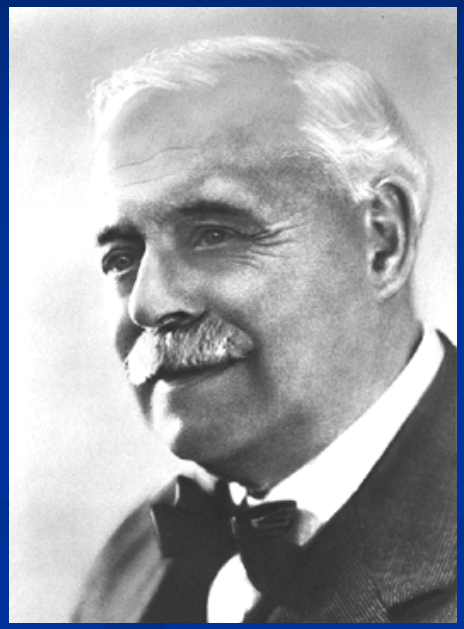
Proximal Humeral Fractures

Mr. Jaime Candal Couto
Consultant Orthopaedic Surgeon
&
Honorary Lecturer
Wansbeck Hospital, U.K.

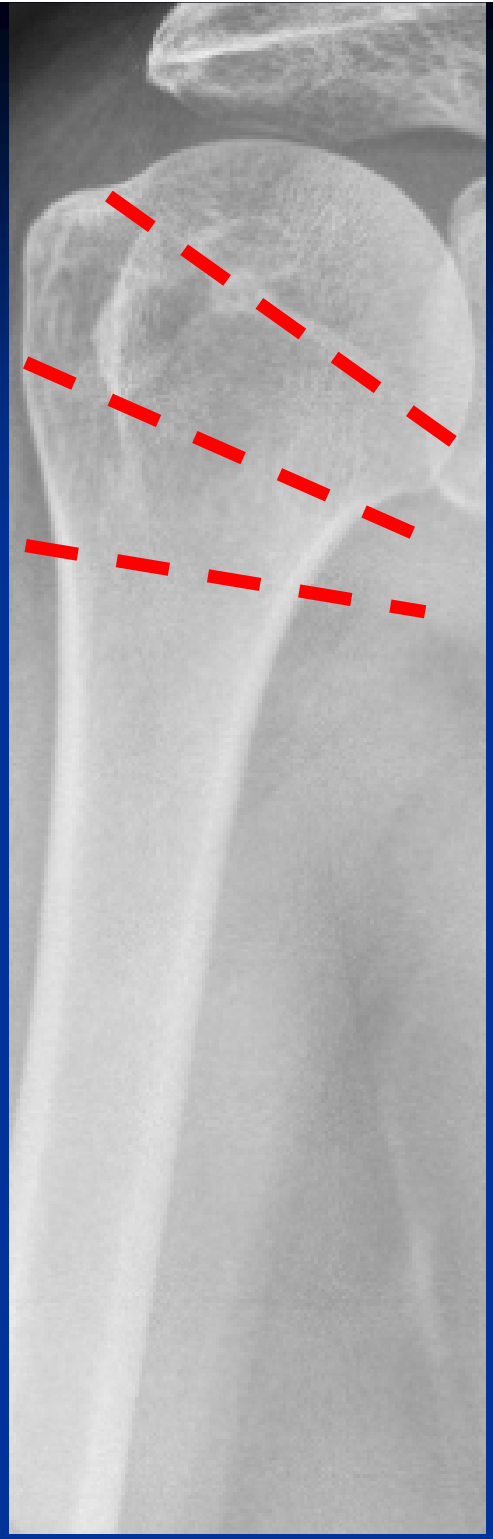
Sir Robert Jones

1857-1933



"…the importance of perfect alignment is overshadowed by the problem of early restoration of the full range of mobility in the shoulder joint. Many fractures are impacted and unless the deformity is gross, the impaction is best left undisturbed. A sling and axillary pad are applied and gentle movements of the shoulder begun at the end of the week...

... Any residual limitation of movement can be later overcome by a timely manipulation under anaesthesia. Operation for mal-union is rarely necessary…"

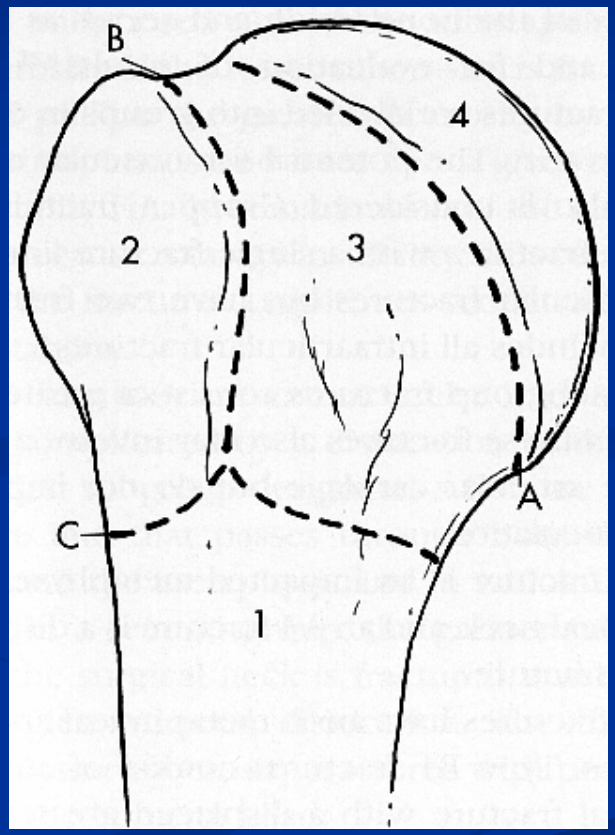


Kocher 1896

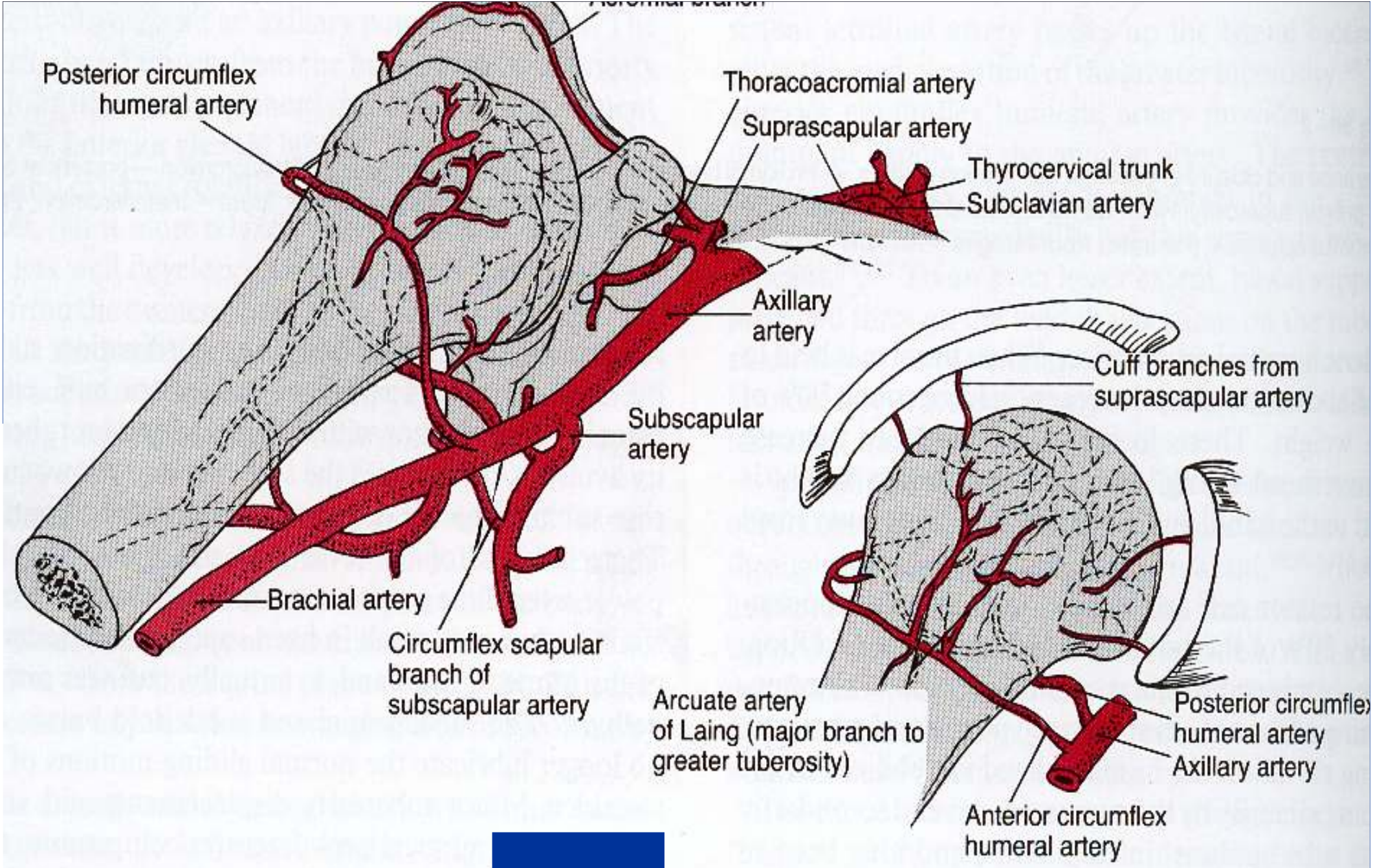
ANATOMICAL NECK

EPIPHYSEAL

SURGICAL NECK



Codman's segments 1934

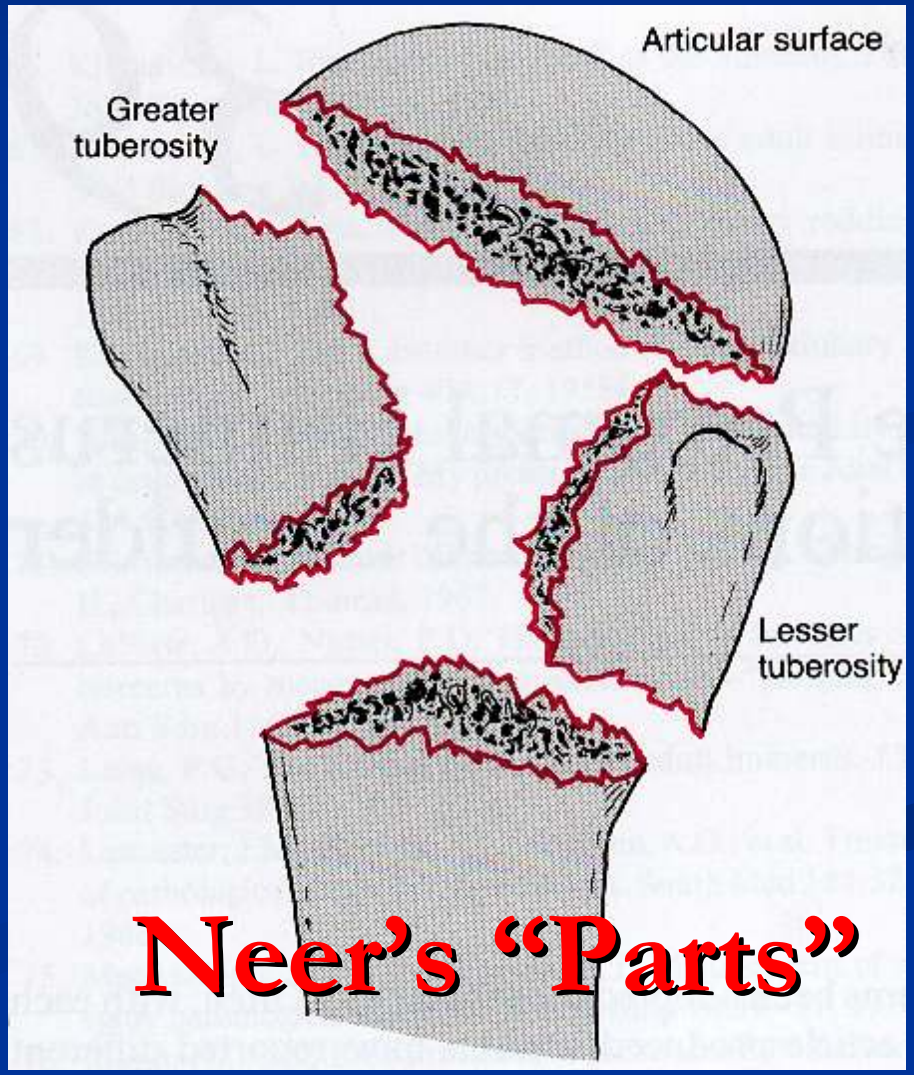


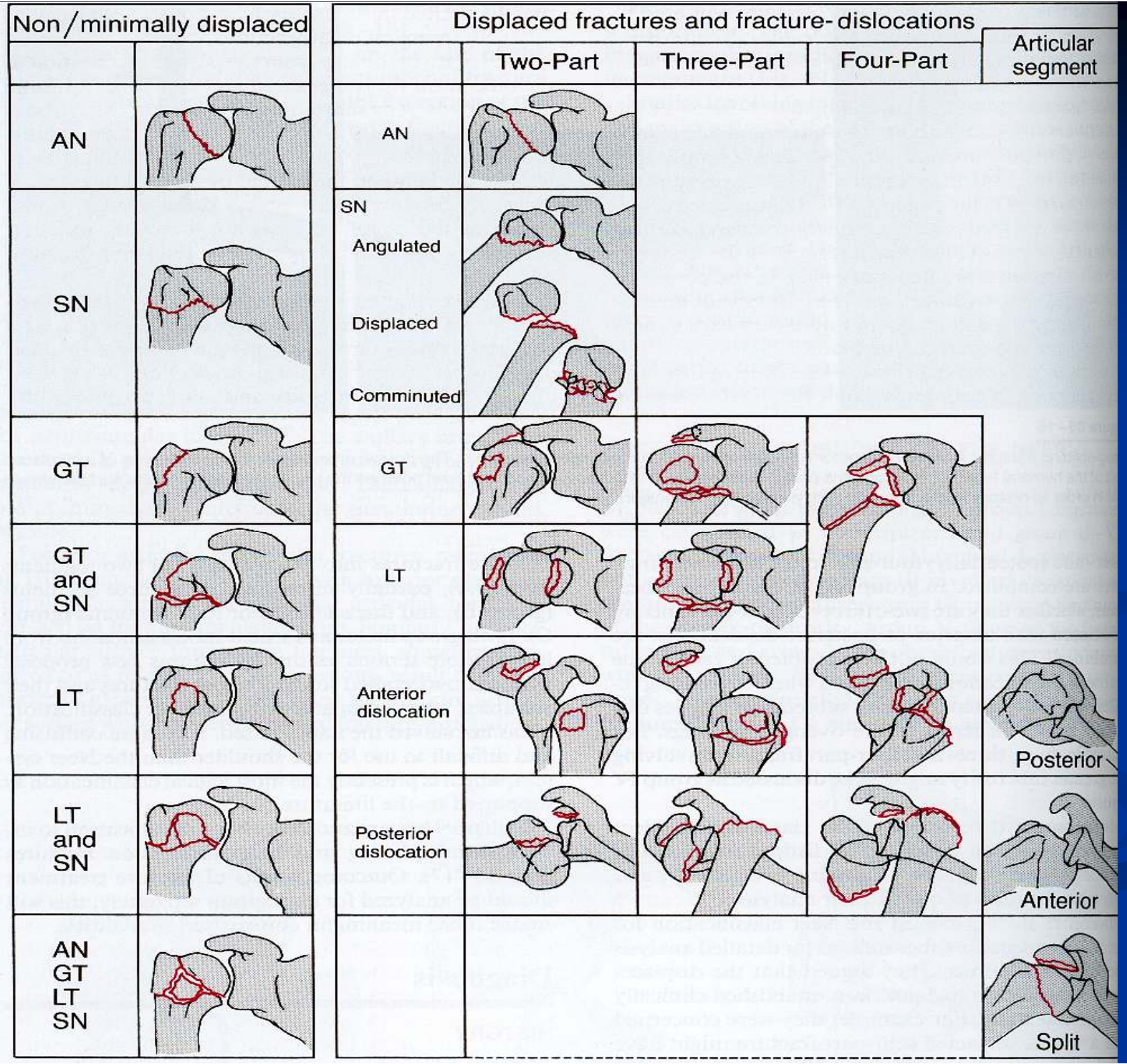
Laing PG: Arterial supply to the adult Humerus; JBJS 1956

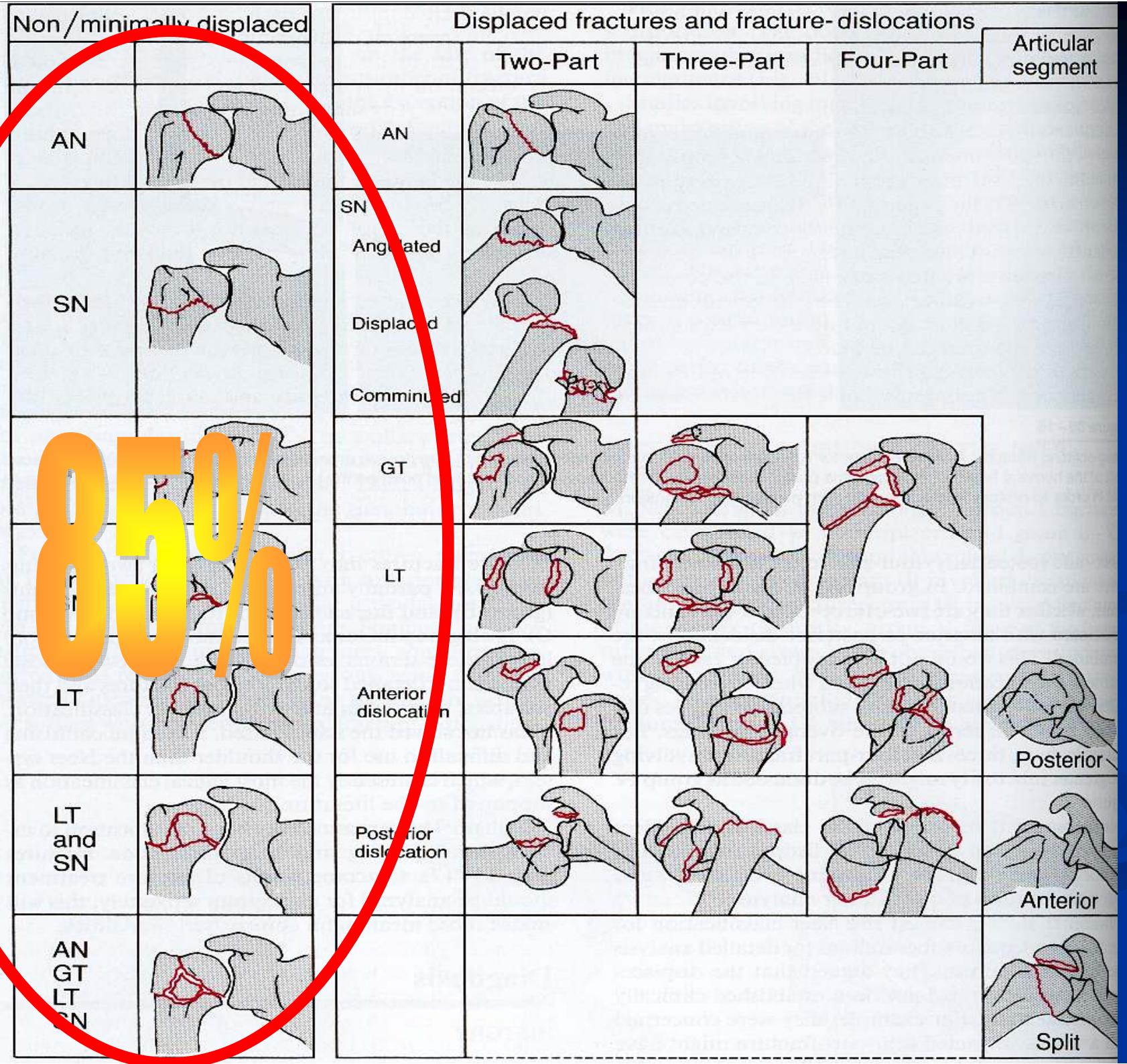
Charles Neer, JBJS 52-A 1970

"Displaced Proximal Humeral Fractures"

- Classification
  - Displacement: 1cm translation or >45° angulation
  - 2 x-ray views
- Evaluation:
  - Neer's outcome measures
- Treatment of 3 & 4 part fractures
- 1953-1969




Non/minimally displaced
Displaced fractures and fracture-dislocations
Two-Part
Three-Part
Four-Part
Articular segment
AN
SN
Angulated
Displaced
Comminuted
GT
GT and SN
LT
LT and SN
AN GT LT SN
Anterior dislocation
Posterior dislocation
Posterior
Anterior
Split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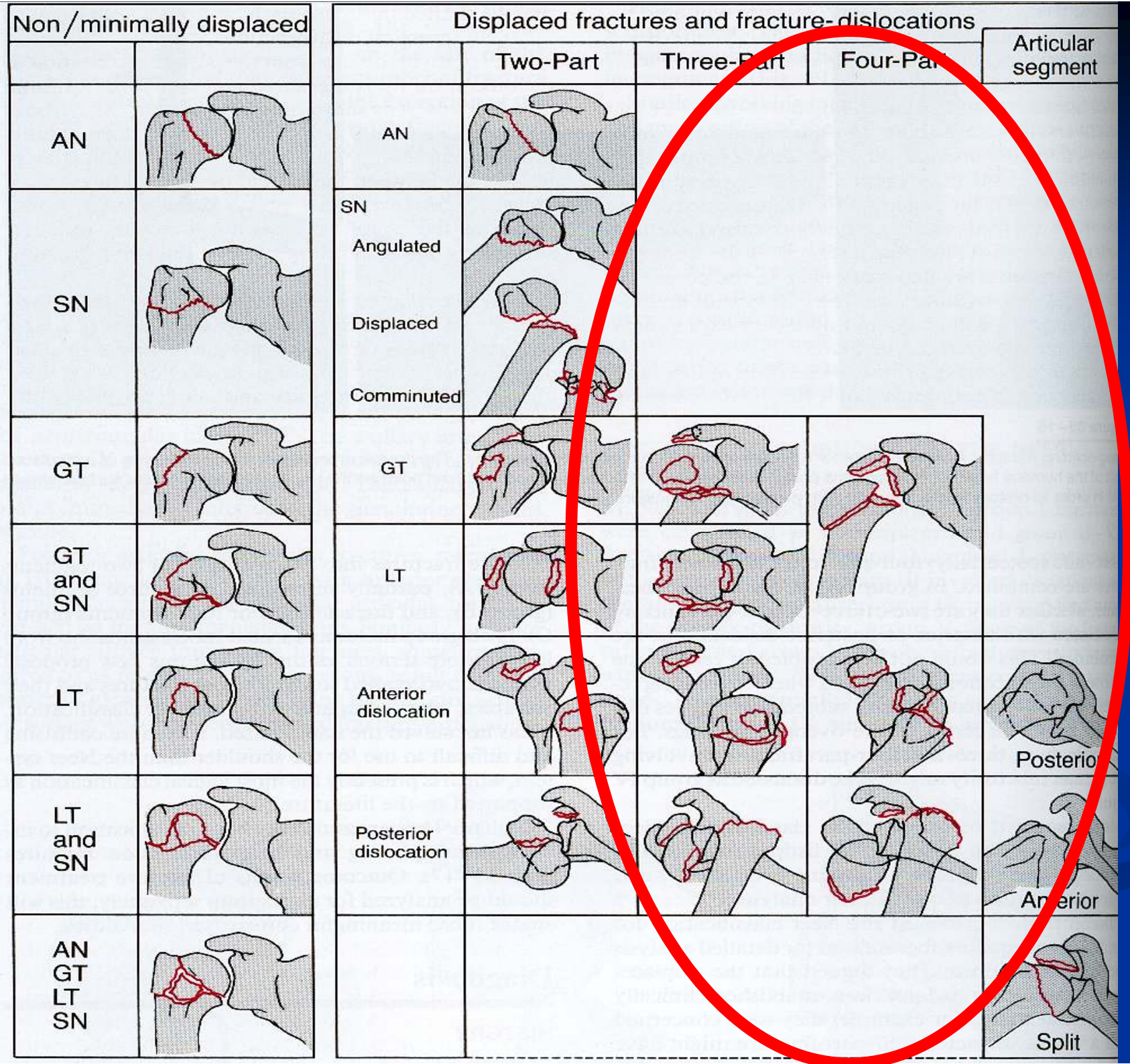
Posterior dislocation
LT and SN
AN GT LT SN
Posterior
Anterior
Split
85%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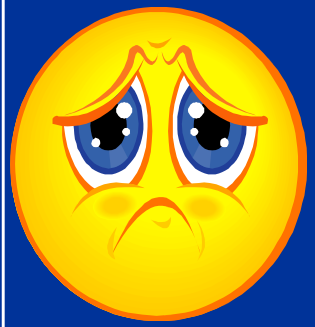
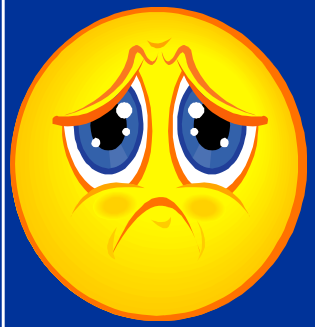
LT
LT and SN
AN GT LT SN
Anterior dislocation
Posterior dislocation
Posterior
Anterior
Split

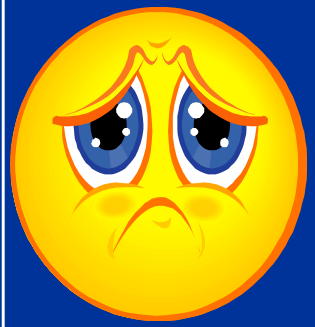
	CLOSED TREATMENT					
	Number	Satisfactory Result				
3 part	20	3				
4 part	11	0				

	CLOSED TREATMENT		OPEN REDUCTION (O.R.I.F. OR EXCISION			
	Number	Satisfactory Result	Number	Satisfactory Result		
3 part	20	3	30	19		
4 part	11	0	13	0		

	CLOSED TREATMENT		OPEN REDUCTION (O.R.I.F. OR EXCISION)		HEMIARTHROPLASTY	
	Number	Satisfactory Result	Number	Satisfactory Result	Number	Satisfactory Result
3 part	20	3	30	19	11	8
4 part	11	0	13	0	32	31

	CLOSED TREATMENT		OPEN REDUCTION (O.R.I.F. OR EXCISION		HEMIARTHROPLASTY	
	Number	Satisfactory Result	Number	Satisfactory Result	Number	Satisfactory Result
3 part	20		30	19	11	8
4 part	11		13		32	31

	CLOSED TREATMENT		OPEN REDUCTION (O.R.I.F. OR EXCISION		HEMIARTHROPLASTY	
	Number	Satisfactory Result	Number	Satisfactory Result	Number	Satisfactory Result
3 part	20		30		11	8
4 part	11		13		32	31

	CLOSED TREATMENT		OPEN REDUCTION (O.R.I.F. OR EXCISION		HEMIARTHROPLASTY	
	Number	Satisfactory Result	Number	Satisfactory Result	Number	Satisfactory Result
3 part	20		30		11	
4 part	11		13		32	


SOLD!

BUT …

1. Neer's **classification** has never been found to be reproducible
2. Neer did not measure the outcome in the **non-operative group**
3. Neer's **ORIF methods** are now outdated
4. Neer was **technically** very good with **hemiarthroplasties!**

Evidence-Based 21st Century Surgery

Epidemiology

- Increasing public health problem
- 5-10% of all fractures
- 3rd most common # >65yrs

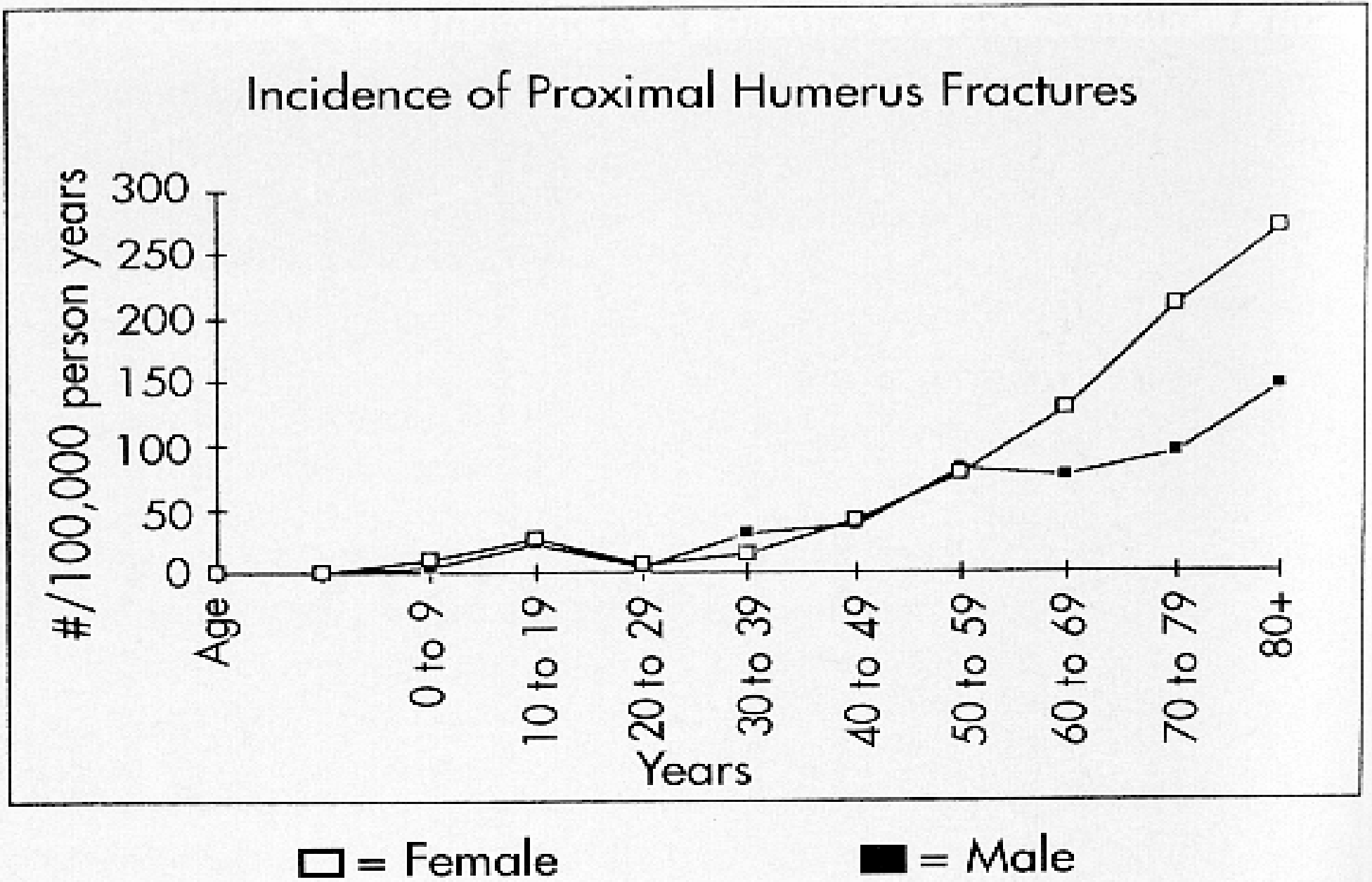
- Incidence ↑ threefold 1970 – 1998
- ? ↑ threefold by 2030

Kannus P, Palvanen M, Niemi S et al, (Finland). Acta, Oct 2000

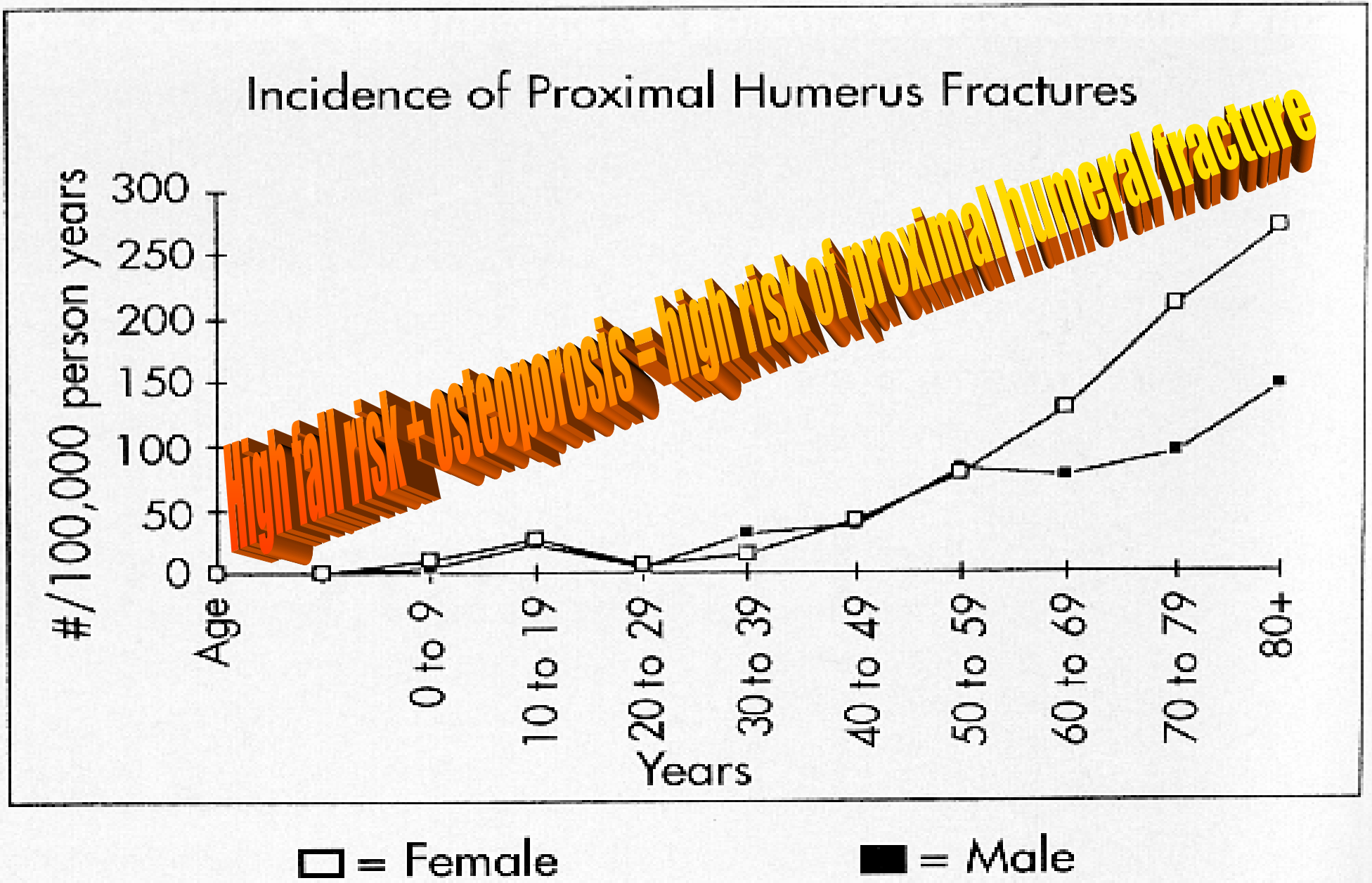
Epidemiology

- Incidence in Finland (2002):
  - Women: 129 / 100,000 population / year
  - Men: 48 / 100,000 population / year
  - Women aged>80: 294/ 100,000 population / year

- Incidence 70% of hip fracture (Minnesotta, 1982)



Lind T, Kroner K, Jensen J: Acta Orthop Trauma Surg, 1989


Incidence of Proximal Humerus Fractures
High fall risk + osteoporosis = high risk of proximal humeral fracture
#/100,000 person years
300
250
200
150
100
50
0
Age
0 to 9
10 to 19
20 to 29
30 to 39
40 to 49
50 to 59
60 to 69
70 to 79
80+
Years
= Female
= Male

1: Modern Classifications

- AO
- Hertel's "Lego"
- CT based

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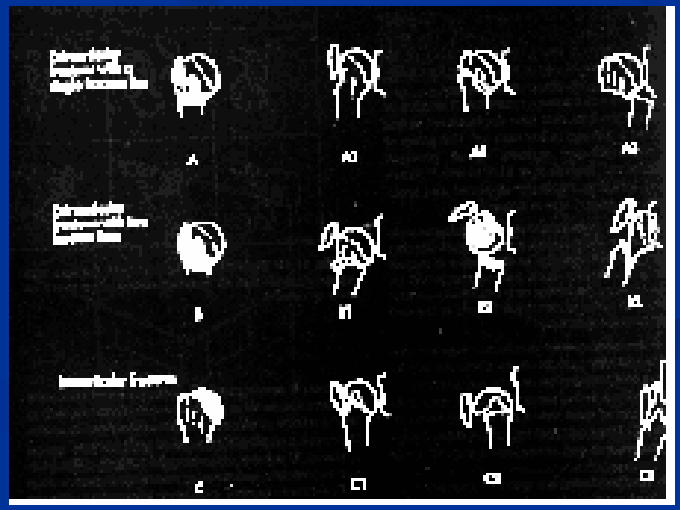
AO Classification

- **A: Extra-articular unifocal fracture**
  - A1: Tuberosity
    - A11: GT not displaced
    - A12: GT displaced
    - A13: With Glenohumeral dislocation
  - A2: Impacted Metaphyseal
  - A21: Without Ap malalignment
    - A22: Varus
    - A23: Valgus
  - A3: Non-impacted Metaphyseal
    - A31:Angulated
    - A32: Translated
    - A33: Multifragmentary
- **B: Extra-articular bifocal fracture**
  - B1: With Metaphyseal impaction
    - B11: Lateral+ GT
    - B12: Medial + LT
    - B13: Posterior +GT
  - B2: Without Metaphyseal impaction
    - B21: Without rotation
    - B22: With rotation
    - B23: Multifrag + one tuberosity
  - B3: With Glenohumeral dislocation
    - B31: Vertical line, GT intact, Ant disloc
    - B32: Vertical line, GT fractured, Ant disloc
    - B33: LT fractured, Posterior disloc
- **C: Articular fracture**
  - C1: With Slight displacement
    - C11: cephalo-tuberc, valgus
    - C12 cephalotuberc, varus
    - C13: Anatomical neck
  - C2: With Marked Displacement
    - C21: cephalo-tuberc, valgus
    - C22 cephalotuberc, varus
    - C23: transcephalic+tuberc, varus
  - C3: Dislocated
    - C31: Anatomical neck
    - C32 Anatomical neck and tuberosities
    - C33 Cephalotubercular fragmentation



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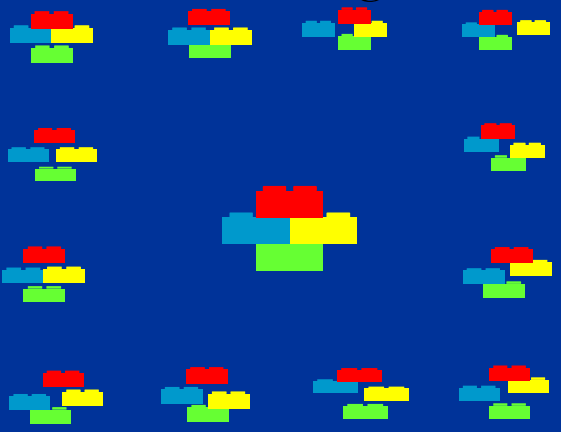
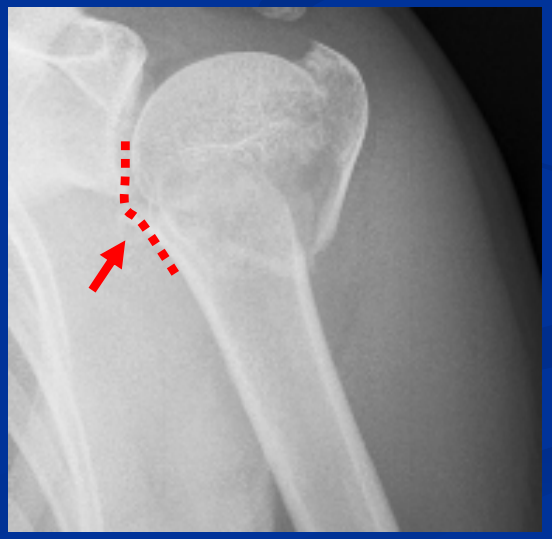
    - B31: Vertical line, GT intact, Ant disloc
    - B32: Vertical line, GT fractured, Ant disloc
    - B33: LT fractured, Posterior disloc
- **fracture**
  - light displacement
    - C11: cephalo-tuberc, valgus
    - C12 cephalotuberc, varus
    - C13: Anatomical neck
  - lacement

Poorly reproducible

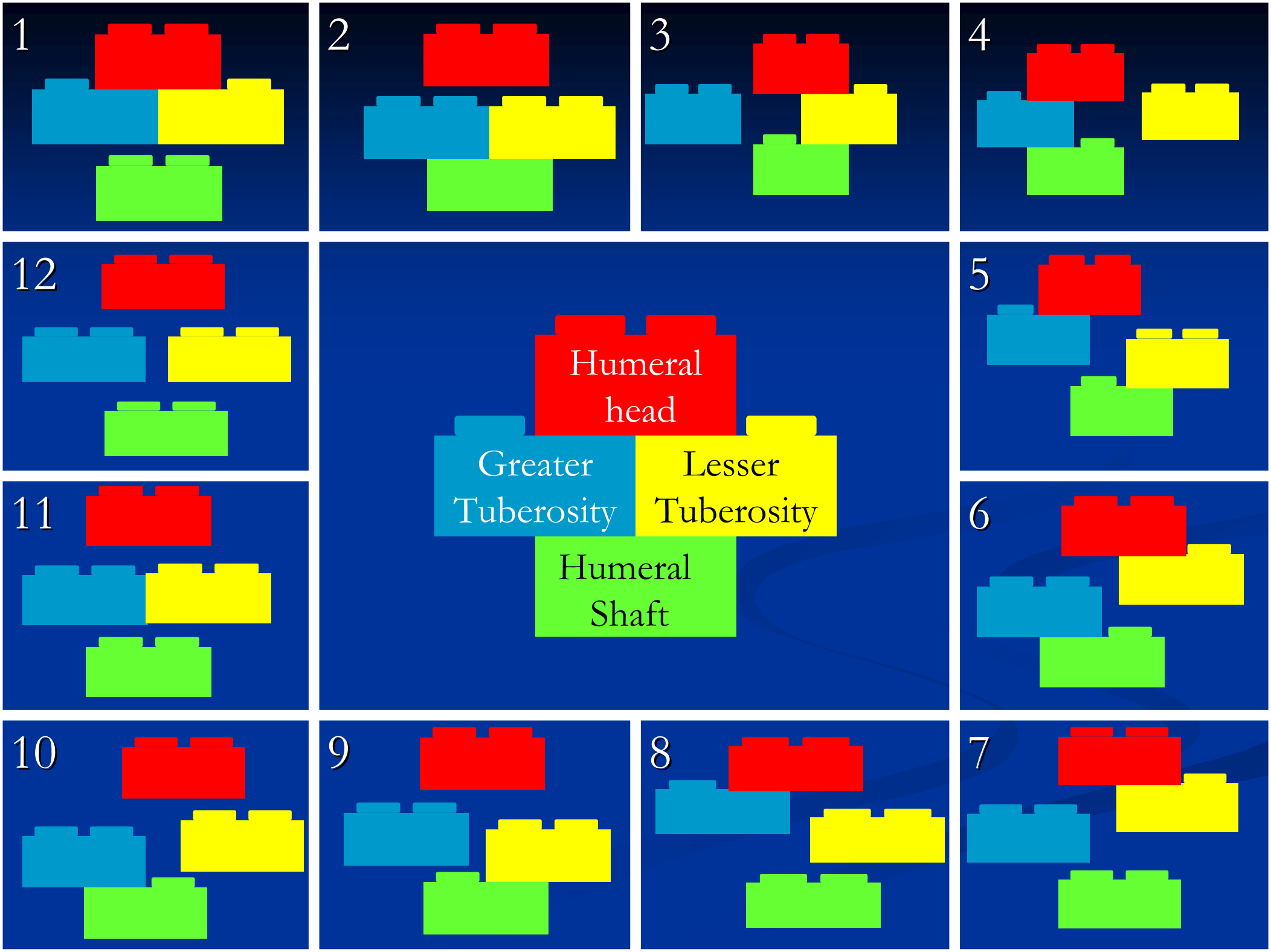
R. HERTEL: predictors of avascular necrosis

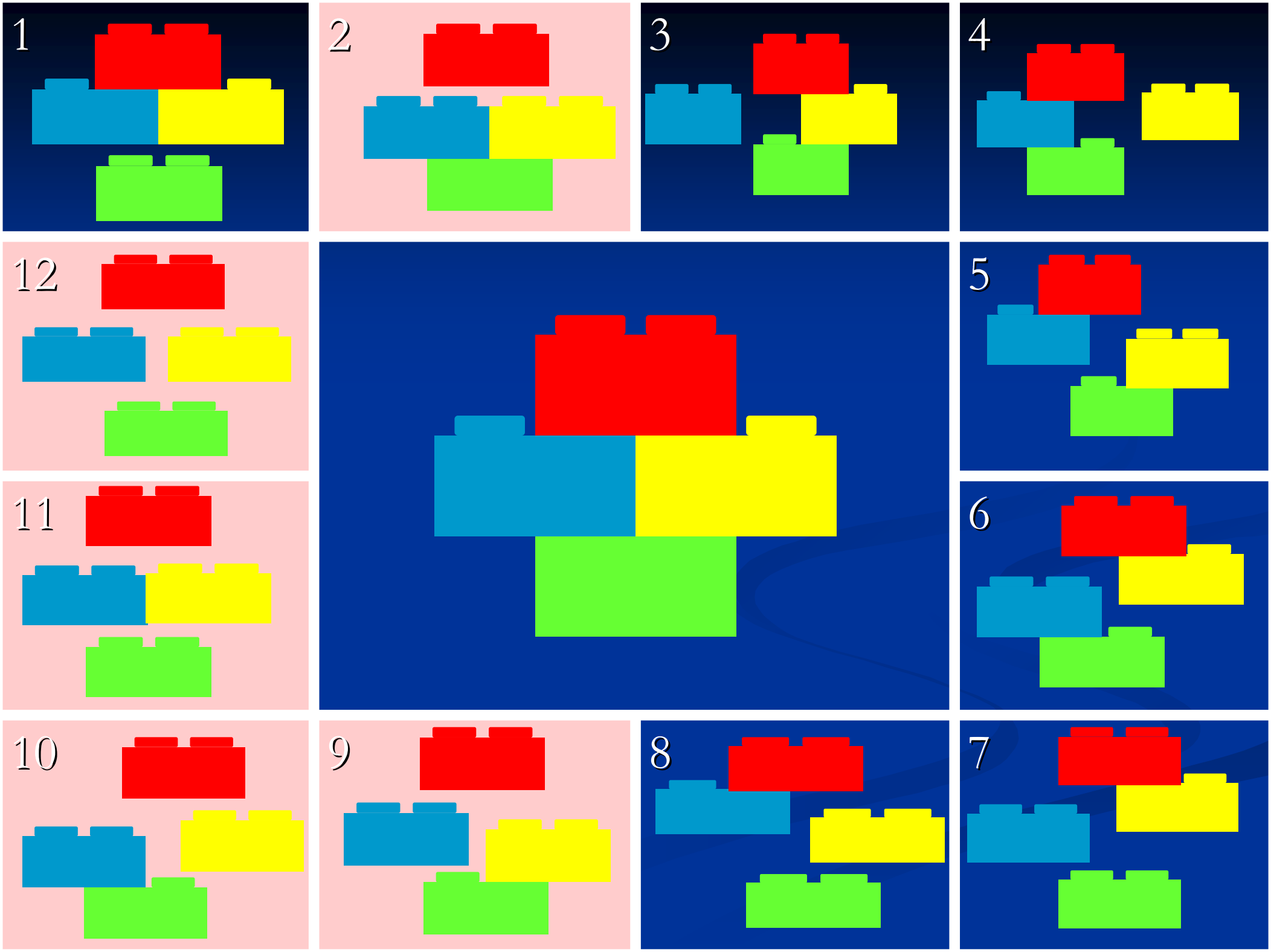
- Predictors of ischaemia
  - Calcar length < 8mm (0.8)
  - Medial hinge disrupted (>2mm) (0.79)
  - Fracture pattern (0.7)
    - "Lego" Classification





Hertel et al JSES 2004 13 427–33


1
2
3
4
12
Humeral head
Greater Tuberosity
Lesser Tuberosity
Humeral Shaft
5
11
6
10
9
8
7


1
2
3
4
12
5
11
6
10
9
8
7

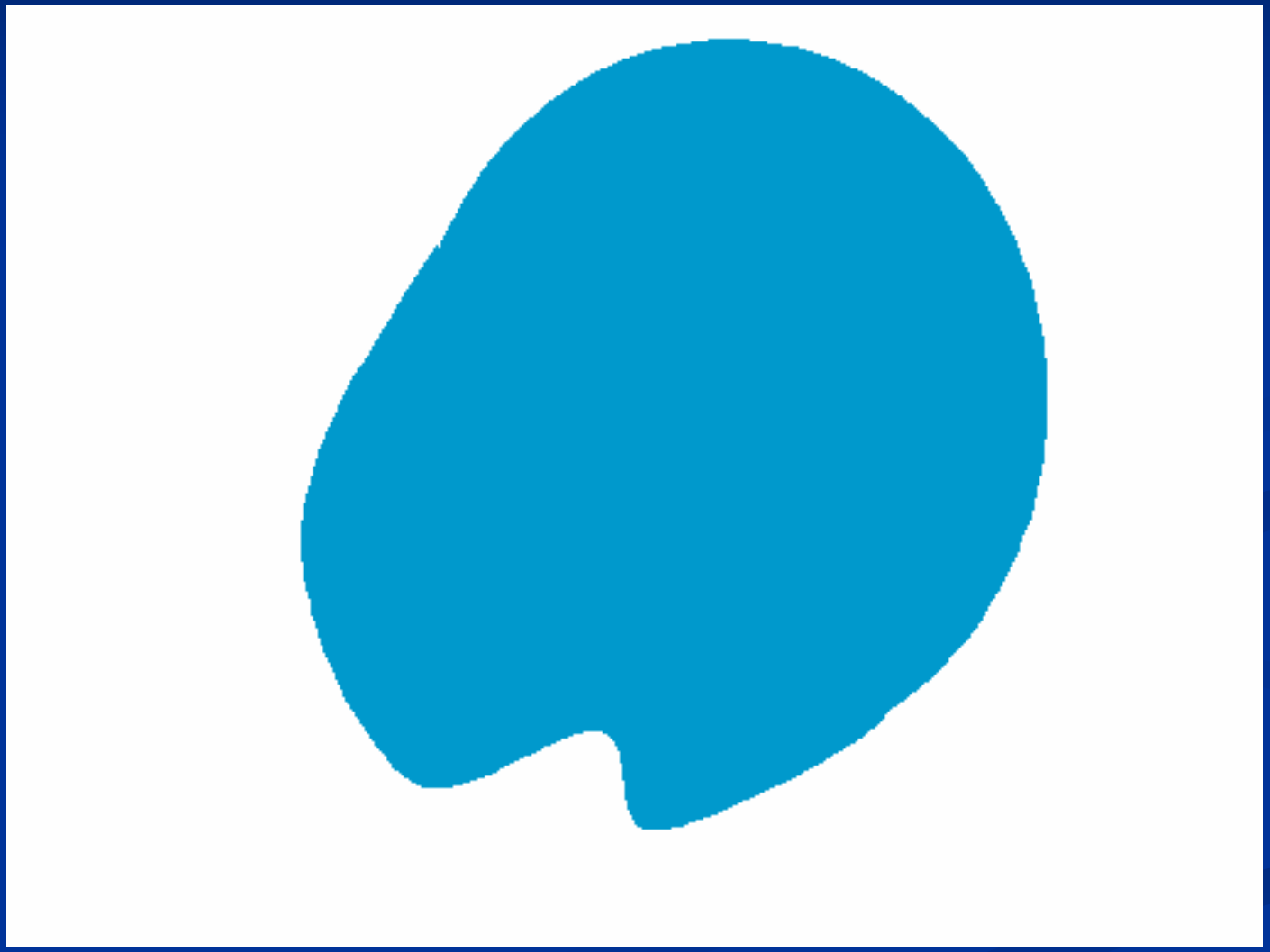
- Weaker predictors of Avascular necrosis
  - 4 part (0.67)
  - >45° head angulation (0.62)
  - Tuberosities displaced >1cm
  - Head split (0.5)

A three-dimensional classification for fractures of the proximal humerus
Edelson G, Kelly I, Vigder F, Reis ND. 2004

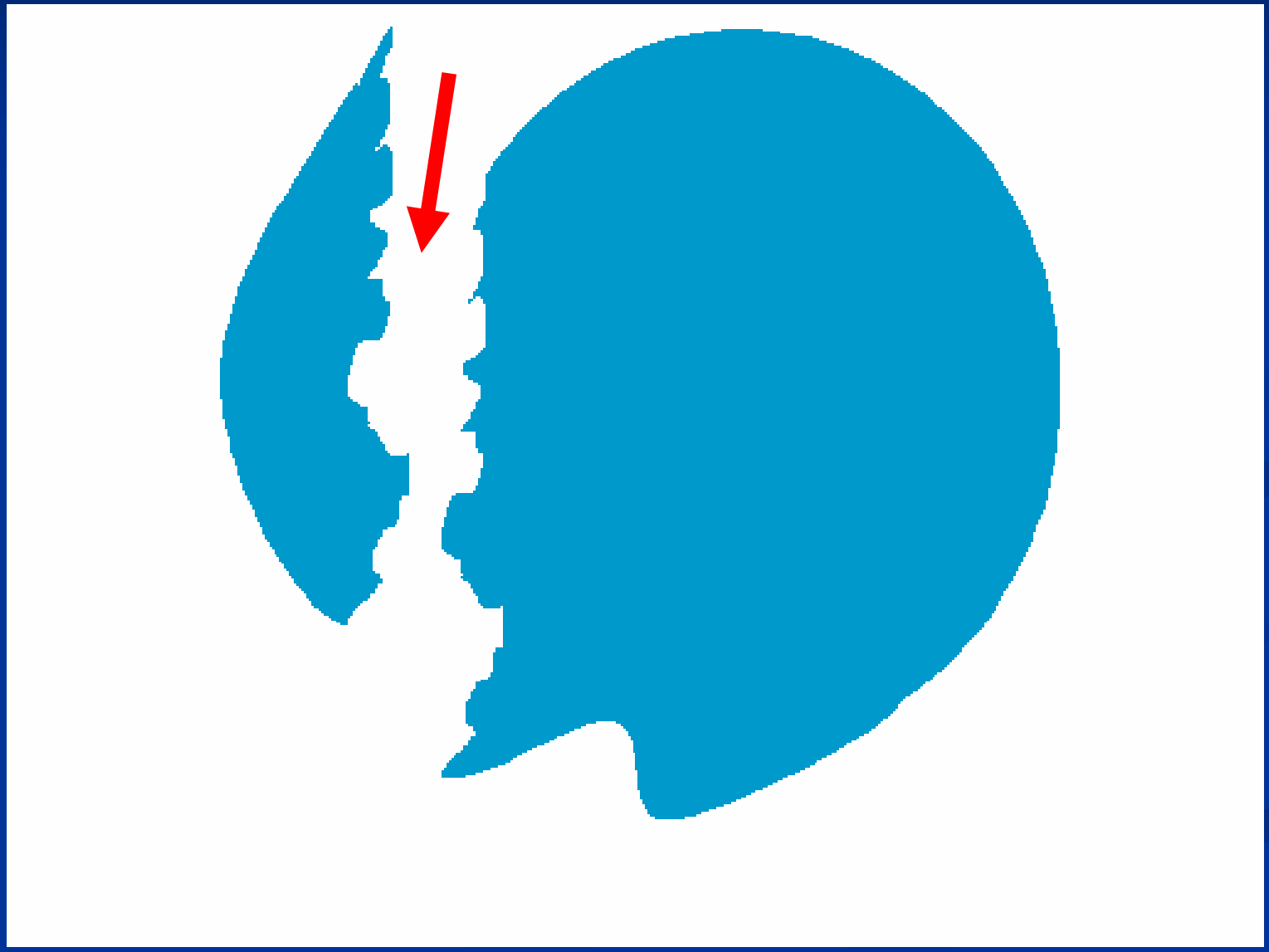
Position of head fragment	2-Part (Surgical neck)	3-Part (Surgical neck and Greater tuberosity)	"Shield" Fracture
Varus			
Valgus			
Neutral			

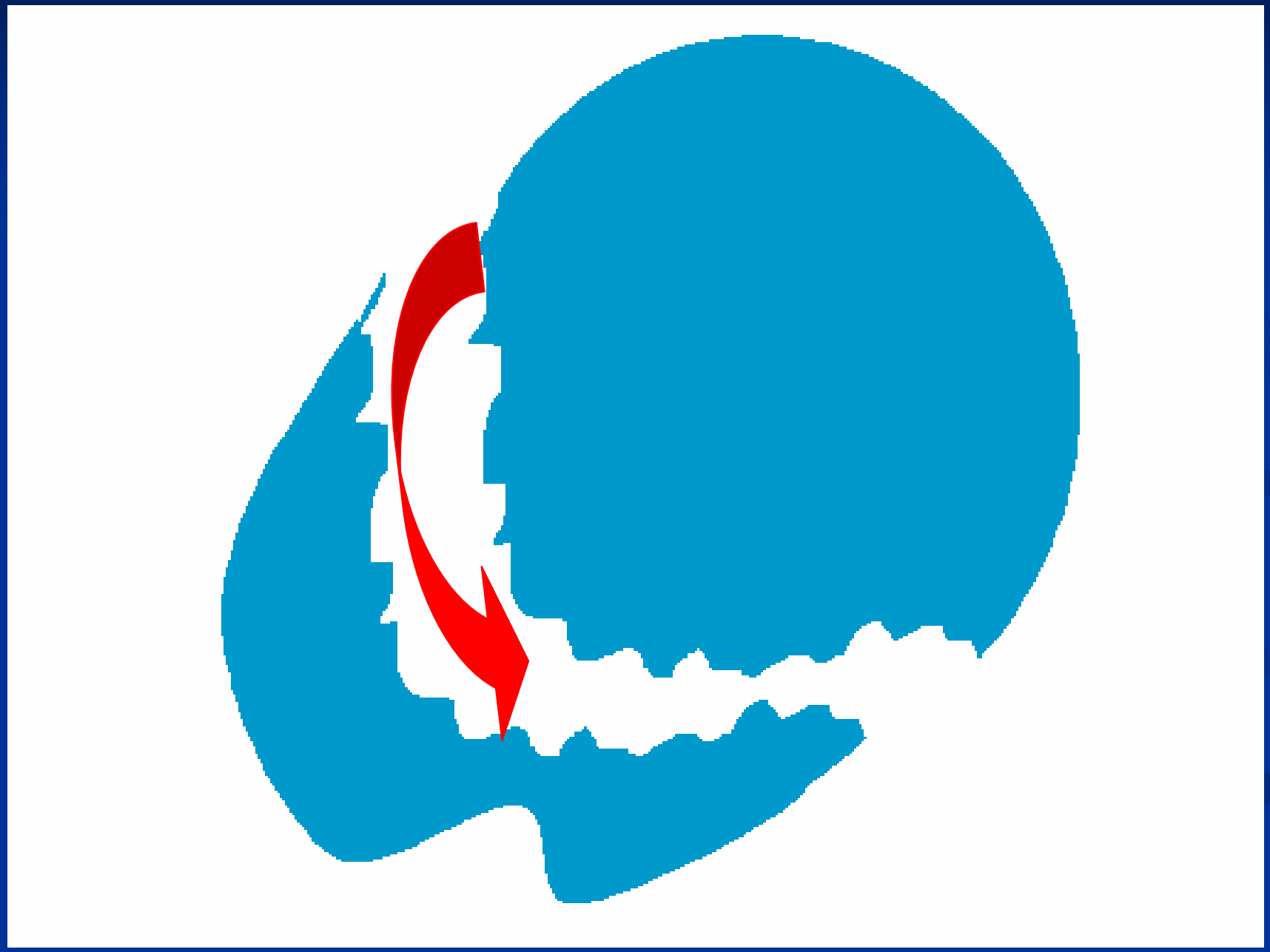
- Isolated Tuberosity Fractures and dislocations classified separately
- 3D CT
- Better inter-observer agreement

Axial View

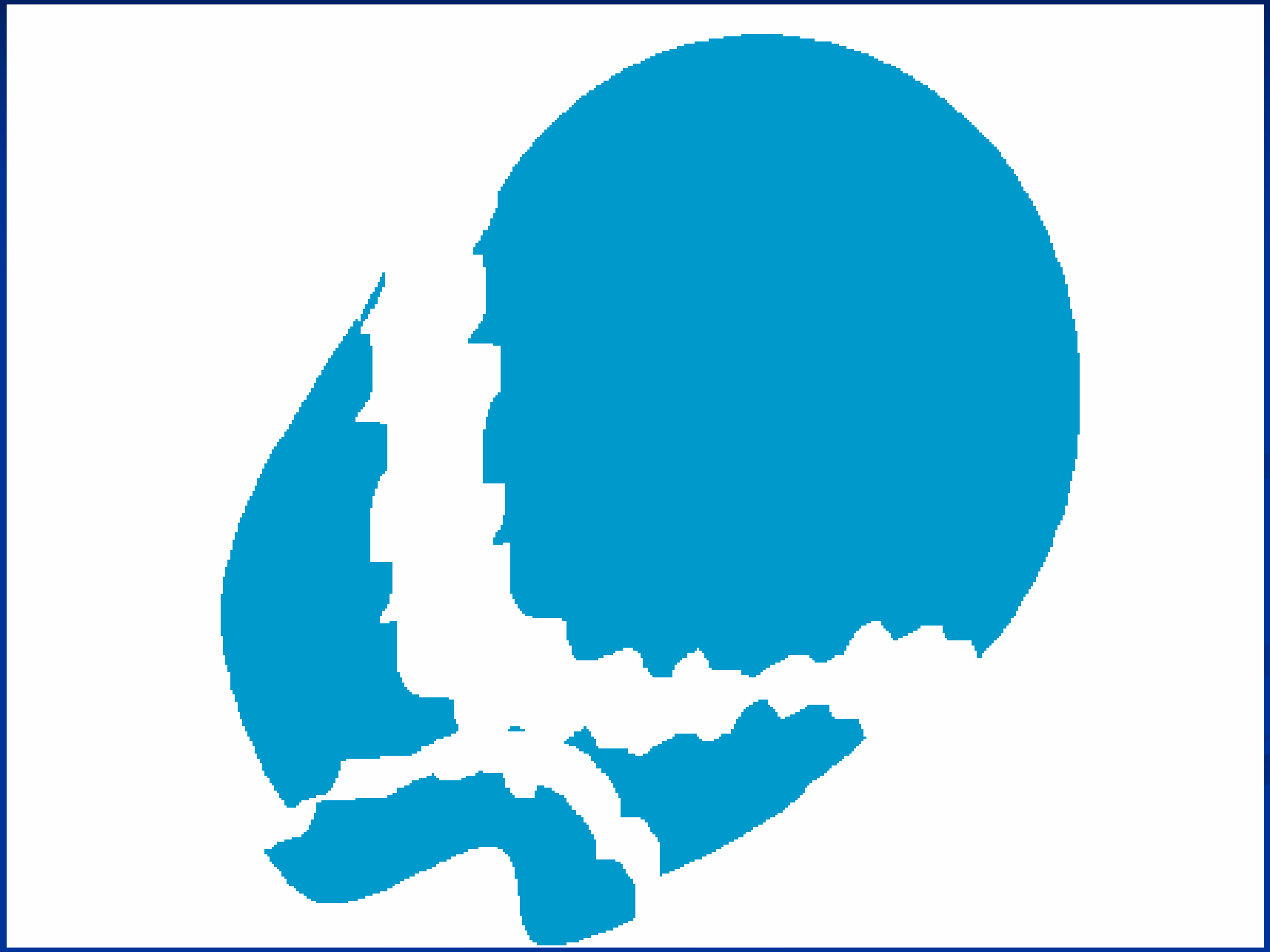


3 Part Fracture





“Shield Fracture”



Varus- 2 part

Valgus-3part

Varus-Shield

2: Non-Operative Management

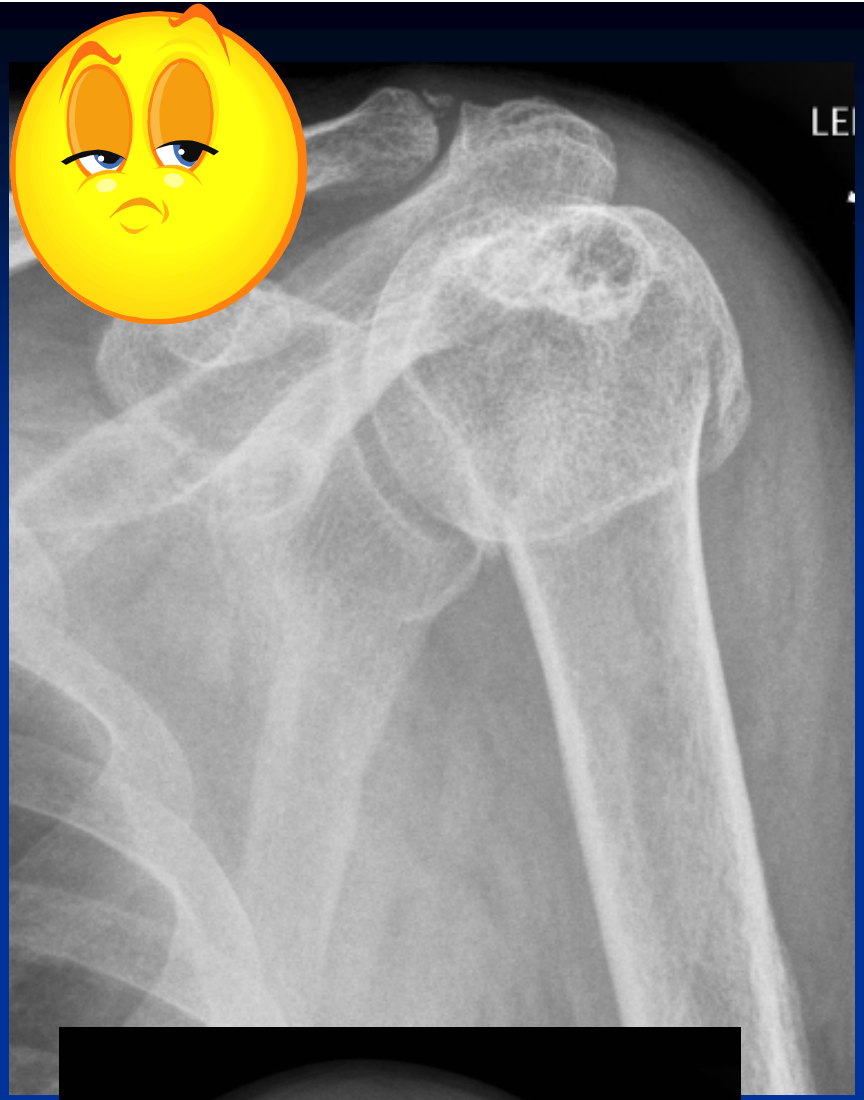
1. Neer's **classification** has never been found to be reproducible
2. **Neer did not measure the outcome in the non-operative group**
3. Neer's **ORIF methods** are now outdated
4. Neer was **technically** very good with **hemiarthroplasties!**

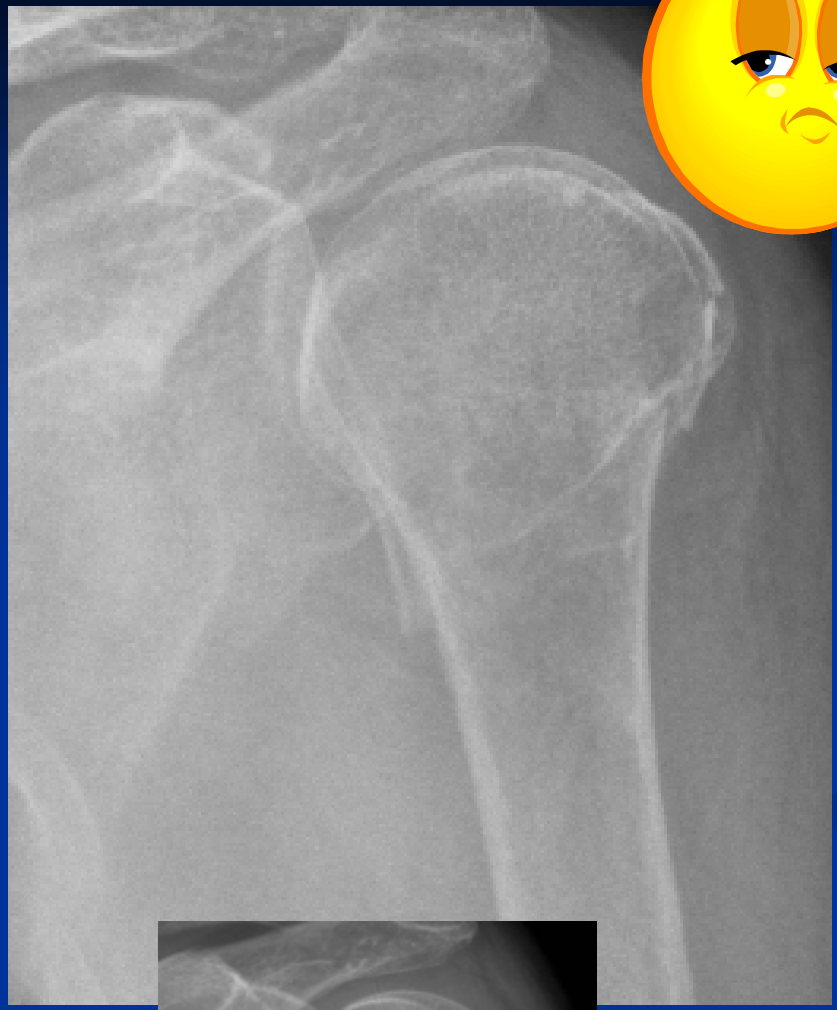
Non-Operative Management

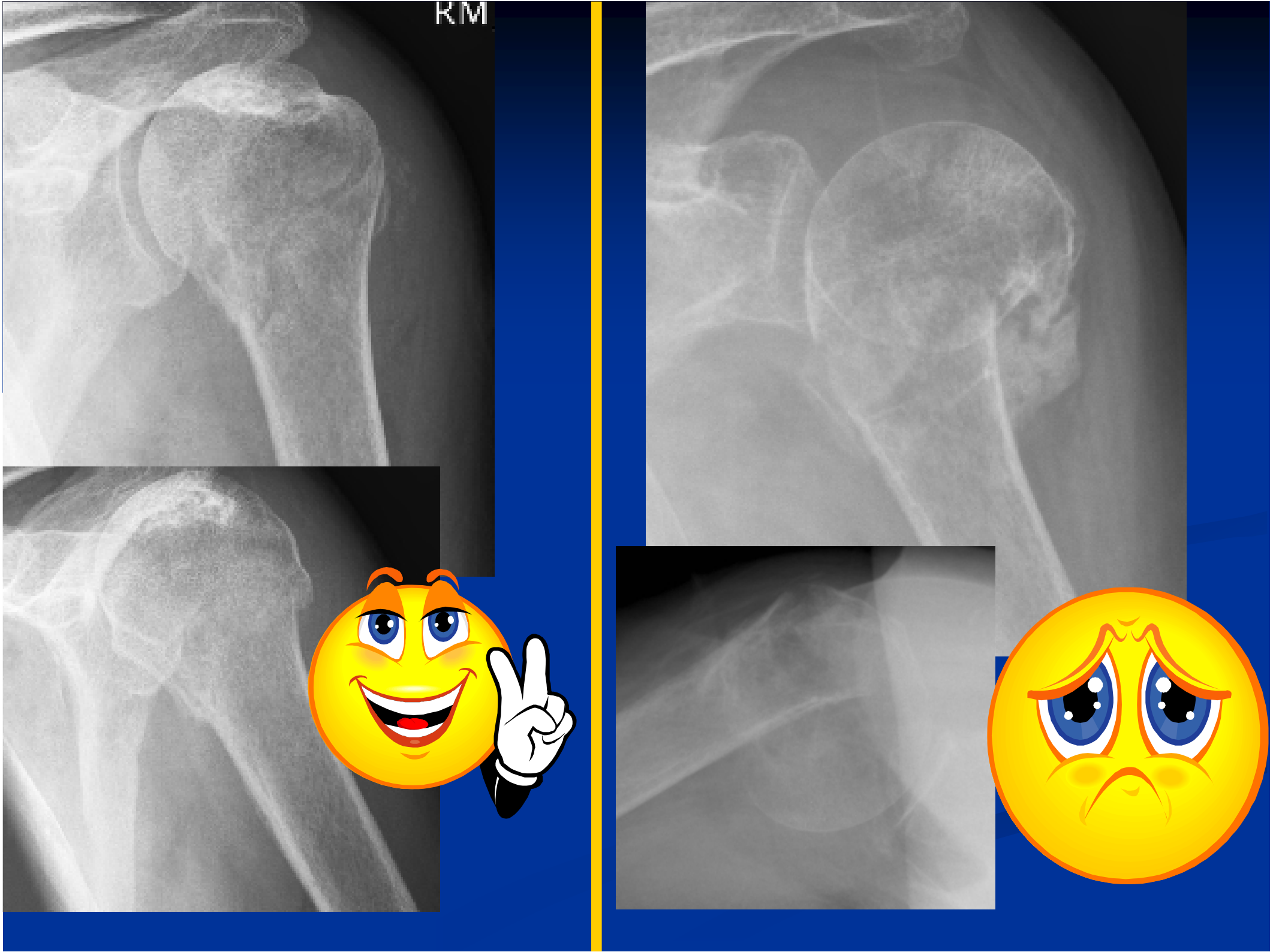
- Sling and early mobilization
- No role for casts or splints
- Fracture Types:
  - "minimally displaced fracture"
  - Valgus impacted
  - 2-part
  - Complex

Non-operative treatment: 1: Minimally displaced fractures


LEFT






RM

Non-operative treatment: 1: Minimally displaced fractures

- Surprisingly very few studies published
- Taken for granted that "do well"

- Hodgson et al, 2007:
  - Prospective randomized study
  - Neer 1 group
  - Immediate physiotherapy vs 3 week initial immobilization

Non-operative treatment: 1: Minimally displaced fractures

	Immediate physiotherapy		3 week initial immobilization	
Croft disability index	At 1 year	At 2 years	At 1 year	At 2 years
0	57.2%		27.5%	
1-4	11.9%		30.0%	
>4	30.9%		42.5%	

Hodgson et al 2007. JSES 16, 143-145

Non-operative treatment: 1: Minimally displaced fractures

	Immediate physiotherapy		3 week initial immobilization	
Croft disability index	At 1 year	At 2 years	At 1 year	At 2 years
0	57.2%	56.8%	27.5%	40.5%
1-4	11.9%	10.8%	30.0%	24.3%
>4	30.9%	32.4%	42.5%	35.2%

Hodgson et al 2007. JSES 16, 143-145

Non-operative treatment: 2: "The Translated 2-Part Fracture"

Court-Brown et al 2001. JBJS Br 83, 799-804

- Prospective
- 126 patients
- Most had satisfactory results
- Unsatisfactory outcome if:
  - Age>79
  - Displacement>66%

Non-operative treatment: 3: Valgus impacted fractures

- Lower rate AVN, better outcome than other 4 part #
- 80% good/excellent results non-operativelly
  - Jakob et al 1991 JBJS 73B 295-8
  - Court-Brownet al 2002 JBJS 84 B 504-508

Non-operative treatment: 4: Complex fractures

- Poor outcome generally reported:
- Variable outcome measures!
  - Neer 1970
  - Leyson 1984
  - Stableforth 1984
  - Young & Wallace 1985
  - Zyto 1998
  - Edelson 2008
    - Etc…

"VERY POOR FUNCTION BUT LITTLE PAIN, PARTICULARLY IN THE ELDERLY"


L
SG

3: Modern Methods of Internal Fixation

- Achieve **stable reduction**
- Adequate Fixation
- Early rehabilitation

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Fixation Methods…

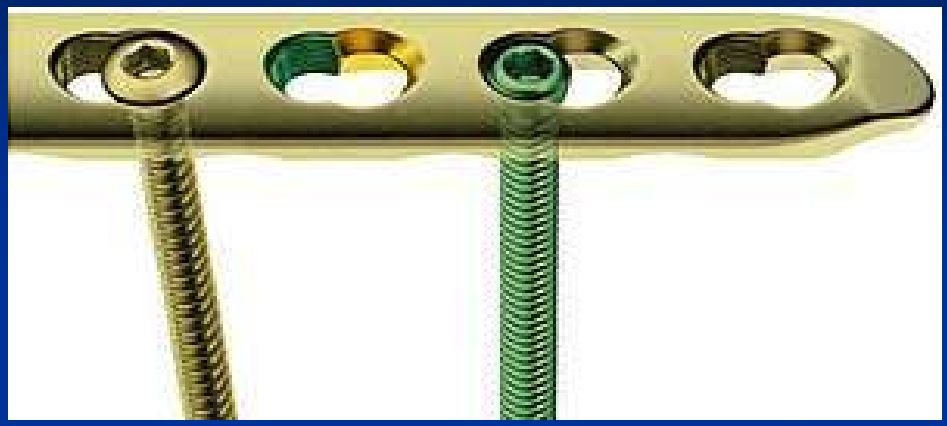
- MUA + sling / bandage
- Percutaneous K-wires
- External fixation
- Rush pins
- Rush pins with tension band wiring
- Tension band wiring
- Circlage wiring
- Sutures with k-wiring
- Parachute technique
- Resch fixator
- Suture anchors
- Capstan screw technique
- Compression screws
- Compression screw with tension band
- Plant tan humeral fixator
- Polarus nail
- Zimmer locking nail
- AO nail
- Russell Taylor humeral nail
- Condylo cephalic nail
- Flexible humeral nails
- Halder humeral nail
- Seidel nail
- AO clover plate
- AO T-plate
- Blade plate
- Philos plate

Common methods

- Locking Plate fixation
- Proximal humeral nail
- Minimally invasive k-wire/screw fixation

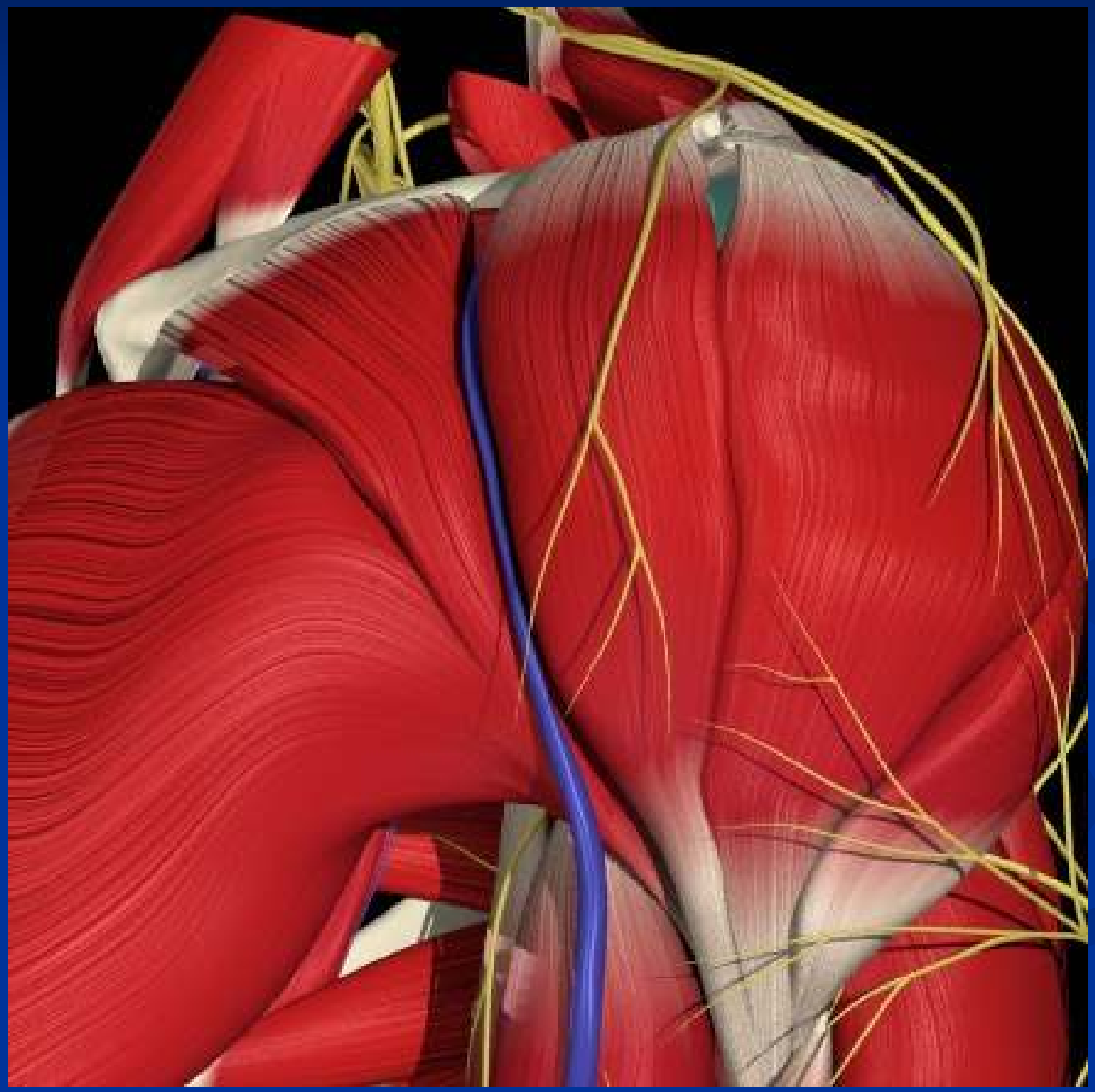
Locking Plate Fixation

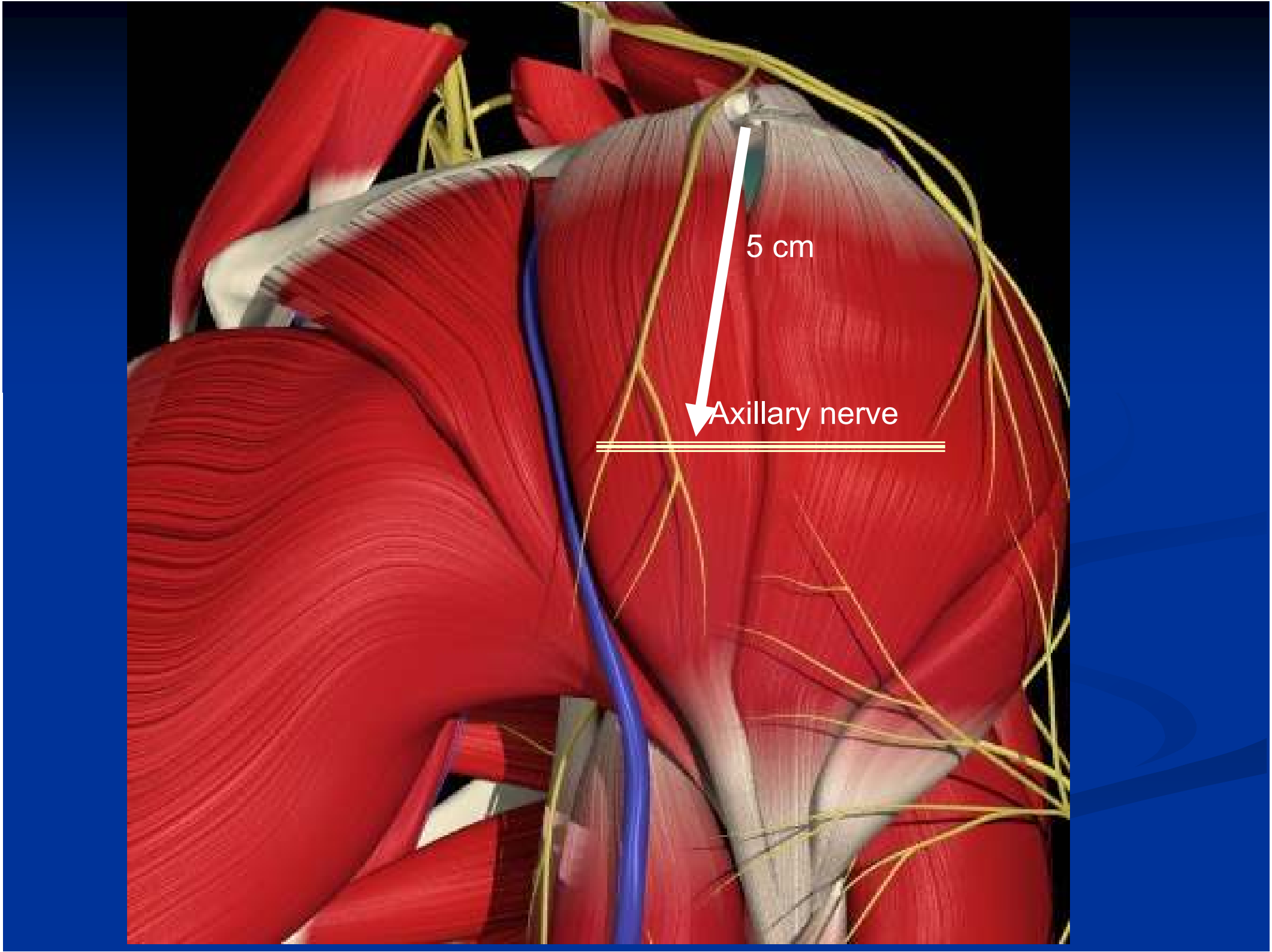
Angular stability

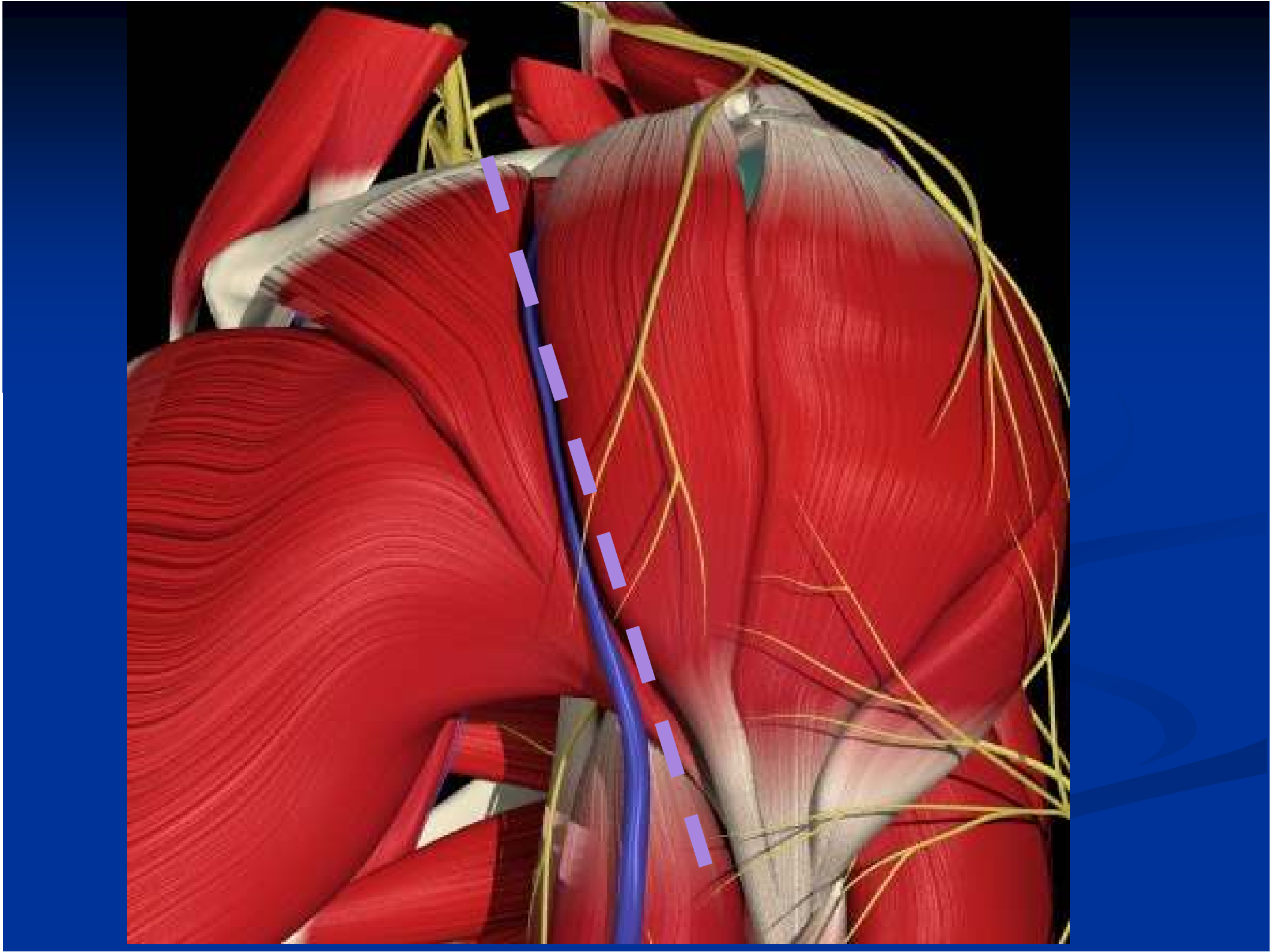


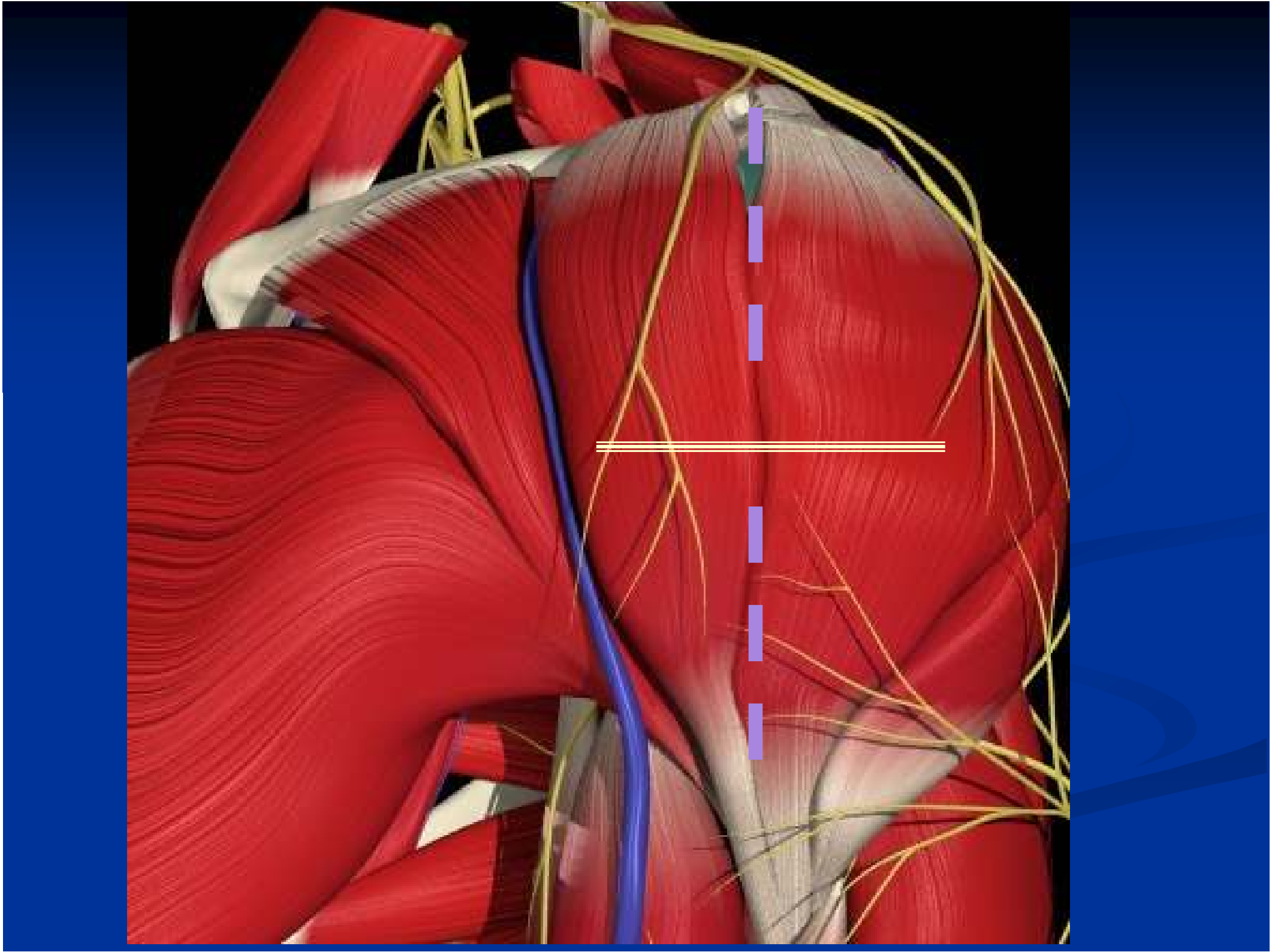
1: Surgical neck: 2 part fracture

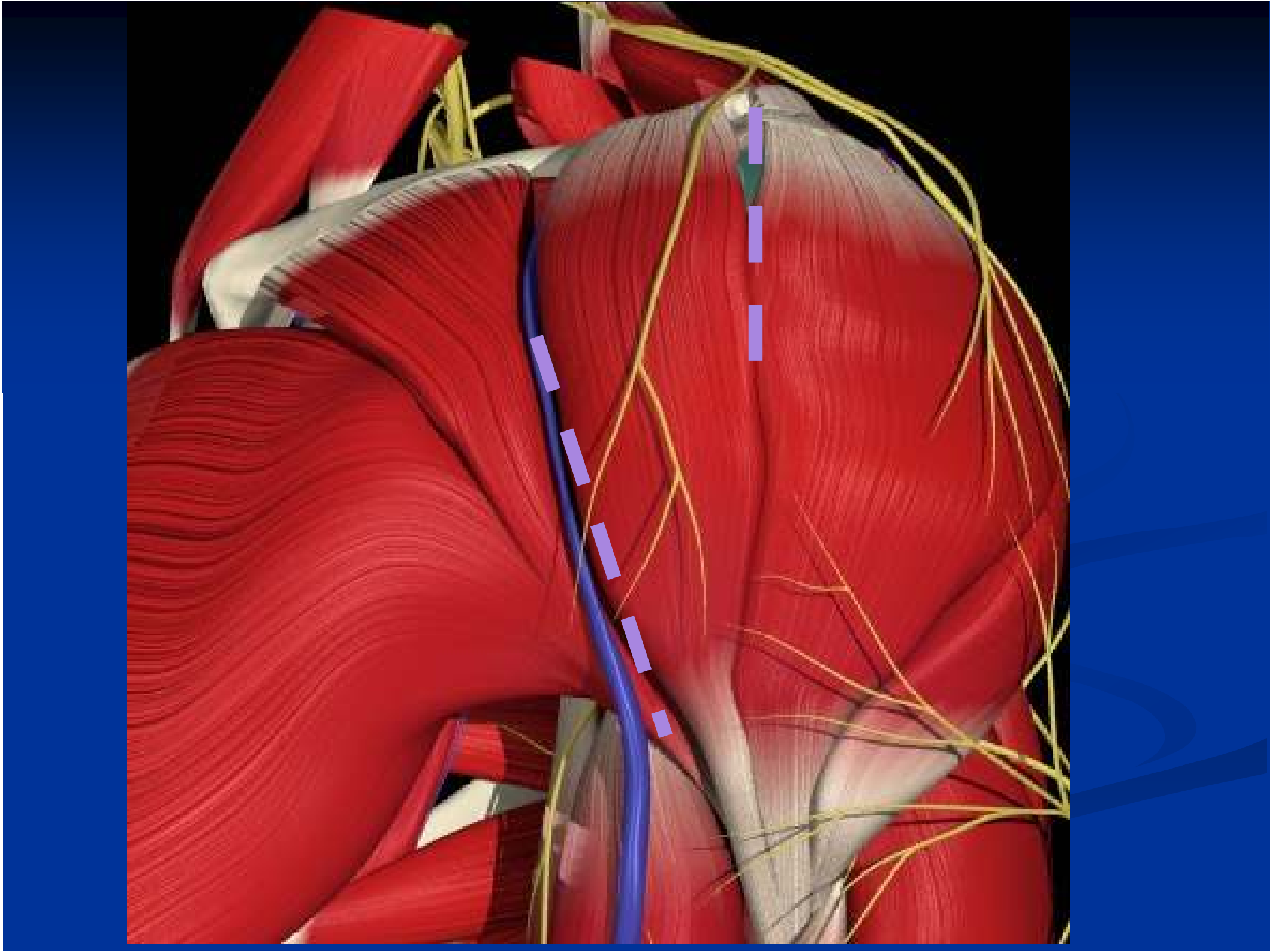
Surgical approaches

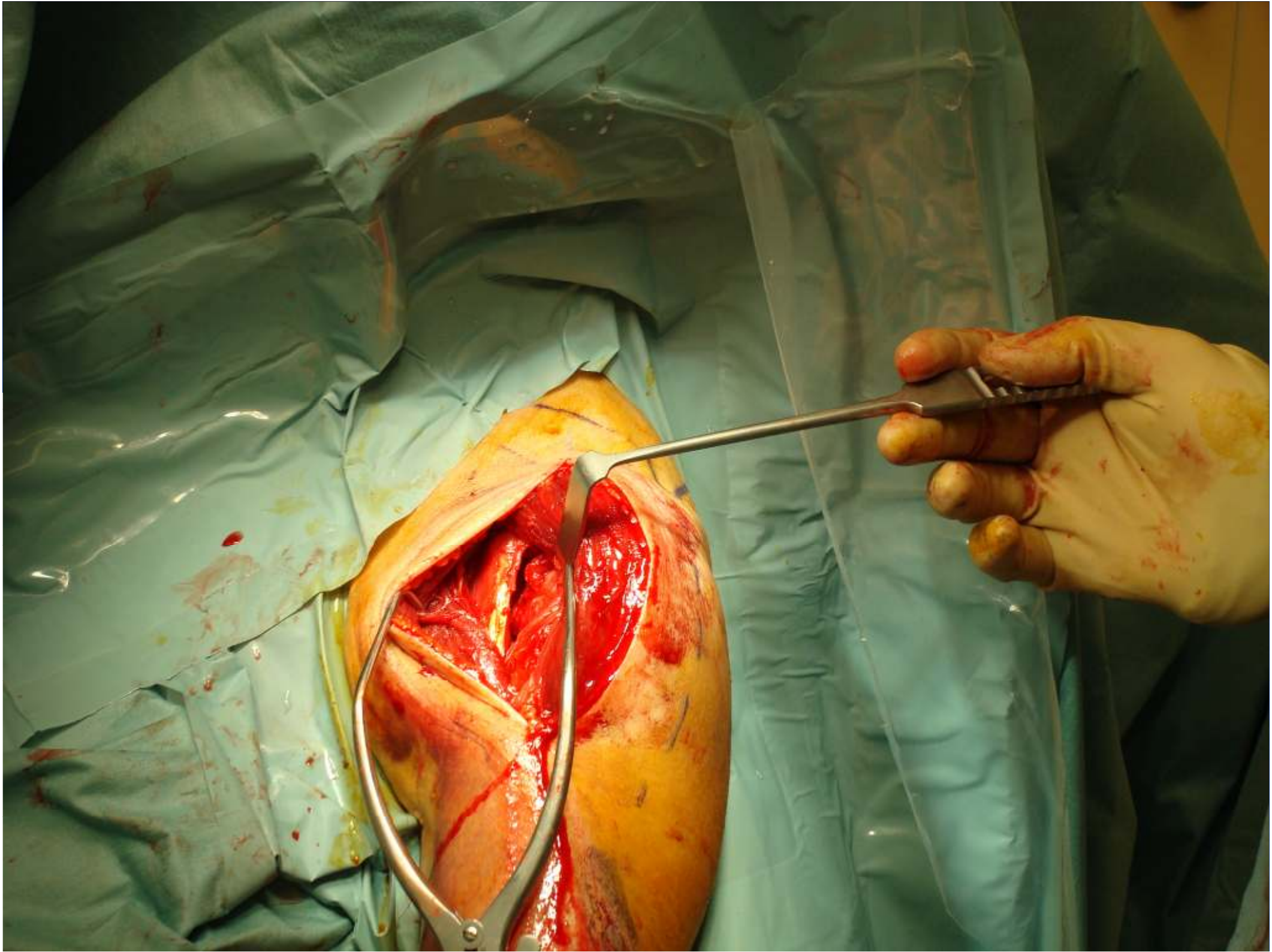


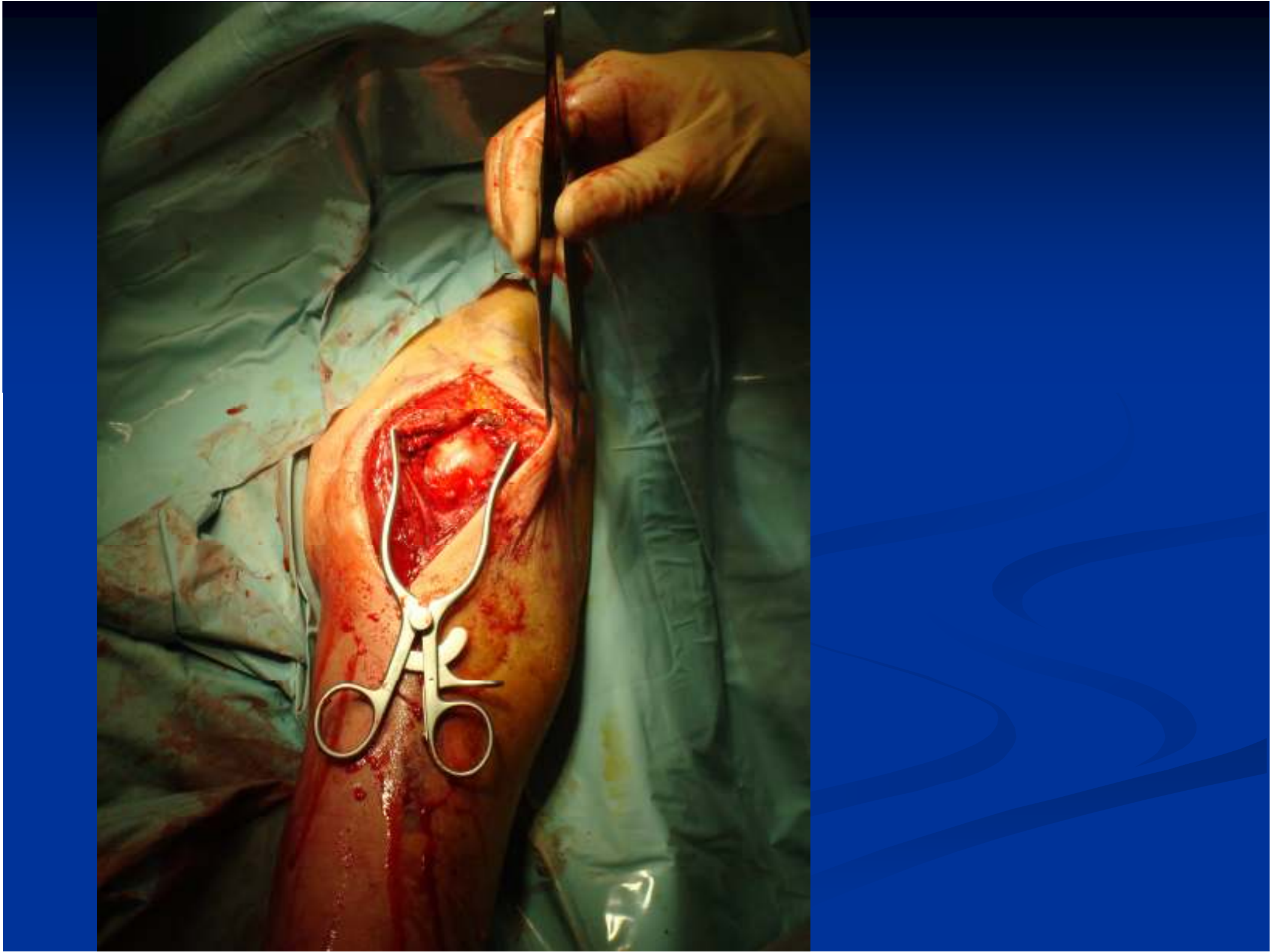

5 cm
Axillary nerve

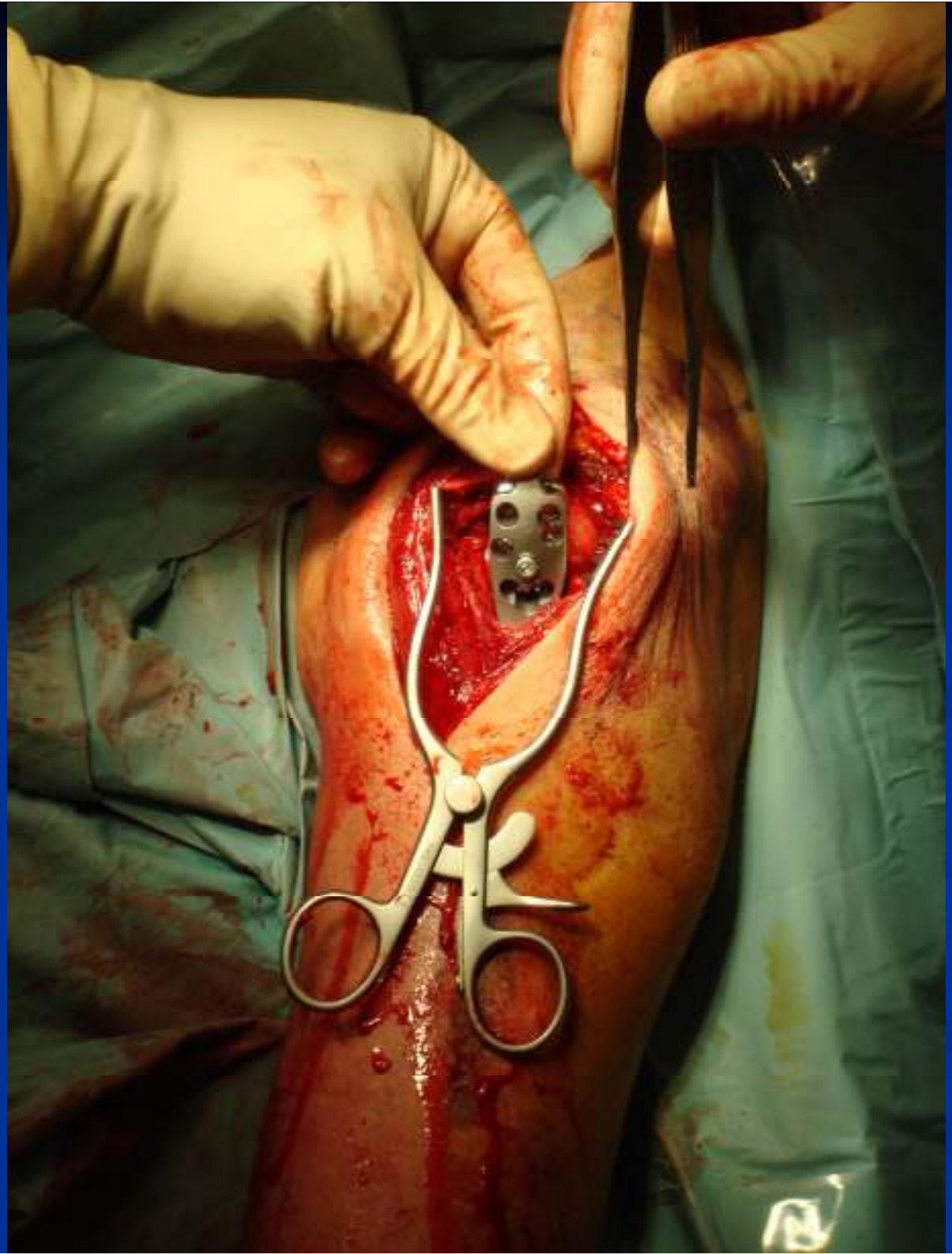


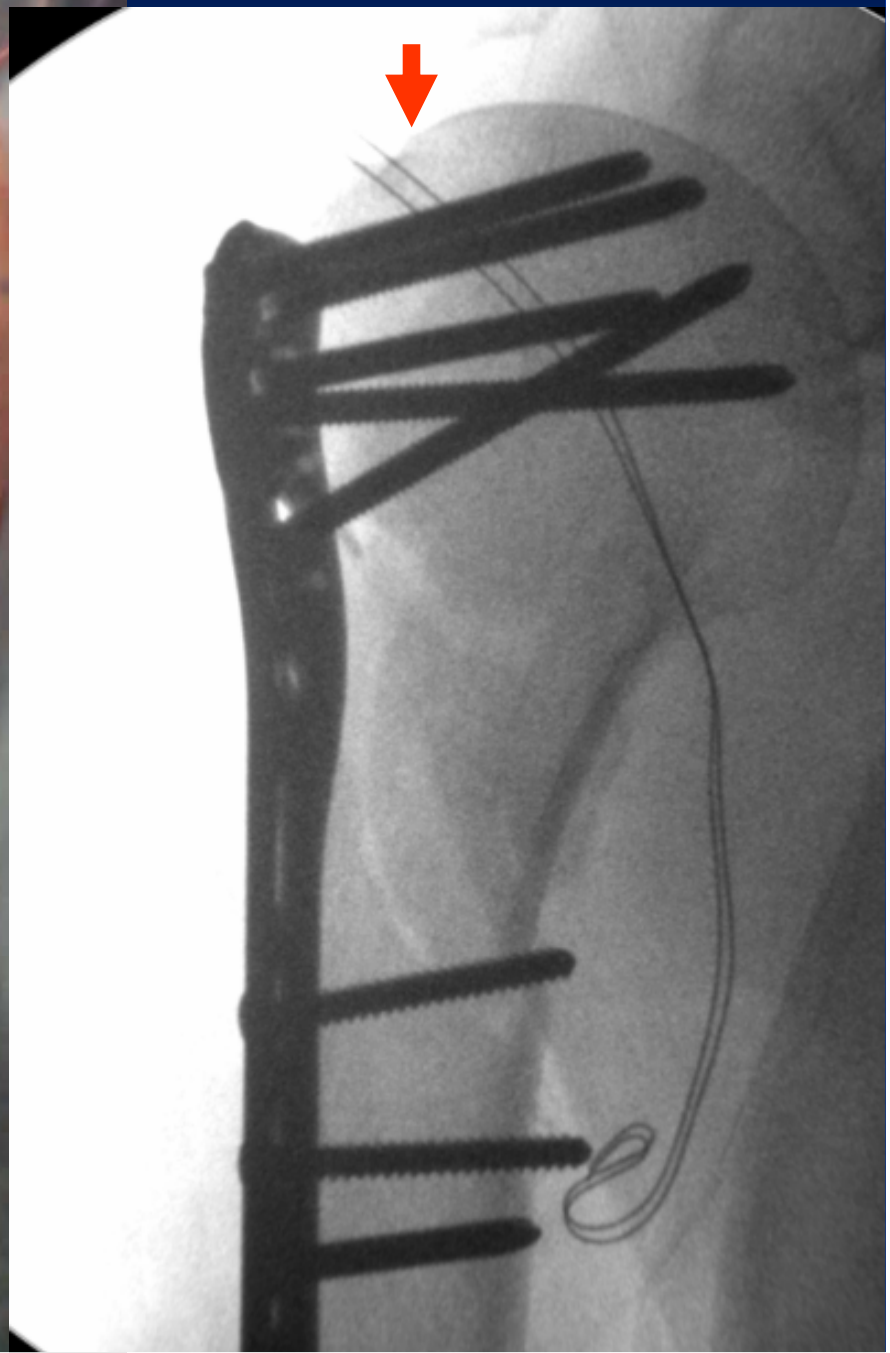


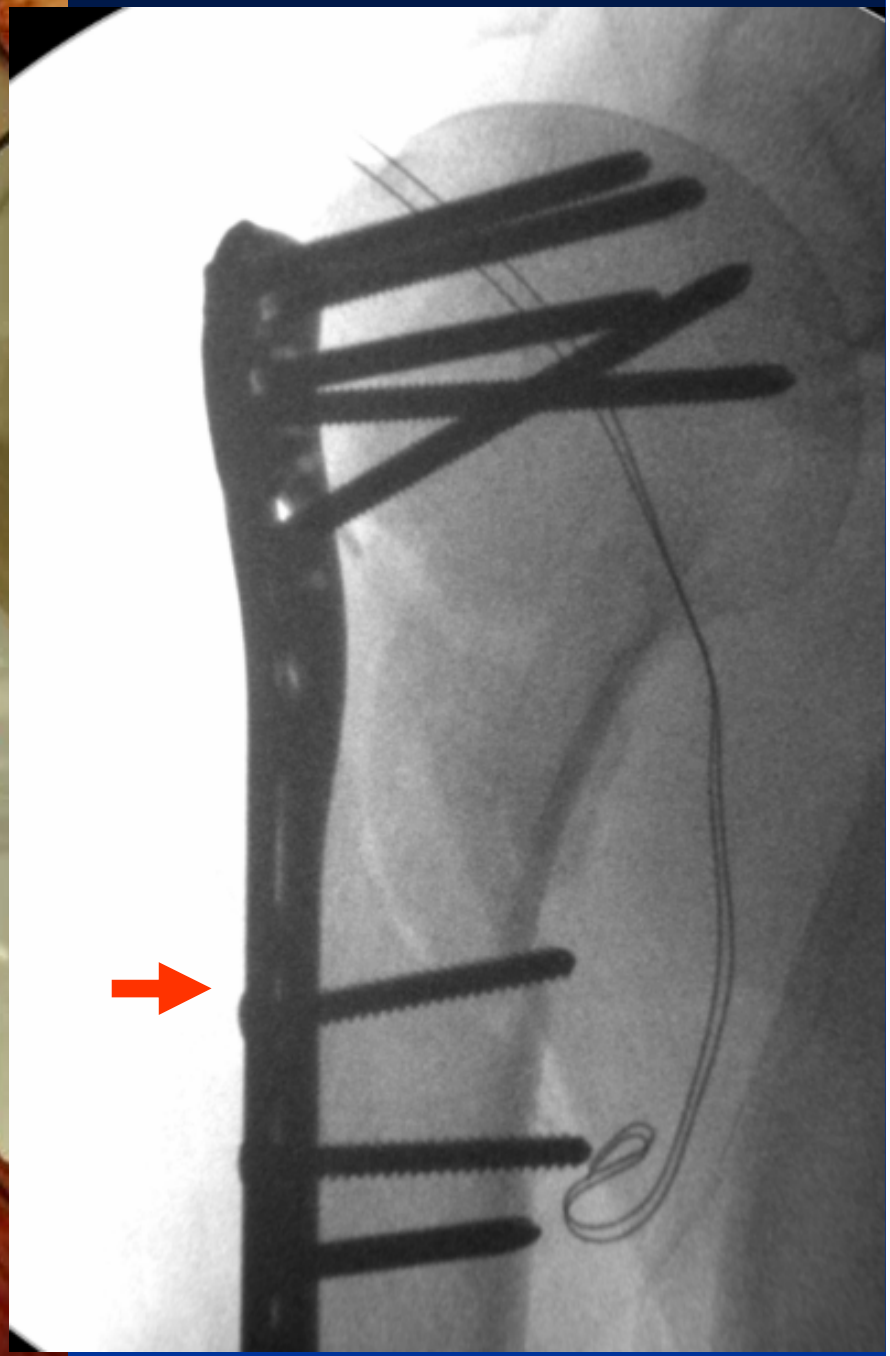


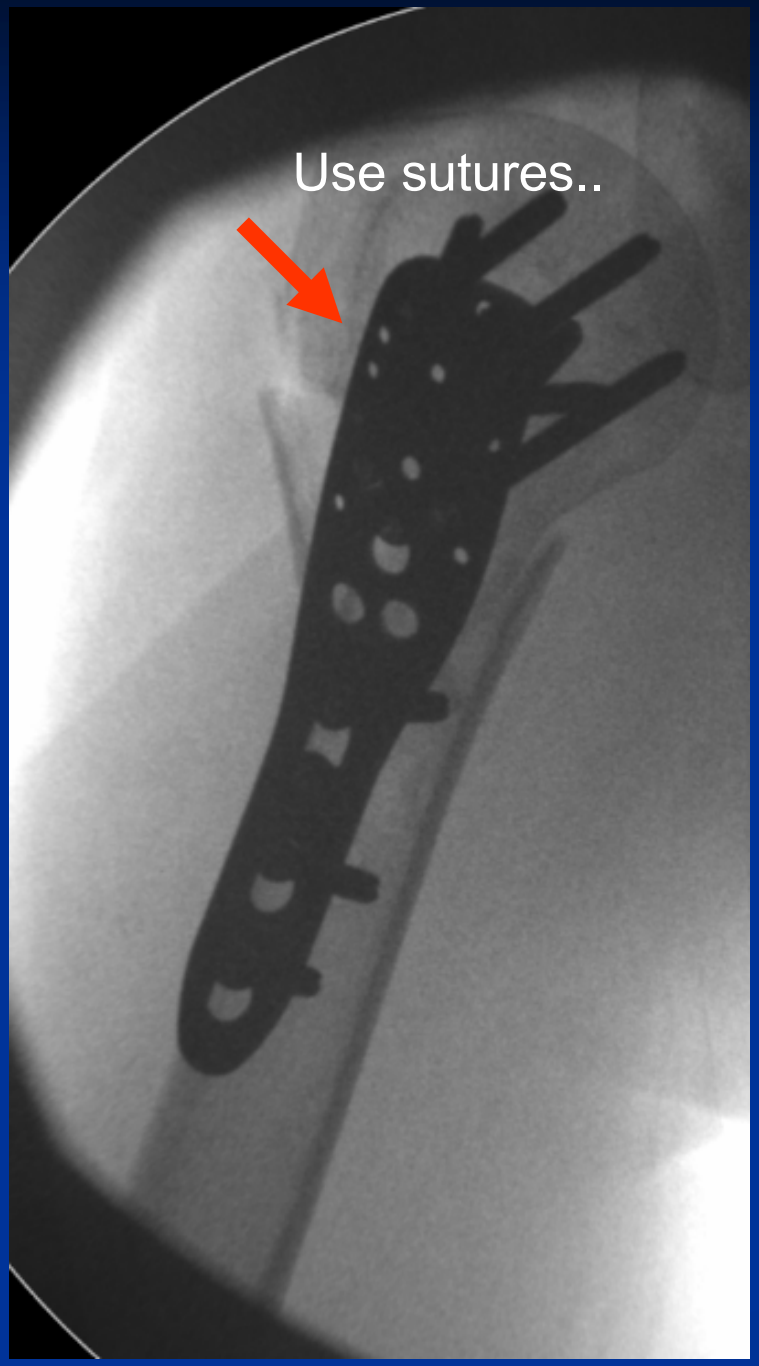


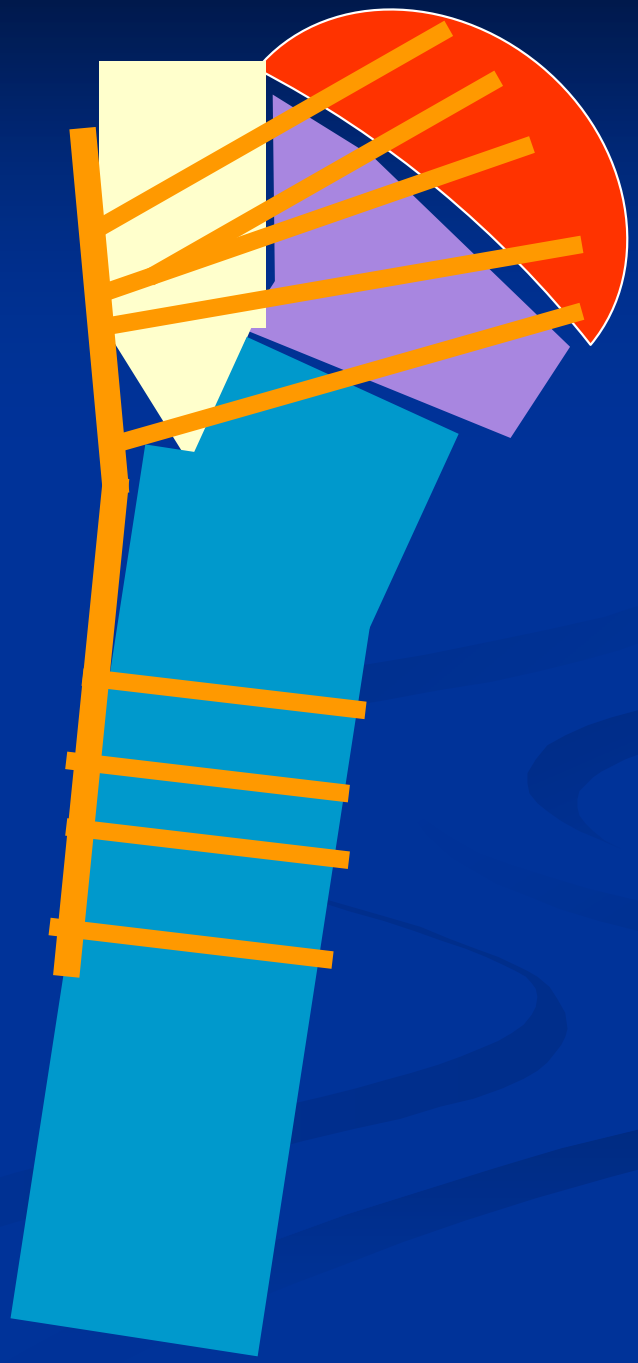






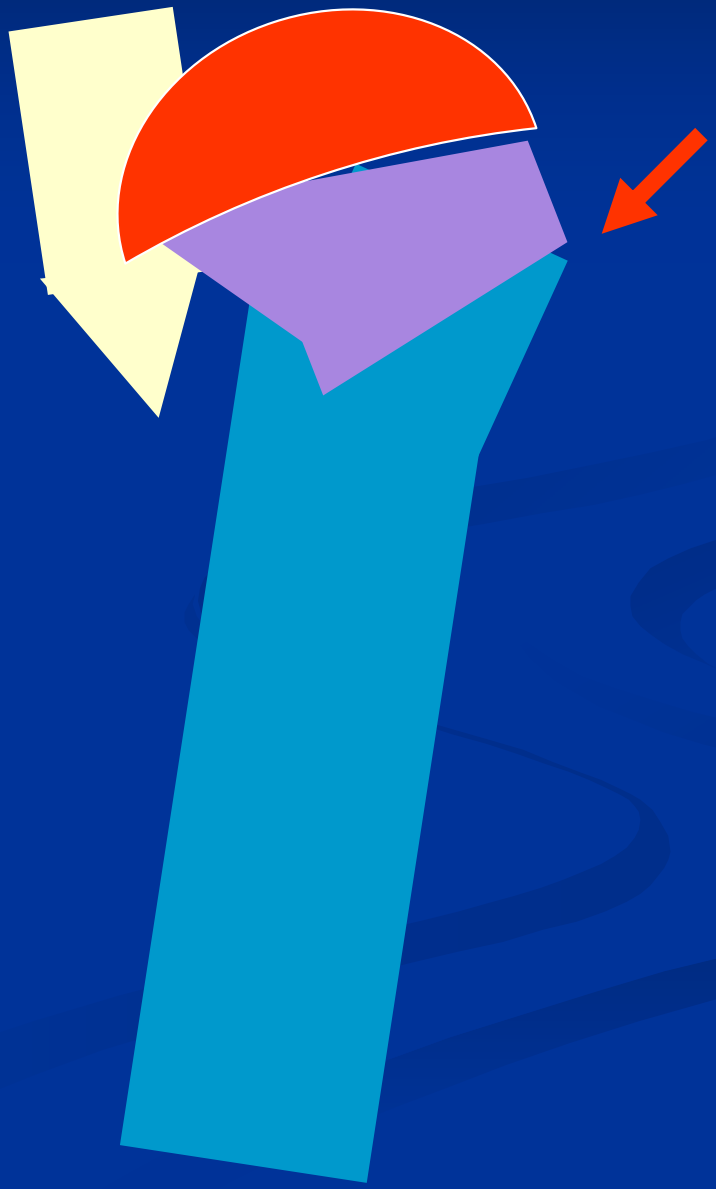



Use sutures..



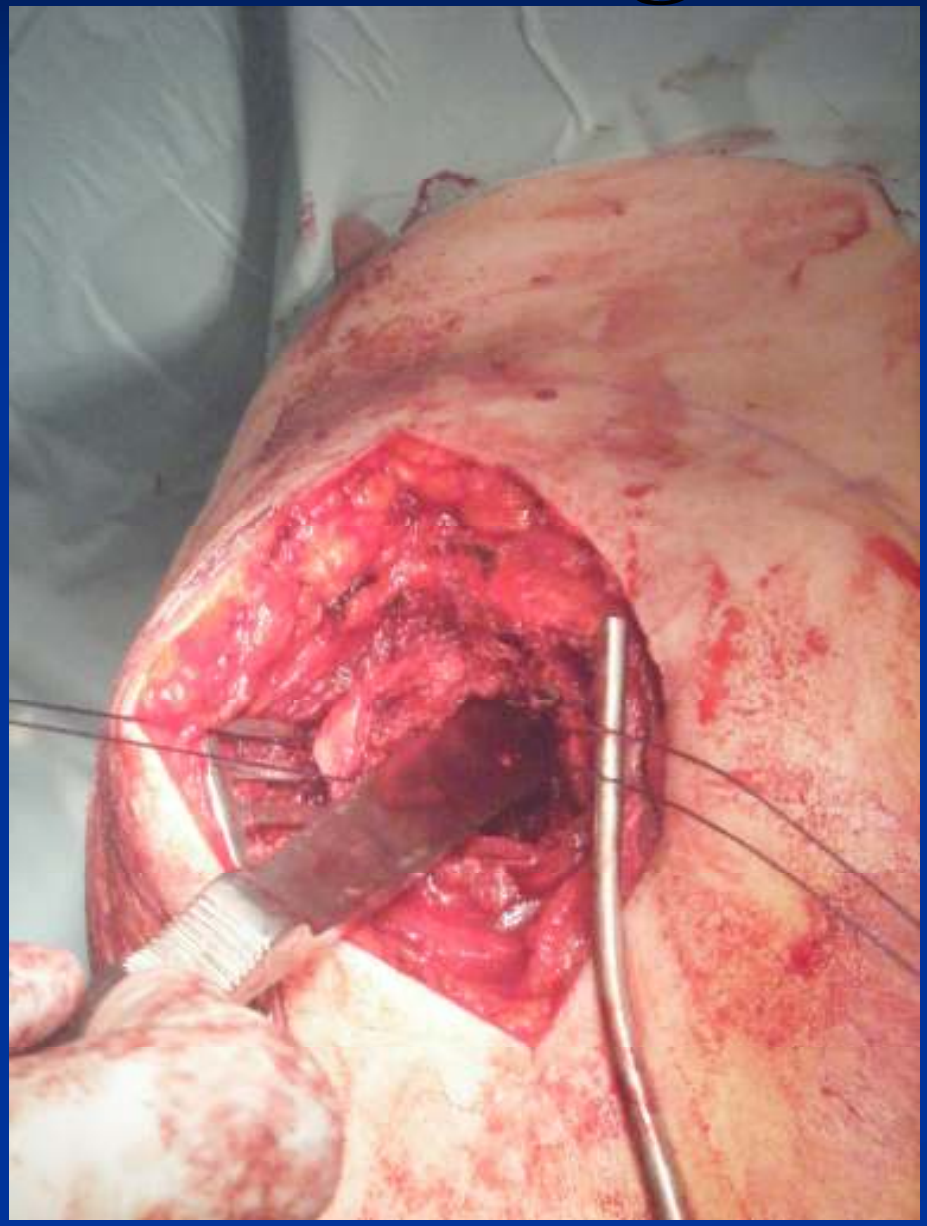

R
NJ

Valgus 3-4 part

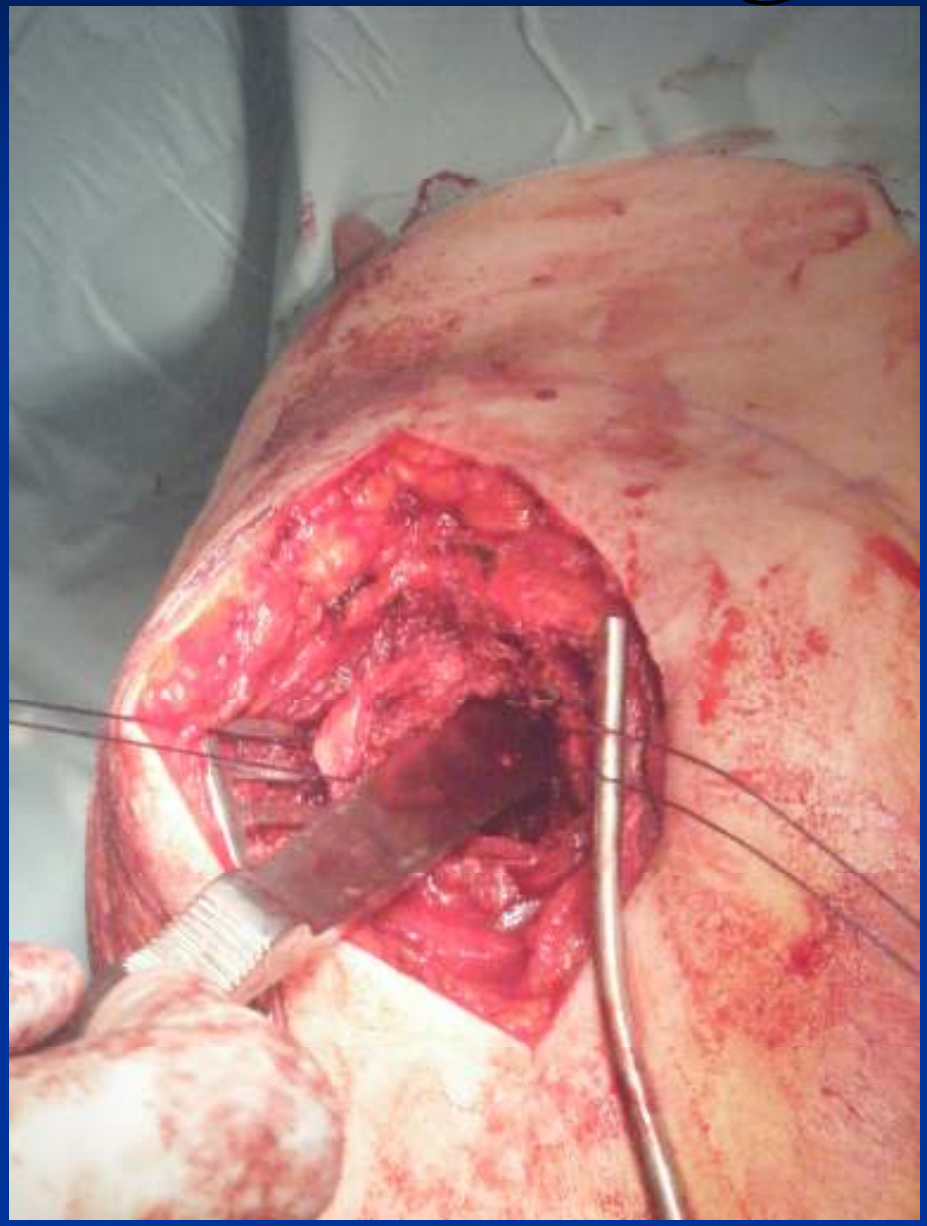


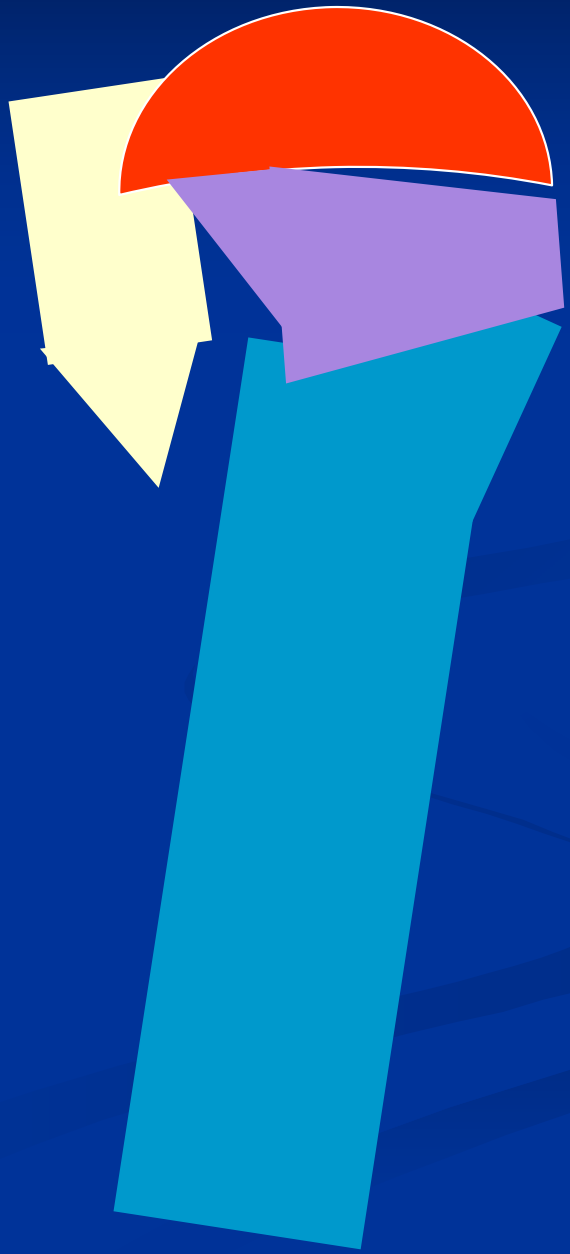
Valgus 3-4 part

Valgus 3-4 part

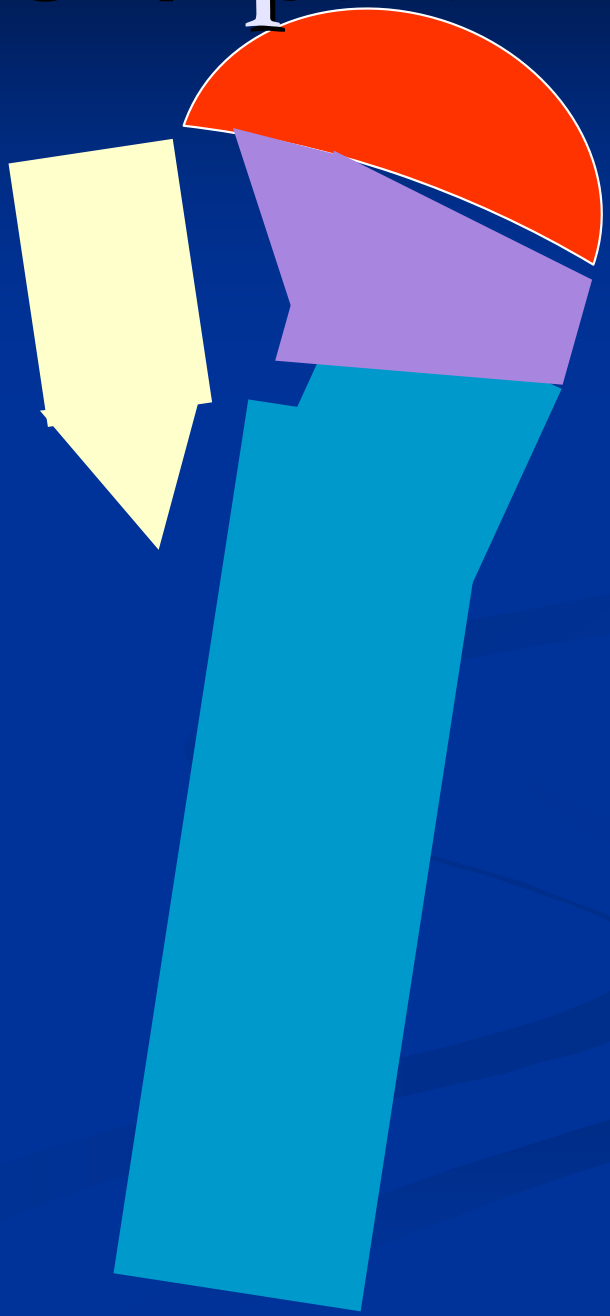


Valgus 3-4 part

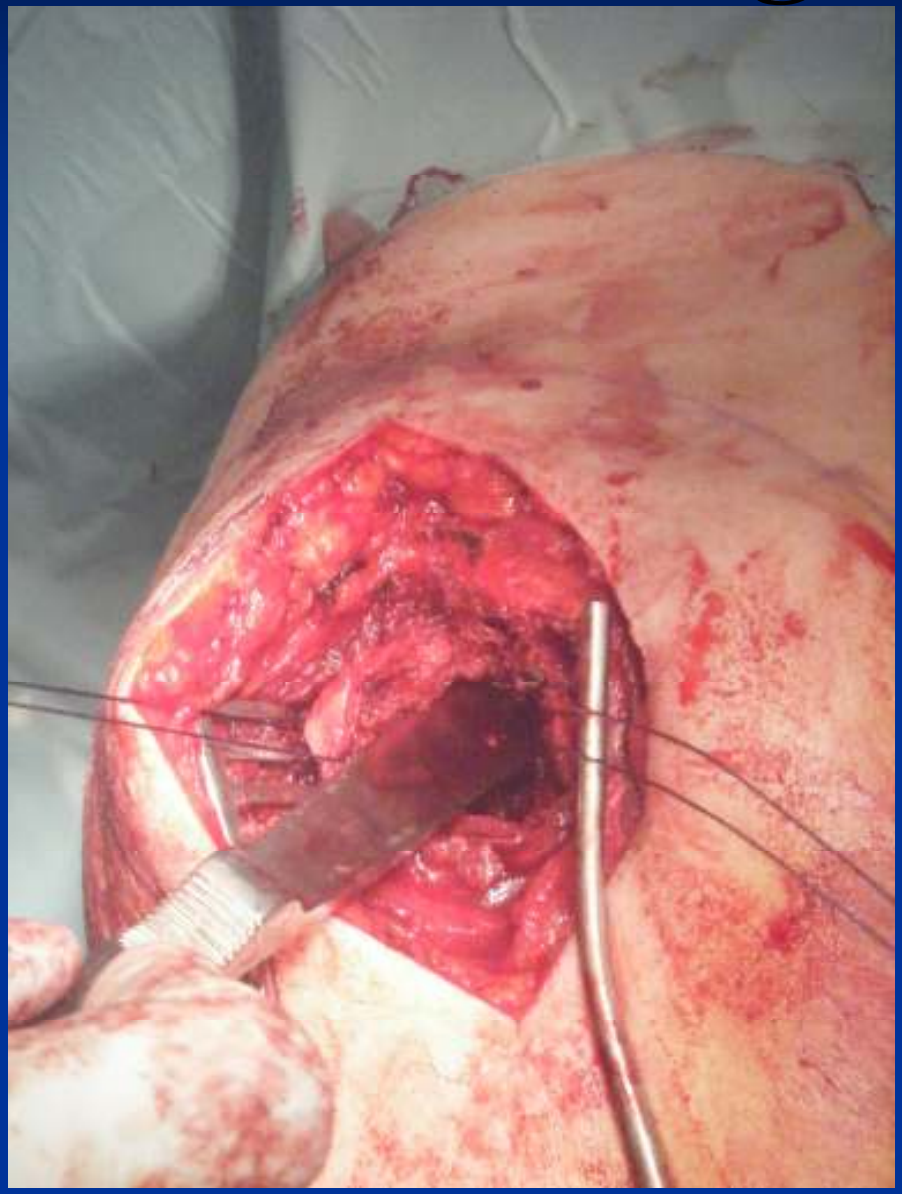




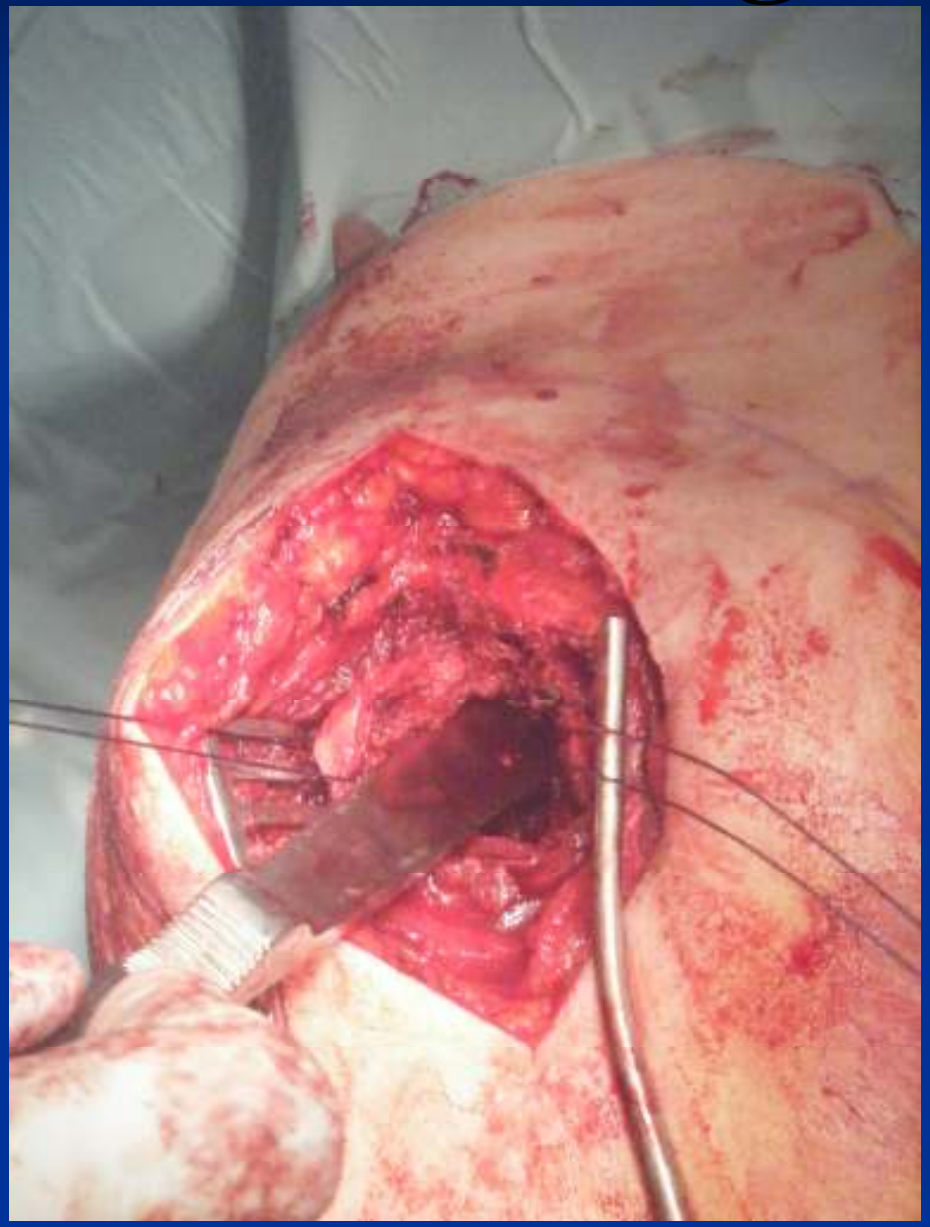
Valgus 3-4 part

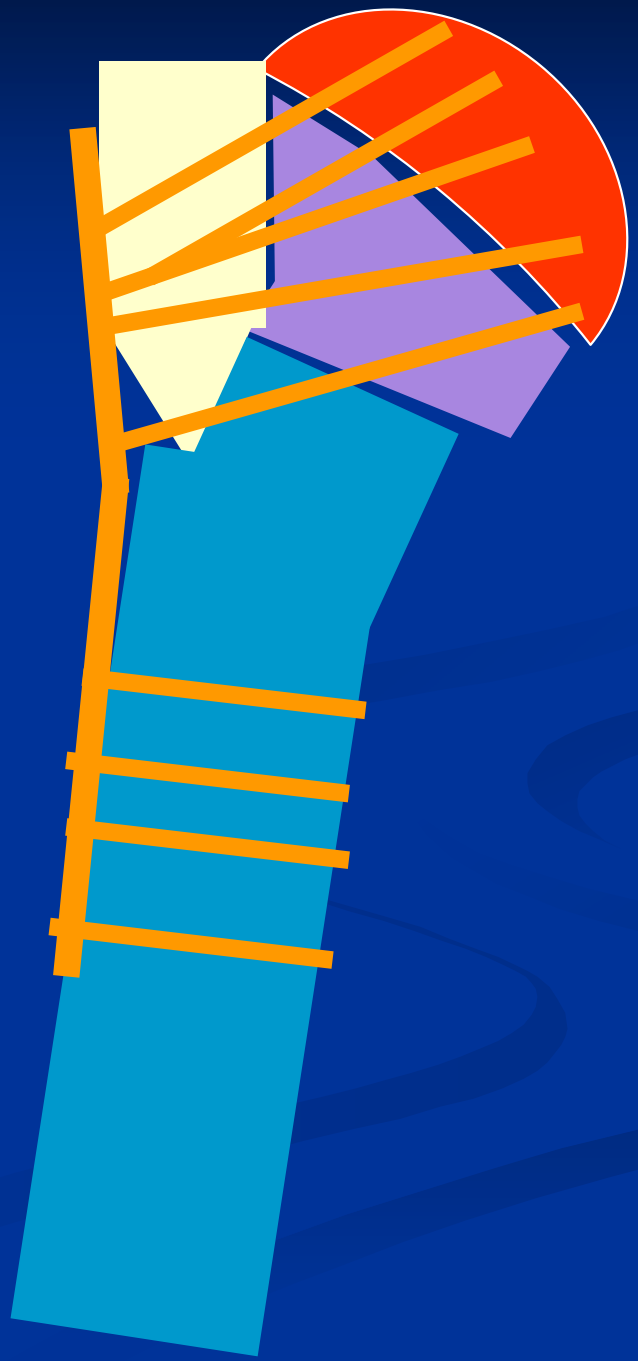


Valgus 3-4 part

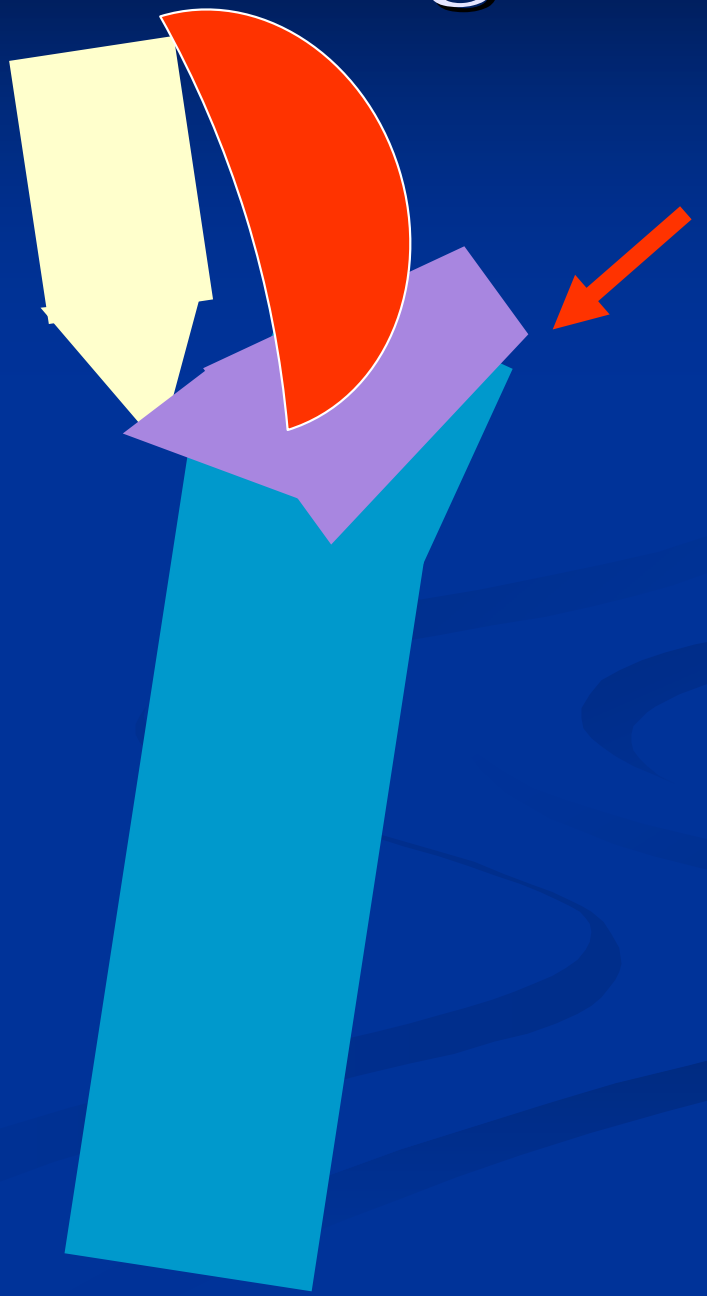


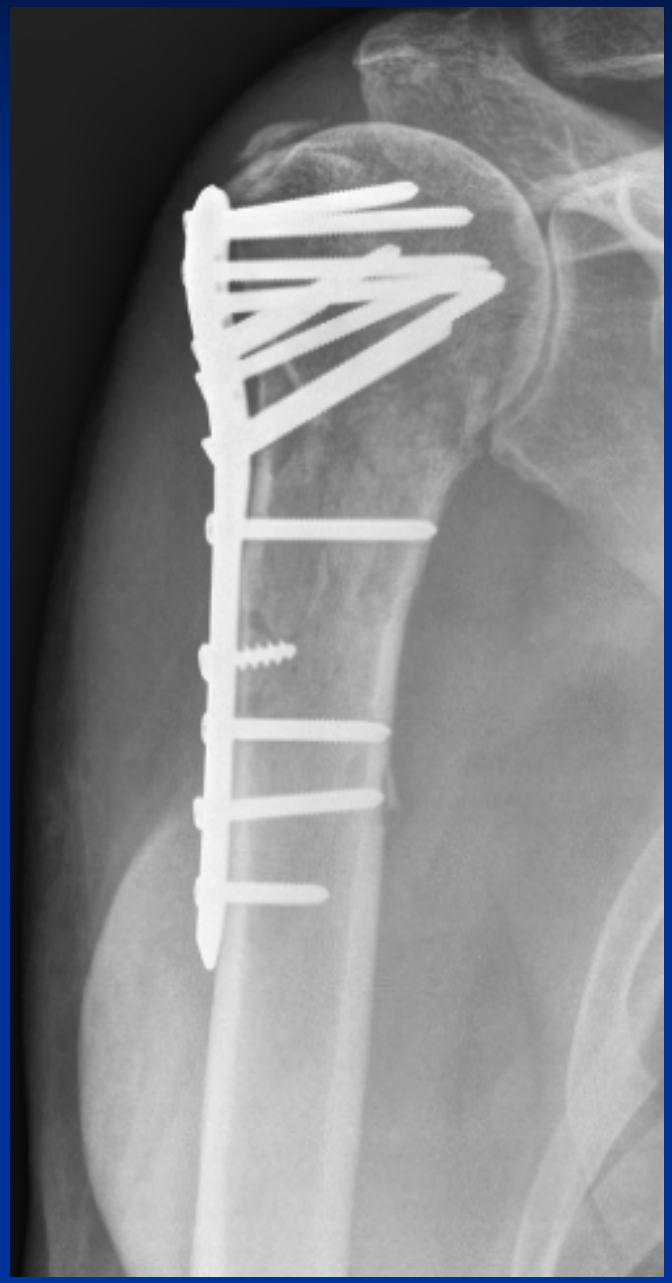
Valgus 3-4 part

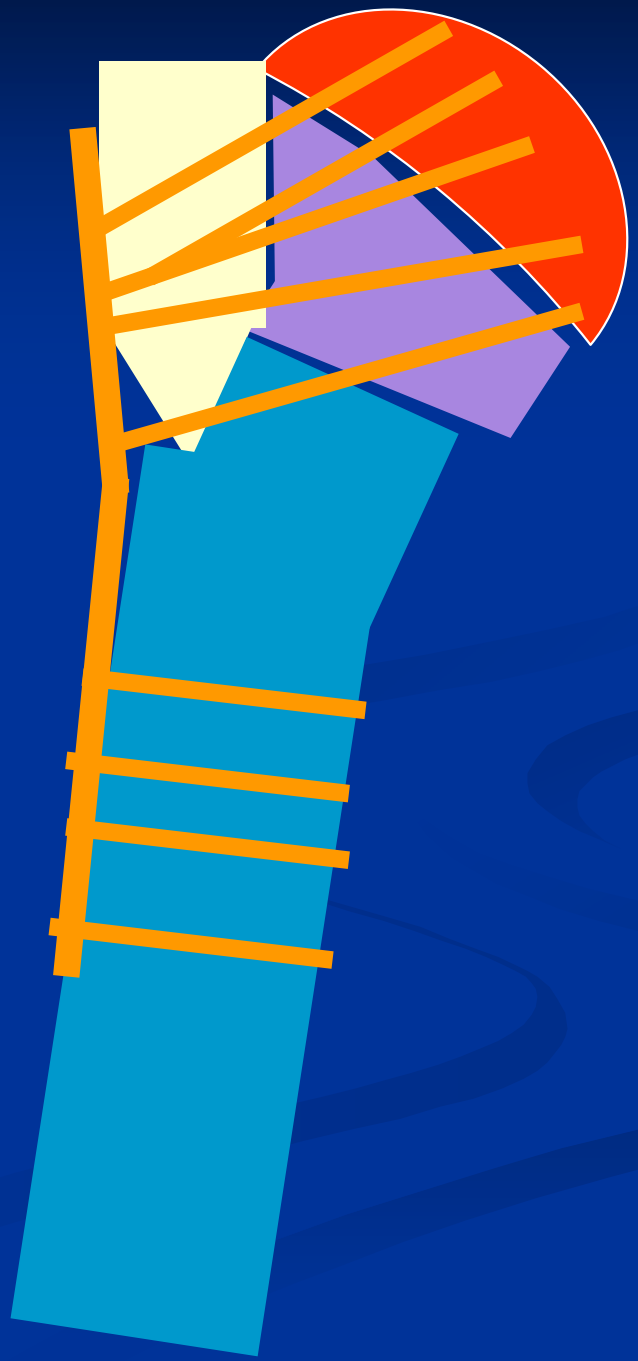


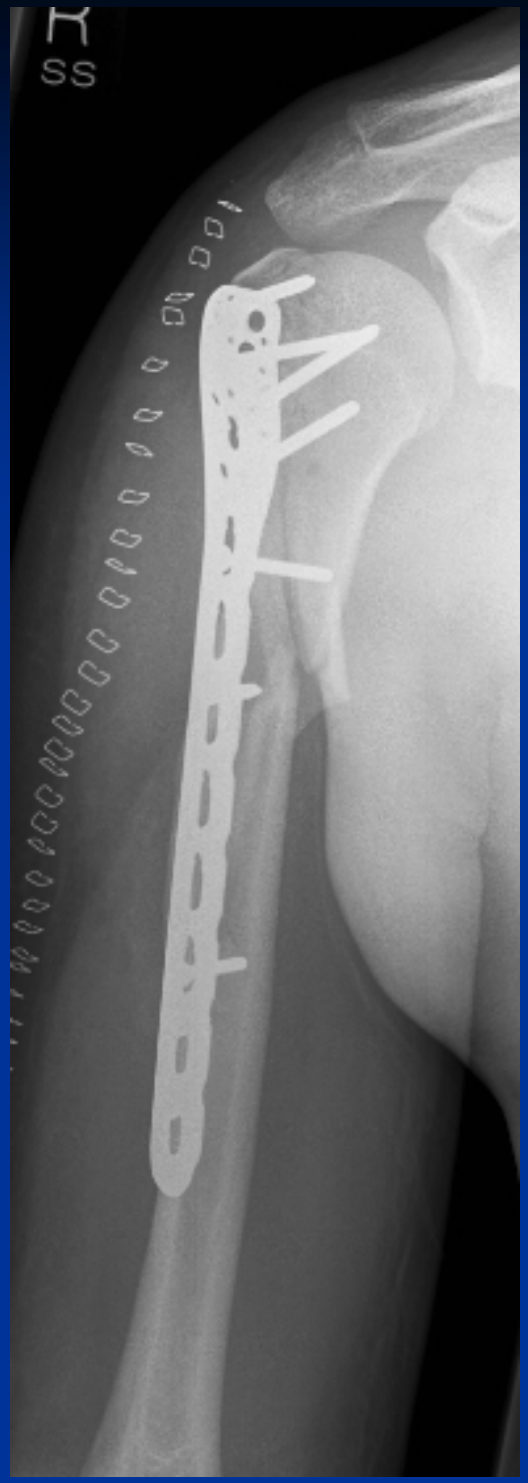


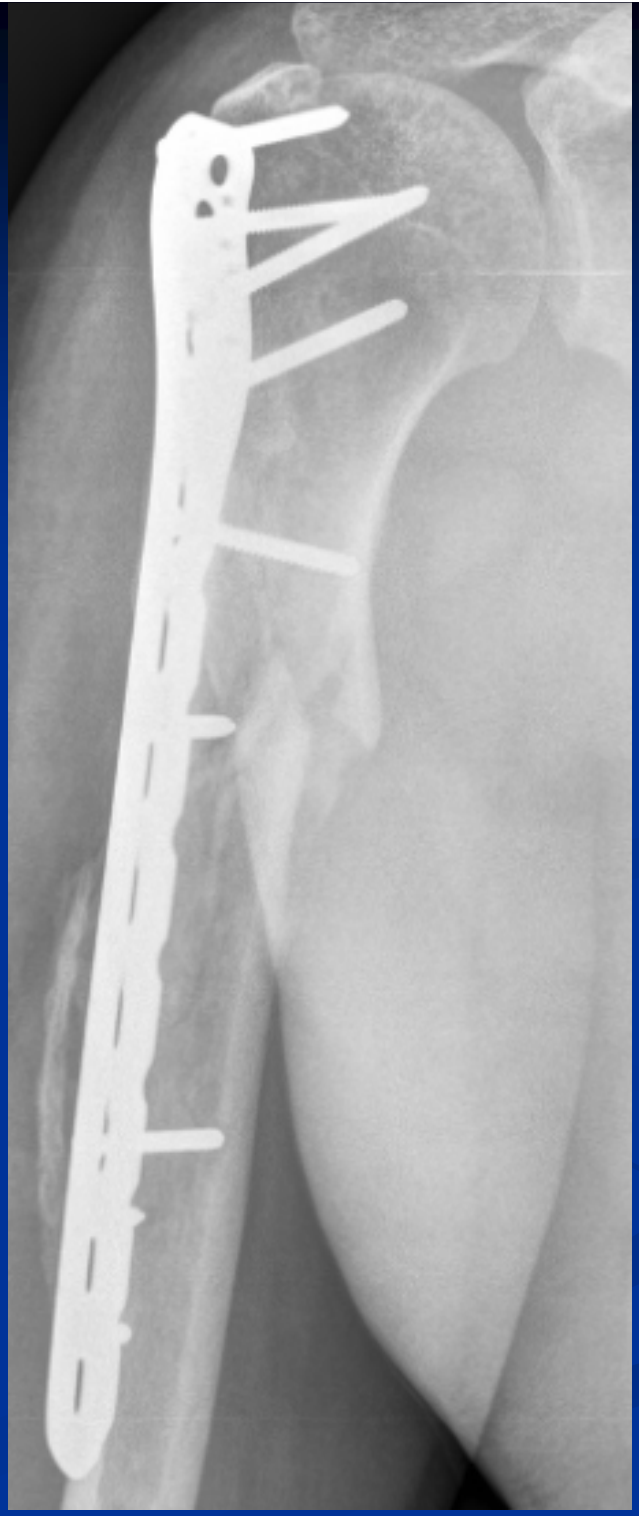
Loss of medial hinge



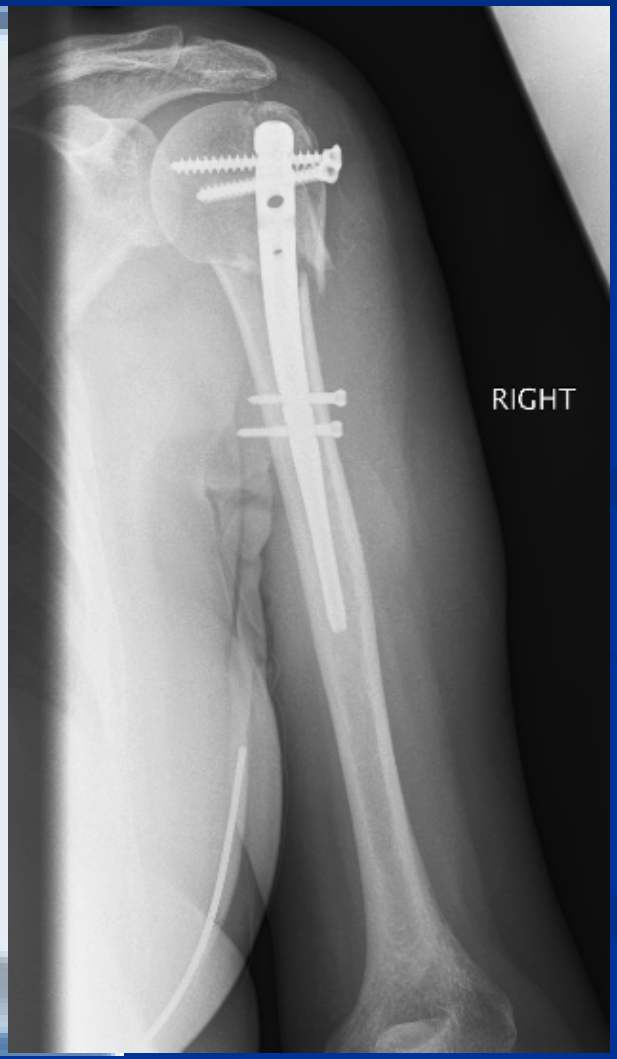


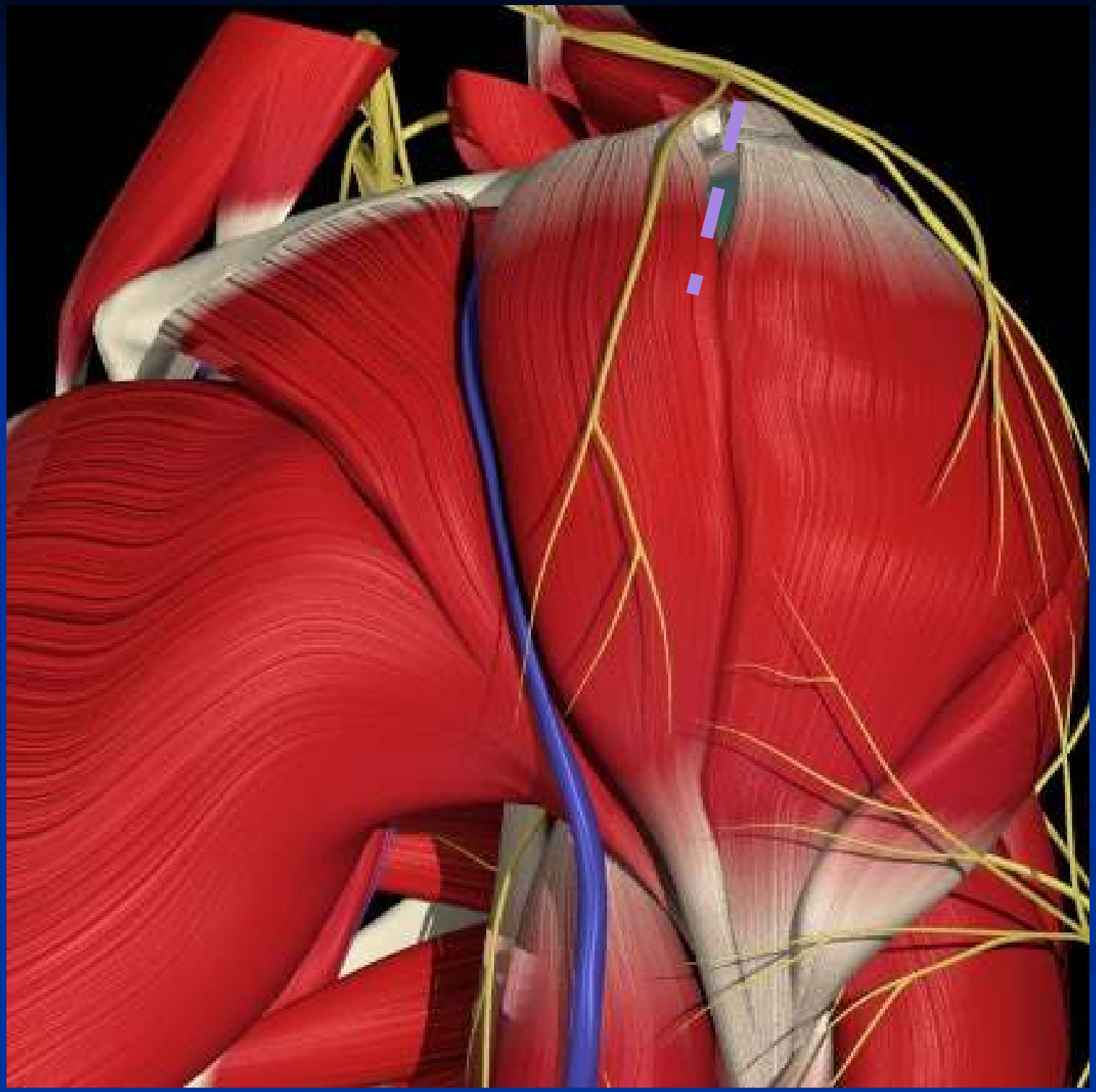


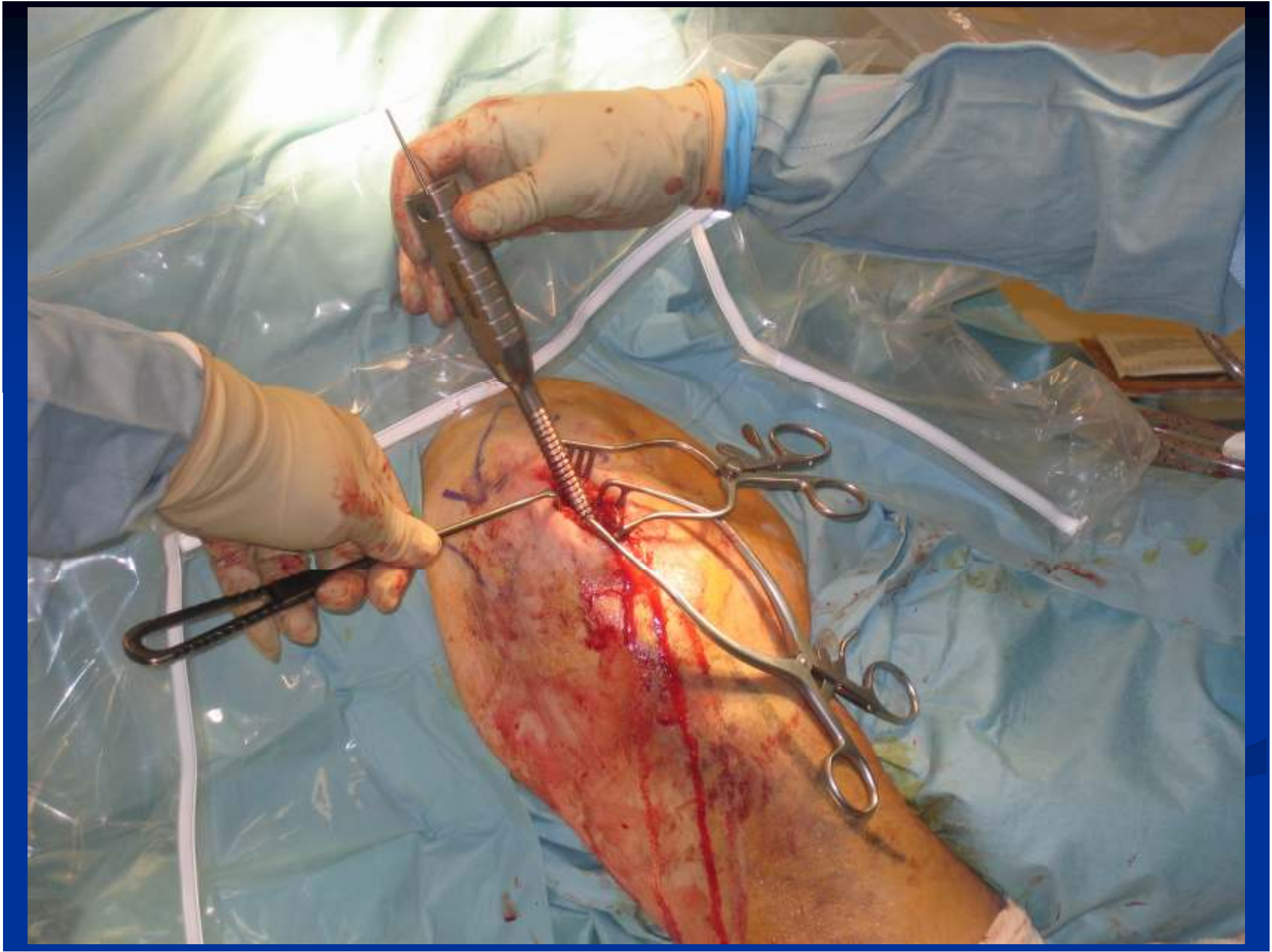

R
SS

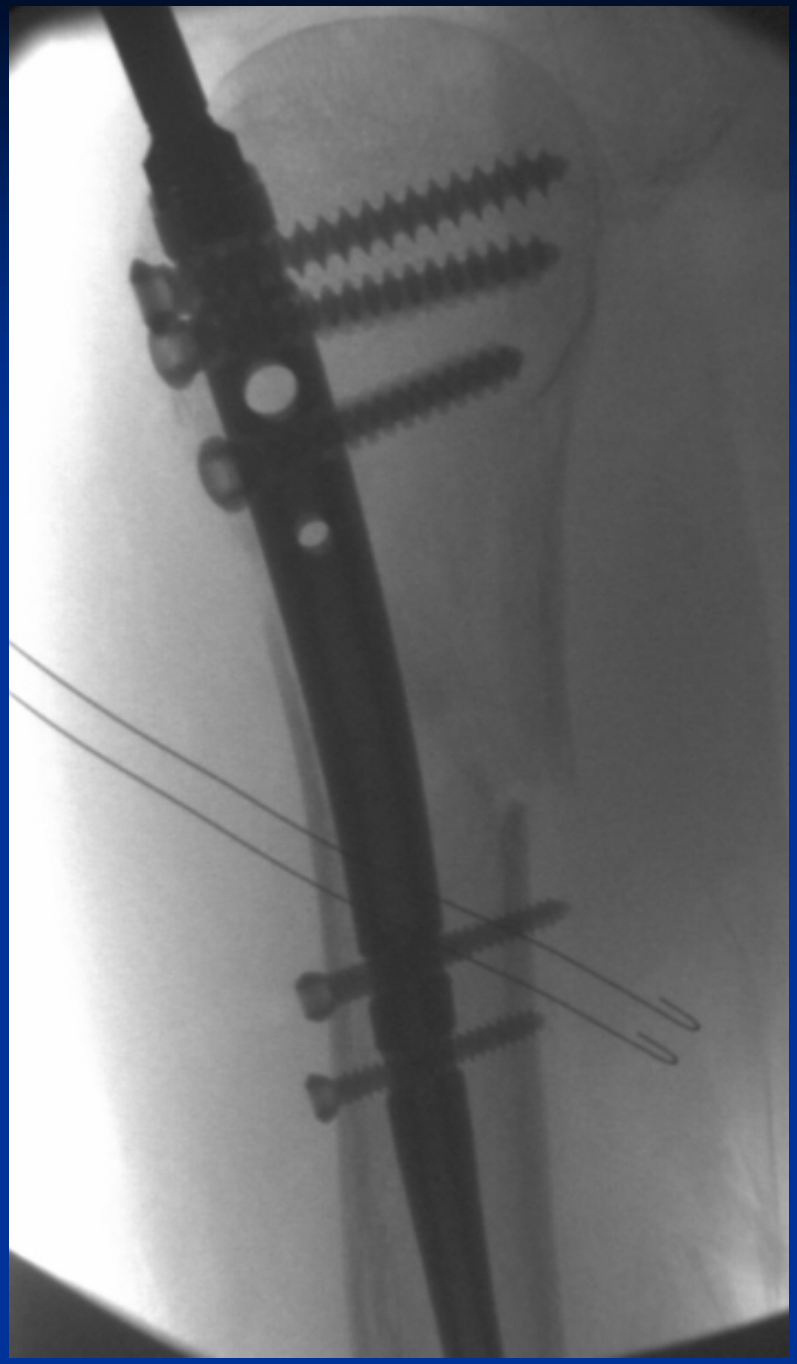


Proximal humeral nail
2-part fractures



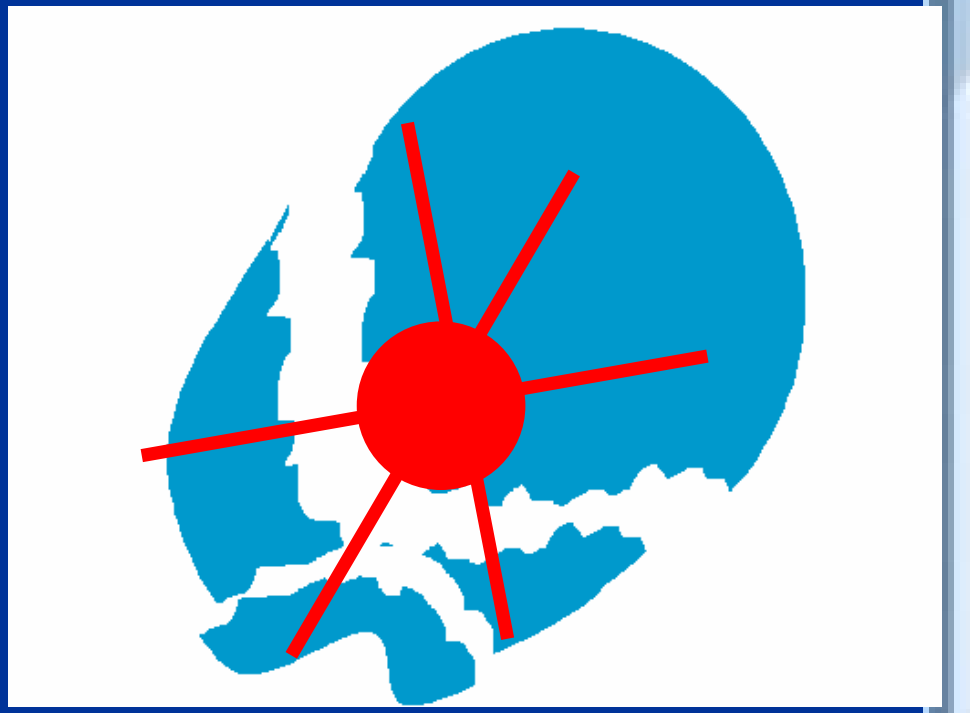






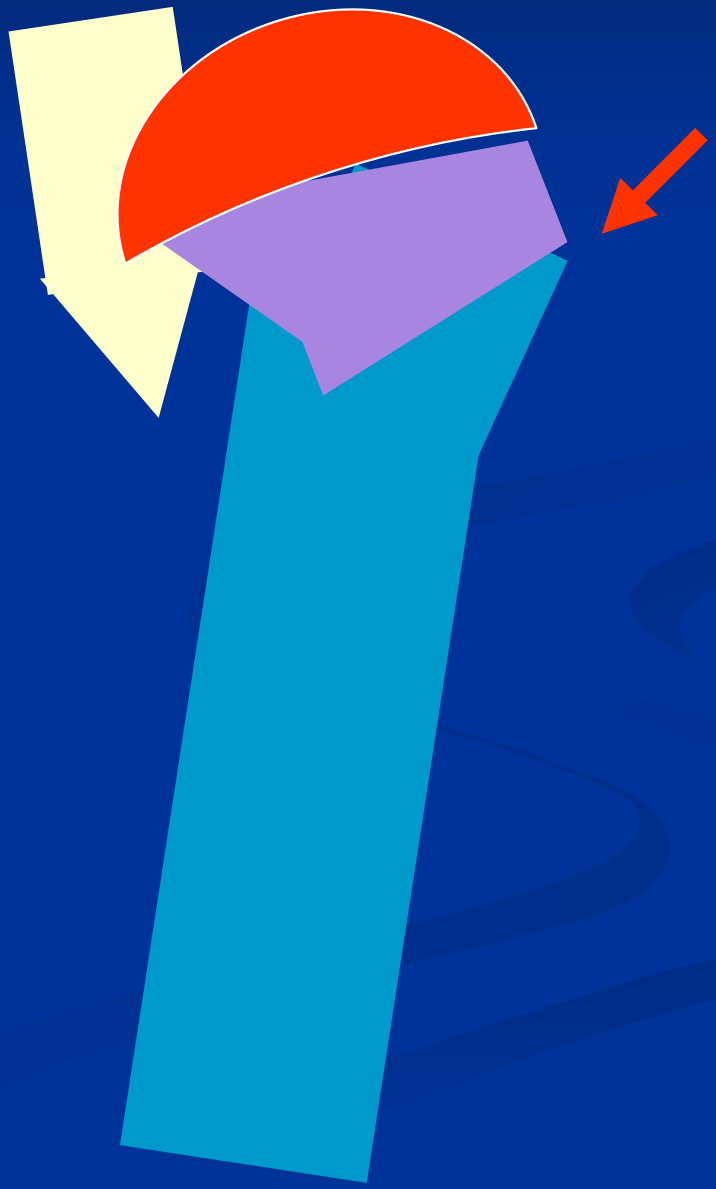
3-4 part fractures?

- Avoid unless very good bone!



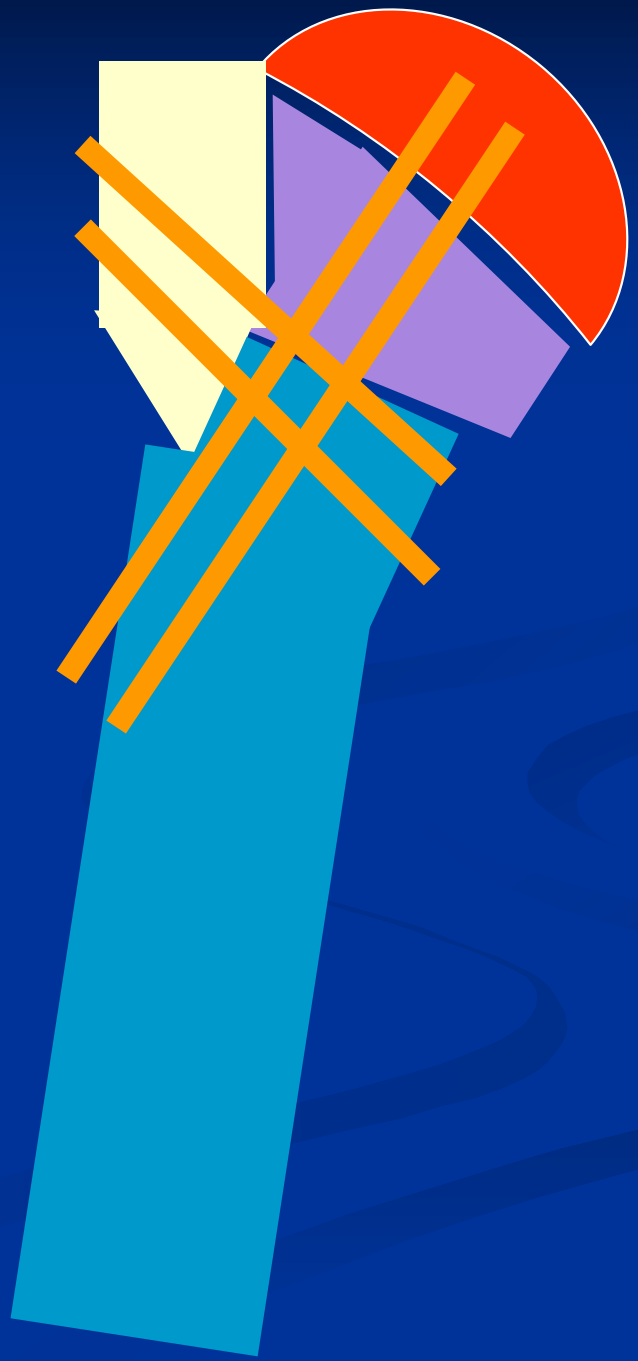
2 part fracture: K-wires

Valgus 3-4 part



Valgus 3-4 part

Valgus 3-4 part



Jaberg et al, JBJS Am 1992;74:508-15

•Threaded K-wires

Resch et al, JBJS 1997;79:295-300

•Valgus impacted #s

Problems:

Rowles & McGrory JBJS Am 2001;83:1695-9

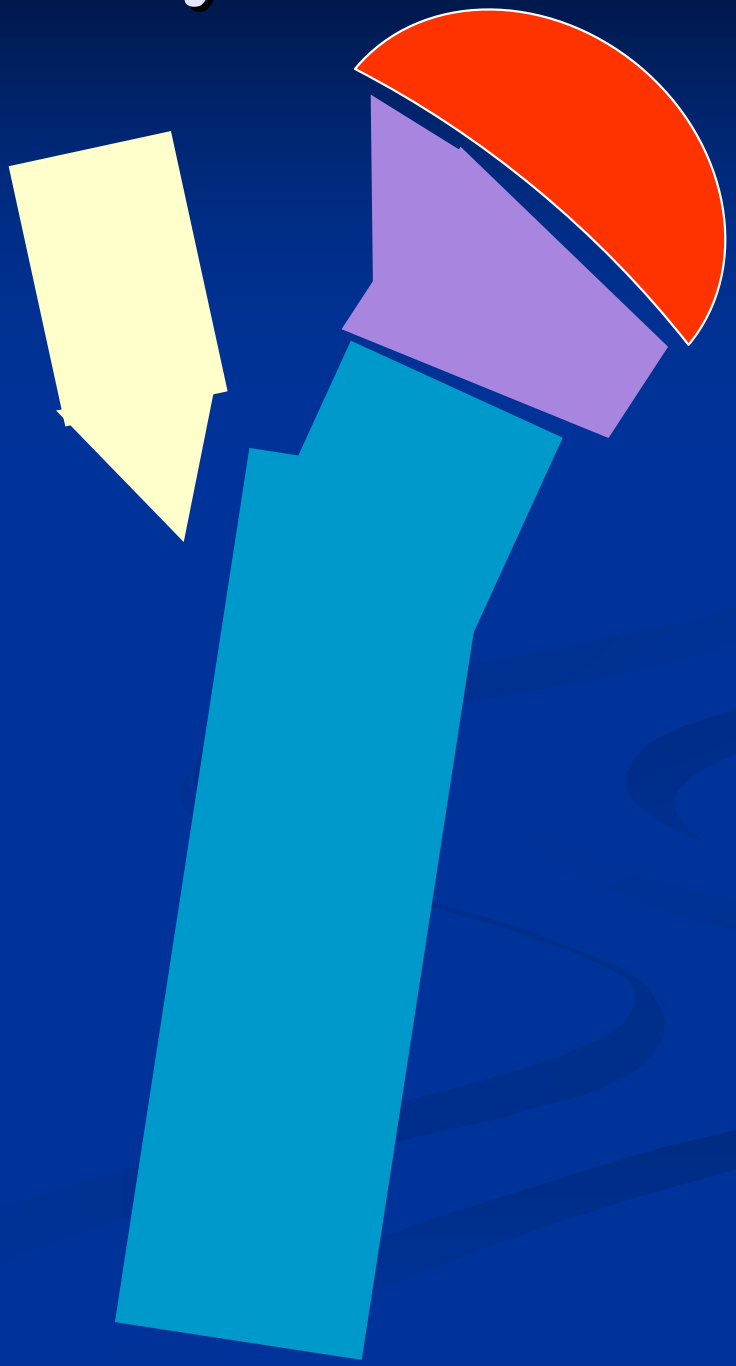
•Ax Nerve

•LHB

•Cephalic Vein

Kamineni et al, Injury 2004;35:1133-36

Greater Tuberosity Fractures



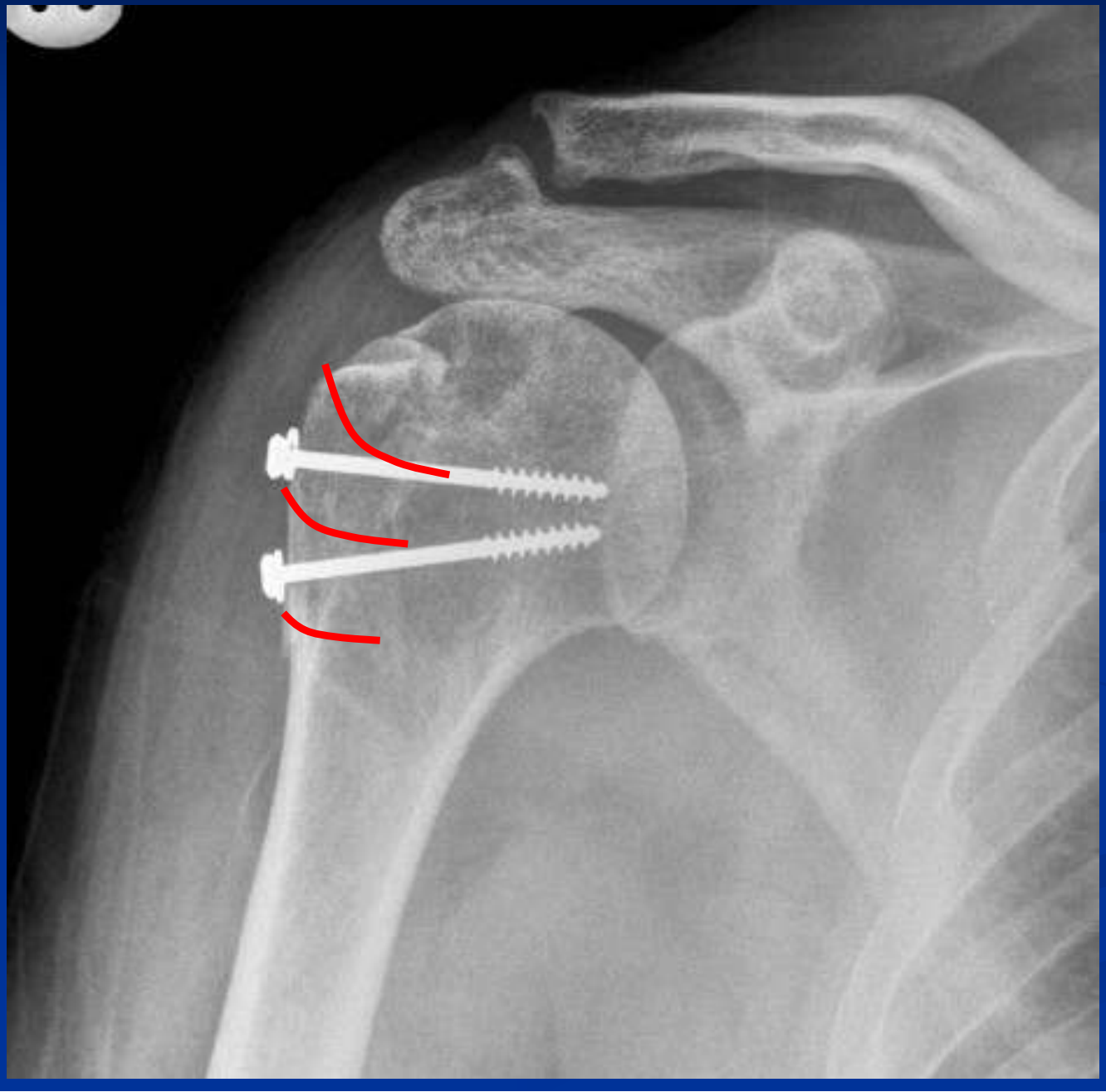
Greater tuberosity fractures

- Up to 10% of PHFs
- Displacement 1cm or more : Fix

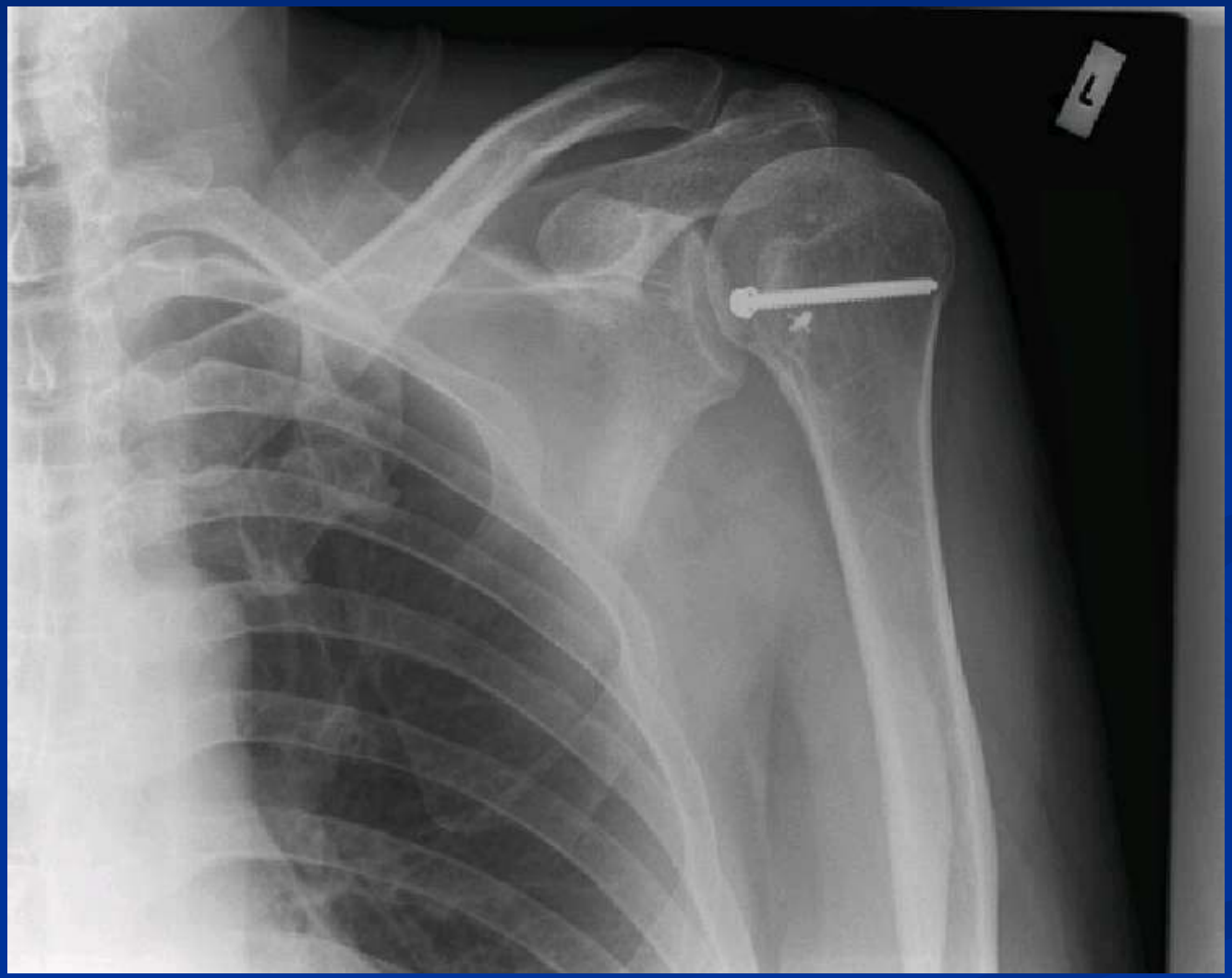
  Rasmussen S, Hvaas I, Dalsgaard J et al 1992
- Displacement >3mm : Fix

  Park TS, Choi IY, Kim YH 1997


RIGHT



Lesser tuberosity fracture


L

PHILOS PLATE FIXATION
MGH-JCUH 2001-2004

Jaime Candal, Paul Baker Karen Bennison, Amar Rangan

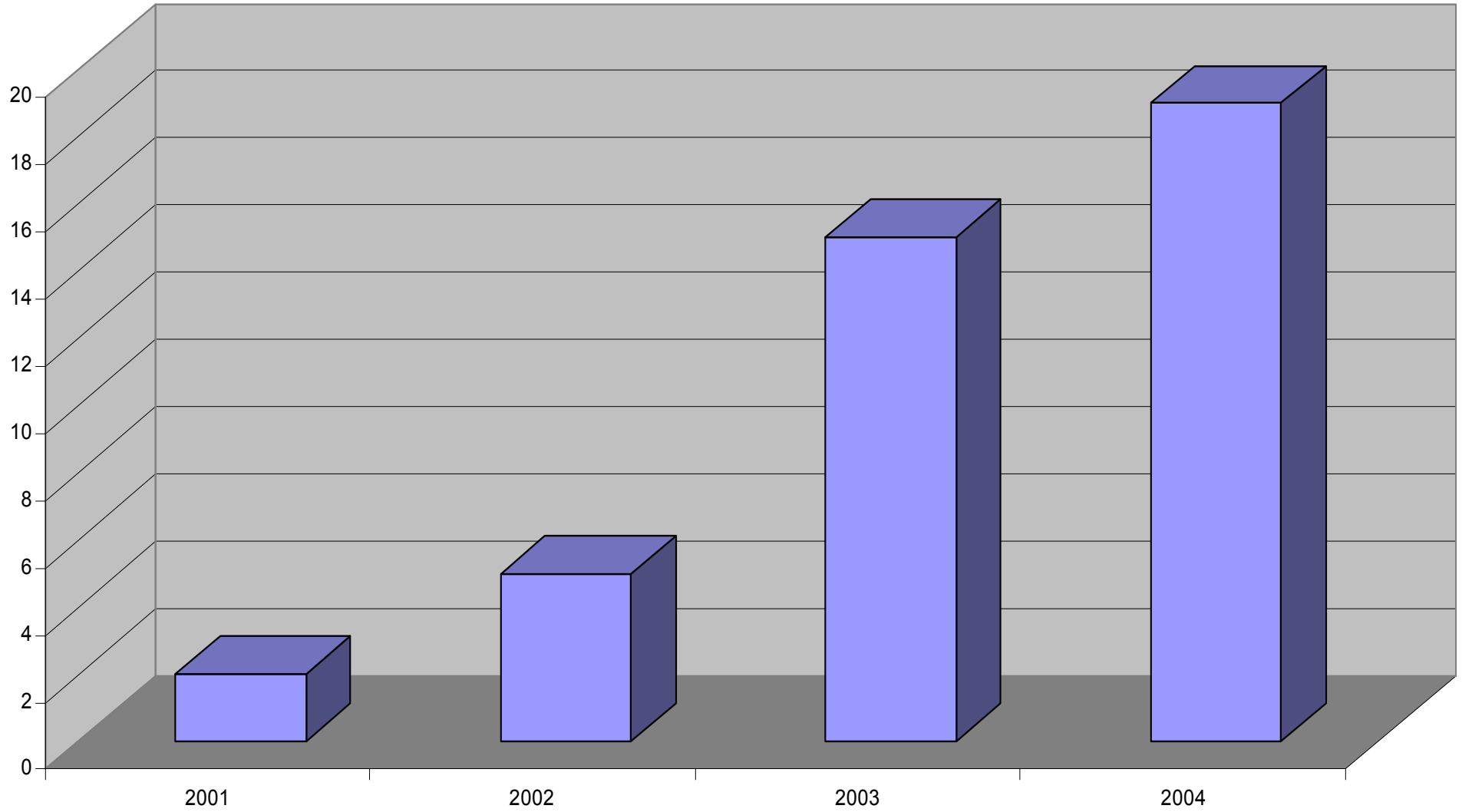
BESS, 2005

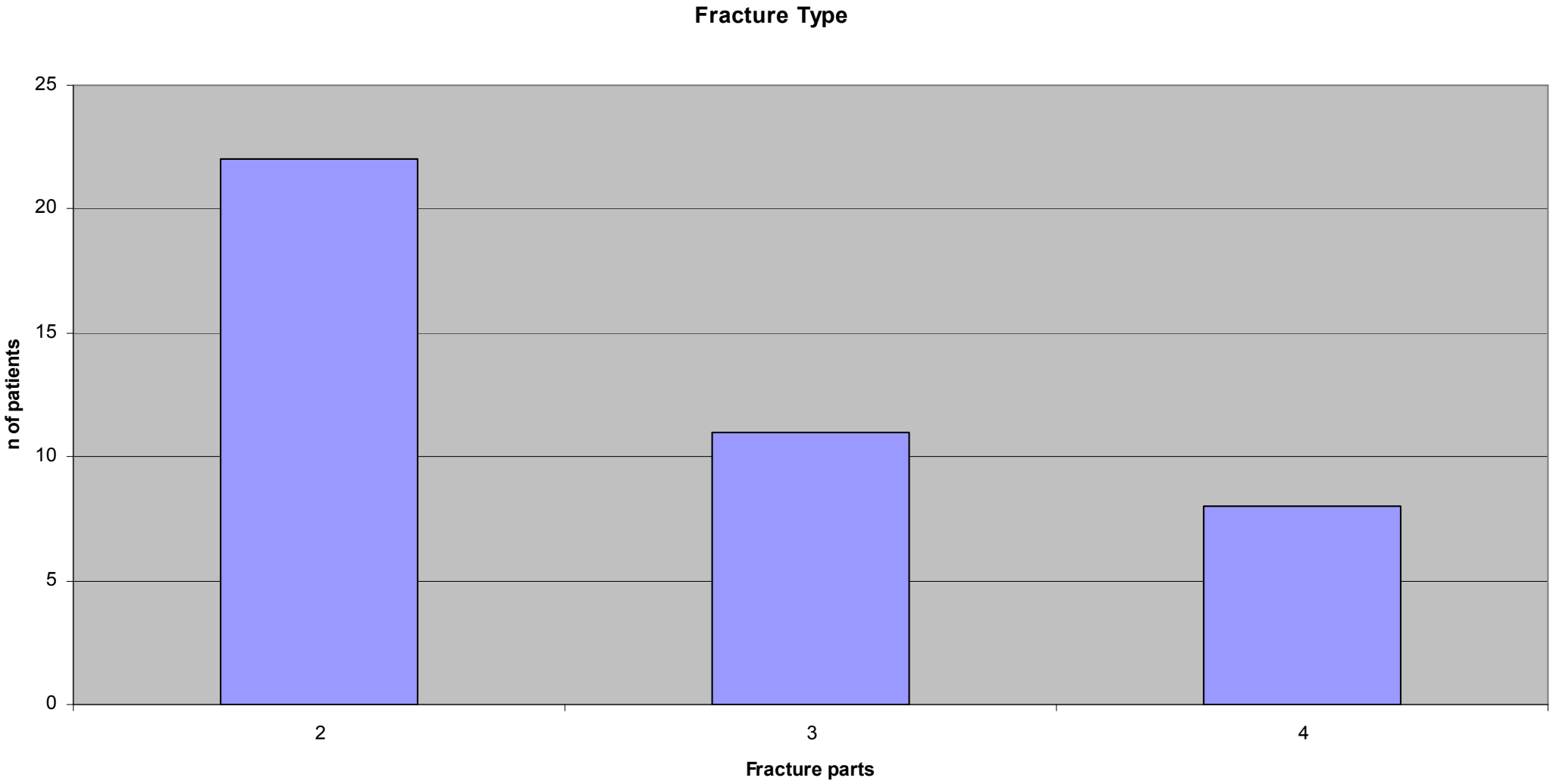
METHOD

RETROSPECTIVE REVIEW(>6 month FU)
Oct 2001-Oct 2004

- 41 PHILOS PLATES
- 21 FEMALE : 20 MALE
- AGE: 54+/-18 (18-84)
- 7 SURGEONS
- X RAYS AVAILABLE IN 37 (4 had no follow up films)
- TELEPHONE INTERVIEW-Oxford score

CASES PER YEAR



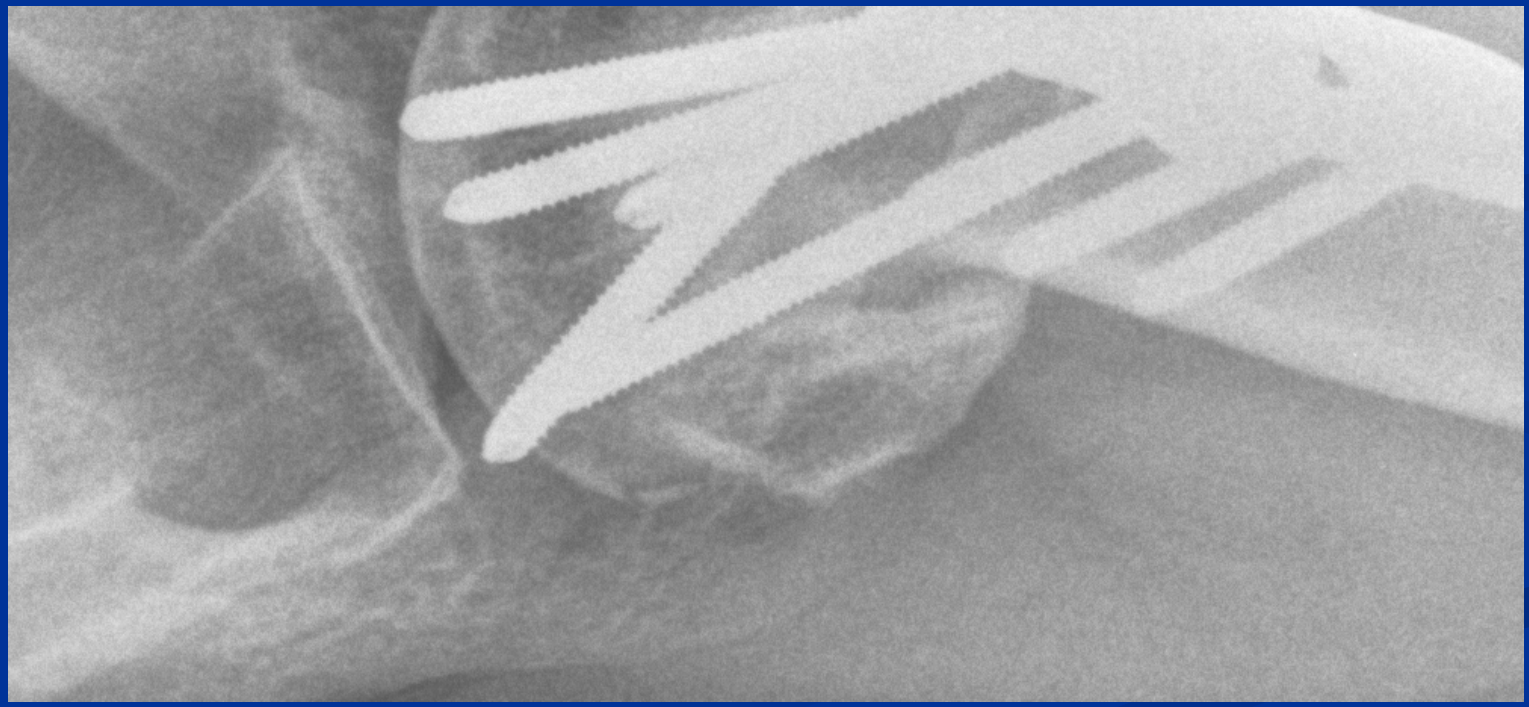

Fracture Type
25
20
15
10
5
0
n of patients
2
3
4
Fracture parts

- Average Length of Hospital Stay 9.5 days (2-45) (£418 per day)
- £3.500 theatre time
- Plate: £240
- Screws: £201 each!

- Around 10K (plus physio, xrays, opd etc)

SCREW PENETRATION

- 10 CASES **(27%)**
- ALL WITHIN 3-4 MONTHS OF SURGERY

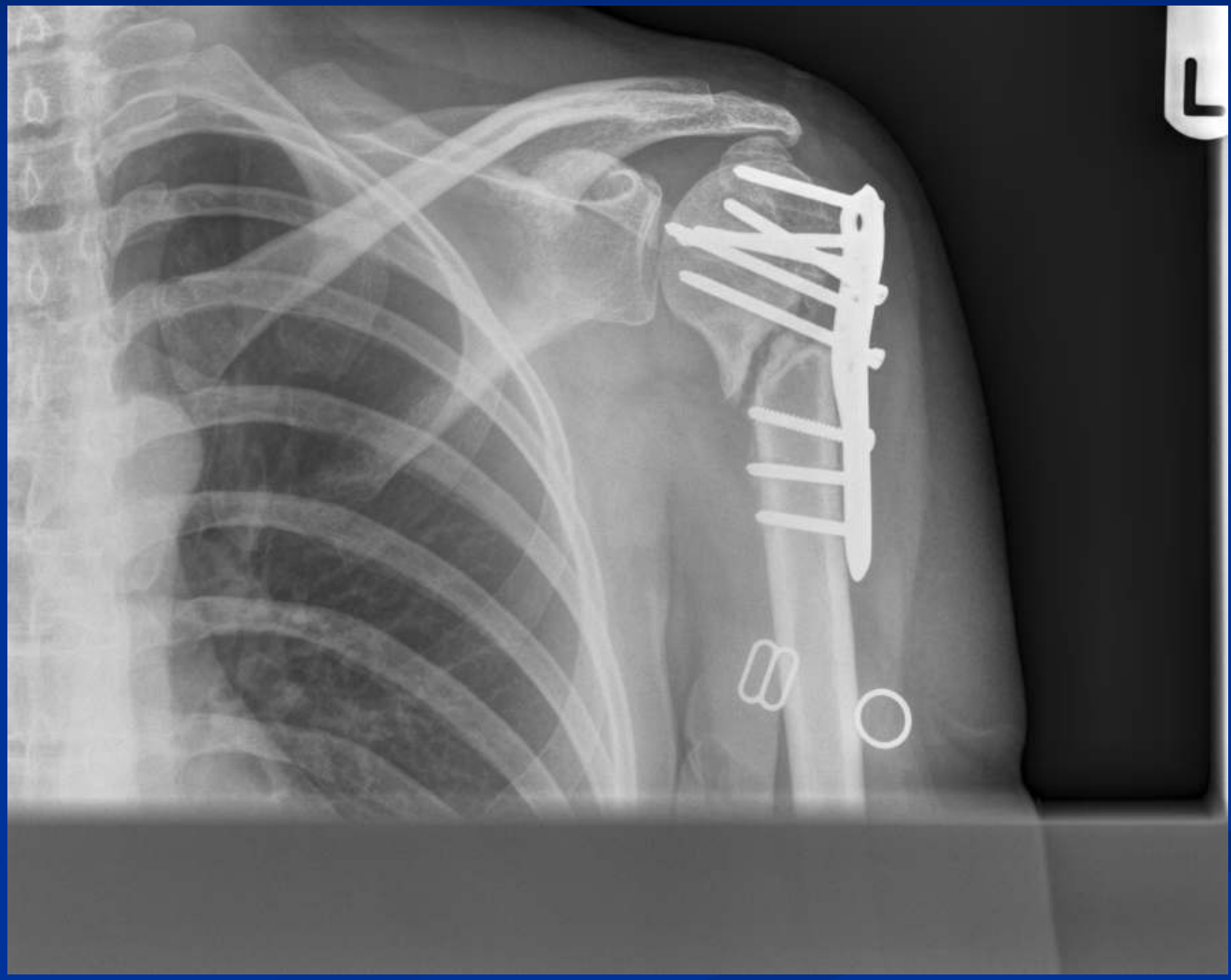


AVASCULAR NECROSIS

- 5 CASES
- 4-4part #
- 1-3part #

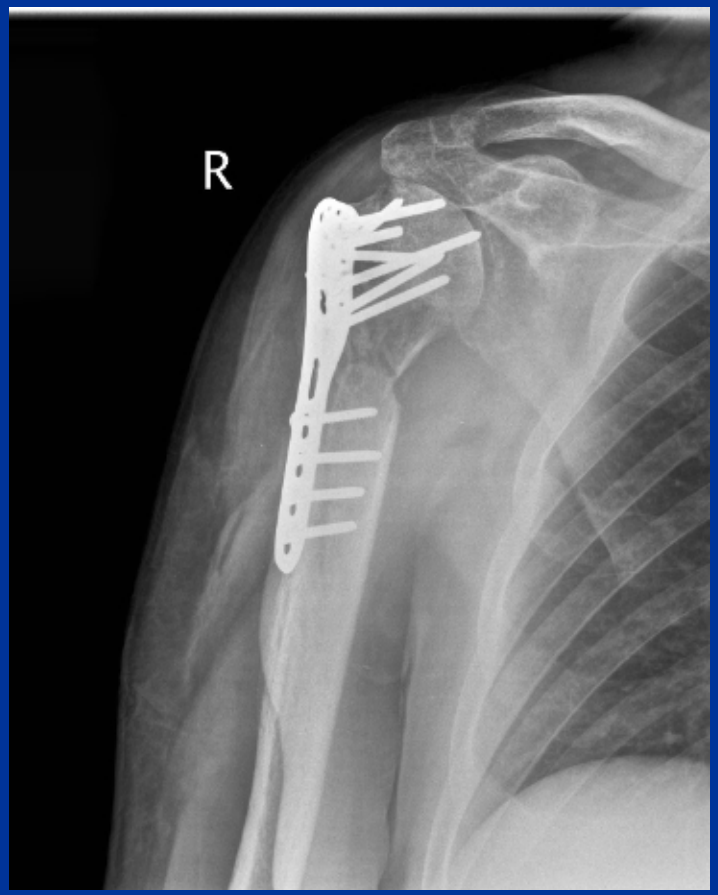
Non-union

- 2 cases



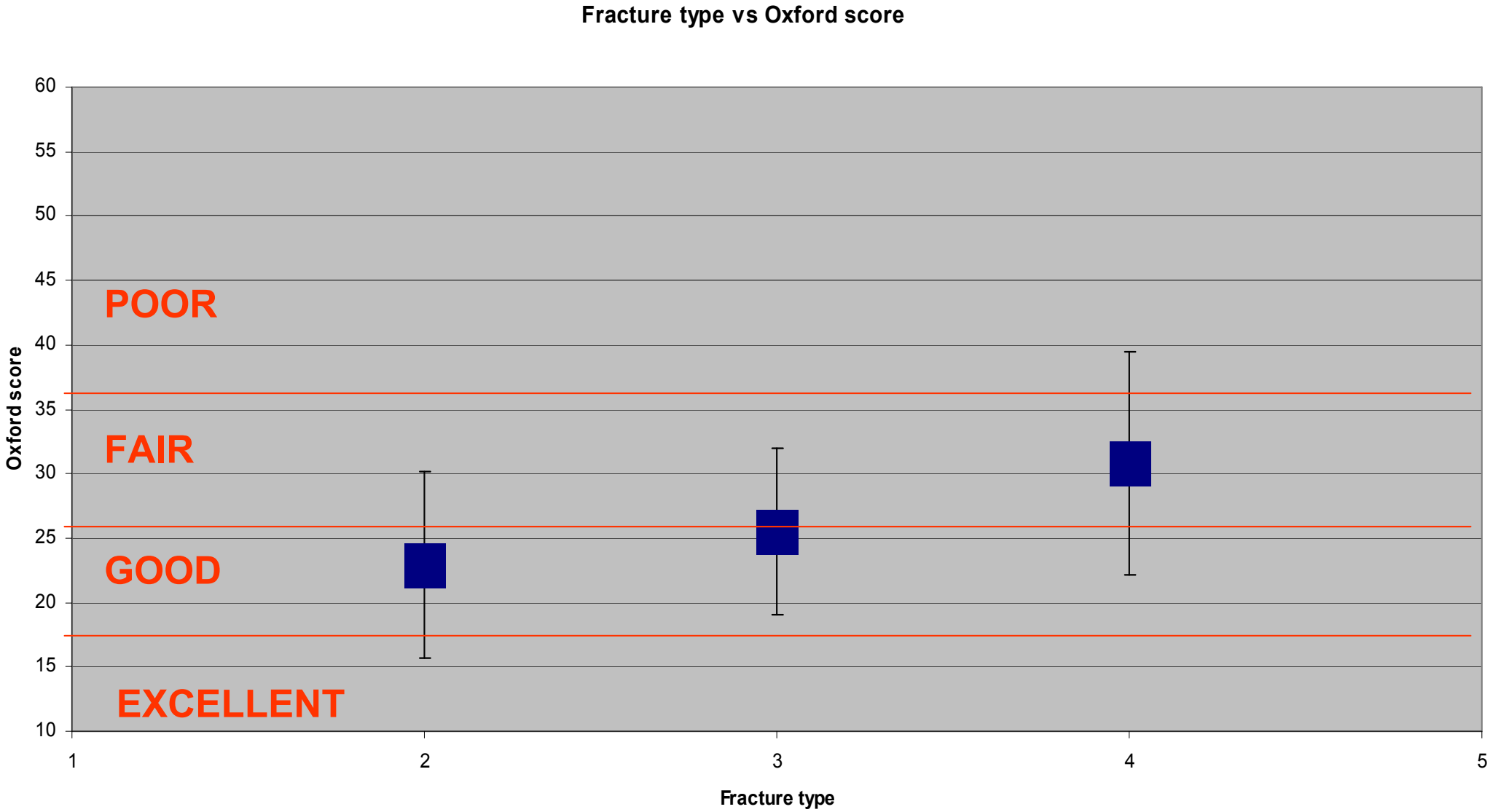
INFECTION

- 3 WOUND INFECTIONS
- 2 DEEP OSTEOMYELITIS



Removal of metalwork

- 3 plates
- 1 screw


Fracture type vs Oxford score
60
55
50
45
40
35
30
25
20
15
10
Oxford score
POOR
FAIR
GOOD
EXCELLENT
1
2
3
4
5
Fracture type

- 86% PATIENTS “HAPPY”

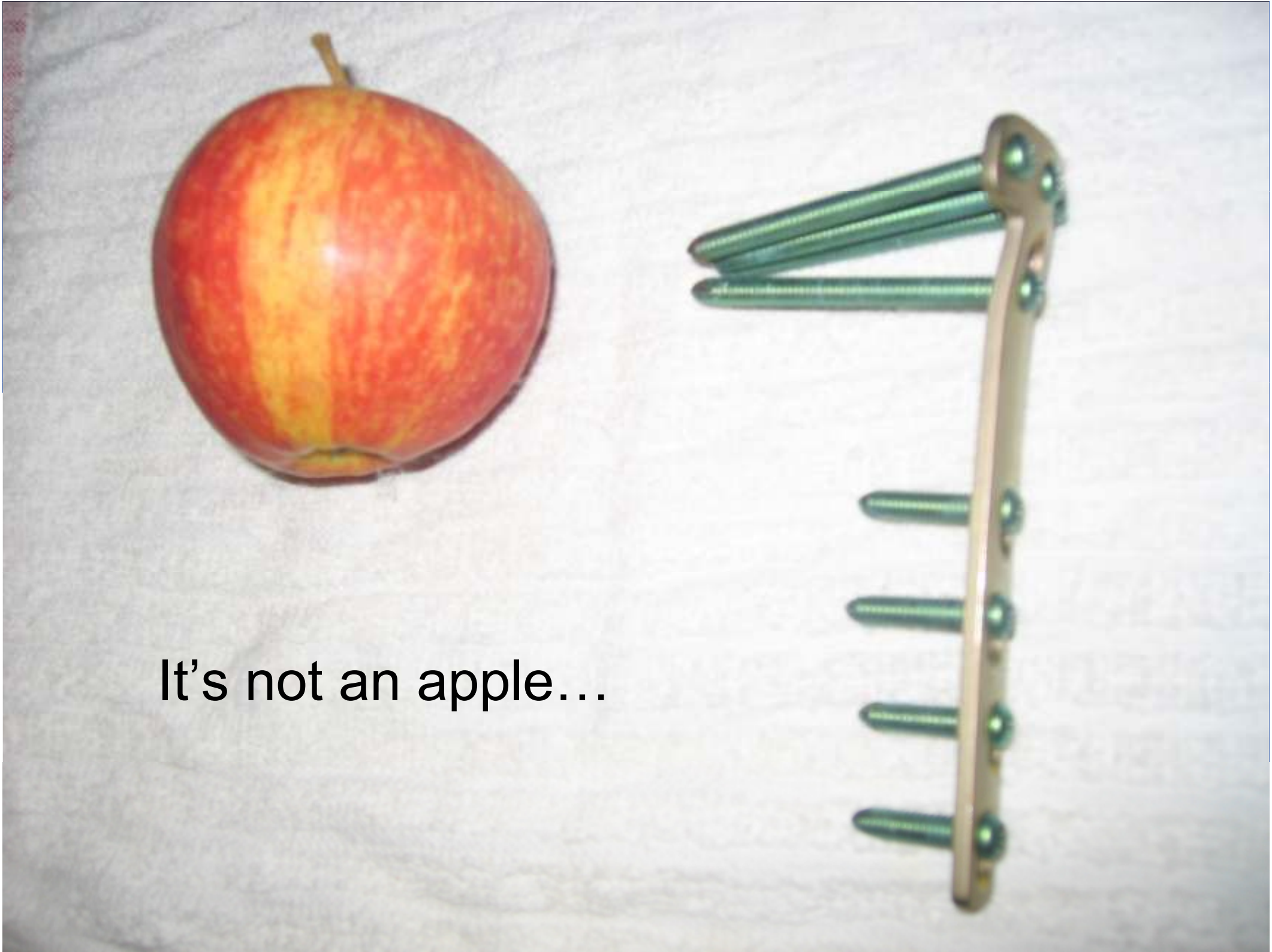
Discussion: Locking plate osteosynthesis

- High complication rate, mixture of good and fair results,

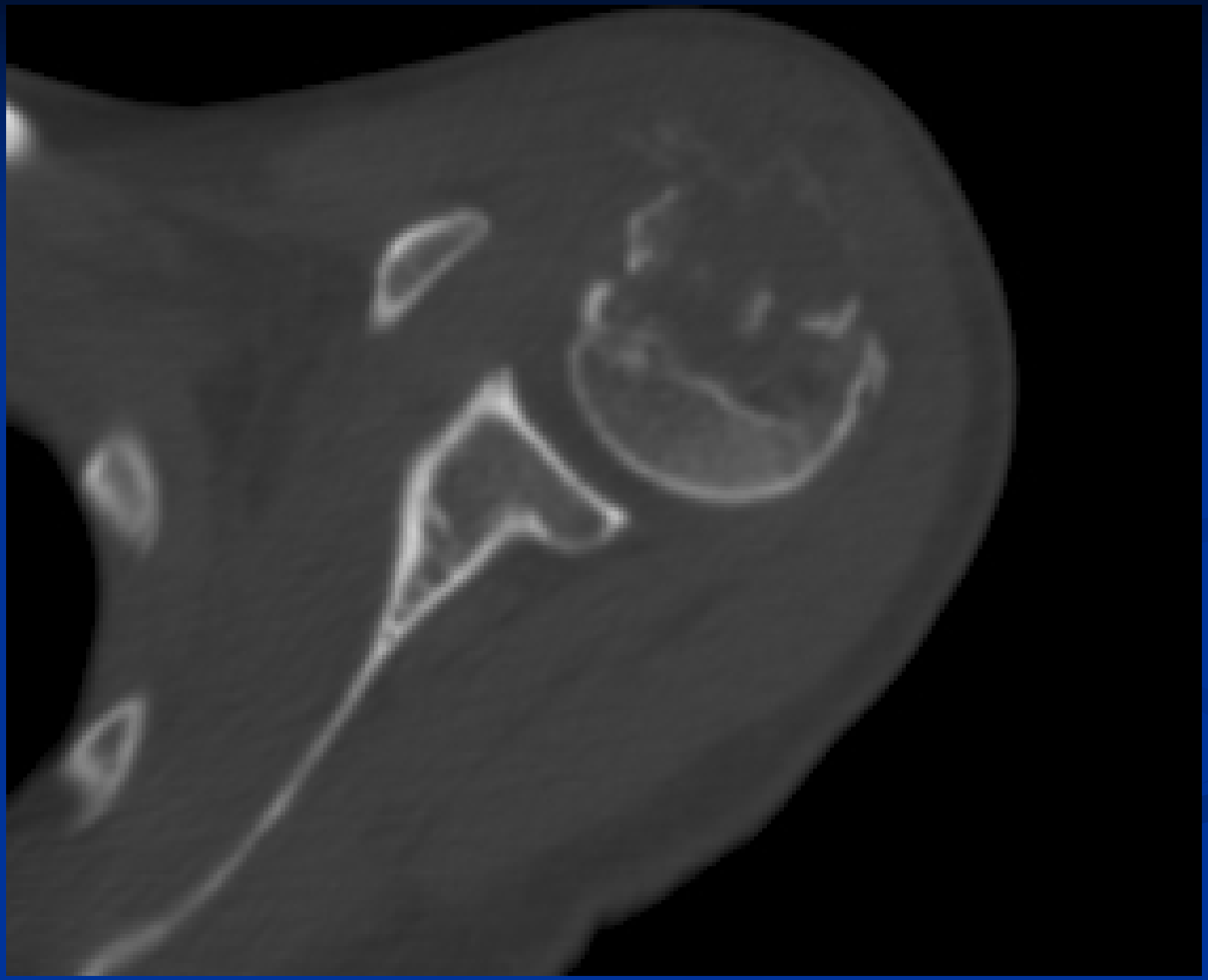
Comparable to literature

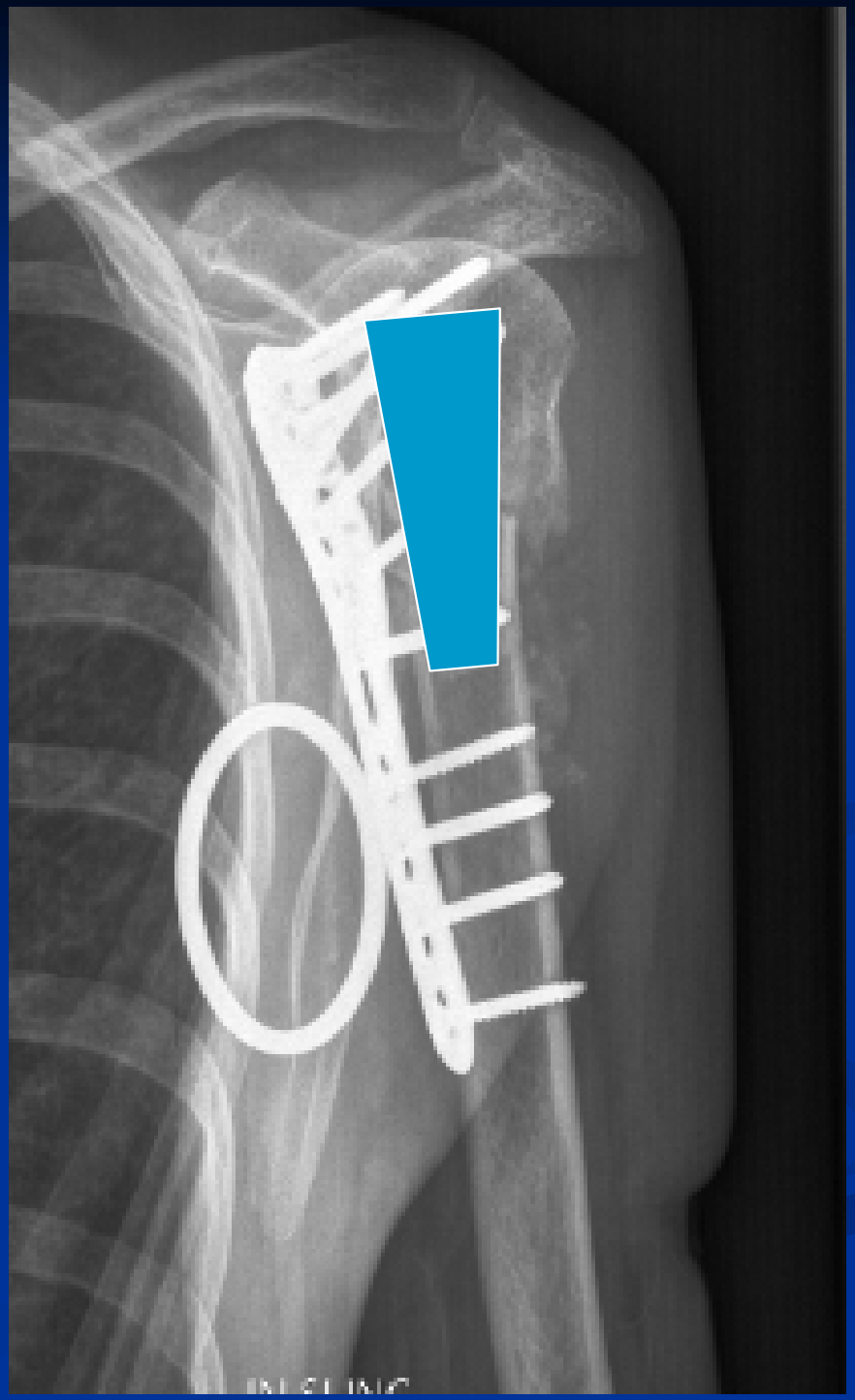
  - Egol et al, 2008
  - Handschin et al, 2008
  - Moonot et al, 2007
  - Charalambous et al 2007
  - Rose et al 2007
  - Bjorkenheim et al, 2004
- Most patients satisfied but consistently good results only in 2 part fractures
- High complication rate in 4-part fractures

Technical tips…


It’s not an apple…

1: You may be trying to fix an egg!





2: You may be fixing dead bone

- ORIF may not be the best treatment

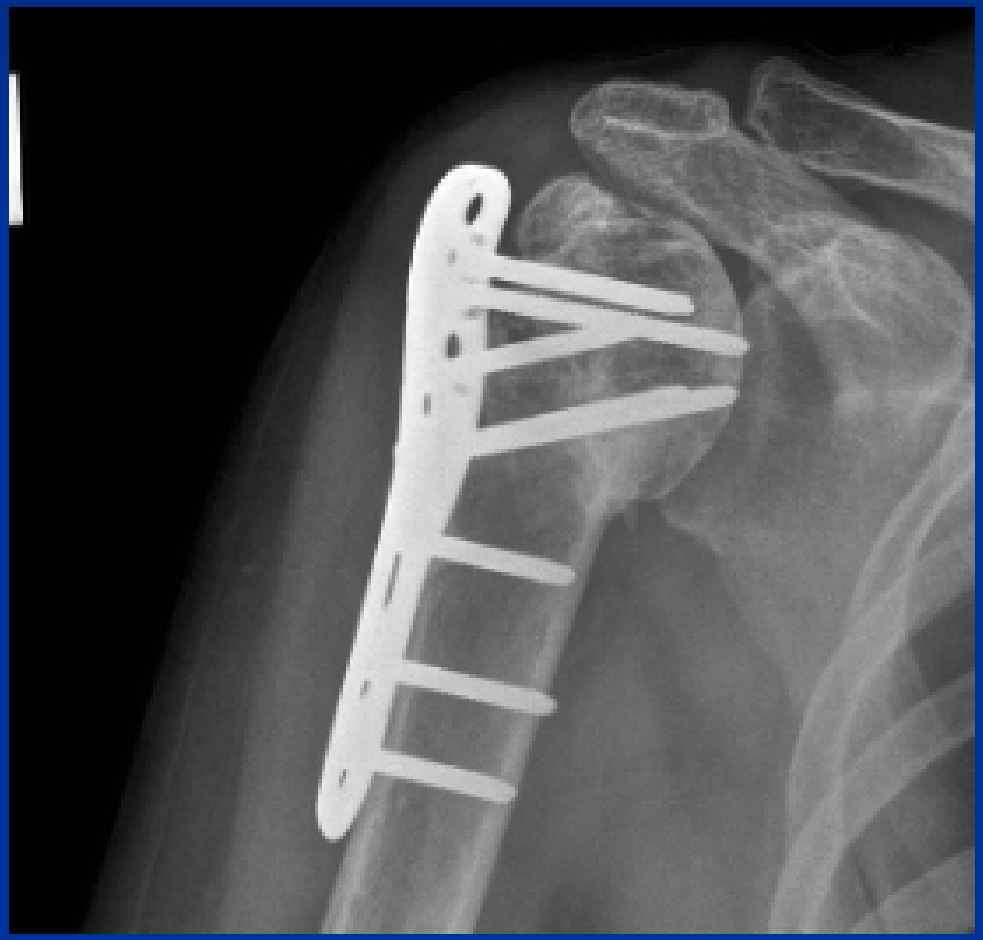
3: Your screws may be too long

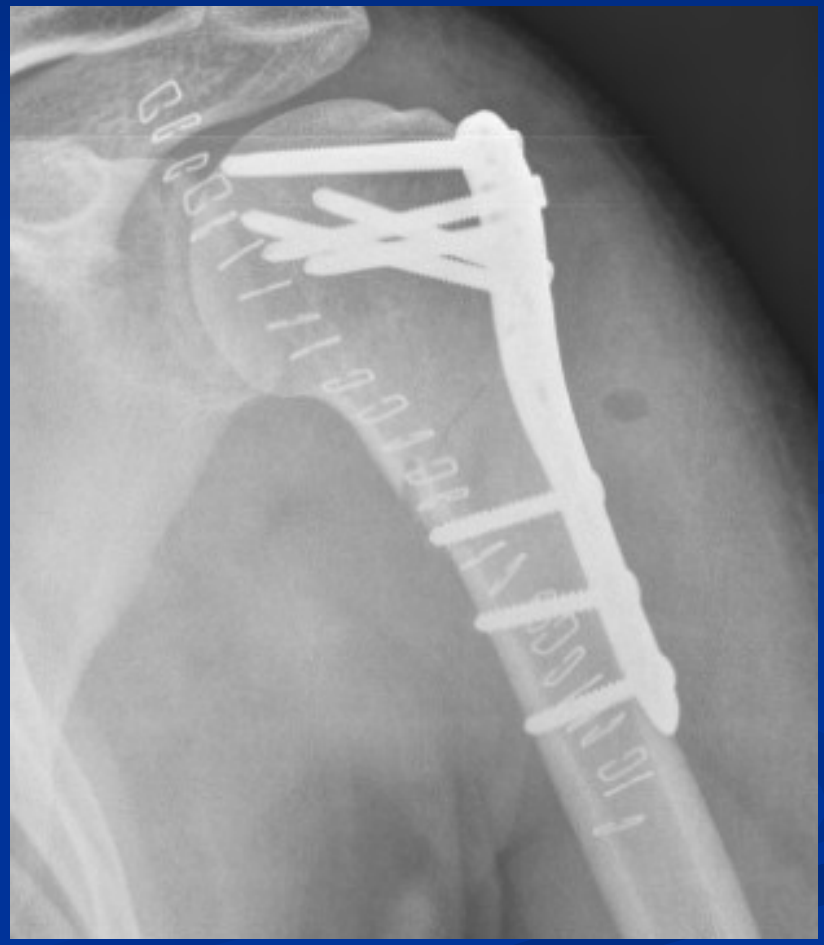
4: Risk of Infection is high

- Alcohol related?

5: Fixation to the shaft may not be as good as you think

6: Proud Plate or varus fixation = Impingement

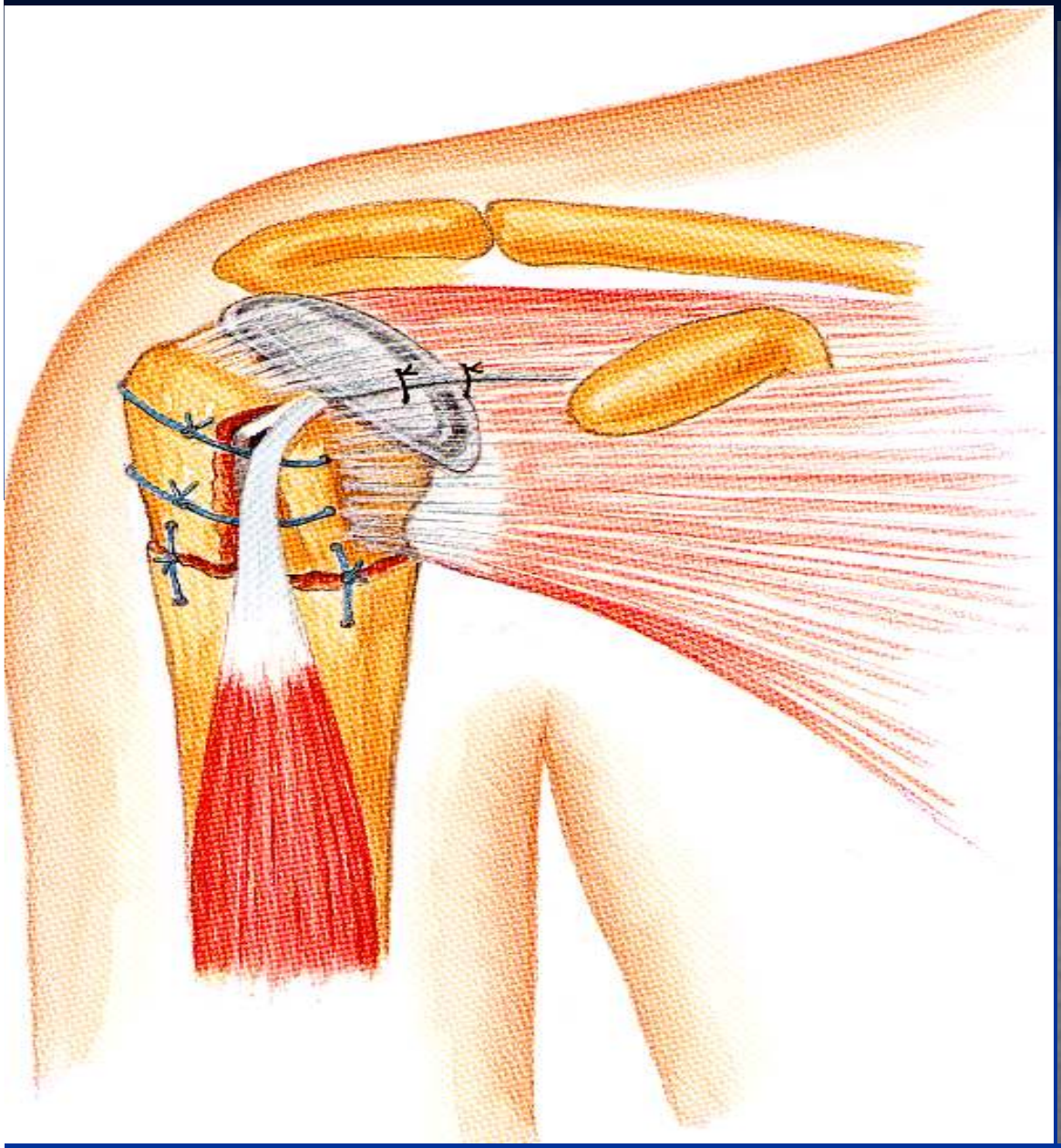




4: Humeral hemiarthroplasty

1. Neer's **classification** has never been found to be reproducible
2. **Neer did not measure the outcome in the non-operative group**
3. **Neer's ORIF methods are now outdated**
4. Neer was **technically** very good with **hemiarthroplasties!**

Displaced, dead, dislocated or dubious density bone…



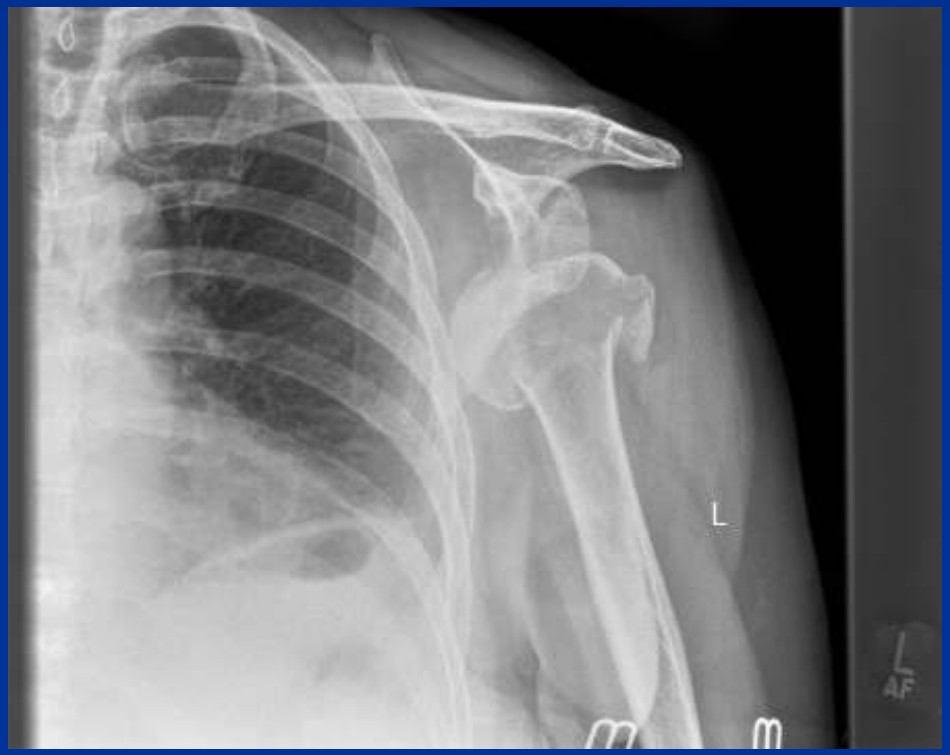

R

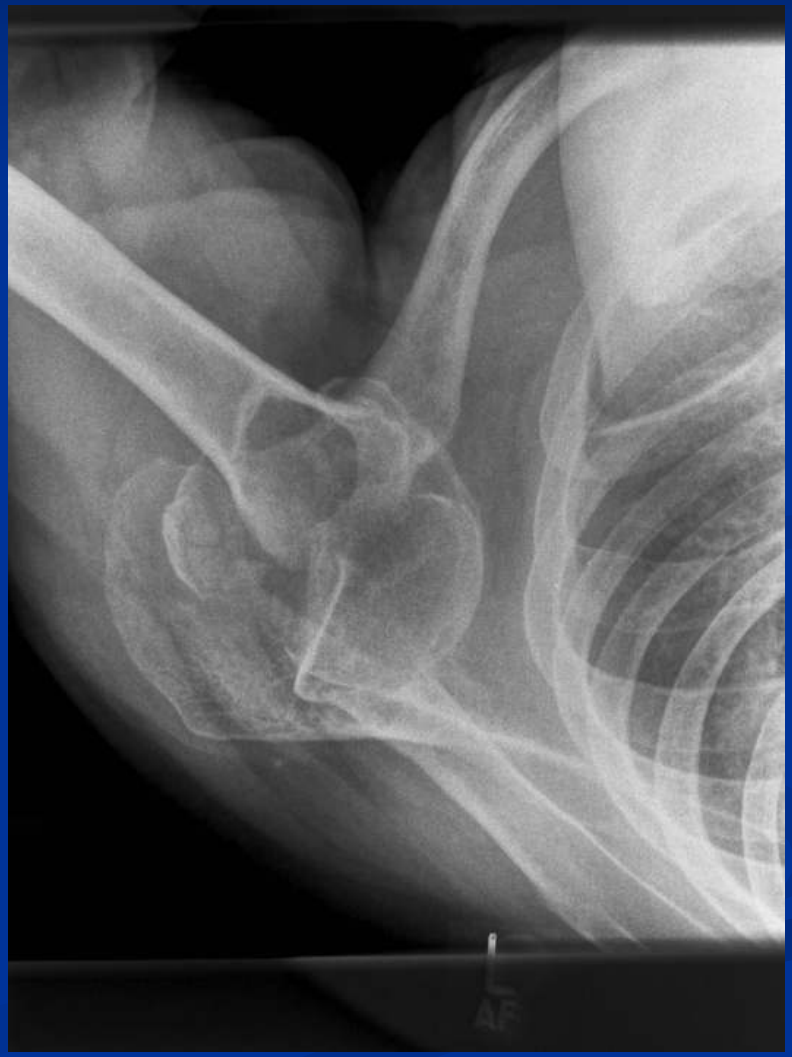

R


LEFT
L

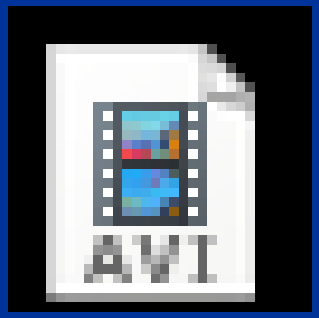

JR

At 6 weeks allow active assisted movements

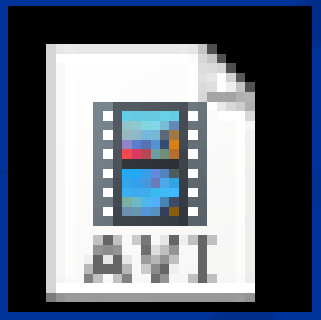

L
L
AF


L
AF


LEFT



DSCF0120.AVI

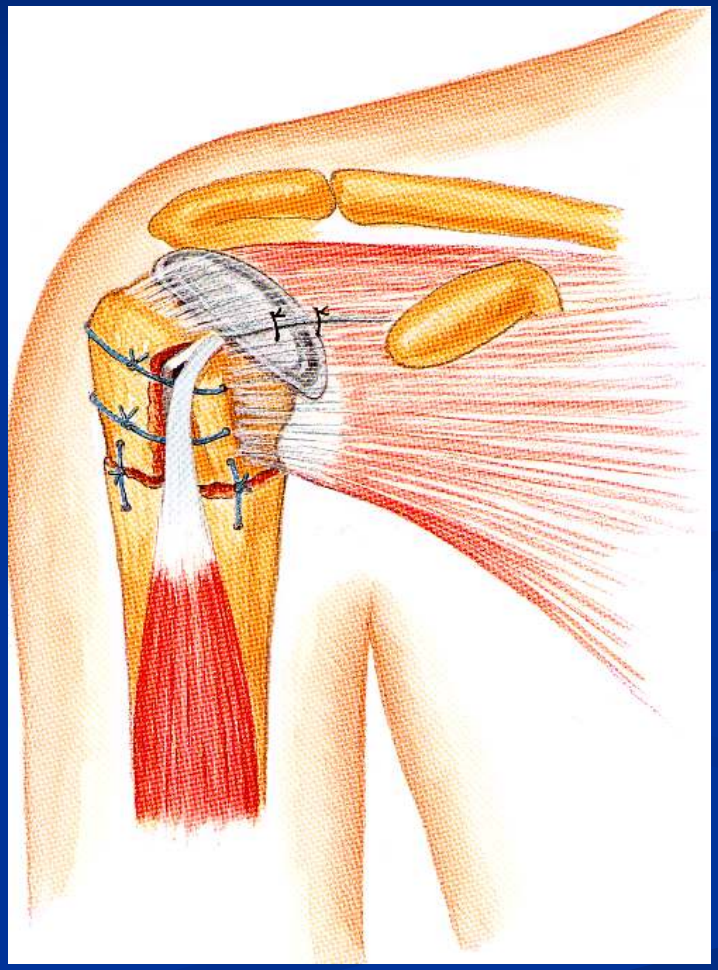


DSCF0121.AVI

1: Approach

- Deltopectoral
  - Ideal if head dislocated
- Mckenzie
  - Easier reconstruction
  - Deltoid scarring

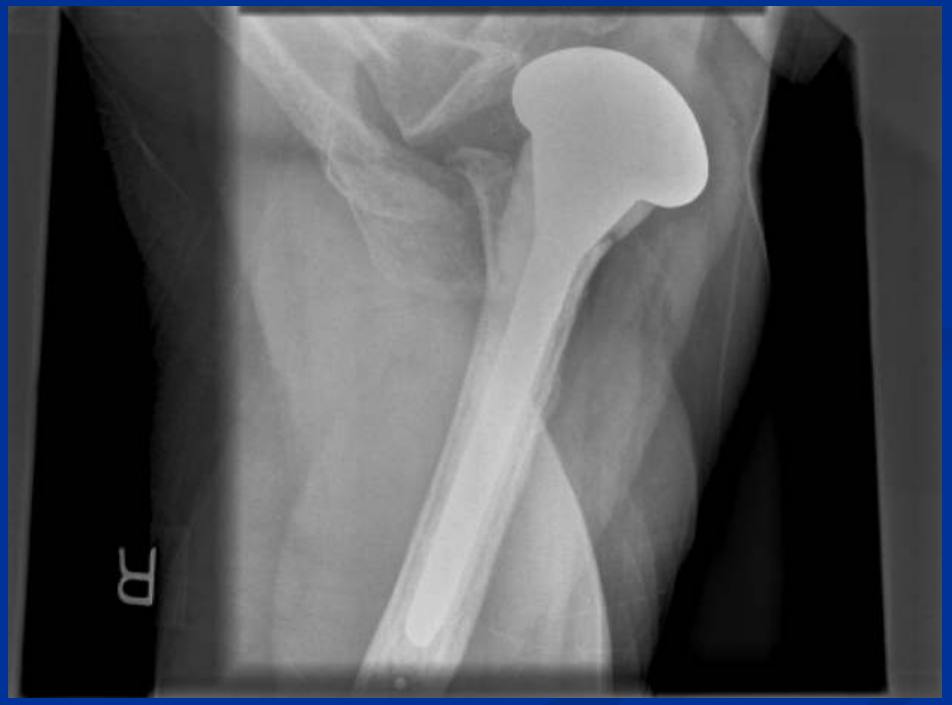
2: Biceps tenotomy/tenodesis



3: Position of prosthesis

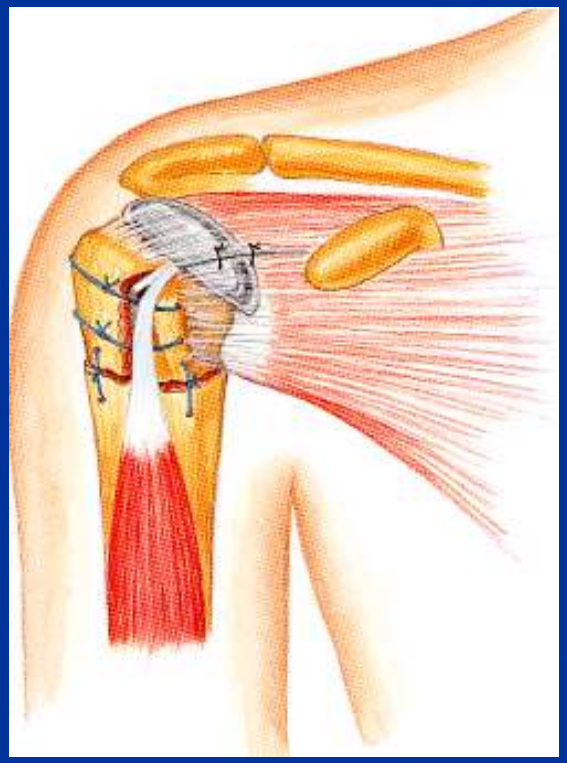
- Retroverion 30-60 degrees
- Height
  - Pec Major tendon
  - Tension
  - Calcar
- Head size
- May use cement


R


R

4: Tuberosity repair

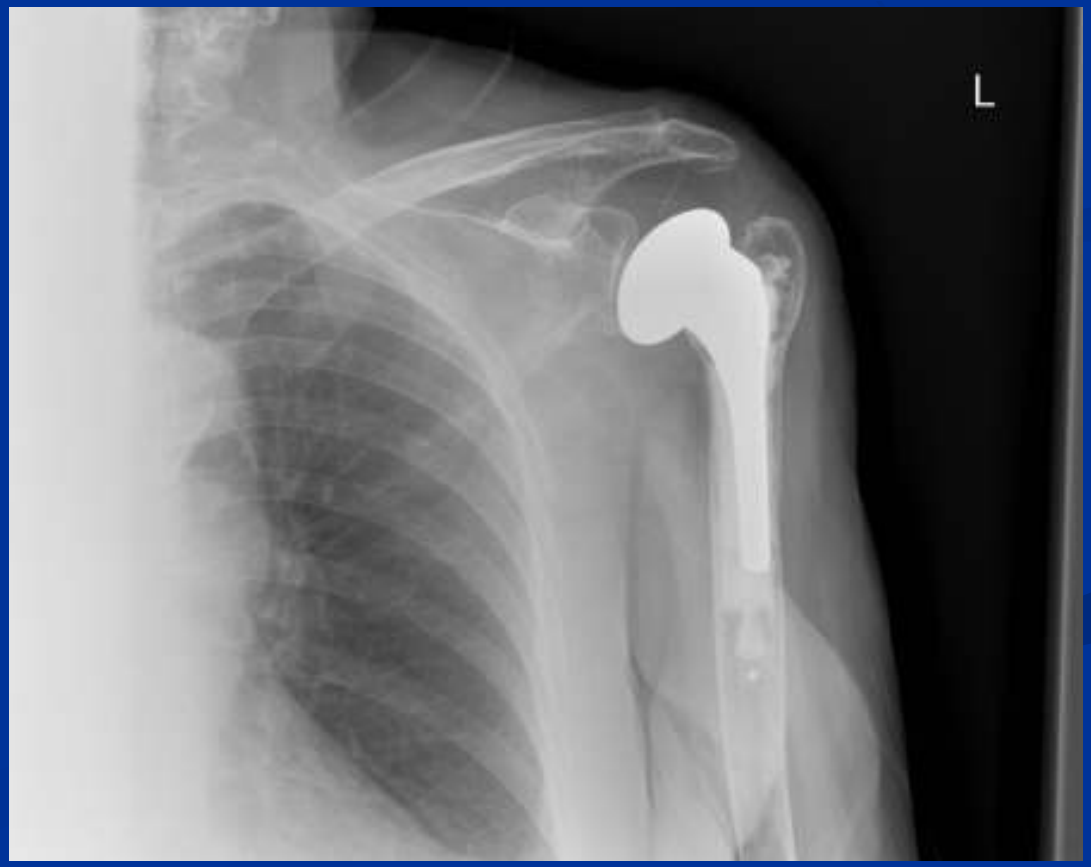
- Non-absorbable Sutures:
  - Tendon/tuberosities
  - Shaft
  - Prosthesis



Boileau et al 2002

5: Hemiarthroplasty for mal-union

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



New Zealand
National Joint Register

THE NEW ZEALAND NATIONAL SHOULDER ARTHROPLASTY REGISTER:

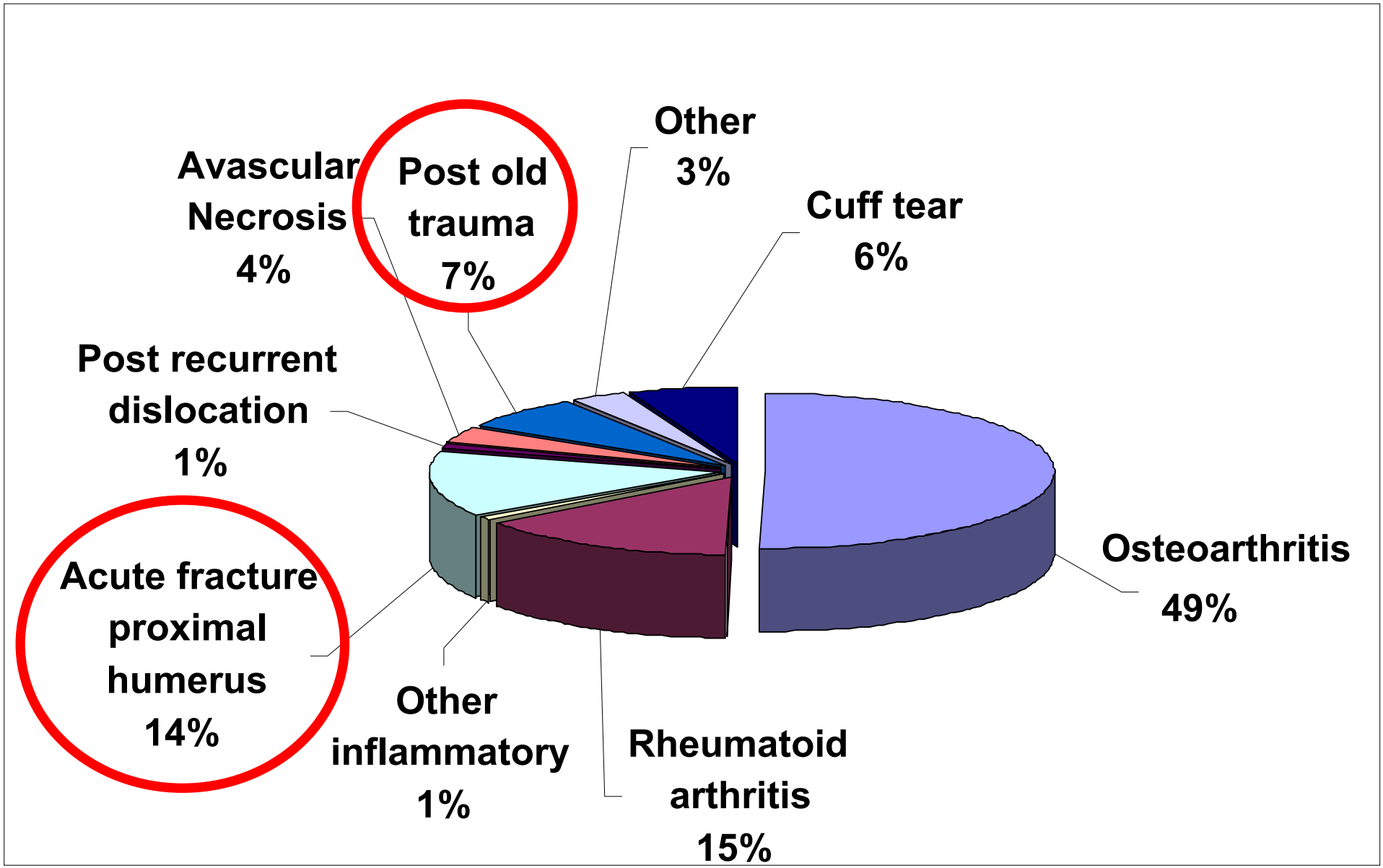
A report of its first 4 years

J CANDAL-COUTO, G GAMBLE[1], T ASTLEY, C BALL, A ROTHWELL[2]

Department of Orthopaedics, North Shore Hospital, Auckland, NZ
[1] Department of Biostatistics, Auckland Medical School, NZ
[2] Department of Orthopaedics, Christchurch Hospital, Christchurch, NZ

BOA 2004

Primary Shoulder Arthroplasty: 686 cases



INDICATIONS & OSS (12-60)

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)		

SURGEON'S WORKLOAD & OSS

Trauma cases only	High volume surgeon	Low volume surgeon
Number of cases	28	45
Mean score	28.1	32.3 *p=0.1048*
Outcome (%)		
• Excellent	14.3 %	11.1 %
• Good	28.6 %	24.4 %
• Fair	35.7 %	31.1 %
• Poor	21.4 %	33.3 %

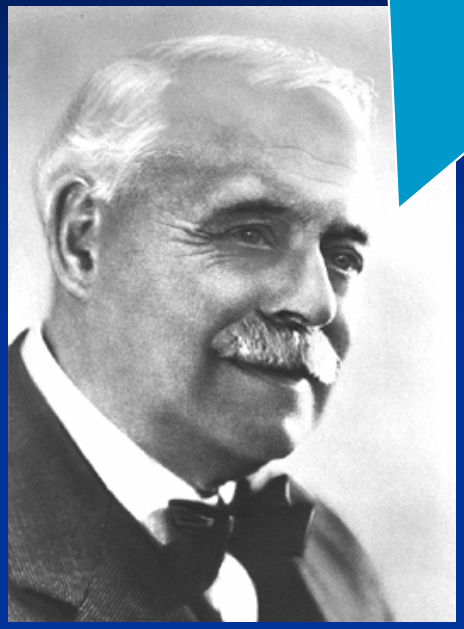
p=0.74

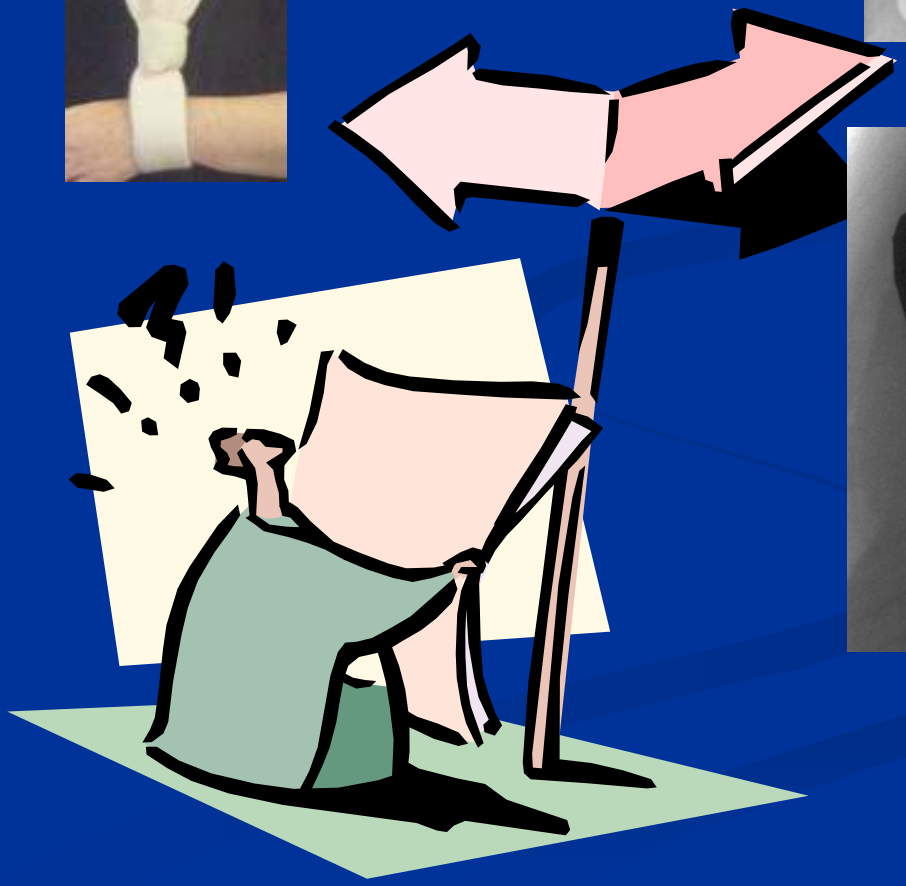
The literature…

- Good pain relief
- Poor / unpredictable function
- Low loosening rate
- Better function if age <70

- *Antuna et al, 2008*
- *Mighell et at 2003*
- *Boileau et al 2002*
- *Langdon et at 1998*
- *Movin et al 1998*
- *Wretemberg et al 1997*
- *Dimakopoulos et al 1997*
- *Goldman et al 1995*
- *Moeckel et al 1992*
- *Neer 1970*

Confused?





4 Meta-analysis

1. Misra A, Kapur R, Maffulli N: Injury Jun 2001
2. Tingart M, Bathis H, Bouillon B et al, Chirurg Nov 2001
3. Handoll HHG, Madhok R: Cochrane Review 2003
4. Lanting B, Macdermid J,Drosdowech D, Faber KJ, JSES 2008

"Data from published literature is inadequate for evidence based decision making with regard to treatment of complex proximal humeral fractures"

Misra A, Kapur R, Maffulli N: Injury Jun 2001

“Scientific evidence for treatment recommendations of displaced proximal humeral fractures is still limited”

Tingart M, Bathis H, Bouillon B et al,
Chirurg Nov 2001

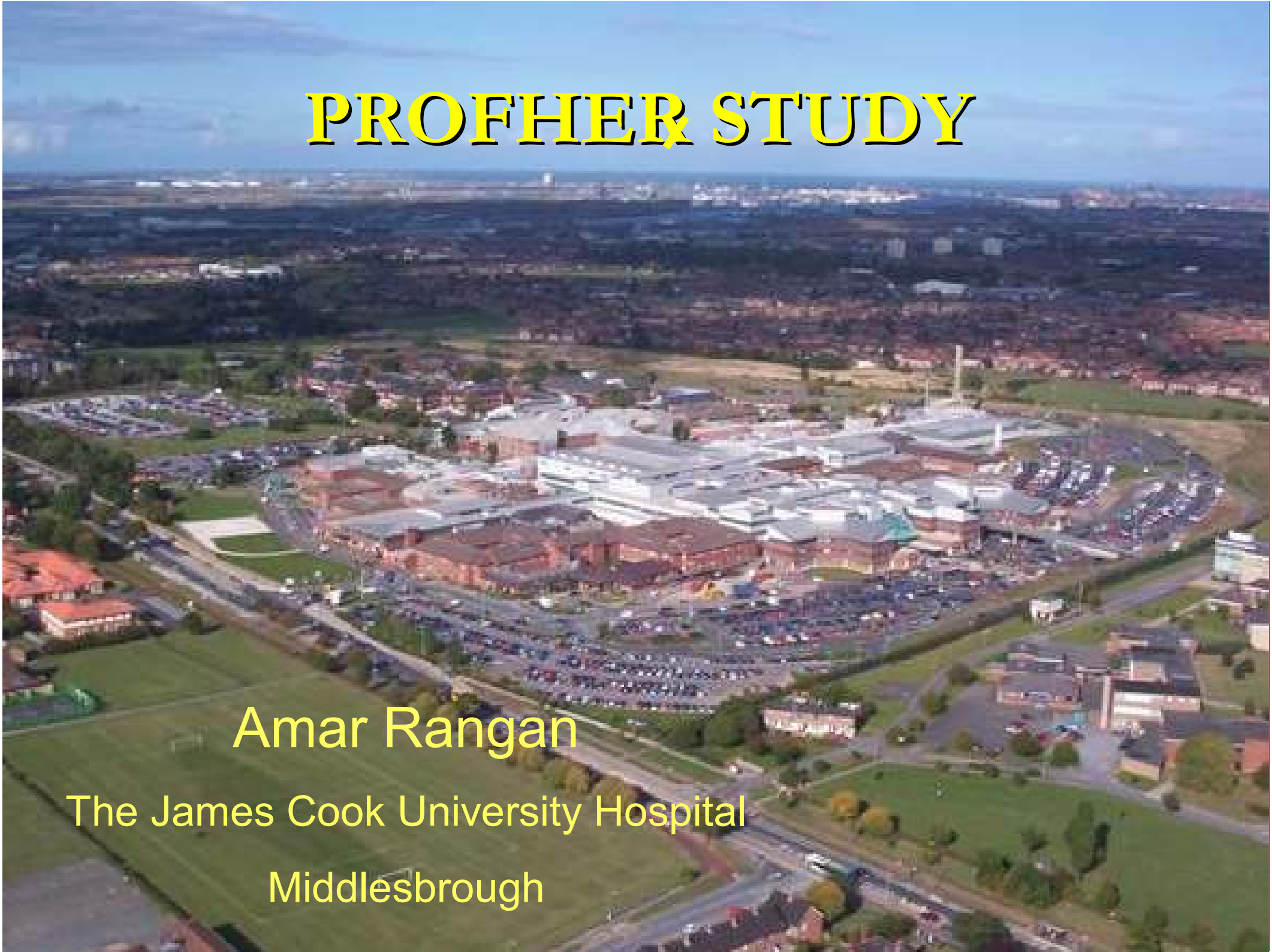
"...there is not enough evidence from presently available trials to determine the best treatment, including surgery, for these fractures"

Handoll HHG, Madhok R: Cochrane review 2003

"The inability to draw conclusions from the current literature, as well as the paucity of quality literature, demonstrates a need for higher quality evidence to enable the clinician to determine the optimal treatment interventions for each fracture"

Lanting B, Macdermid J,Drosdowech D, Faber KJ, JSES 2008

PROFHER STUDY



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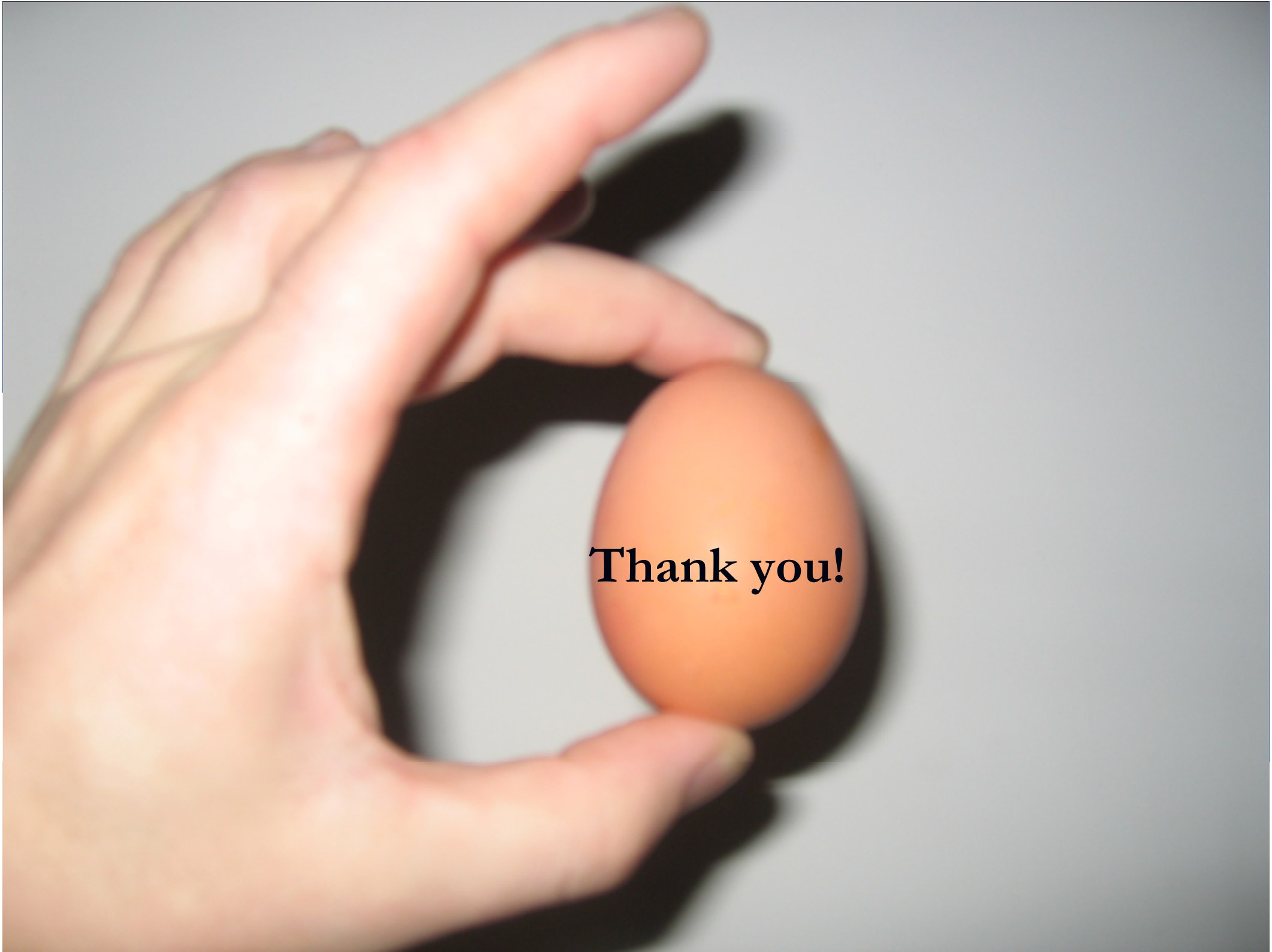
Does Surgery Make a difference?

Risks vs Benefits

POFHER

- £2 million funding by HTA
- Multicenter study, based in North East England
- Prospective
- Randomized
- Inclusion: Is there a treatment dilemma?
  - Group A: Non-operative- Standard regime
  - Group B: Operative- Surgeon's surgical choice


Thank you!

A fixed angle device