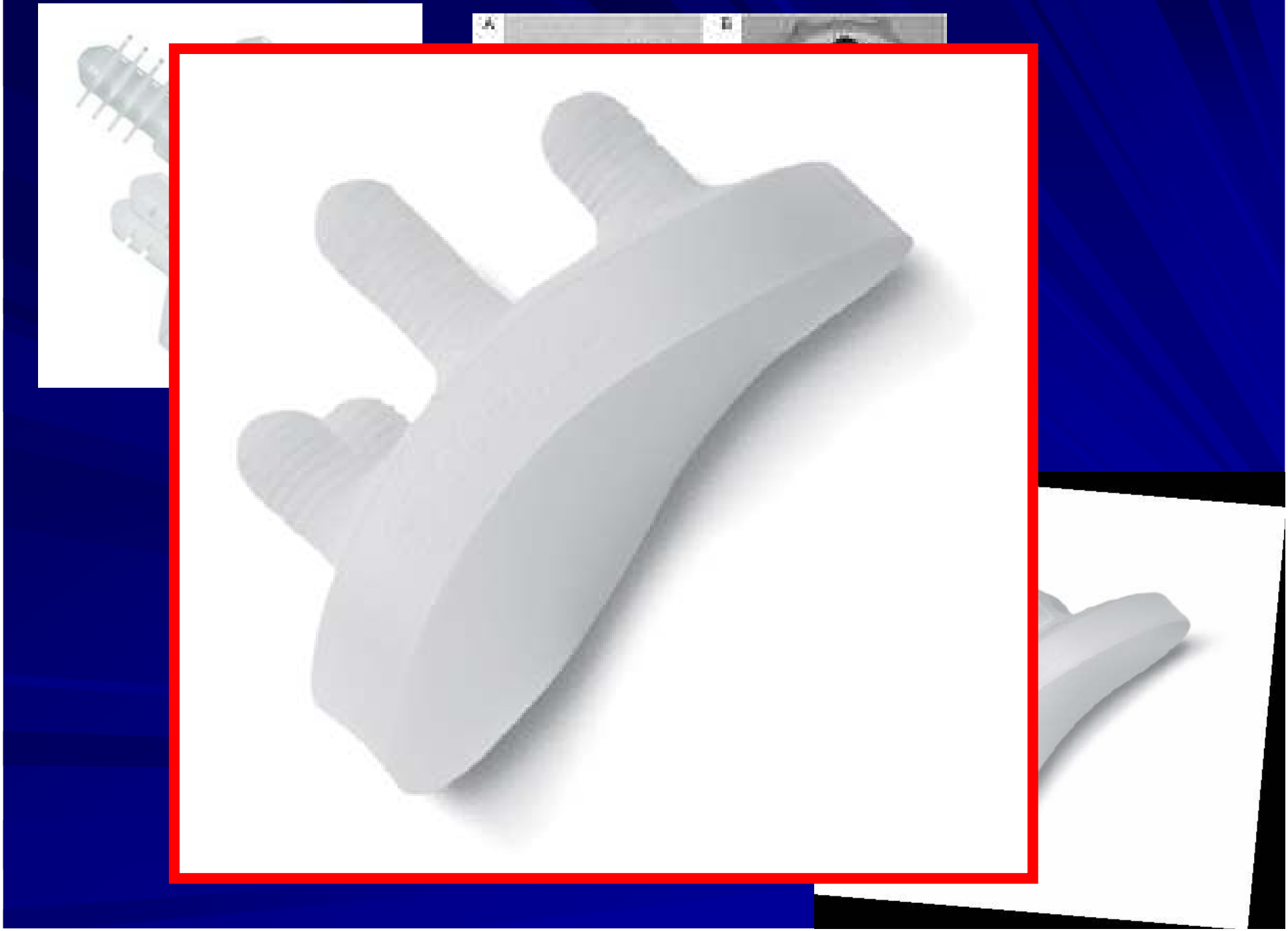
WHICH GLENOID?

- Biomechanical and early clinical clearly favours:

1. **Pegged**
2. **Curved Back**
3. **Cemented, all plastic**
4. **Radial mismatch 4-7mm**

- ***Strauss et al, JSES 2009***



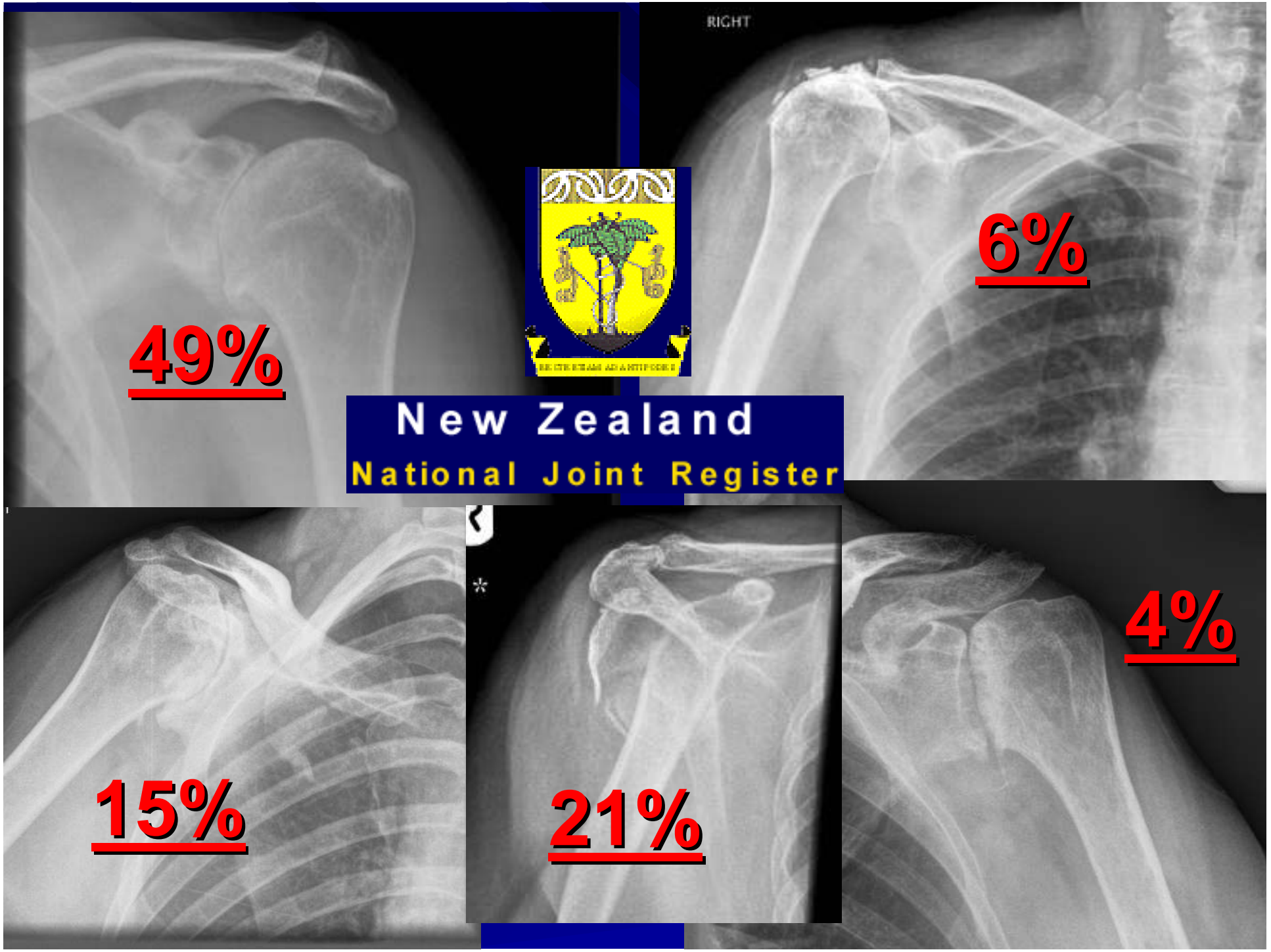


Alternatives to glenoid prosthetic replacement?

- Allograft
  - Meniscal
  - Achilles tendon
- “Ream & run”
- Microfracture

– MAY BE CONSIDERED IN THE YOUNG

3: The Patient


RIGHT
49%
6%
New Zealand
National Joint Register
15%
21%
4%

INDICATIONS AND TYPE OF ARTHROPLASTY

Pathology	HHA	TSA	"Reverse Shoulder"
Osteoarthritis	138	213	3
Rheumatoid arthritis	68	35	1
Other inflammatory arthritis	3	2	1
Acute proximal humeral fracture	94	3	0
Old trauma	37	10	2
Post recurrent dislocation	3	2	0
Avascular Necrosis	21	5	0
Cuff tear/ Cuff tear arthropathy (44) (*)	36	1	7
Other	3	4	0

(*) cuff tear does not exclude of other pathology. 8 cases had a second diagnosis: 3 OA, 1 RhA, 2 AVN and 2 "old trauma".

INDICATIONS & OSS

- Excellent: 12-18
- Good: 19-26
- Fair: 27-36
- Poor: 37-60

Pathology (n of cases)	**Mean Score**	***t-test***
Osteoarthritis (246)	22.4	*P< 0.0001*
Rheumatoid arthritis (75)	26.7	
Other Inflammatory (6)	29.1	
Acute Fracture Proximal humerus (42)	31.4 *	*P< 0.0001*
Old trauma (31)	29.8 *	*P< 0.0001*
Avascular necrosis (15)	25.5	
Cuff tear/ CT arthropathy (31)	29.6	
Post recurrent Dislocation (3)	27.3	
(*)Acute fractures vs old trauma *p=0.51* (N.S)		

INDICATIONS AND TYPE OF ARTHROPLASTY & OSS

Diagnosis	**Hemiarthroplasty**		**Total Shoulder Arthroplasty**		
	Number of cases	Average Score	Number of cases	Average Score	
Osteoarthritis	88	*25.4*	158	*20.7*	*P<0.0001*
Rheumatoid Arthritis	47	*28.3*	28	*24.4*	*P=0.09*
Avascular Necrosis	11	*27.2*	4	*21*	*P=0.075*
Trauma (acute + old)	64	*31.6*	9	*24.7*	*P=0.647*
Cuff Tear/ CT arthropathy	25	*31.2*	1 *5 (*)*	*21.0* *23.4*	*P=0.03*
(*) These 5 cases had a Reverse Shoulder Arthroplasty					

Osteoarthritis

- TSR Vs HHA?
- Resurfacing option?

Osteoarthritis

- TSR results significantly superior to hemiarthroplasty alone
  - ***Edwards et al, JSES 2003***
- But alternative view that HHA alone gives “acceptable” results
  - ***Norris et al, JSES 2002***

Radnay et al, JSES 2007

- Largest Meta-analysis (23 studies)
  - 1952 patients (OA only)
  - 4 year follow up
  - 1966-2004
  - TSR significantly better that HHA:
    - Pain Relief
    - Forward elevation
    - Gain in forward elevation
    - Gain in external rotation
    - Patient satisfaction

But which option gives better long-term results?

Failure mechanisms:

HHA: Glenoid erosion

TSR: Glenoid loosening

Revision TSR for glenoid loosening

- 76% glenoid loosening at 15 years, Neer-2 TSR
  - ***Sperling at al, JSES 2004***
- Revision at 4 years: 6.4%
  - ***Radnay et al, JSES 2007***
- Large variations in reported literature: prosthetic design
  - Aequalis prosthesis >95% survival at 10 years

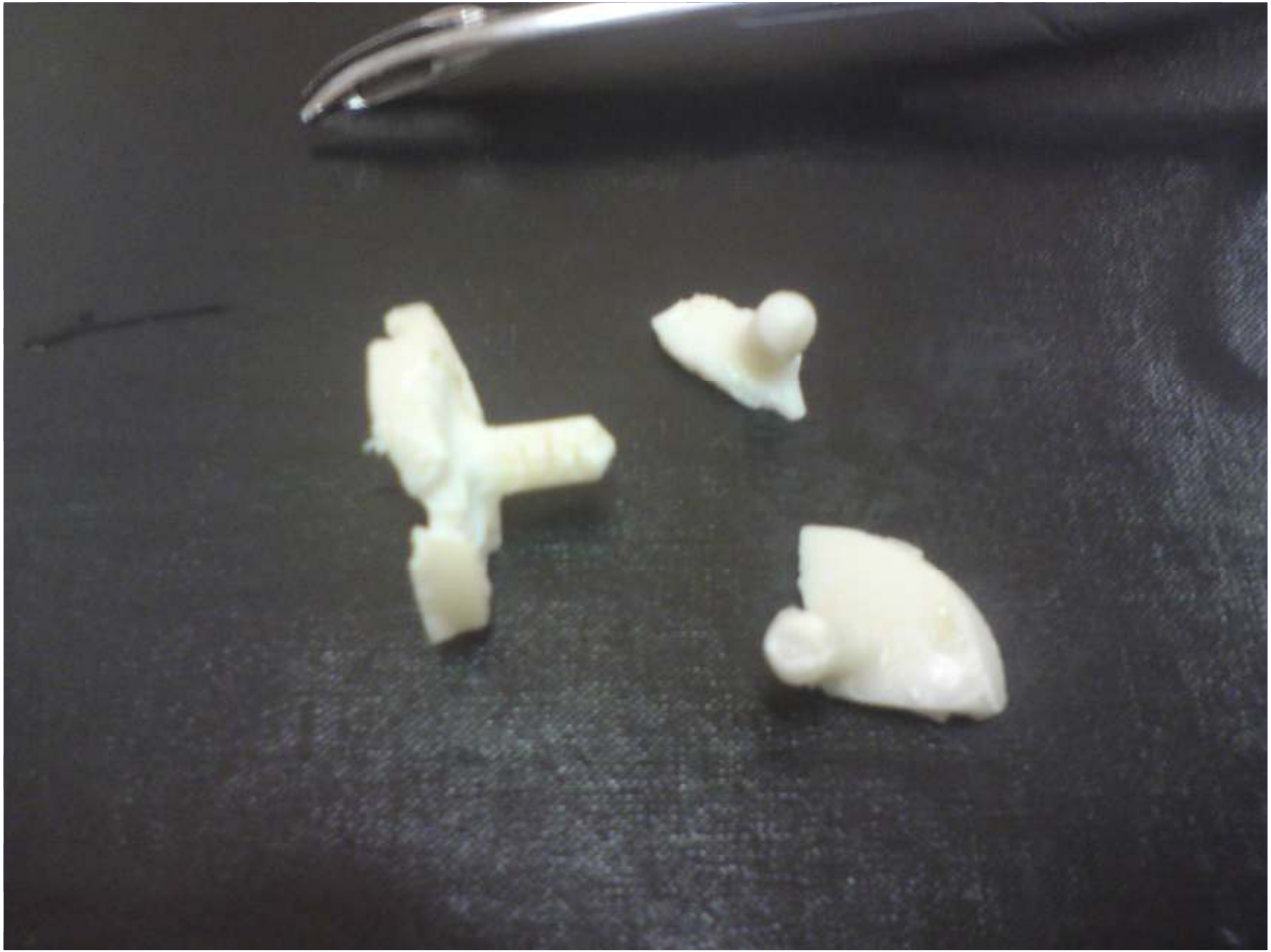
T Bunker, Bess 2008

Revision TSR for glenoid loosening

- Difficult surgery
- Bone graft
- 1-2 stage revision

- Both re-implantation of glenoid and conversion to hemiarthroplasty improve pain and function but reimplantation of glenoid better
  - ***Deutsh et al. JSES 2007***


R



Revision HHA to TSR for glenoid erosion

- More likely if preoperative glenoid arthrosis, particularly if posterior glenoid wear
- In non-concentric wear, risk of poor results >40%
  - Levine et al JSES 1997
- Even if concentric wear, TSR provides superior results
  - Gartsman et al, JBJS-A, 2000

Revision HHA to TSR for glenoid erosion

- 10% revision at 4 years
  - ***Radnay et al, JSES 2007***
- Glenoid erosion in 72% cases at 15 years
  - ***Sperling at al, JSES 2004***
- Results of HHA revision to TSR not universally good and never as good as primary TSR

TSR vs HHA

Sperling at al, JSES 2004

- >15 year retrospective study (1976-1985)
- Patients age< 50
- Neer-2
- 78 HHA - 36 TSR

	10 year survival	20 year survival
HHA	82%	75%
TSR	97%	84%

	HHA	TSR
Excellent	10%	21%
Satisfactory	30%	31%
Unsatisfactory	60%	48%

My practice

- Young: resurface
- Old: TSR if possible

Rheumatoid Arthritis

- TSR >HHR
- Glenoid deformity may not allow replacement
- DEFICIENCY OF ROTATOR CUFF DICTATES POOR FUNCTION


R
ASA


JL/RM
JL/RM
LEFT
RM


R
DT

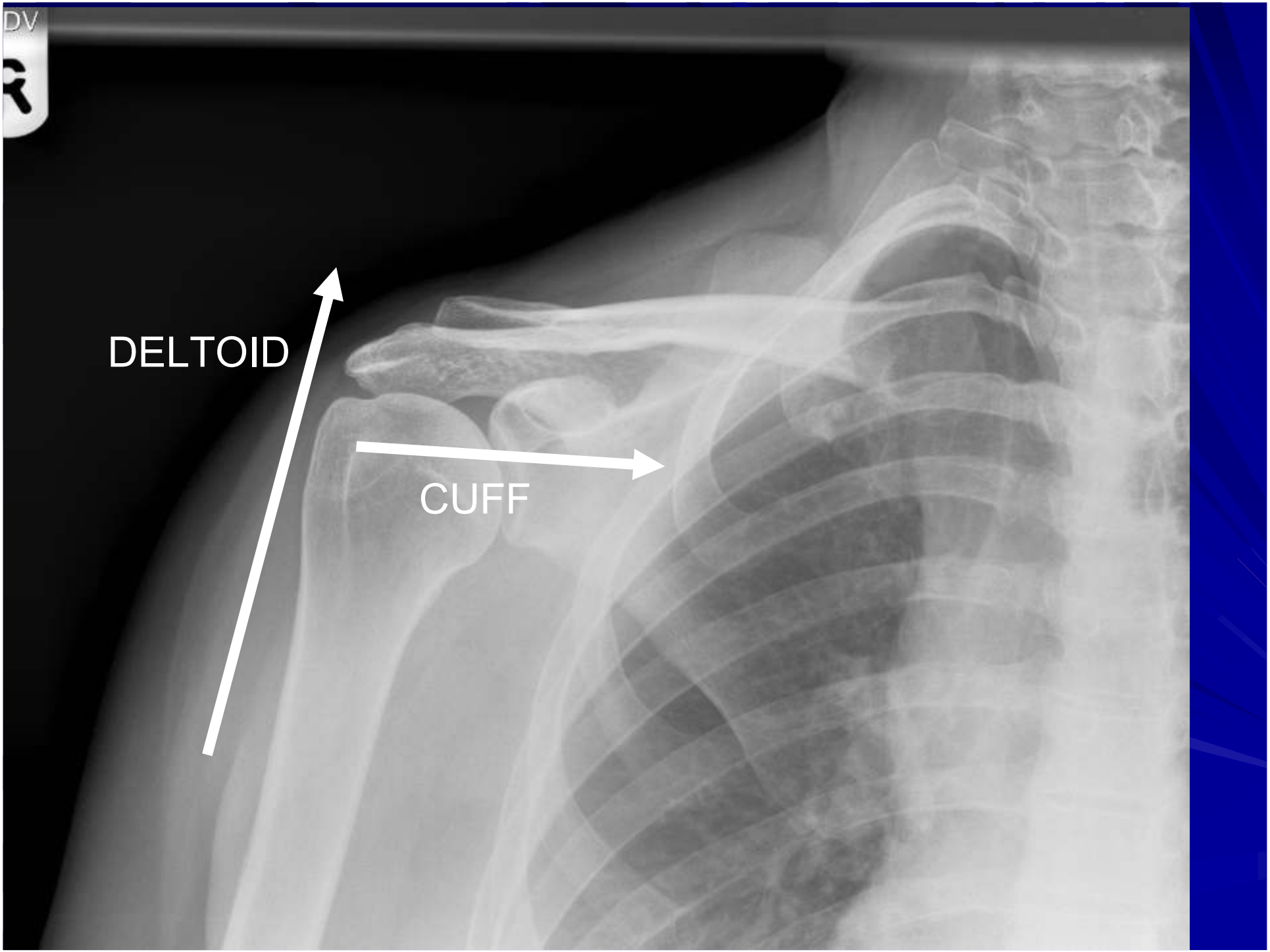

RT


R
AM/KH

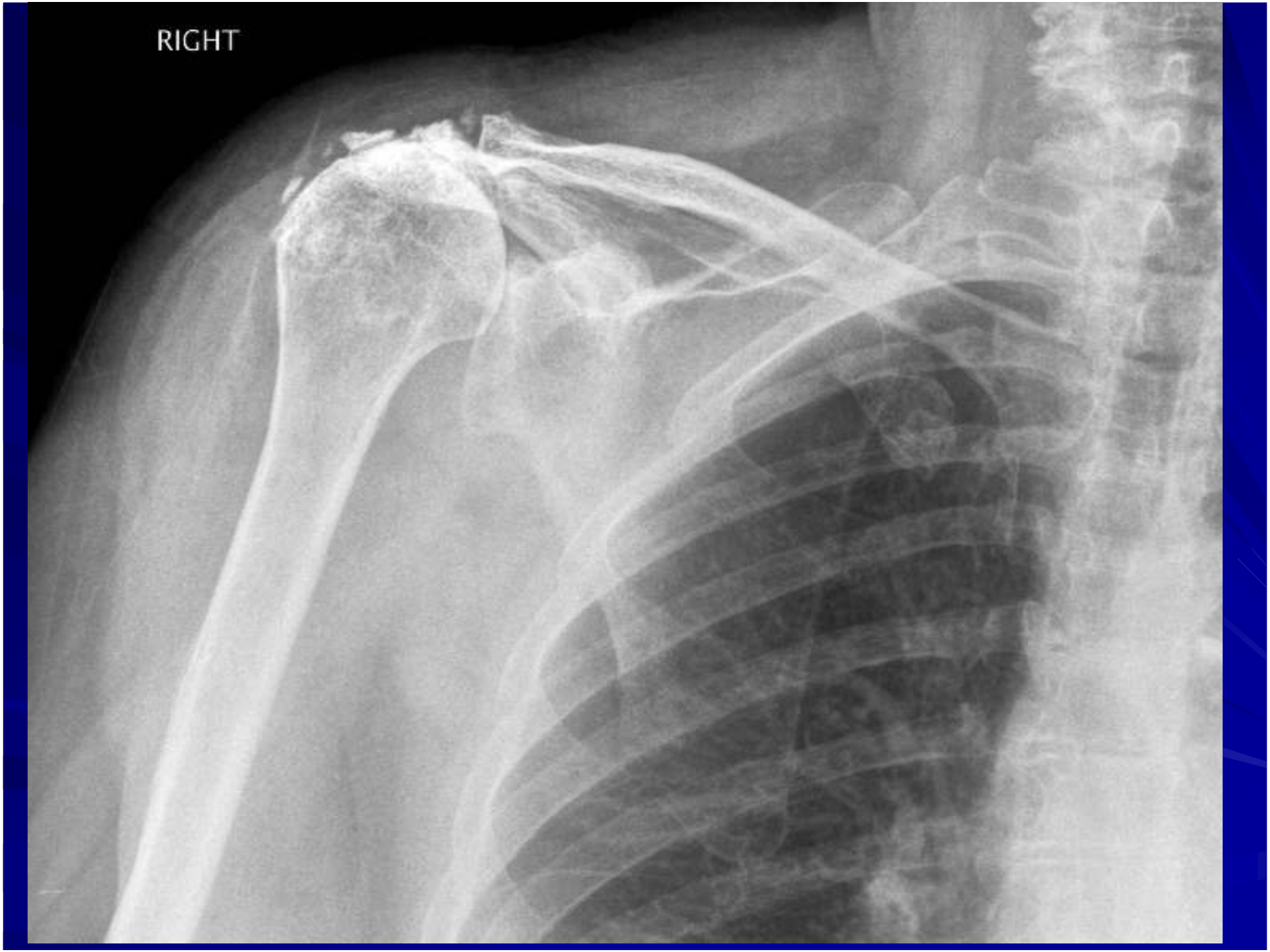

R
AM/KH


R
SS

Rotator cuff arthropathy


DV
DELTOID
CUFF


R
AF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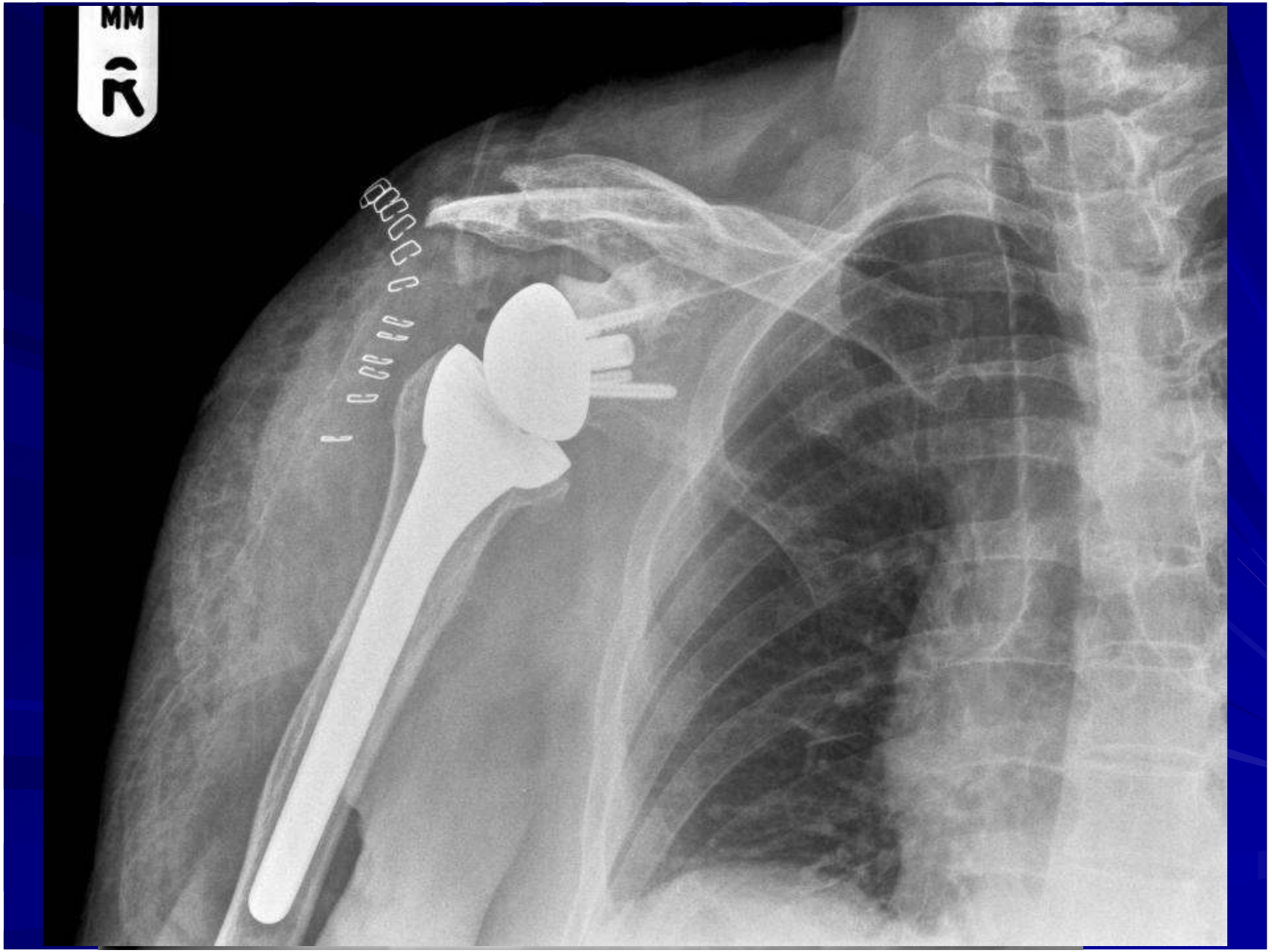
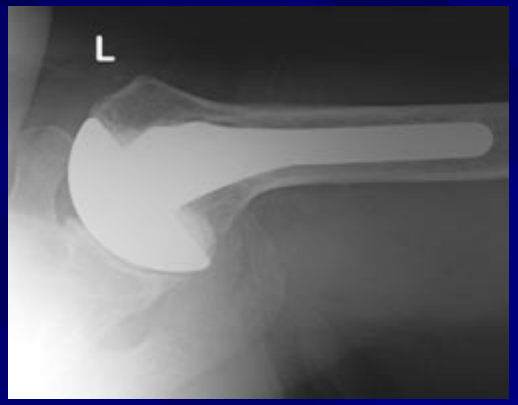

MM
R

Thank you


L


L


9
130°


R

POST TRAUMATIC CONDITIONS

- Difficult!!
- Outcome unpredictable
- Osteotomy of GT probably best avoided
  - *Boileau et al 2001*
- "Double Bubble"