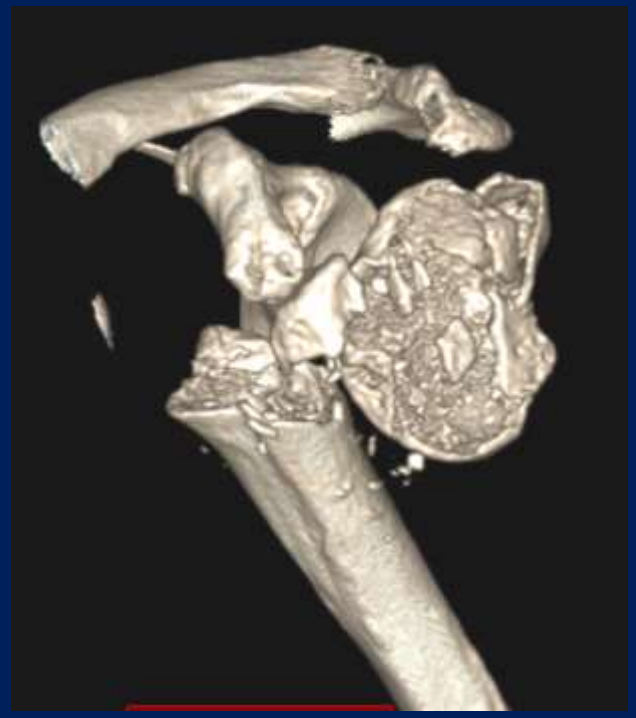
Proximal Humerus Fractures



Evan S Lederman, MD

Clinical Associate Professor of Orthopedic Surgery
University of Arizona College of Medicine - Phoenix

Banner Sports Medicine | Banner University Medicine

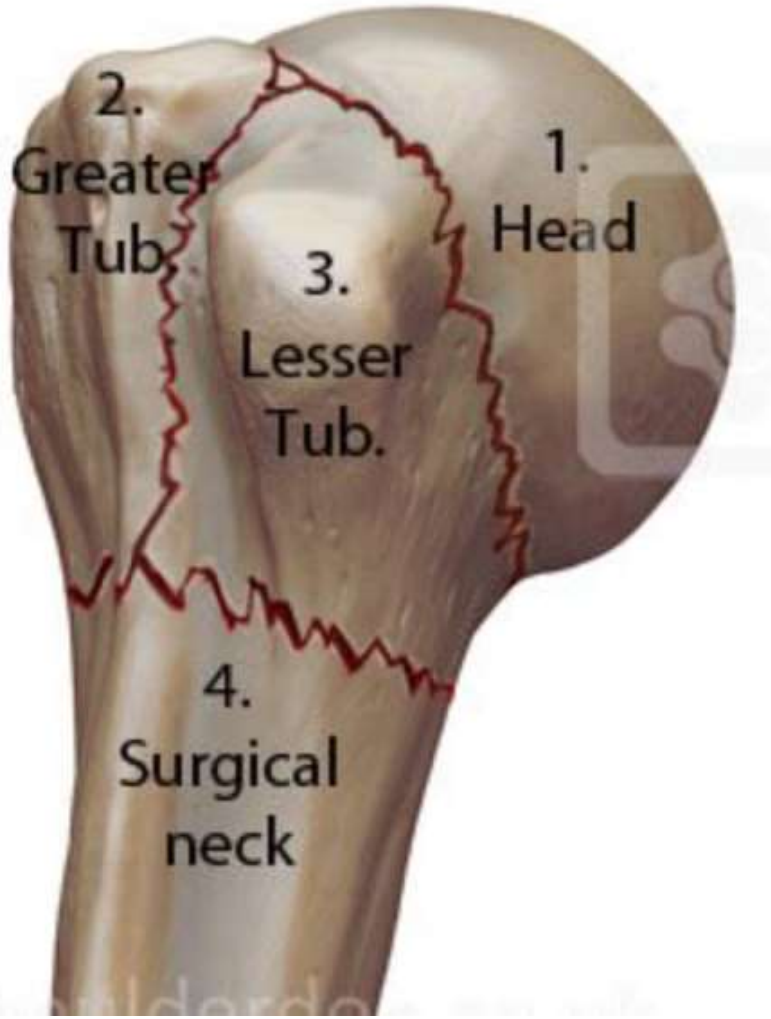
I (and/or my co-authors) have something to disclose.

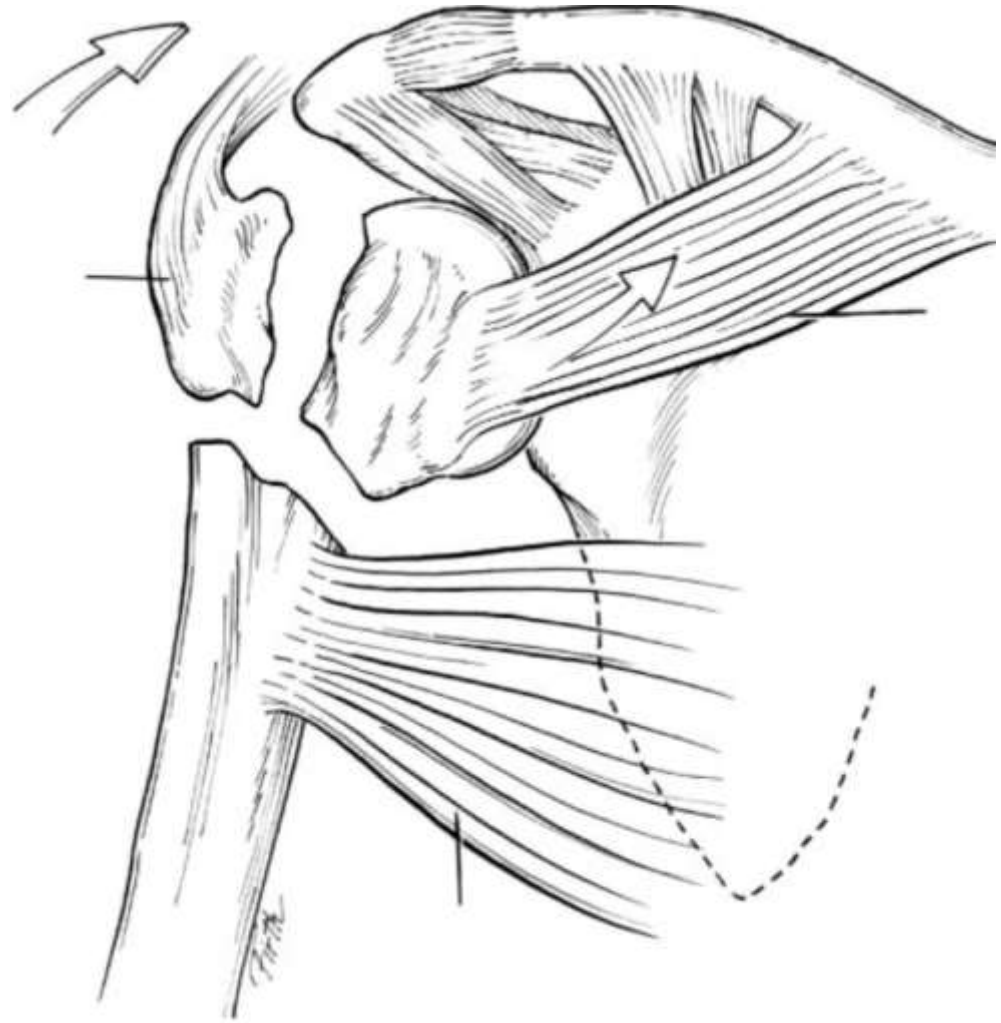
Detailed disclosure information is available via:

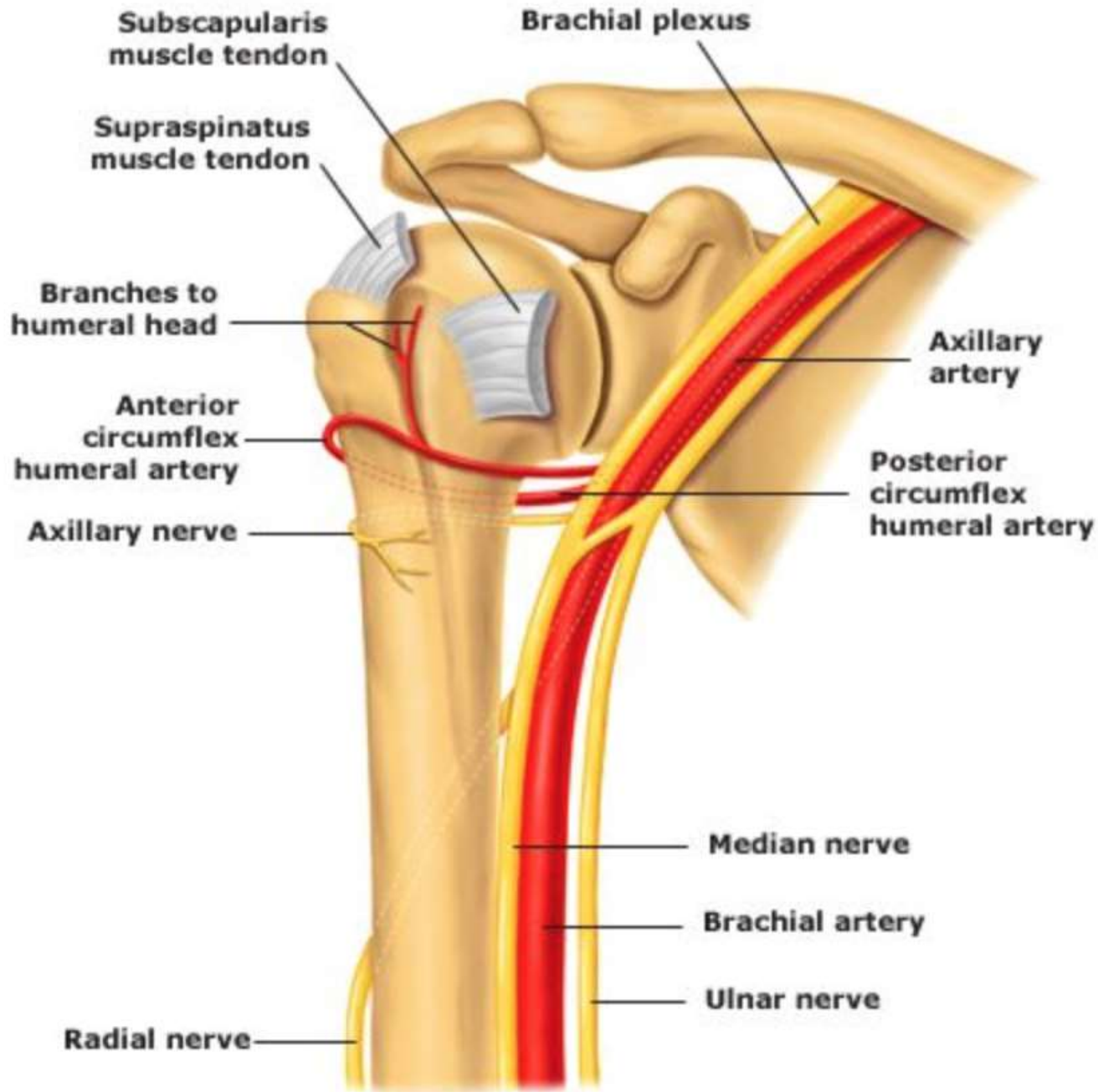
"My Academy" app;

Printed Final Program; or

AAOS Orthopaedic Disclosure Program on the AAOS website at http://www.aaos.org/disclosure


2.
Greater
Tub.
1.
Head
3.
Lesser
Tub.
4.
Surgical
neck




Subscapularis muscle tendon
Brachial plexus
Supraspinatus muscle tendon
Branches to humeral head
Axillary artery
Anterior circumflex humeral artery
Posterior circumflex humeral artery
Axillary nerve
Median nerve
Brachial artery
Ulnar nerve
Radial nerve

Options

Classifying Proximal Humerus Fractures Neer…

Neer Classification

“Part”= 45⁰ Angulation

= > 1cm Displacement

“Parts”/Segements

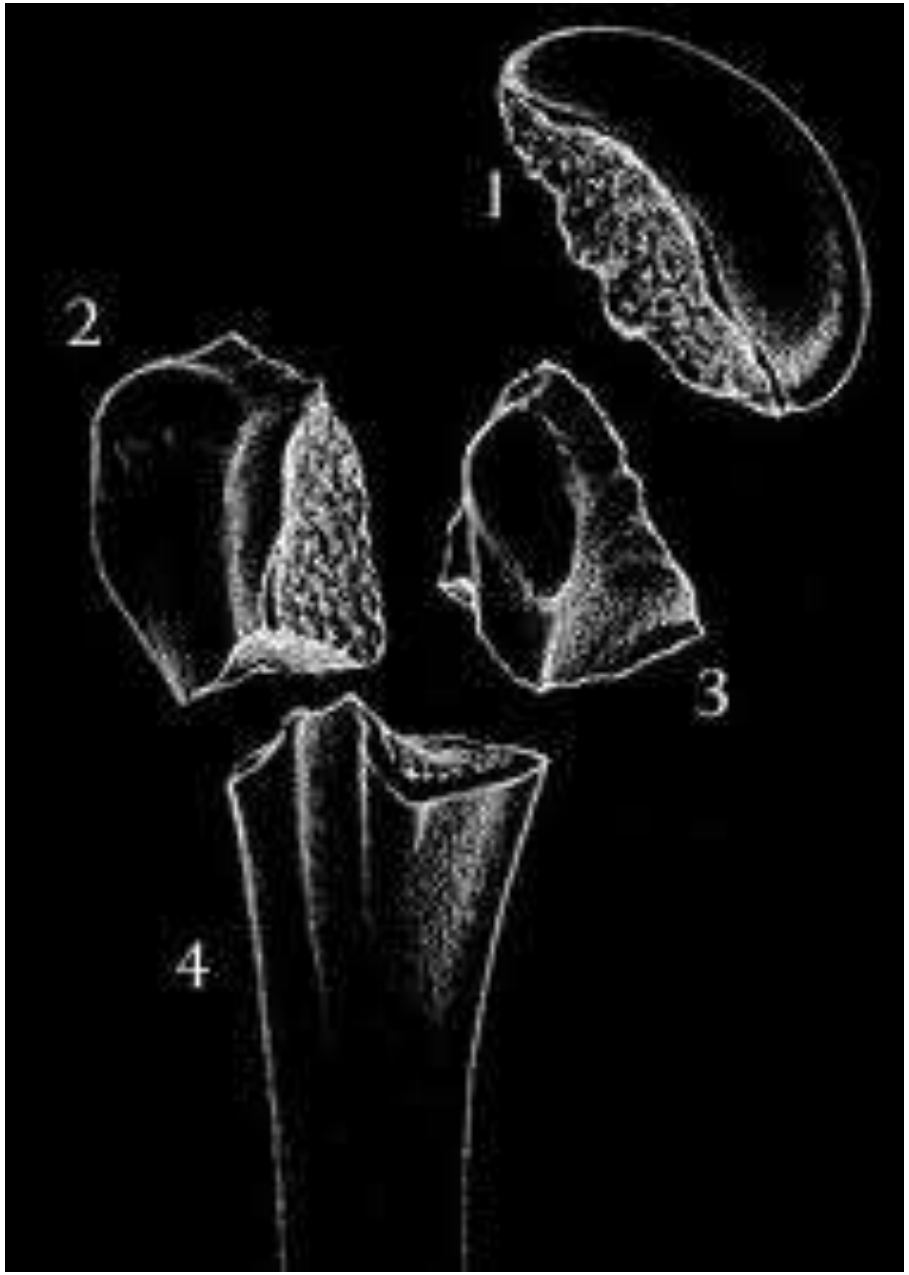
: Humeral Head (1)

: Greater Tuberosity (2)

: Lesser Tuberosity (3)

: Humeral Shaft (4)

*** Can also have Head Split**



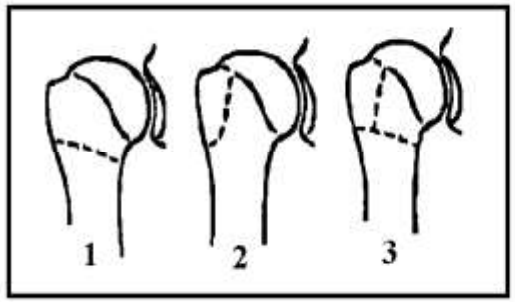
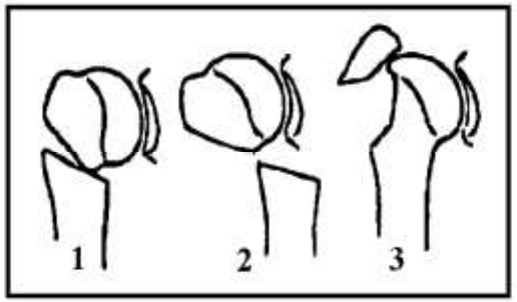
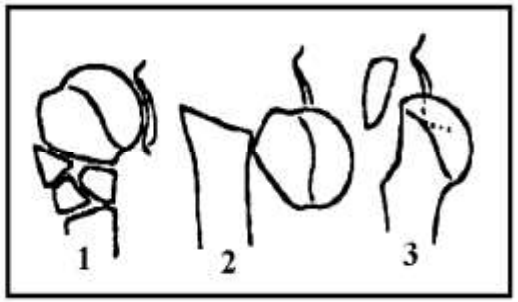
Banner Health

AO Fracture Classification 2-Part

Based on:

- Location
- Presence of impaction
- Angulation
- Translation
- Comminution of surgical neck
- Presence of dislocation

A : Extraccapsular or two segments involved

A1 : Undisplaced	A2 : Displaced	A3 : Displaced, with additional complicating factor
		
1. Surgical neck 2. Tuberosity 3. Surgical neck and tuberosity	1. Surgical neck angulated 2. Surgical neck completely displaced 3. Tuberosity displaced	1. Surgical neck and metaphyseal comminution 2. Surgical neck with dislocation 3. Tuberosity displaced with dislocation

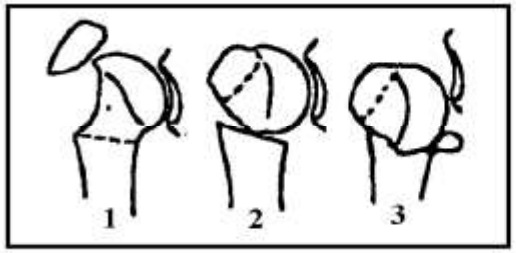
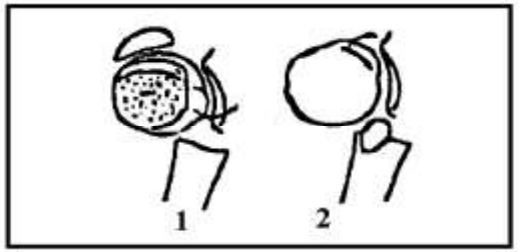
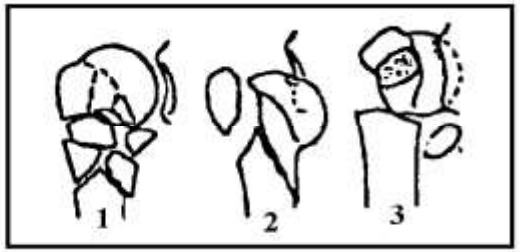
Banner Health

AO Fracture Classification 3-Part

Based on:

- Location
- Presence of impaction
- Angulation
- Translation
- Comminution of surgical neck
- Presence of dislocation

B : Partially intracapsular or three segments involved

B1 : One of three segment undisplaced	B2 : Three segments displaced	B3 : Three segments displaced with additional complicating factor
		
1. Tuberosity displaced, surgical neck undisplaced 2. Surgical neck displaced, tuberosity undisplaced 3. Surgical neck varus impaction, lesser tuberosity displaced	1. Surgical neck and greater tuberosity displaced 2. Surgical neck and lesser tuberosity displaced	1. Metaphyseal comminution involving greater and lesser tuberosity 2. Surgical neck and greater tuberosity displaced with dislocation 3. Surgical neck and lesser tuberosity displaced with dislocation

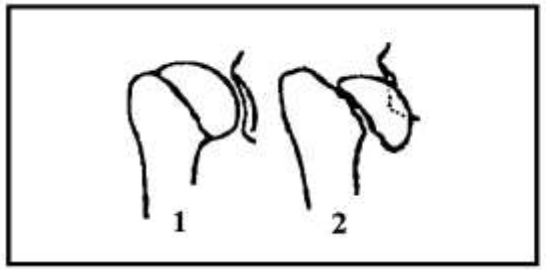
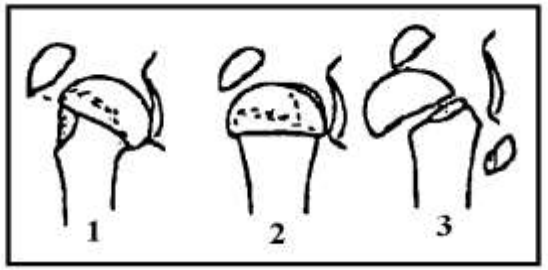
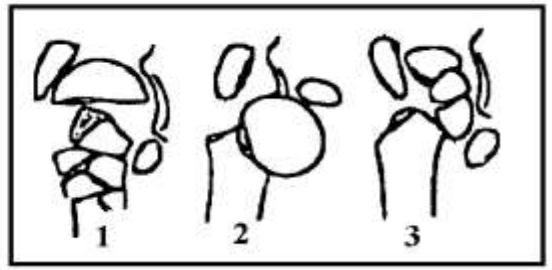
Banner Health

AO Fracture Classification 4-Part

Based on:

- Location
- Presence of impaction
- Angulation
- Translation
- Comminution of surgical neck
- Presence of dislocation

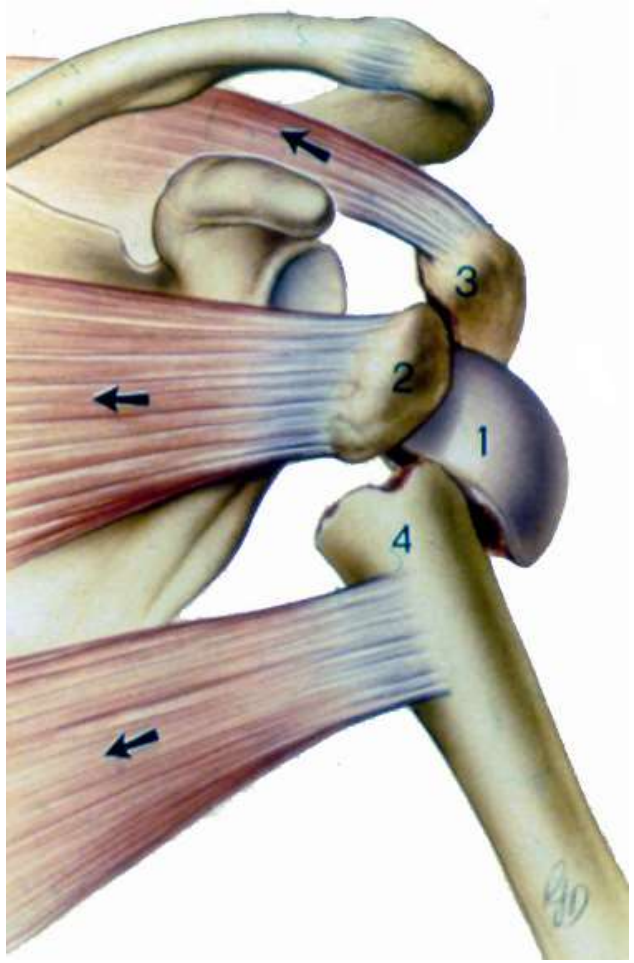
C : Intracapsular or four segments involved

C1 : Anatomical neck	C2 : Four segments	C3 : Four segments displaced with impacted or displaced additional complicating factor
		
1. Anatomical neck undisplaced or displaced 2. Anatomical neck dislocated	1. Moderate valgus impaction 2. Severe valgus impaction tuberosity displaced 3. Anatomical neck and tuberosities displaced	1. Anatomical neck and tuberosities displaced, metaphyseal comminution 2. Anatomical neck and tuberosities displaced, dislocation 3. Anatomical neck and tuberosities displaced, comminutive articulation

Epidemiology

- 49% minimally displaced
  - Not surgically treated

- **28% two-part surgical neck fractures**
- 9% three-part GT-SN fractures
- 3% four-part fractures
- *…Most displaced fractures are "fixable"*
- *…Over 50% of "surgically fixable" fractures are 2 part surgical neck fractures*



Court-Brown *et al*, Acta Orthop Scand 2001

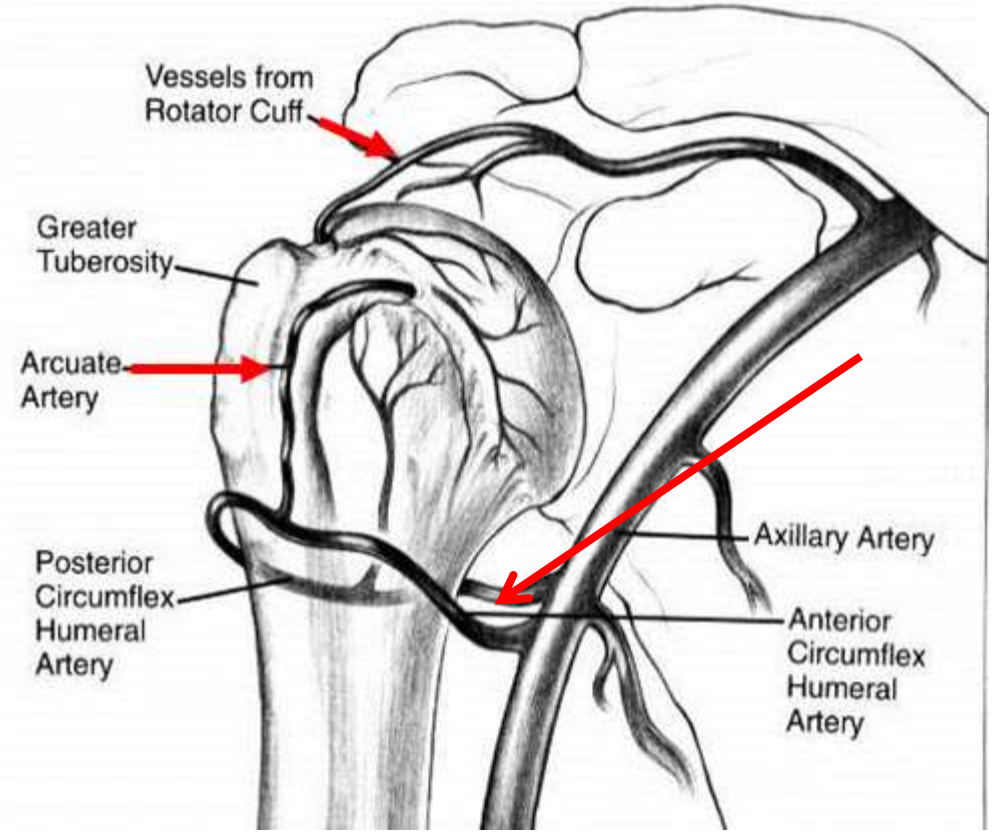
Classifying Proximal Humerus Fractures

Neer Classification

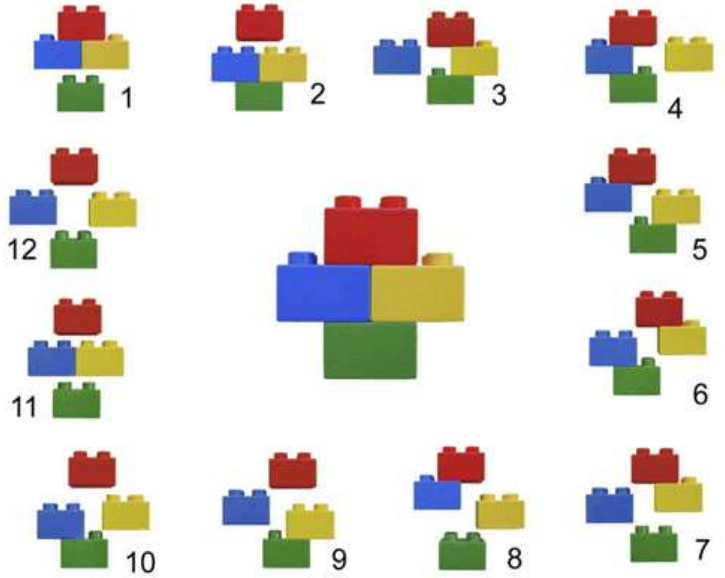
	2 part	3 part	4 part
Anatomical neck			
Surgical neck			
Greater tuberosity			
Lesser tuberosity			
Fracture dislocation anterior			
Fracture dislocation posterior			

Predictors of humeral head ischemia after intracapsular fracture of the proximal humerus

R. Hertel, A. Hempfing, M. Stiehler, and M. Leunig, *Berne, Switzerland*



Binary Classification System for Proximal Humerus Fractures



Red – Articular Cartilage/Head

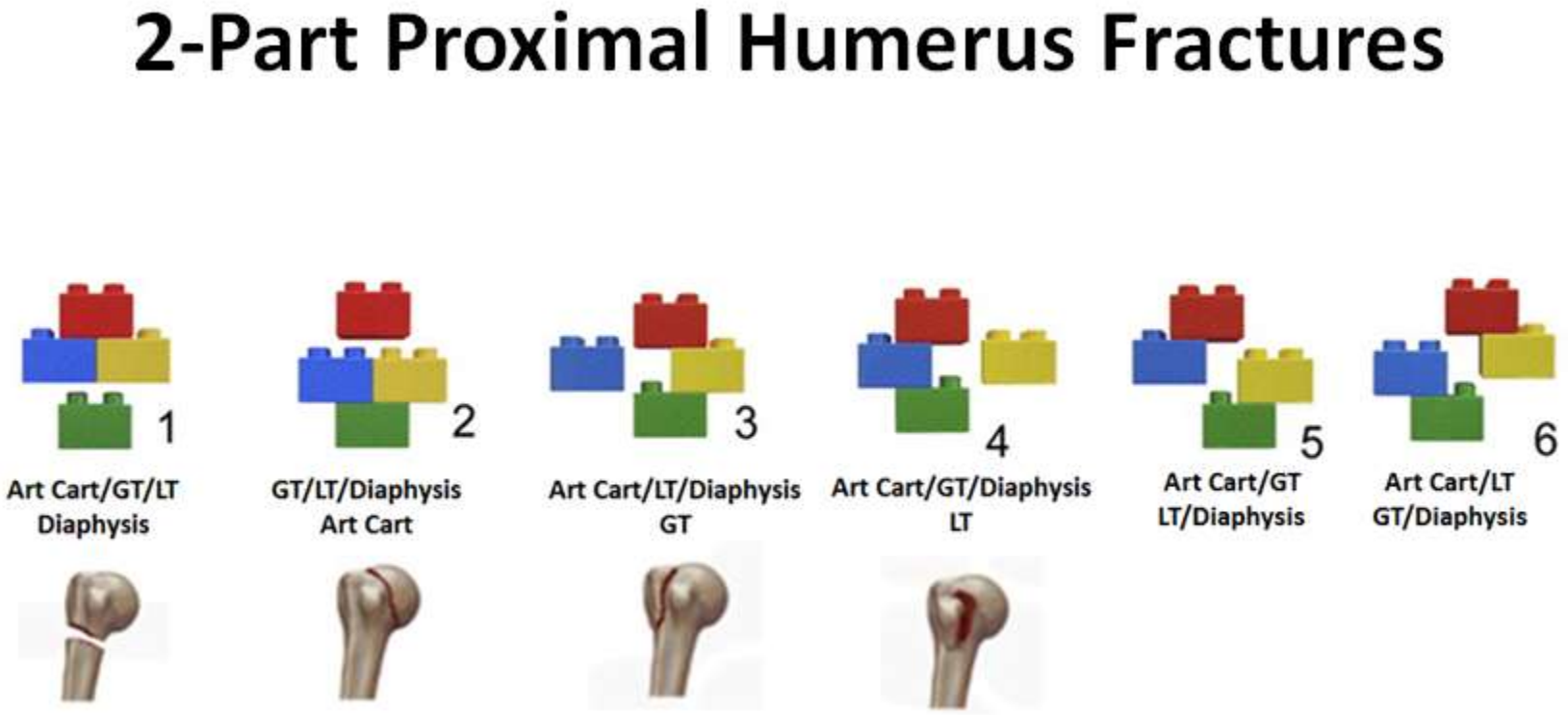
Blue – Greater Tuberosity

Yellow – Lesser Tuberosity

Green – Diaphysis of Humerus

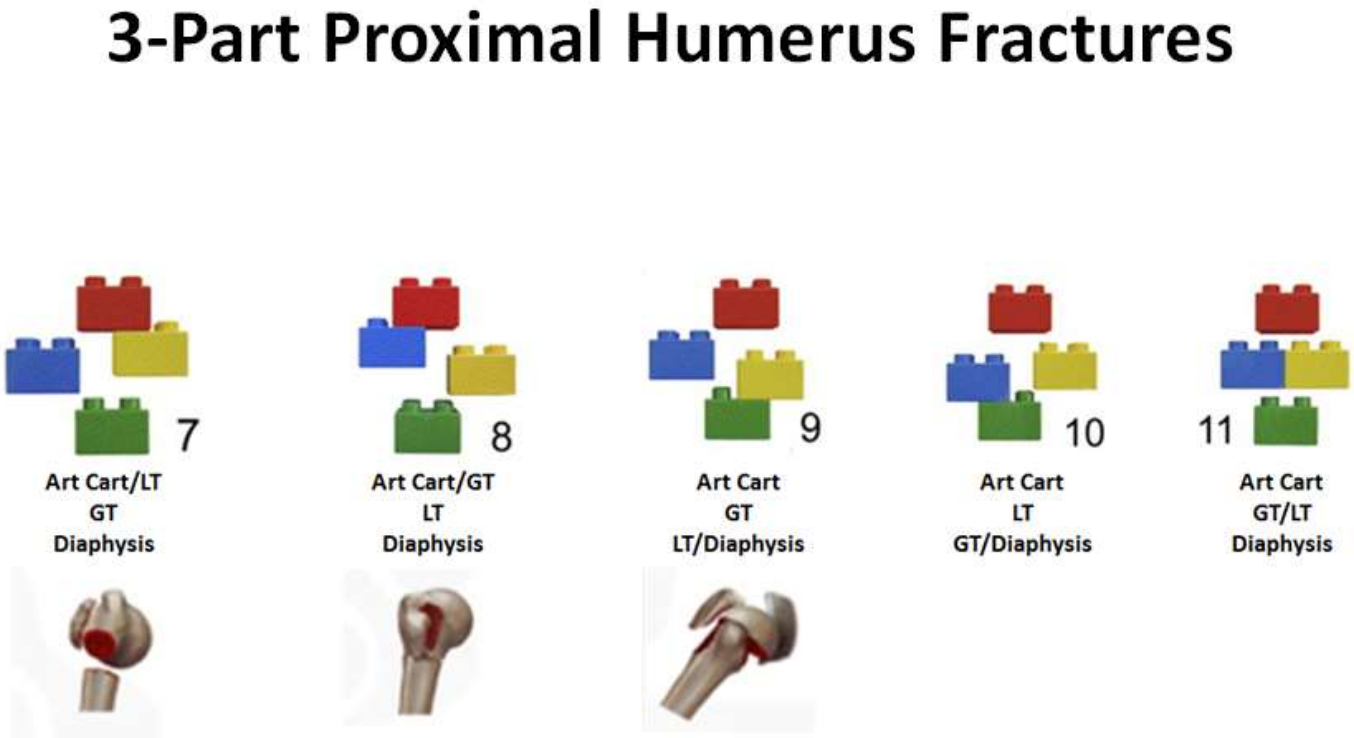
6

- ***Classifying Proximal Humerus Fractures Combining Classifications***



5

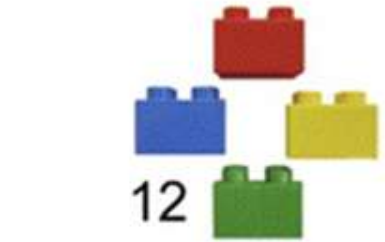
- ***Classifying Proximal Humerus Fractures Combining Classifications***



1

- ***Classifying Proximal Humerus Fractures Combining Classifications***

4-Part Proximal Humerus Fractures



Art Cart
GT
LT
Diaphysis

Head-Split

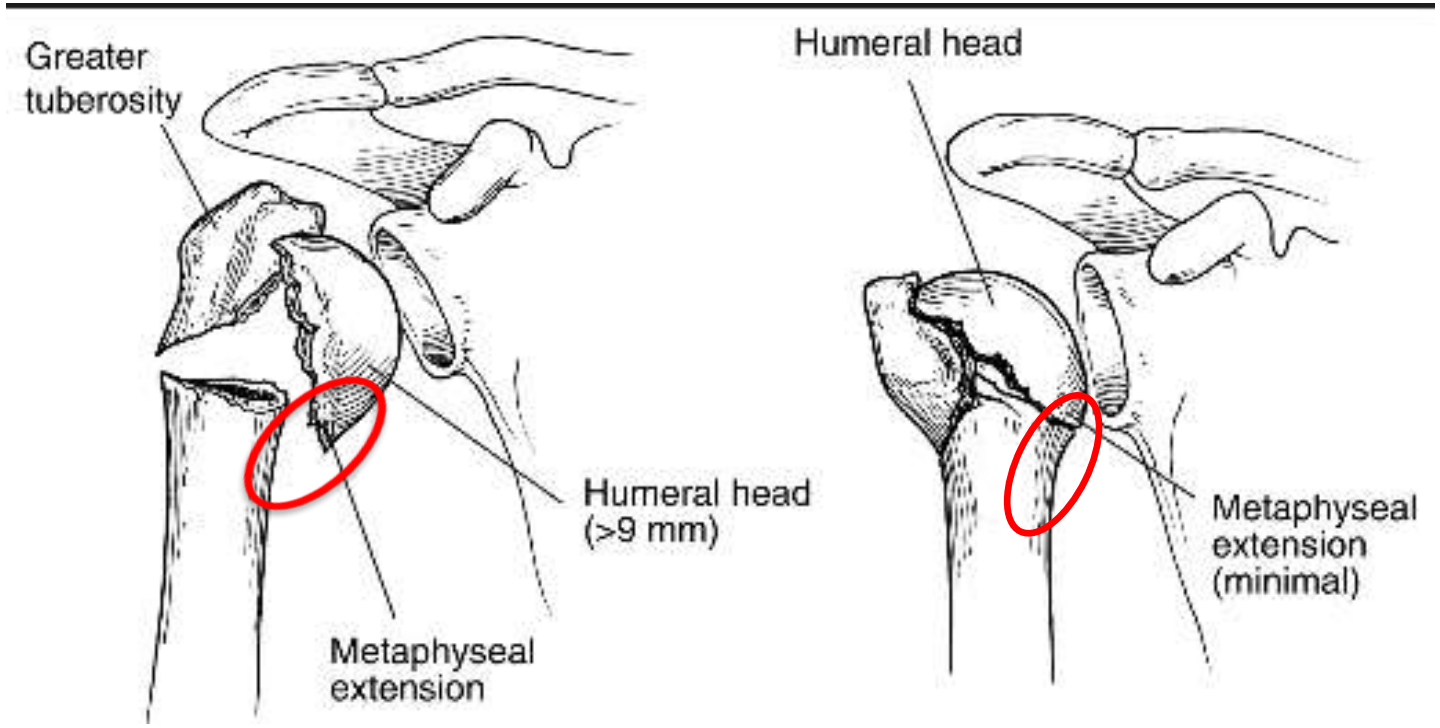
Treatment…

"This is a bad injury"

"Your shoulder will never be the same no matter what we do…"

Determining Treatment…

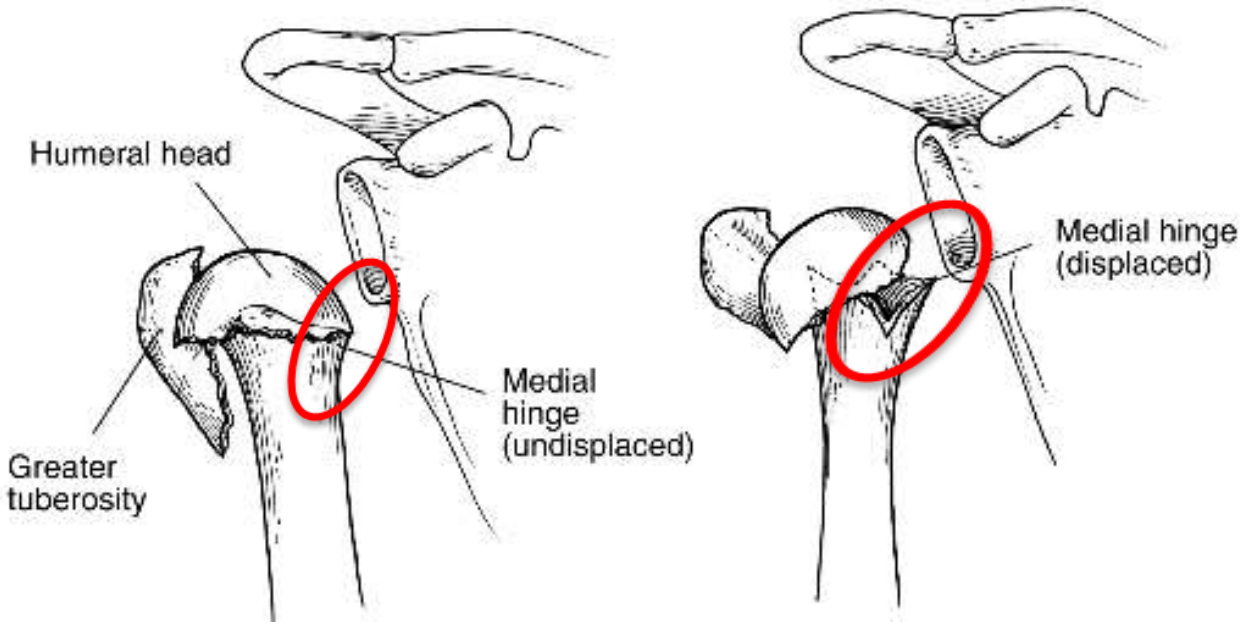
- **Metaphyseal Extension < 5mm = Ischemia**



Hertel et al

Determining Treatment…

- **Medial Hinge displaced > 5mm = Ischemia**



Hertel et al

Avascular Necrosis

Stage 1

Stage 2

Stage 3

Stage 4

Stage 5

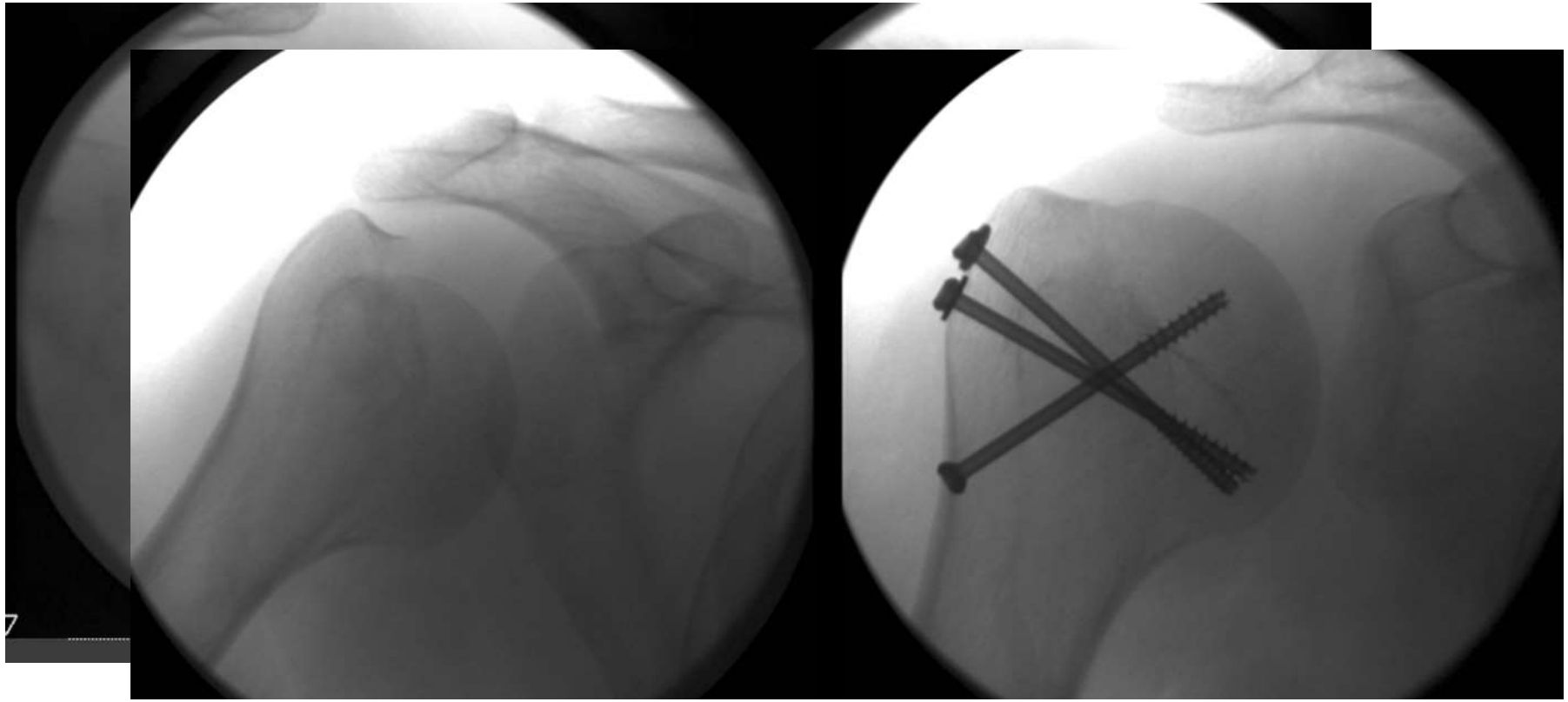
Treatment of Acute Fractures of the Proximal Humerus

- Non-operative (***VAST MAJORITY***)
  - Sling immobilization or 30-degree pillow brace (3-6 weeks)
  - Early ROM (usually begin at 3 weeks)
- Percutaneous Fixation
- ORIF/Osteosynthesis
  - Proximal humeral plates
    - Standard small frag/large frag
    - Contoured proximal humeral locking plates
  - Intramedullary nail
  - Suture/wire fixation of tuberosity fragments
  - Suture Bridge (ATS) for greater tuberosity fracture
- Shoulder Arthroplasty
  - Hemiarthroplasty with tuberosity osteosynthesis
  - Reversed Prosthesis with tuberosity osteosynthesis

Two-Part PHF - Pin

Younger patients with good healing potential

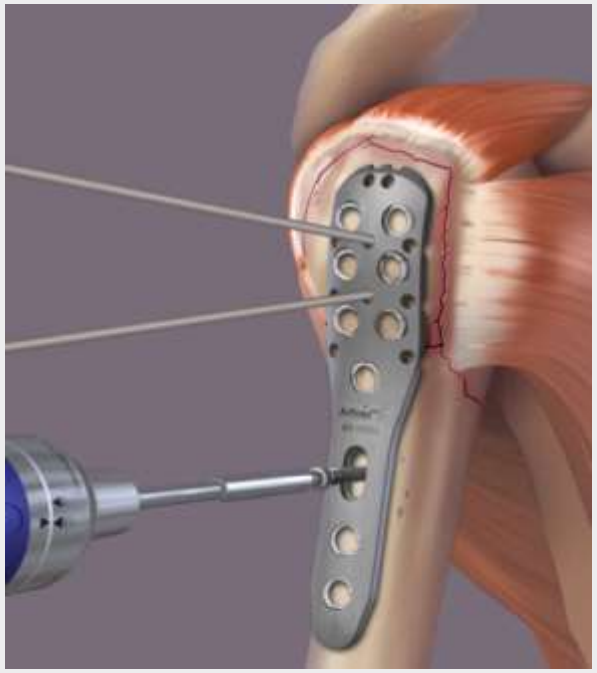
Older patients with co-morbidities



2, 3 & 4 Part PHF - Plate

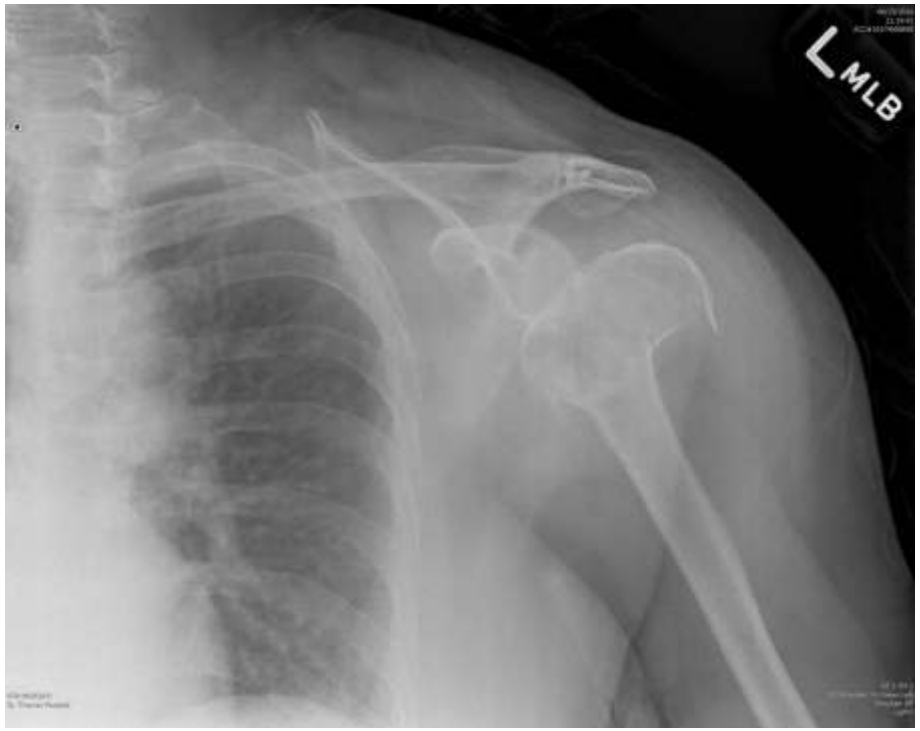
- Good Bone Quality
- Younger patients even with risk of AVN

  * Hemi/TSA/Reverse has better outcome with healed/"some" tuberosity



3 & 4 Part/Head Split PHF - Hemi

- Healthy patient with high risk of AVN
- Tuberosity repair/healing important



3 & 4 Part/Head Split - Reverse

- Displaced/Comminuted 3 Or 4 Part Proximal Humerus Fractures
- Fractures With Irreparable Rotator Cuff Or Greater/Lesser Tuberosity
- Fractures With Poor Bone Quality Or In Patients With Comorbidities That May Lead To Non-union Or Avascular Necrosis
- Failed Hemiarthroplasty/Suture Plate
  - *Potentially More Predictable Outcome In OLDER Patients
  - High Complication Rate

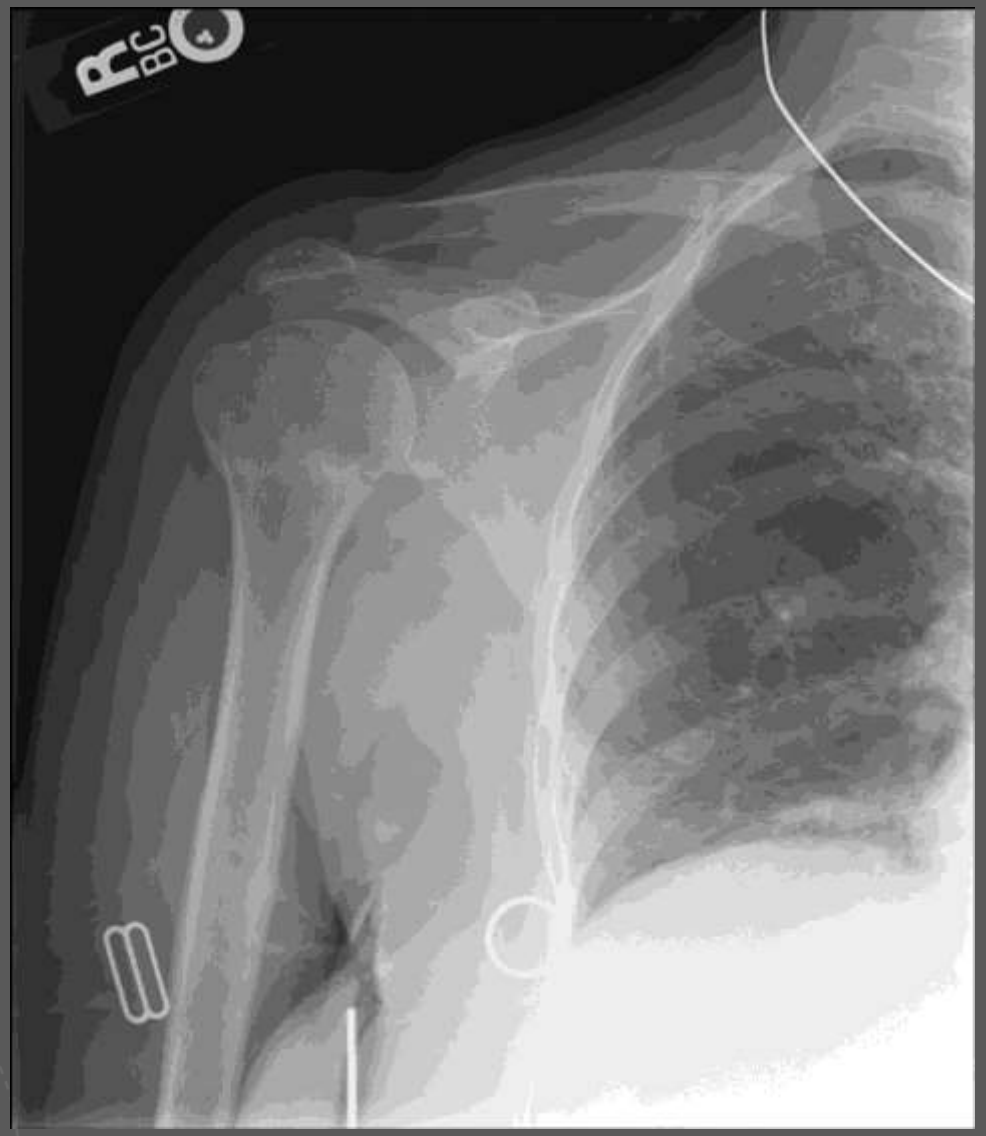
CASE

58 RHD female Dentist. Fell skiing.

3 DAYS AFTER INJURY

10 DAYS

18 WEEKS



18 WEEKS

CASE

- 85 y.o. Male, RHD
- Fall at home 2 days ago
- Placed in splint at urgent care
- Married, drives, independent in all ADL’s
- Walks daily and fixes things around the house

- PMH-CABG, DVTs
- Coumadin, Synthroid, Effexor, Lipitor, Trental
- Cardiologist says Coumadin cannot be stopped.

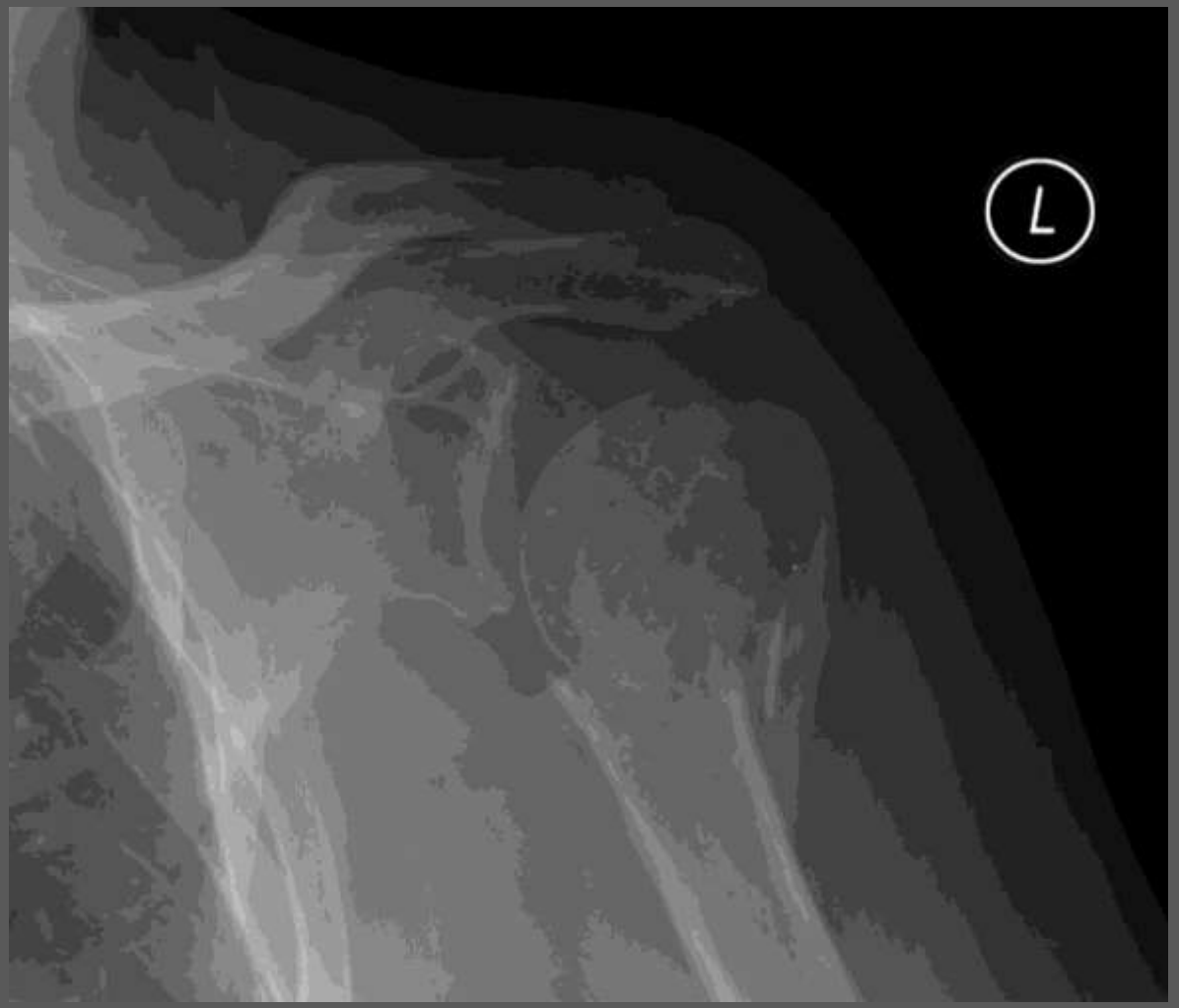
2 DAYS POST INJURY

9 days

16 days

30 days

84 days



84 DAYS

Banner Health

Non-operative Protocol
Sling 6 Weeks

Week 1

- Sleep sitting up
- Nothing under Elbow
- Ice
- Pain Meds
- Minimize NSAIDs

Week 2-3

- Passive ROM hand, Wrist and Elbow
- Start Pendulums

Week 3-6

- Home Pulley
- Pendulums
- AAROM
  - Elevation and ER

Plain Xray at week 1, 2, 3 and 6

Non-operative Protocol

Week 6-12

- AROM
- Initiate PT
- Allow ADL's

Week 12-16

- Progressive resistance
- Gradual return to normal daily activities

Week 16

- Advance to full activity
- Home PRE's

Consider Surgical Intervention at these timepoints

Week 1-6

Loss of satisfactory reduction

Week 12-24

Stiffness Unresponsive to Treatment

Week 24+

- Mechanical Pain
- Persistent Pain
- Persistent Stiffness
- Non-Union
- Malunion
- AVN
- DJD

CASE

- 52 Fall at home
- Working
- Healthy

Displaced 3 part fracture with head split


1966 M
49
EFT
PS BV300


66 M
T

Case

- 54 Female. RHD. Fall at home 4 days ago. Isolated injury. Seen in ER. Placed in sling.
- PMH: HTN, MVP, Hyper chol
- Meds: Lisinopril, Lipitor
- SH: Neg, Retired
- PE: 5’8”, 212lbs


PA
8/2


PA
8/2


Y: 0.00 mm Z: 0.00 mm
4096
2048
0
10 day post-op

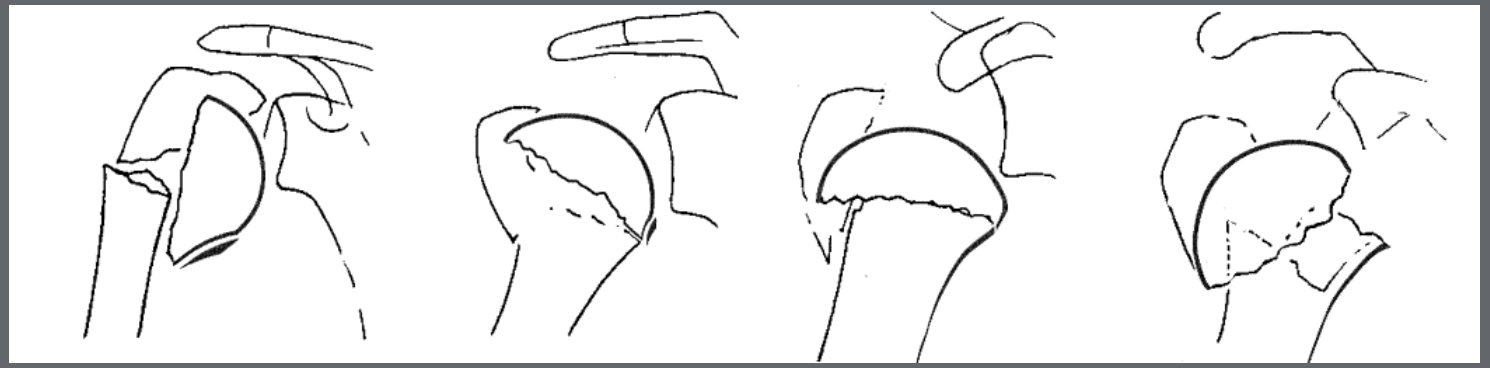

1
4096
2048
0
4 months post op

4 months post-op

Arthroplasty Indications

- 4part fractures
  - Older patients
  - Osteopenic bone
  - Anatomic neck component
- 3part fractures
  - Older/osteopenic patients
- Head-splitting fractures
- Impaction fracture of head >40%
  - Associated with locked dislocation

- Predictors of humeral head ischemia after intracapsular fracture of the proximal humerus
  - R. Hertel, A. Hempfing, M. Stiehler, and M. Leunig, Berne, Switzerland
  - J Shoulder Elbow Surg July/August 2004
  - Metaphyseal fragment < 8mm
  - Metaphyseal Hinge



Techniques in Shoulder & Elbow Surgery 1(2):86-109, 2000 © 2000 Lippincott Williams & Wilkins, Inc., Philadelphia

TECHNIQUE

Tuberosity Osteosynthesis and Hemiarthroplasty for Four-Part Fractures of the Proximal Humerus

PASCAL BOILEAU, M.D.
Department of Orthopaedic Surgery
Hôpital de L'Archet—University of Nice
Nice, France

GILLES WALCH, M.D.
Department of Orthopaedic Surgery
Clinique Ste. Anne Lumière
Lyon, France

SUMANT G. KRISHNAN, M.D.
Department of Orthopaedic Surgery
Hôpital de L'Archet—University of Nice
Nice, France

- **Seminal publication in 2000 introducing technique in HA for tuberosity reconstruction**
- **NOT with a Fracture Prosthesis**
- **Most widely used technique today**

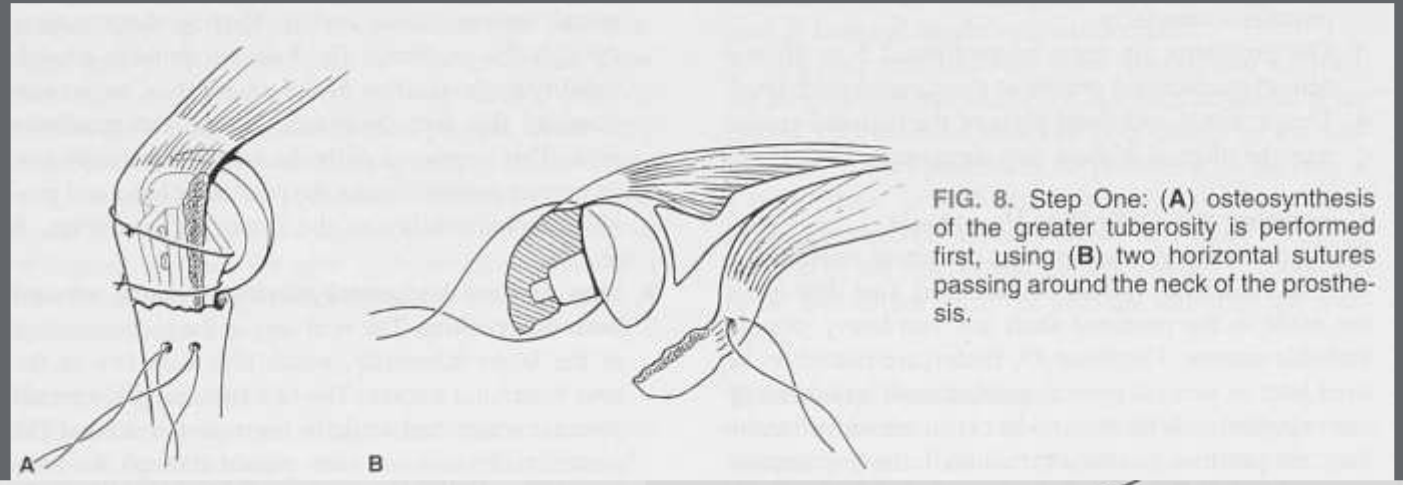


FIG. 8. Step One: (**A**) osteosynthesis of the greater tuberosity is performed first, using (**B**) two horizontal sutures passing around the neck of the prosthesis.

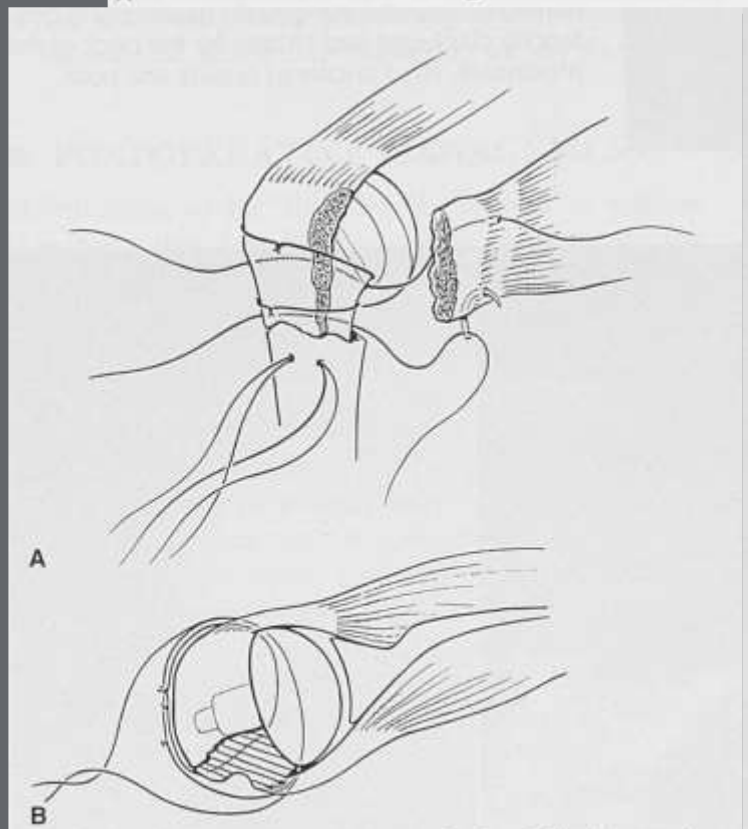


FIG. 10. Step Two: (**A**) osteosynthesis of the lesser tuberosity is then performed using the two remaining horizontal sutures, (**B**) passing again around the neck of the prosthesis and "closing the book."

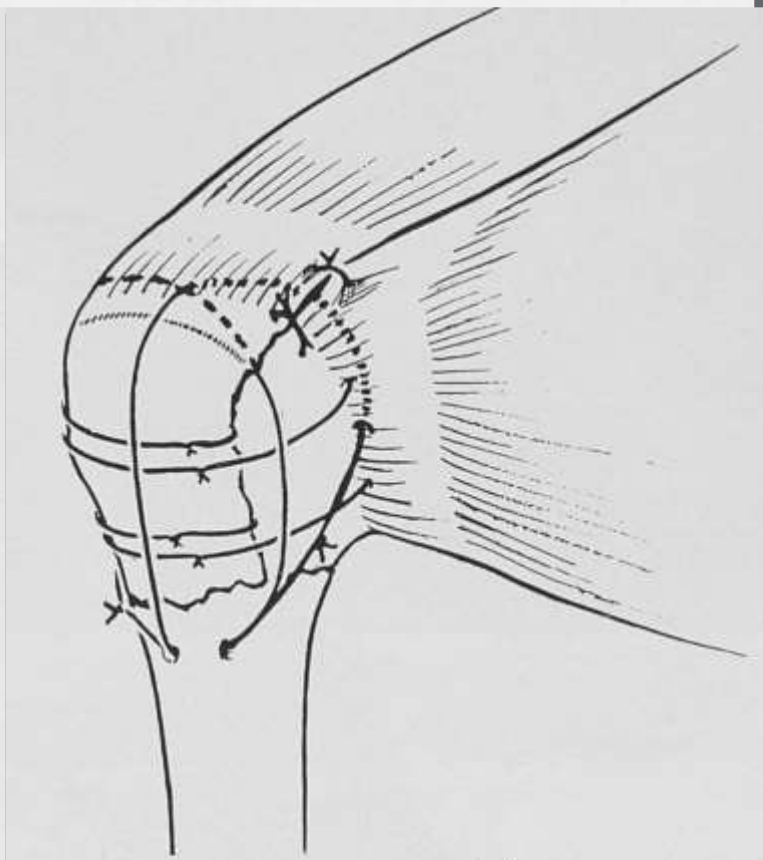
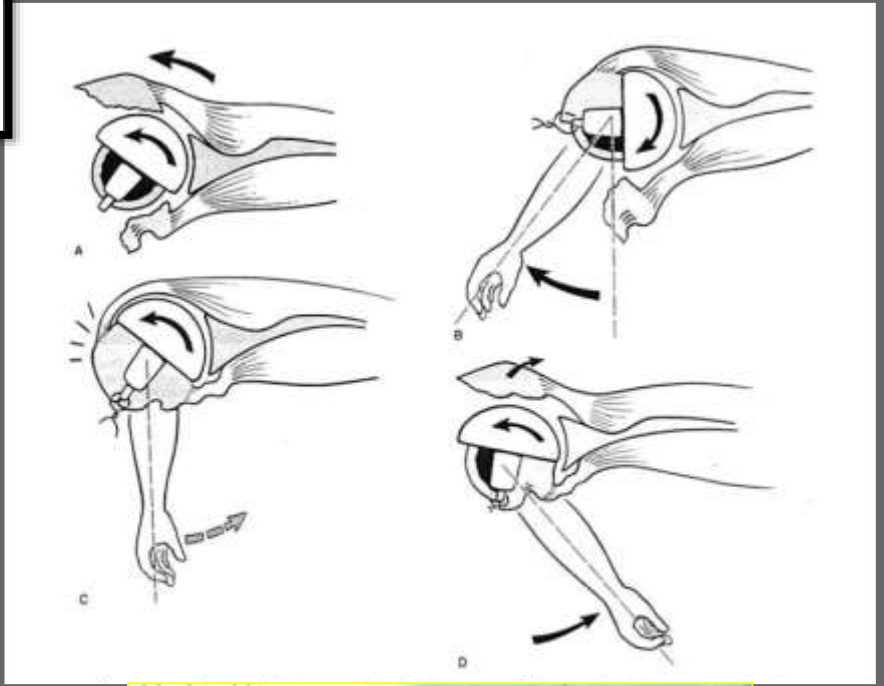


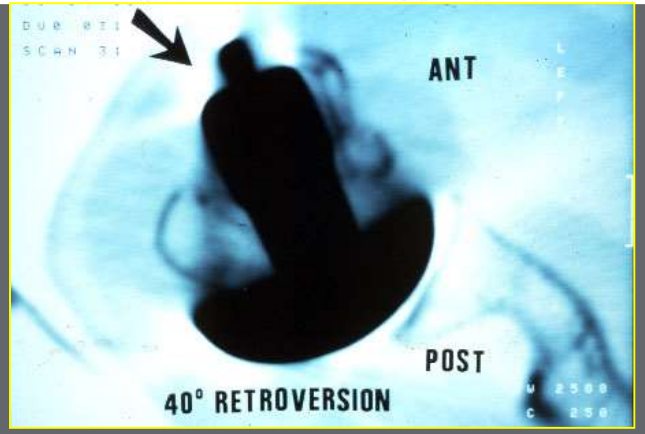
FIG. 11. Step Three: the two vertical sutures are passed in the anterosuperior and posterosuperior cuff using a tension-band technique (final aspect).

Tuberosity malposition and migration: Reasons for poor outcomes after hemiarthroplasty for displaced fractures of the proximal humerus

P. Boileau, S. G. Krishnan, L. Tinsi, G. Walch, J. S. Coste, and D. Molé, *Nice, France*

- 66 patients with mean age of 66 years
- **Patients did much better with healed tuberosities**
- **Prosthetic design was important in outcome!**
  - **Standard prothesis = 50% OF Greater Tuberosity migration**
  - **Fracture prosthesis = 20% of Greater Tuberosity migration**





Does A "Fracture" Prosthesis Help??

- **Purpose:**

  To compare a standard humeral stem with a fracture-specific humeral stem in HA for the treatment complex humerus fractures

  - **The GT was healed anatomically in 45% of the patients in standard stem and 87% of those in FX stem**
  - Function much better in Fracture Stems (FF 136° vs 113° and ER 34° vs 23°) ($P < .0001$)
  - Patients >75 years did worse with both stem types

- **Conclusions:**
  - Better Function with Healed Tuberosities
  - **The use of a prosthesis designed to reconstruct the tuberosities resulted in dramatically improved FUNCTION**

J Shoulder Elbow Surg (2013) 22, 1495-1506

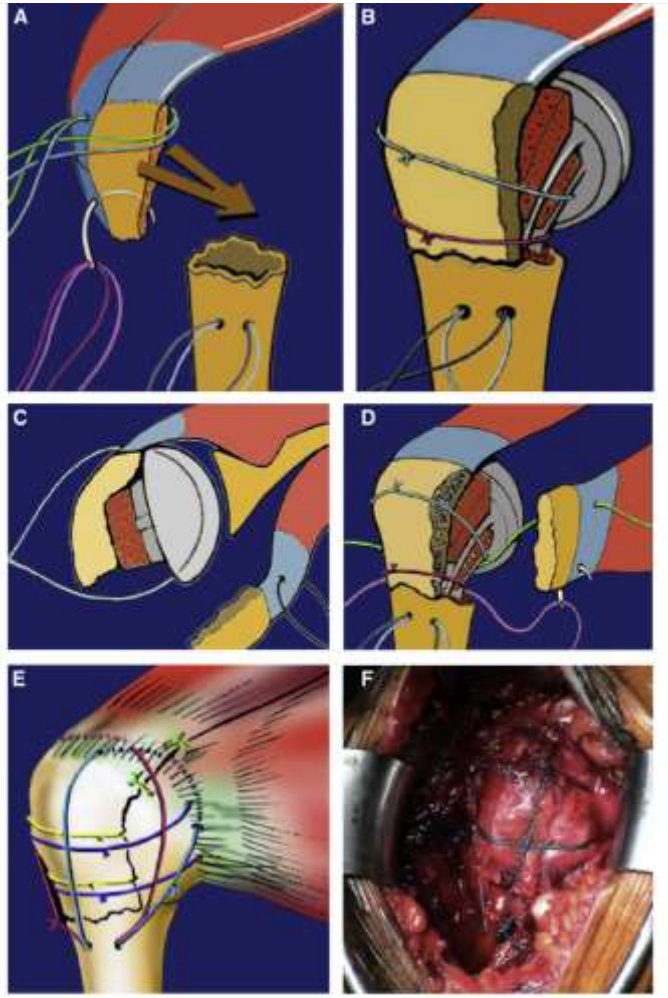
ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Can surgeons predict what makes a good hemiarthroplasty for fracture?

Pascal Boileau, MD[a,*], Matthias Winter, MD[b], Alec Cikes, MD[c], Yung Han, MD[a], Michel Carles, MD, PhD[d], Gilles Walch, MD[e], Daniel G. Schwartz, MD[a]



Suture/Implant Configurations

Baumgartner et al. Journal of Orthopaedic Surgery and Research 2011, 6:36
http://www.josr-online.com/content/6/1/36

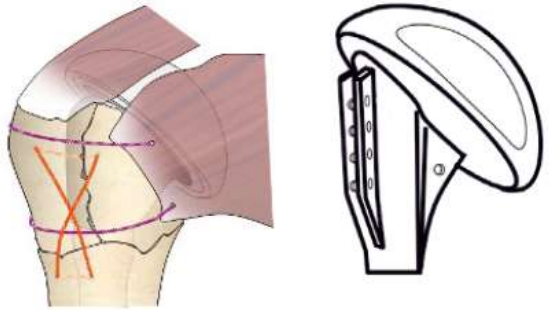
JOURNAL OF ORTHOPAEDIC SURGERY AND RESEARCH

REVIEW Open Access

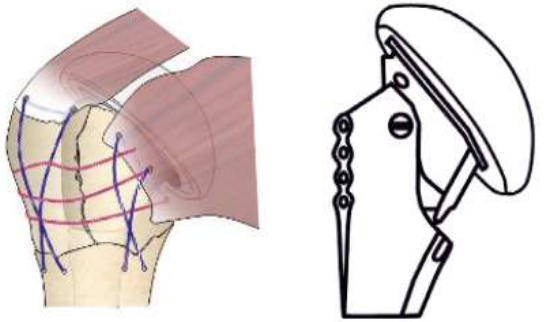
Review of fixation techniques for the four-part fractured proximal humerus in hemiarthroplasty

Daniel Baumgartner[1*], Betsy M Nolan[2], Robert Mathys[3], Silvio Rene Lorenzetti[4] and Edgar Stüssi[5]

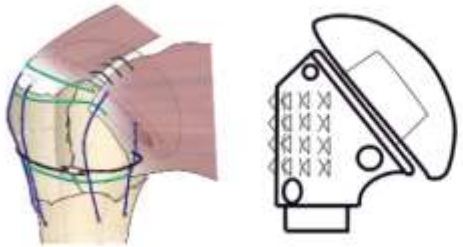
(Frankle and Mighell 2004)



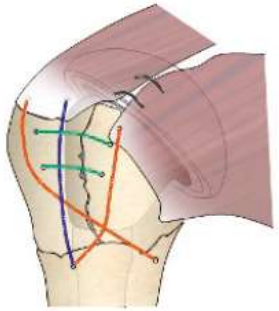
Voigt 2007



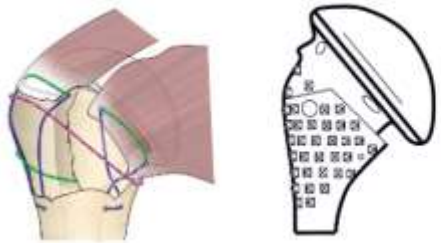
Reuther 2008



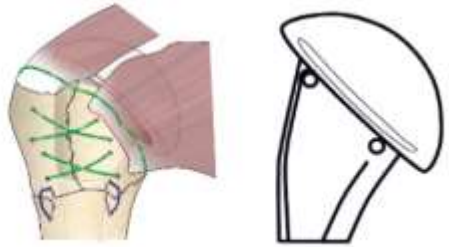
Dines 2002
Abrutyn 2003



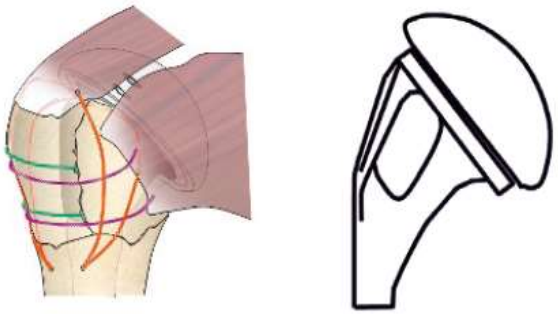
Gerber OP-Manual



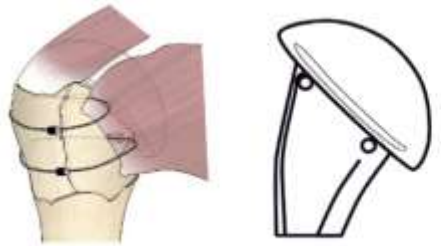
Beutler De Wilde, Poster



Boileau OP-Manual



Krause 2007
Hertel



ELSEVIER SAUNDERS

Orthop Clin N Am 39 (2008) 441–450

ORTHOPEDIC CLINICS OF NORTH AMERICA

Hemiarthroplasty for Proximal Humeral Fracture: Restoration of the Gothic Arch

Sumant G. Krishnan, MD*, Phillip W. Bennion, MD, John R. Reineck, MD, Wayne Z. Burkhead, MD

Calculations to Restore Gothic Arch

Normal side
Ruler
Xray 11.2 cm
Actual 10.0 cm
Magnif. 1.12 cm

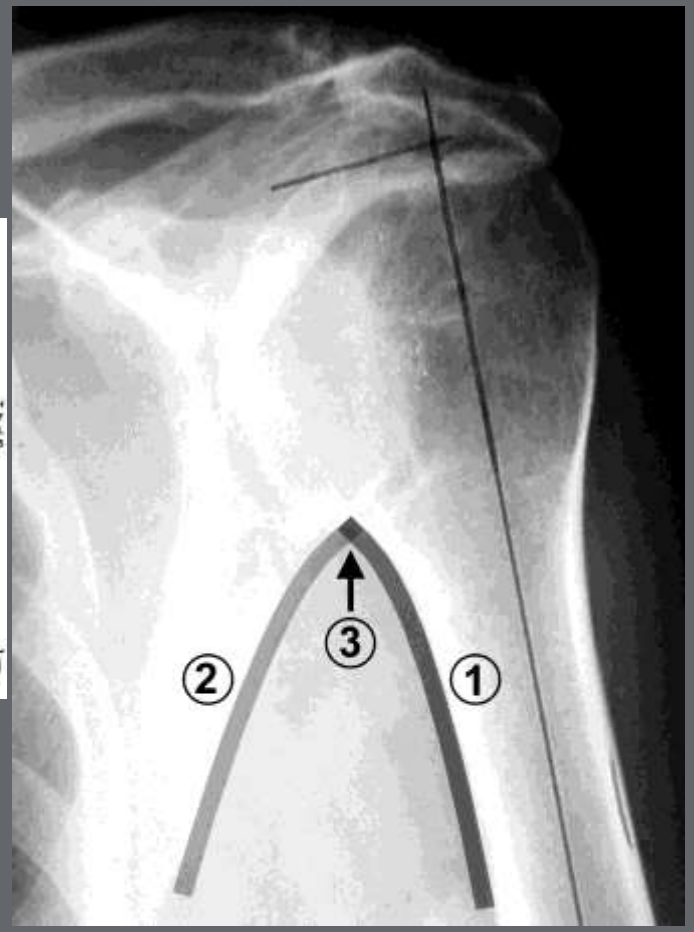
Fracture side
Ruler
Xray 12.1 cm
Actual 10.0 cm
Magnif. 1.21 cm

Humeral length (N)
Xray 35.0 cm
Actual 31.3 cm

Fx length (F)
Xray 32.6 cm
Actual 26.9 cm

Step 1. Fx to top of head: N - F = H
Actual N (31.3 cm) Minus Actual F (26.9 cm) Equals H (4.4 cm)

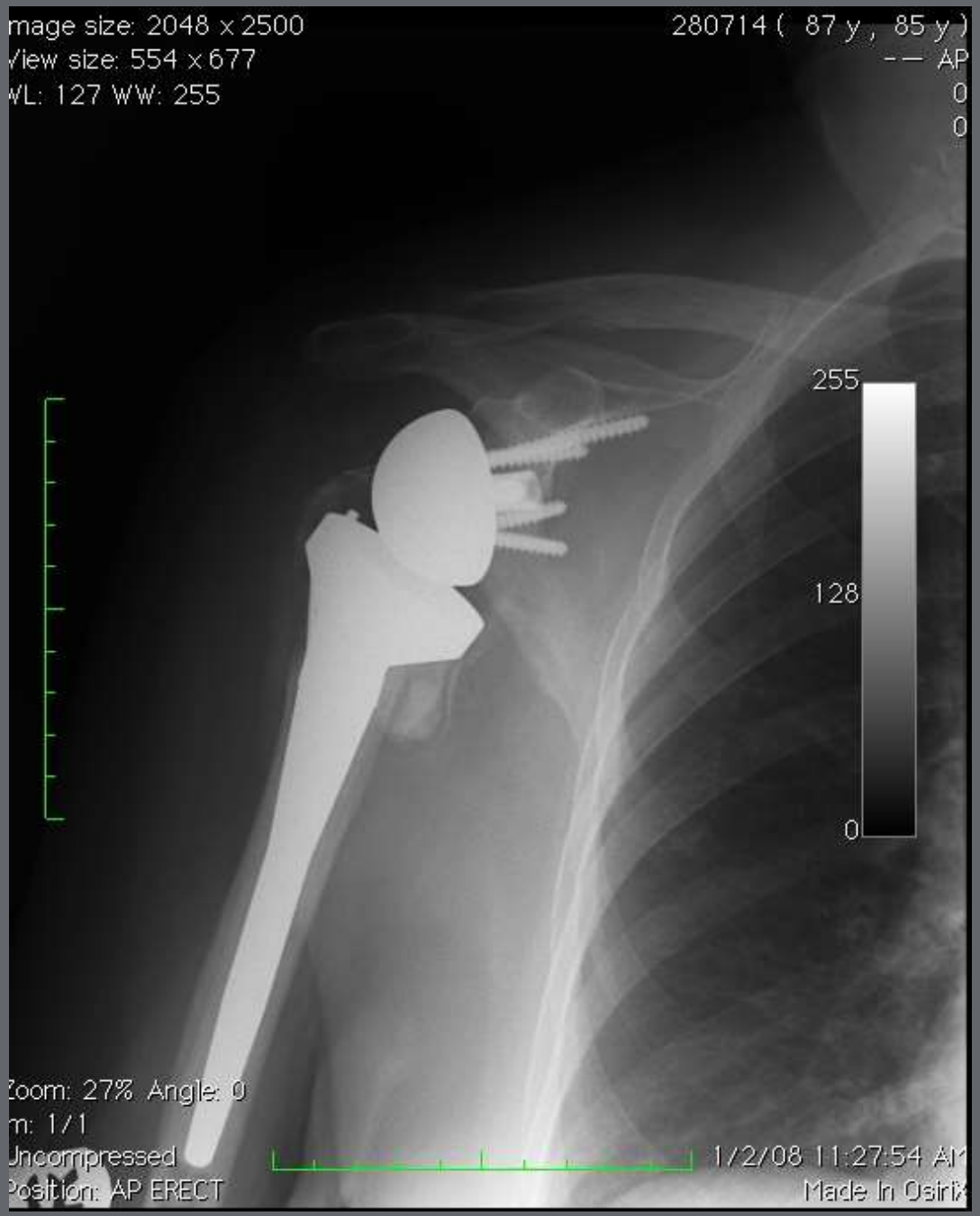
Step 2. Greater tuberosity length (G)
Xray 5.5 cm
Actual 4.5 cm (This number should be within 3-5 mm of fracture to top of head "H")



Case

- 85 y.o. female RHD s/p fall onto Right arm on week ago. RHD.
- PMH: HTN, DVT, Hypothyroid
- PSH: Appy, Hysterectomy
- Meds: Vytorin, Adalat, ASA, Synthroid
- SH: Lives independently. Drives

10 days post op



2 yrs post op


48 x 2500
x 677
4096
280714 (87 y , 85 y
EXTERNAL
R
4096
2048
0
gle: 0
12/14/09 12:13:40 P
ECT
Made In Osir

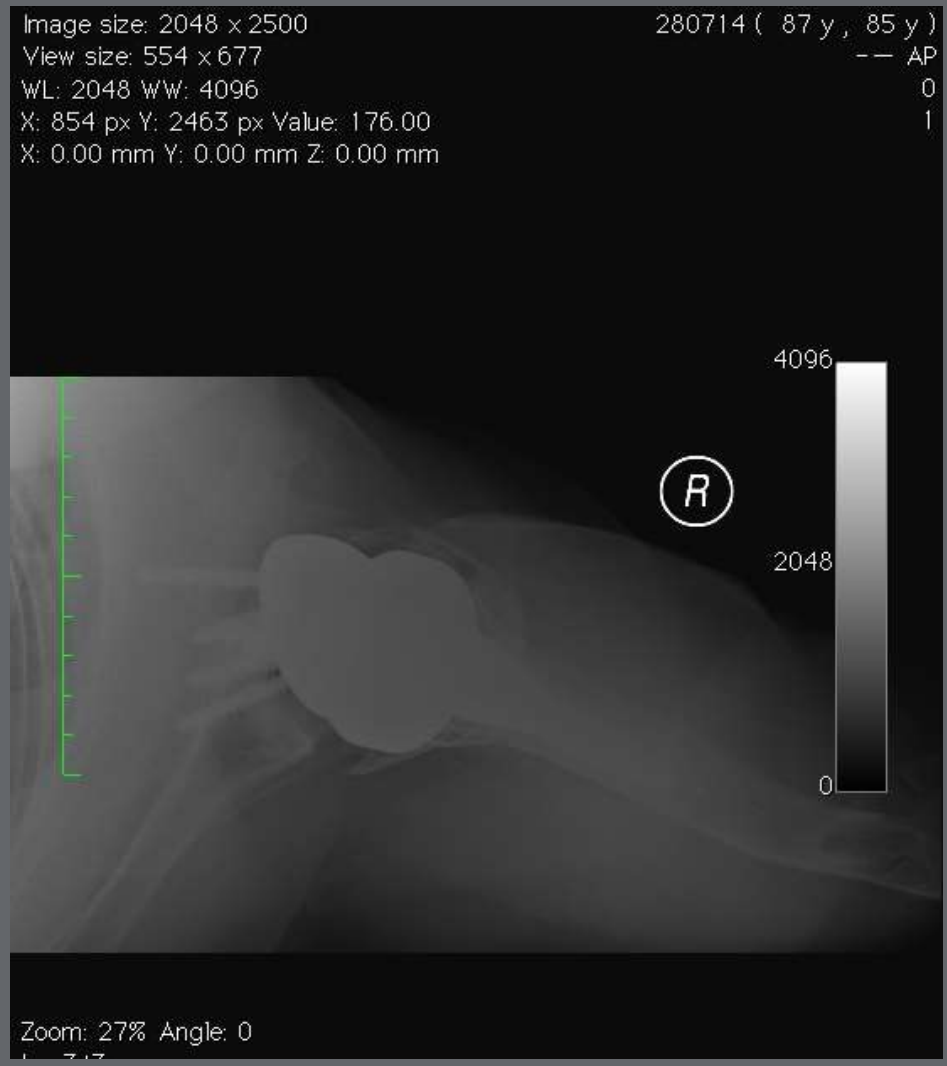
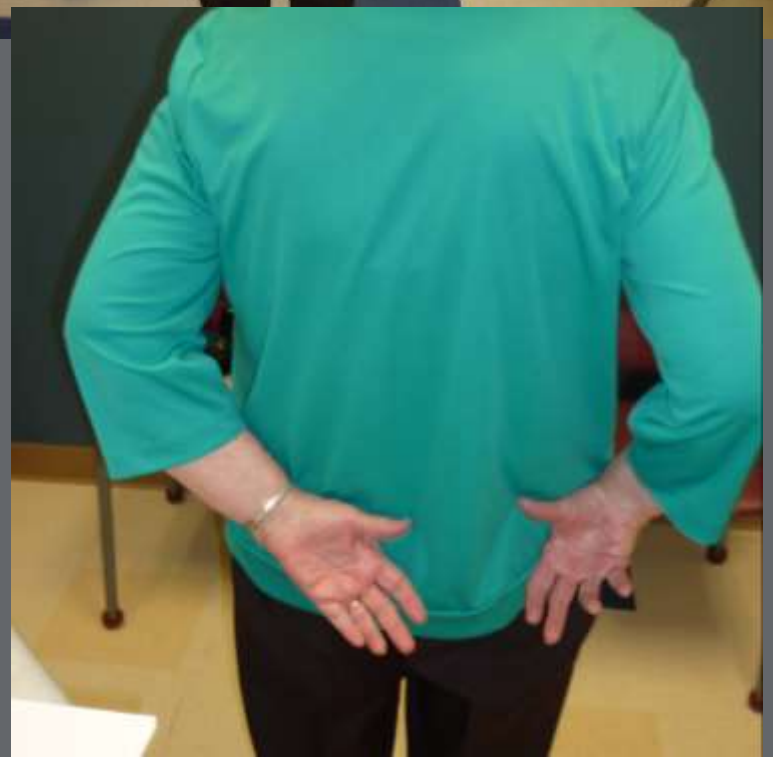
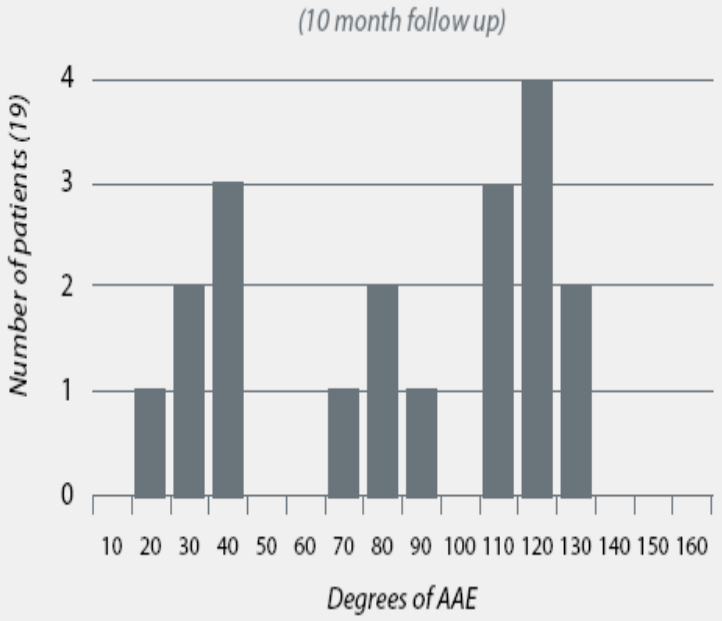


Image size: 2048 x 2500
View size: 554 x 677
WL: 2048 WW: 4096
X: 854 px Y: 2463 px Value: 176.00
X: 0.00 mm Y: 0.00 mm Z: 0.00 mm
280714 (87 y , 85 y)
-- AP
0
1
4096
2048
0
R
Zoom: 27% Angle: 0



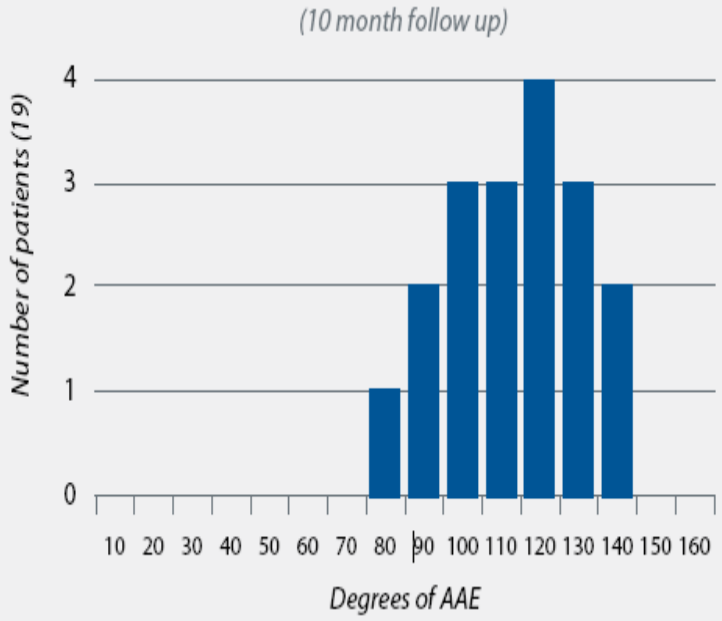
HEMI vs. REVERSED

Hemi



Hemiarthroplasty for acute fractures can be a viable option; however, consistent results are not always achieved.

Reversed Fx



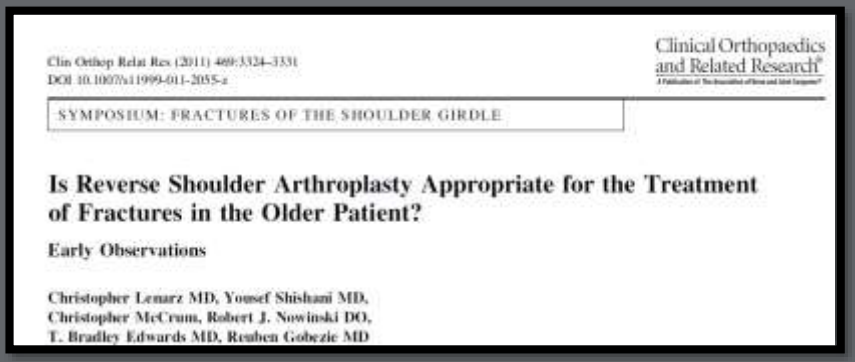
More predictable and consistent results in AAE were achieved with reversed for fracture. Better results were correlated with greater tuberosity healing.

*Data courtesy of D. Molé and F. Sirveaux, Acute Humeral Head Fractures: Reverse Shoulder Arthoplasty, Nancy, France, 2004.

Determining Treatment

- ***Factors affecting healing potential***
  - Age
  - Osteoporosis/Osteopenia
  - Comorbidities
    - (DM, Chronic corticosteroid use, etc.)
  - Tobacco Use
  - Gender

How Do You Treat These in Older Patients?


Clin Orthop Relat Res (2011) 469:3324–3331
DOI 10.1007/s11999-011-2055-z

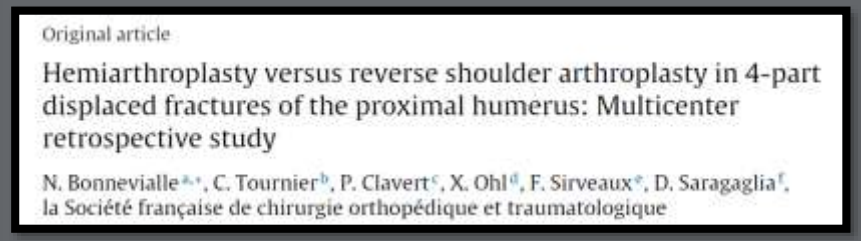
Clinical Orthopaedics and Related Research®

SYMPOSIUM: FRACTURES OF THE SHOULDER GIRDLE

Is Reverse Shoulder Arthroplasty Appropriate for the Treatment of Fractures in the Older Patient?

Early Observations

Christopher Lenarz MD, Yousef Shishani MD, Christopher McCrum, Robert J. Nowinski DO, T. Bradley Edwards MD, Reuben Gobezie MD


Original article

Hemiarthroplasty versus reverse shoulder arthroplasty in 4-part displaced fractures of the proximal humerus: Multicenter retrospective study

N. Bonnevialle[a,*], C. Tournier[b], P. Clavert[c], X. Ohl[d], F. Sirveaux[e], D. Saragaglia[f], la Société française de chirurgie orthopédique et traumatologique


J Shoulder Elbow Surg (2014) 23, 197-204

ELSEVIER

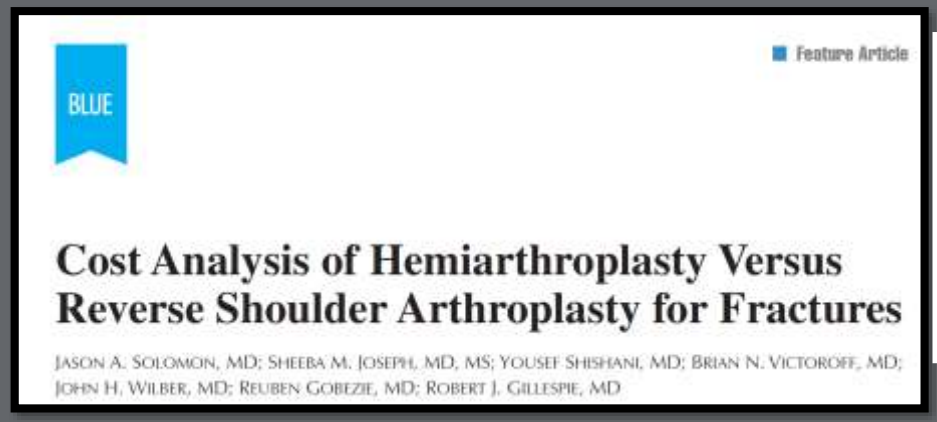
Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Reverse total shoulder arthroplasty for acute proximal humeral fracture: comparison to open reduction–internal fixation and hemiarthroplasty

Peter N. Chalmers, MD[a,*], William Slikker III, MD[a], Nathan A. Mall, MD[b], Anil K. Gupta, MD[a], Zain Rahman, MA[a], Daniel Enriquez, MA[a], Gregory P. Nicholson, MD[a]

Hemi- vs. Reverse TSA.....


BLUE

Feature Article

Cost Analysis of Hemiarthroplasty Versus Reverse Shoulder Arthroplasty for Fractures

JASON A. SOLOMON, MD; SHEEBA M. JOSEPH, MD, MS; YOUSEF SHISHANI, MD; BRIAN N. VICTOROFF, MD; JOHN H. WILBER, MD; REUBEN GOBEZIE, MD; ROBERT J. GILLESPIE, MD


J Shoulder Elbow Surg (2014) 23, 1419-1426

ELSEVIER

Journal of Shoulder and Elbow Surgery

SHOULDER

Reverse shoulder arthroplasty versus hemiarthroplasty for acute proximal humeral fractures. A blinded, randomized, controlled, prospective study

Emilio Sebastiá-Forcada, MD[a], Román Cebrián-Gómez, MD[a], Alejandro Lizaur-Utrilla, MD, PhD[a,*], Vicente Gil-Guillén, MD, PhD[b]


J Shoulder Elbow Surg (2016) 25, 330-340

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

REVIEW ARTICLE

Hemiarthroplasty versus reverse shoulder arthroplasty for treatment of proximal humeral fractures: a meta-analysis

Dave R. Shukla, MD*, Steven McAnany, MD, Jun Kim, MD, Sam Overley, MD, Bradford O. Parsons, MD

J Shoulder Elbow Surg (2016) 25, 330-340

ELSEVIER

JOURNAL OF SHOULDER AND ELBOW SURGERY

www.elsevier.com/locate/ymse

REVIEW ARTICLE

Hemiarthroplasty versus reverse shoulder arthroplasty for treatment of proximal humeral fractures: a meta-analysis

Dave R. Shukla, MD*, Steven McAnany, MD, Jun Kim, MD, Sam Overley, MD, Bradford O. Parsons, MD

- Meta-analysis on studies comparing HA to RTSA
- 130 RTSA and 125 HA cases
- Average follow-up 25 months

Table I Demographic information for studies included in the meta-analysis

Study	Level of evidence	Study population	Patients (No.)	Age (y)	Follow-up (mo)	FE (°)	SD FE (°)	Abd (°)	SD Abd (°)	ER (°)
Sebastia-Forcada,[47] 2014	I	Spain	A: 31, B: 30	A: 74.7, B: 73.3	A: 29.4, B: 27.7	A: 120.3 (40-180), B: 79.8 (20-180)	A: 35, B: 40	A: 112.9 (50-170), B: 78.7 (30-150)	A: 30, B: 30	A: 4.7 (0-10), B: 3.3 (0-10)
Baudi,[6] 2014	III	Italy	A: 28, B: 25	A: 77, B: 70	A: 27, B: 26	A: 131 ± 36, B: 89 ± 44	A: 36, B: 44	A: 128 ± 36 B: 82 ± 40	A: 36, B: 40	A: 15 ± 11, B: 23 ± 15
Chalmers,[15] 2014	III	USA	A: 9, B: 9	A: 77, B: 72	A: 14, B: 59	A: 133 ± 20, B: 106 ± 29	A: 20, B: 29	–		A: 41 ± 19, B: 28 ± 19
Cuff,[17] 2013	II	USA	A: 24, B: 23	74.4	30	A: 139 (102-172), B: 100 (30-170)	A: 17.5, B: 35	–		A: 24 (8-42), B: 25 (0-48)
Garrigues[21] 2013	III	USA	A: 12, B: 11	75	43.2	A: 121 (90-145), B: 91 (30-140)	A: 13.75, B: 27.5	–		A: 34 (10-45), B: 31 (5-60)
Young,[58] 2010	IV	New Zealand	A: 10, B: 10	A: 77.2, B: 75.5	A: 22, B: 44	A: 115 (45-140), B: 108 (50-180)	A: 23.75, B: 32.5	–		A: 49 (5-105), B: 48 (10-90)
Gallinet,[20] 2009	IV	France	A: 16, B: 17	A: 74, B: 74	A: 12.4, B: 16.5	A: 97.5 (20-150), B: 53.5 (30-100)	A: 32.5, B: 17.5	A: 91 (10-150), B: 60 (30-90)	A: 12.25, B: 15	A: 9 (0-80), B: 13.5 (0-30)

A, reverse shoulder arthroplasty; *Abd*, abduction; *ASES*, American Shoulder and Elbow Surgeons; *B*, hemiarthroplasty; *DASH*, Disabilities of the Arm, Shoulder and Hand; *ER*, external rotation; *FE*, forward elevation; *SD*, standard deviation; *UCLA*, University of California, Los Angeles Shoulder Rating Scale.

Conclusion: In this case-control study, RTSA appears to provide superior range of motion earlier and more predictably than HA and ORIF, with significant cost savings to Medicare.

Can surgeons predict what makes a good hemiarthroplasty for fracture?

Pascal Boileau, MD[a,*], Matthias Winter, MD[b], Alec Cikes, MD[c], Yung Han, MD[a], Michel Carles, MD, PhD[d], Gilles Walch, MD[e], Daniel G. Schwartz, MD[a]

J Shoulder Elbow Surg (2013) 22, 1495-1506

had significantly lower functional results and higher rates of tuberosity complications ($P < .0001$).

Conclusion: Good functional outcomes can be anticipated after hemiarthroplasty for proximal humeral fractures if the greater tuberosity is anatomically positioned (ie, lateral to the stem) and healed around the prosthesis. The use of a specific fracture stem allows to double the rate of tuberosity healing compared to a conventional stem (87% vs. 45%), decreases complications and improves shoulder function. Risk factors associated with poor functional results and anatomic failures are (1) patient age (≥75 years), (2) patient gender (women), and (3) use of a conventional (bulky) stem.

Level of evidence: Level III, Retrospective Cohort, Treatment Study

ELSEVIER
SHOULDER
JOURNAL OF SHOULDER AND ELBOW SURGERY

Reverse shoulder arthroplasty versus hemiarthroplasty for acute proximal humeral fractures. A blinded, randomized, controlled, prospective study

Emilio Sebastiá-Forcada, MD[a], Román Cebrián-Gómez, MD[a], Alejandro Lizaur-Utrilla, MD, PhD[b,*], Vicente Gil-Guillén, MD, PhD[b]

- **Results:**
  - RSA patients had significantly higher (P =.001) mean University of California–Los Angeles (29.1 vs 21.1) and Constant (56.1 vs 40.0) scores.
  - Higher forward elevation (120.3 vs 79.8), and abduction (112.9 vs 78.7)
  - In the RSA group, 64.5% of tuberosities healed and 13.2% resorbed
  - ***Boileau technique used for repair.***
- **Conclusions:**
  - The findings of this study indicated that RSA was superior to HA with respect to pain, functional outcome, and revision rate.
  - Revision from HA to RSA does not appear to improve outcomes.

Technique in RTSA

- *Is it better to use RTSA as a primary intervention or salvage procedure in fracture cases for the older patient?*

Early Versus Late Reverse Shoulder Arthroplasty for Proximal Humerus Fractures: Does It Matter?

Adam Seidl, MD; Daniel Sholder, BS; William Warrender, MD; Michael Livesey, BS; Gerald Williams Jr., MD; Joseph Abboud, MD; Surena Namdari, MD, MSc

Research performed at the Rothman Institute, Thomas Jefferson University, Philadelphia, PA, USA

Received: 23 November 2016 *Accepted: 10 May 2017*

Results: Forty-seven patients met inclusion criteria with 15 in the acute RSA group and 32 in the secondary RSA group. The acute RSA group demonstrated better external rotation (28˚) than the secondary RSA group (18˚, *P=0.0495*). The acute RSA group showed a trend towards better Single Assessment Numeric Evaluation (SANE) scores. Tuberosity healing rate was higher in the acute RSA group.

Table 1. Comparison between early and late RSA groups

	Early	Late	*P-Value*
Patients	15	32	
Gender (Male : Female)	2 : 13	6 : 26	1.0
Age (Range)	77.3 (64-87)	70.6 (50-85)	*0.021*
BMI (Range)	30.1 (20.5-49.4)	33.1 (21.1-53.5)	0.264
ASES (Range)	77.0 (36.7-93.3)	72.4 (41.7-98.3)	0.173
SANE (Range)	80.9 (50-100)	69.9 (20-100)	0.070
SST (Range)	7.3 (2-11)	7.2 (3-11)	0.919
EBL (Range)	330.5 (75-800)	435.4 (150-1200)	0.352
Scapular Notching	0%	28% (9/32, 7 grade 1 & 2 grade 2)	*0.041*
Baseplate Tilt	+3.7 (-22.2 – 22.4)	+15.7 (-4.2 – 38.5)	0.004
Complications	0%	22% (7/32)	0.079

Conclusion: While acute and secondary RSA can yield successful outcomes, acute RSA results in a higher tuberosity healing rate and improved external rotation.

Technique in RTSA

Tuberosity malposition and migration: Reasons for poor outcomes after hemiarthroplasty for displaced fractures of the proximal humerus

P. Boileau, S. G. Krishnan, L. Tinsi, G. Walch, J. S. Coste, and D. Molé, *Nice, France*

THE JOURNAL OF BONE & JOINT SURGERY

The reverse shoulder prosthesis in the treatment of fractures of the proximal humerus in the elderly

Is Tuberosity Reconstruction Important?

Techniques in Shoulder & Elbow Surgery 9(1):15–22, 2008

TECHNIQUE

Reverse Prosthesis for Proximal Humerus Fracture, Technique and Results

François Sirveaux, MD, PhD, Grégory Navez, MD, Olivier Roche, MD, and Daniel Molé, MD
Clinique de Traumatologie et d'Orthopédie
SINCAL, Nancy, France

ELSEVIER
Journal of Shoulder and Elbow Surgery

Reverse shoulder arthroplasty for four-part proximal humerus fracture in elderly patients: can a healed tuberosity improve the functional outcomes?

Yong-Min Chun, MD, PhD[a], Doo-Sup Kim, MD, PhD[b], Doo-Hyung Lee, MD, PhD[c], Sang-Jin Shin, MD, PhD[d,*]

ELSEVIER
Journal of Shoulder and Elbow Surgery

How the greater tuberosity affects clinical outcomes after reverse shoulder arthroplasty for proximal humeral fractures

Xavier Ohl, MD, PhD[a], Nicolas Bonnevialle, MD, PhD[b,*], David Gallinet, MD[c], Nassima Ramdane, PhD[d], Philippe Valenti, MD[e], Lauryl Decroocq, MD[f], Pascal Boileau, MD, PhD[f], SOFCOT[g]

The reverse shoulder prosthesis in the treatment of fractures of the proximal humerus in the elderly

J.-F. Cazeneuve, D.-J. Cristofari

From Orthopaedic Centre, Centre Hospitalier, Laon, France

- ***Excision of Tuberosities!***
- 30 cases --- 75 years --- 1-14 years FU
- Mean constant score = 59/100
- Complications:
  - 2 instability, 1 infection
  - 1 Glenoid loosening
  - 7 proximal humeral bone lysis + notching
  - 1 humeral loosening
- *"The remnant of the tuberosities were excised"*
- ***TERRIBLE RESULTS .....***

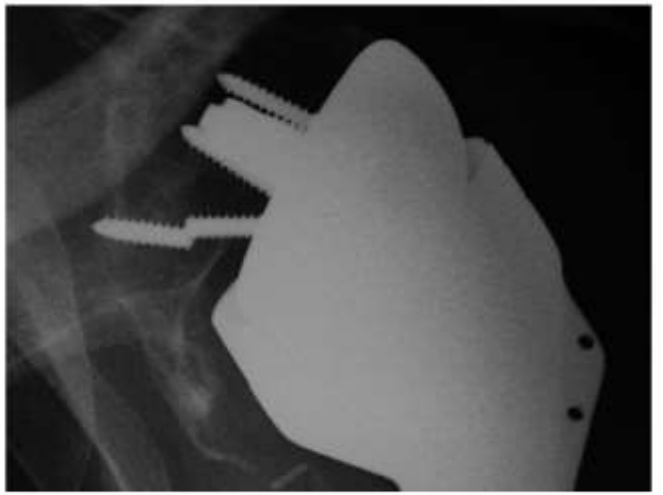


Fig. 1

Aseptic loosening at 12 years.

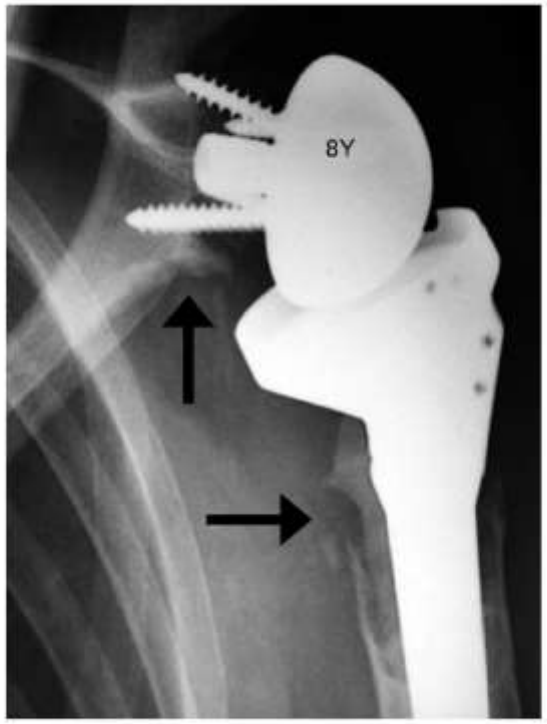


Fig. 5

Scapular notching (arrow) at eight years with proximal humeral bone loss

Techniques in Shoulder & Elbow Surgery 9(1):15–22, 2008

TECHNIQUE

Reverse Prosthesis for Proximal Humerus Fracture, Technique and Results

François Sirveaux, MD, PhD, Grégory Navez, MD, Olivier Roche, MD, and Daniel Molé, MD
Clinique de Traumatologie et d'Orthopédie
SINCAL, Nancy, France

Surprise…surprise… Tuberosity Healing Matters!

Table III Comparison of range of motion between healed and non-healed tuberosity groups after Reverse shoulder arthroplasty for fracture proximal humerus

Range of motion	Study (yr)	Healed tuberosity, ° Mean (range) or ± SD	Nonhealed tuberosity, ° Mean (range) or ± SD	*P* value
Forward flexion	Cuff[19] (2013)	147 (126-172)	132 (102-150)	.213
	Sebastiá-Forcada[53] (2014)	112.1	117.5	.695
	Gallinet[24] (2013)	127.2	96.5	.002
	Garofalo[27] (2015)	145.3 ± 19.3	114.1 ± 15.8	<.001
	Grubhofer[30] (2016)	123 (45-165)	94 (40-130)	.01
	Chun[14] (2017)	125 ± 18	127 ± 14	.647
Abduction	Sebastiá-Forcada[53] (2014)	116.3	107.5	.399
	Gallinet[24] (2013)	112.8	90.4	.011
	Grubhofer[30] (2016)	115 (40-165)	92 (40-140)	.11
External rotation with elbow by side	Cuff[19] (2013)	28 (8-40)	12 (10-12)	.02
	Sebastiá-Forcada[53] (2014)	1.9*	2.5*	.184
	Gallinet[24] (2013)	19.7	1.6	.0004
	Garofalo[27] (2015)	34.3 ± 11.8	12.9 ± 11.6	<.001
	Grubhofer[30] (2016)	21 (10-60)	2 (0-10)	.01
	Chun[14] (2017)	29 ± 8	10 ± 9	<.001
External rotation in 90° abduction	Gallinet[24] (2013)	49.4	10.3	.00001
	Chun[14] (2017)	25 ± 10	7 ± 9	<.001
Internal rotation	Cuff[19] (2013)	50%	25%	.714
	Sebastiá-Forcada[53] (2014)	3.1*	2.4*	.157
	Gallinet[24] (2013)	Lumbar 4	Coccyx	.043
	Garofalo[27] (2015)	45.6 ± 18.9	25.7 ± 19.1	<.001
	Grubhofer[30] (2016)	6 (0-10)*	3 (0-8)*	.01
	Chun[14] (2017)	15 ± 2	17 ± 1	.125
Internal rotation in 90° abduction	Gallinet[24] (2013)	55.6	36.8	.004

* Indicates range of motion based on points system as part of the Constant-Murley score.

J Shoulder Elbow Surg (2019) 28, e78–e91

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

REVIEW ARTICLE

Tuberosity healing after reverse shoulder arthroplasty for complex proximal humeral fractures in elderly patients—does it improve outcomes? A systematic review and meta-analysis

Nimesh P. Jain, MS (Orth)[a,*], Syed S. Mannan, MS, FRCS (Orth)[a], Ramasubramanian Dharmarajan, FRCS(Orth)[a], Amar Rangan, FRCS (Orth)[b,c,d]

135 vs. 155 degrees rTSA for Fracture

Laurence Higgins, MD MBA

Results

135 DEGREES (N=29)

- Inferior Displacement- 8mm
- Tuberosity Healing 93%
- Active ER 31
- SSV - 82%

155 DEGREES (N=41)

- Inferior Displacement- 15mm
- Tuberosity Healing 73%
- Active ER - 22
- SSV - 74%

* $p < 0.05$

Technique

- *How do You Reconstruct the Tuberosities??*

J Shoulder Elbow Surg (2018) ■■, ■■–■■

ELSEVIER

JOURNAL OF SHOULDER AND ELBOW SURGERY

www.elsevier.com/locate/ymse

ORIGINAL ARTICLE

Reverse shoulder arthroplasty for acute fractures in the elderly: is it worth reattaching the tuberosities?

Pascal Boileau, MD[a,*], Tjarco D. Alta, MD, PhD[b], Lauryl Decroocq, MD[a], François Sirveaux, MD, PhD[c], Philippe Clavert, MD, PhD[d], Luc Favard, MD, PhD[e], Mikaël Chelli, MD[a]

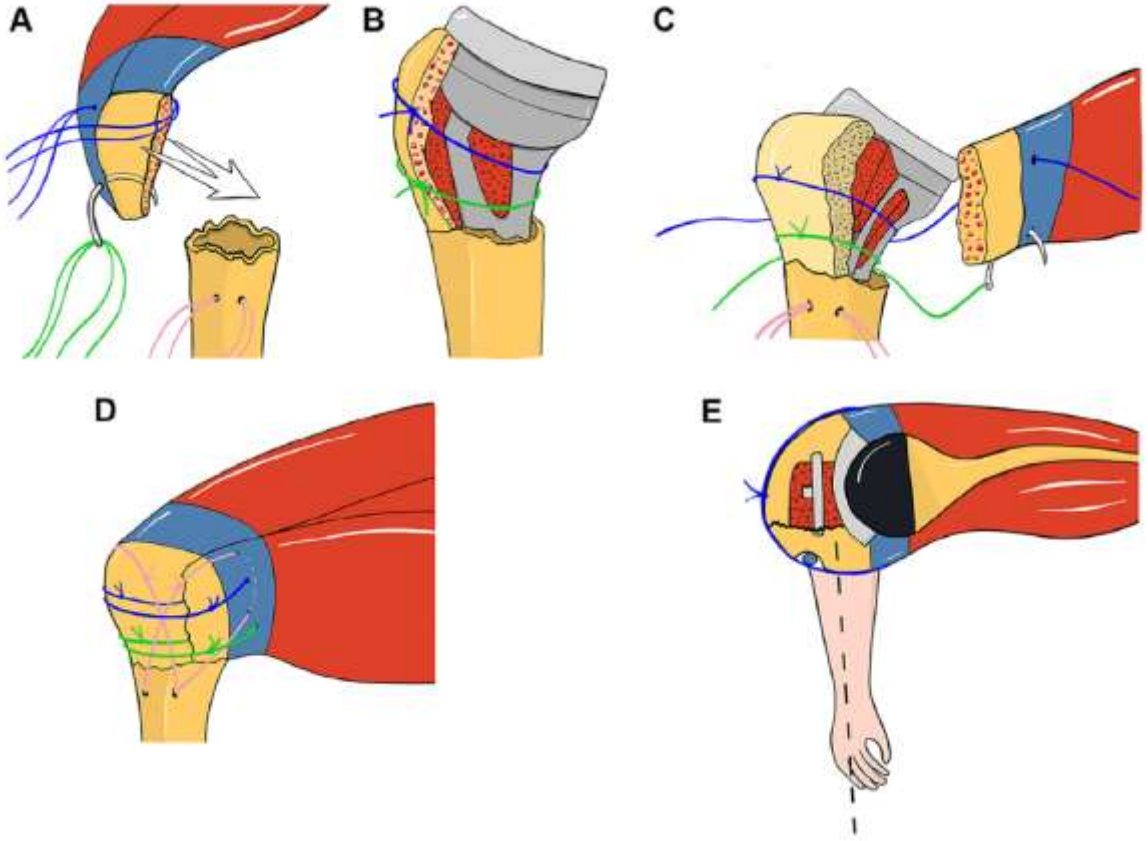
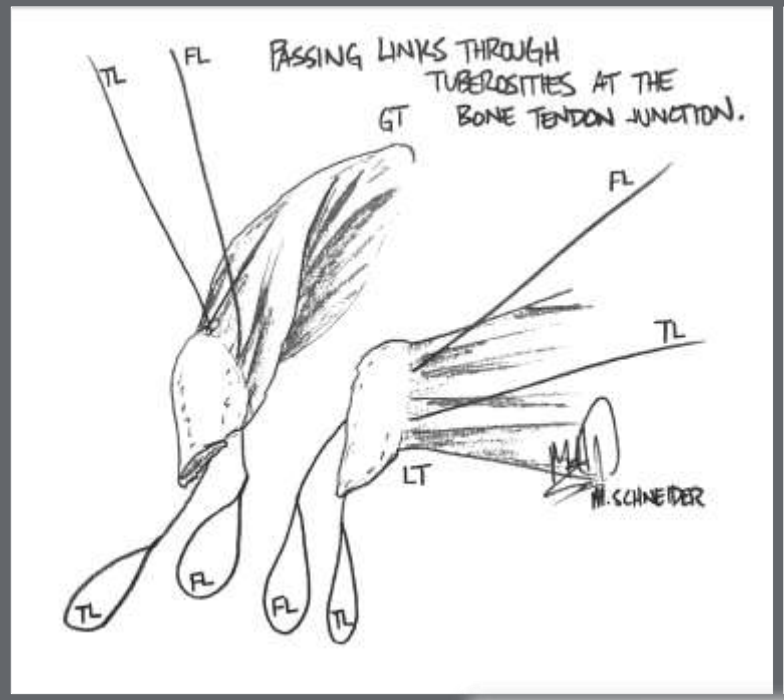


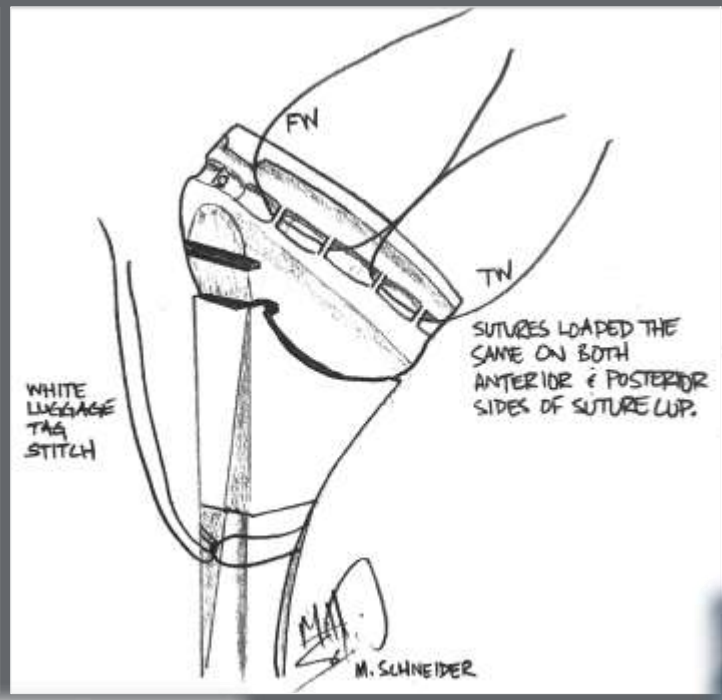
Table II Functional results according to greater tuberosity healing

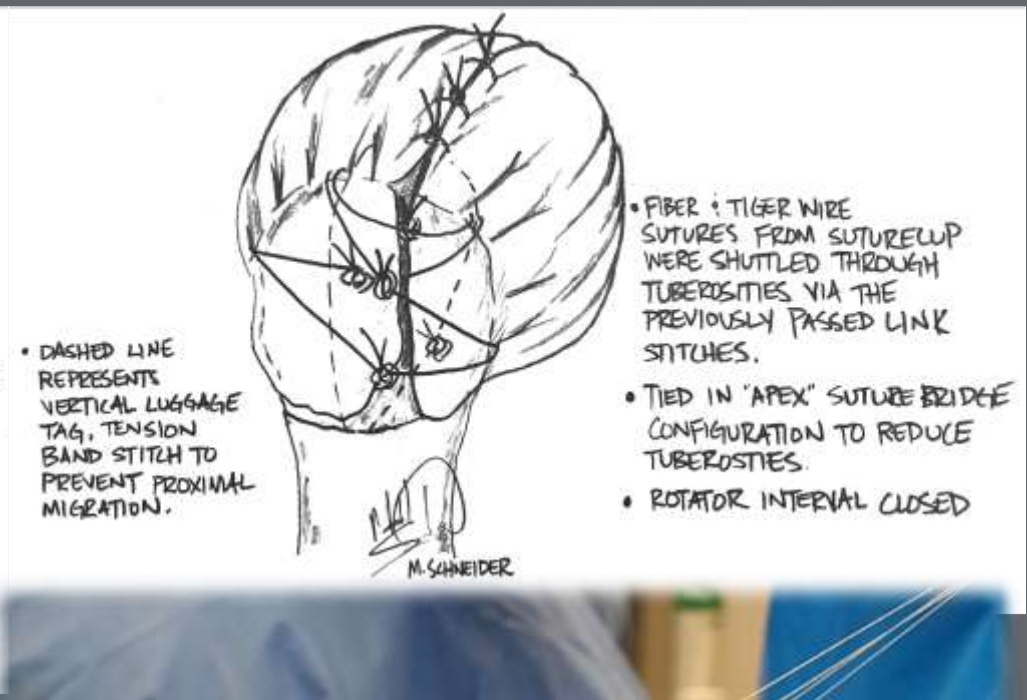
Variable	Greater tuberosity		*P* value
	Anatomically healed (n = 32)	Migrated/resorbed (n = 6)	
Age at surgery, yr	79 ± 4 (70-88)	81 ± 4 (78-88)	.28
Female, %	88	100	1
Constant score			
Pain	14 ± 1 (11-15)	13 ± 2 (9-15)	.11
Activity	16 ± 8 (0-20)	13 ± 6 (7-20)	.90
Mobility	28 ± 7 (6-38)	22 ± 10 (10-32)	.015*
Strength	6 ± 3 (0-12)	3 ± 2 (0-6)	.06
Constant score (/100 points)	64 ± 15 (28-80)	51 ± 12 (30-73)	.018*
Adjusted Constant score, %	92 ± 22 (45-142)	84 ± 30 (52-132)	.62
Subjective Shoulder Value, %	83 ± 15 (50-100)	65 ± 15 (40-80)	.029*
Satisfied or very satisfied	75	20	.014*
Active shoulder mobility			
Anterior elevation, °	141 ± 25 (50-170)	115 ± 26 (90-150)	.023*
External rotation, °	27 ± 12 (0-50)	11 ± 12 (0-30)	.010*
Internal rotation, points†	5.2 ± 2.7 (2-10)	4.3 ± 1.5 (2-6)	.42

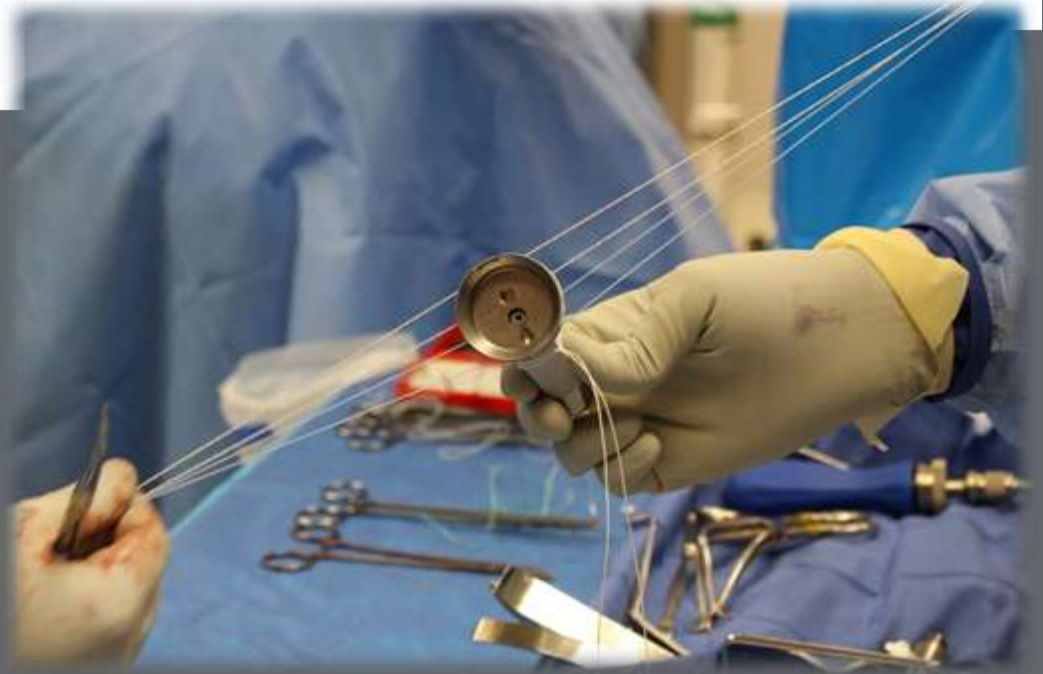
Reverse Fracture Designs

My Reverse Fracture Technique?



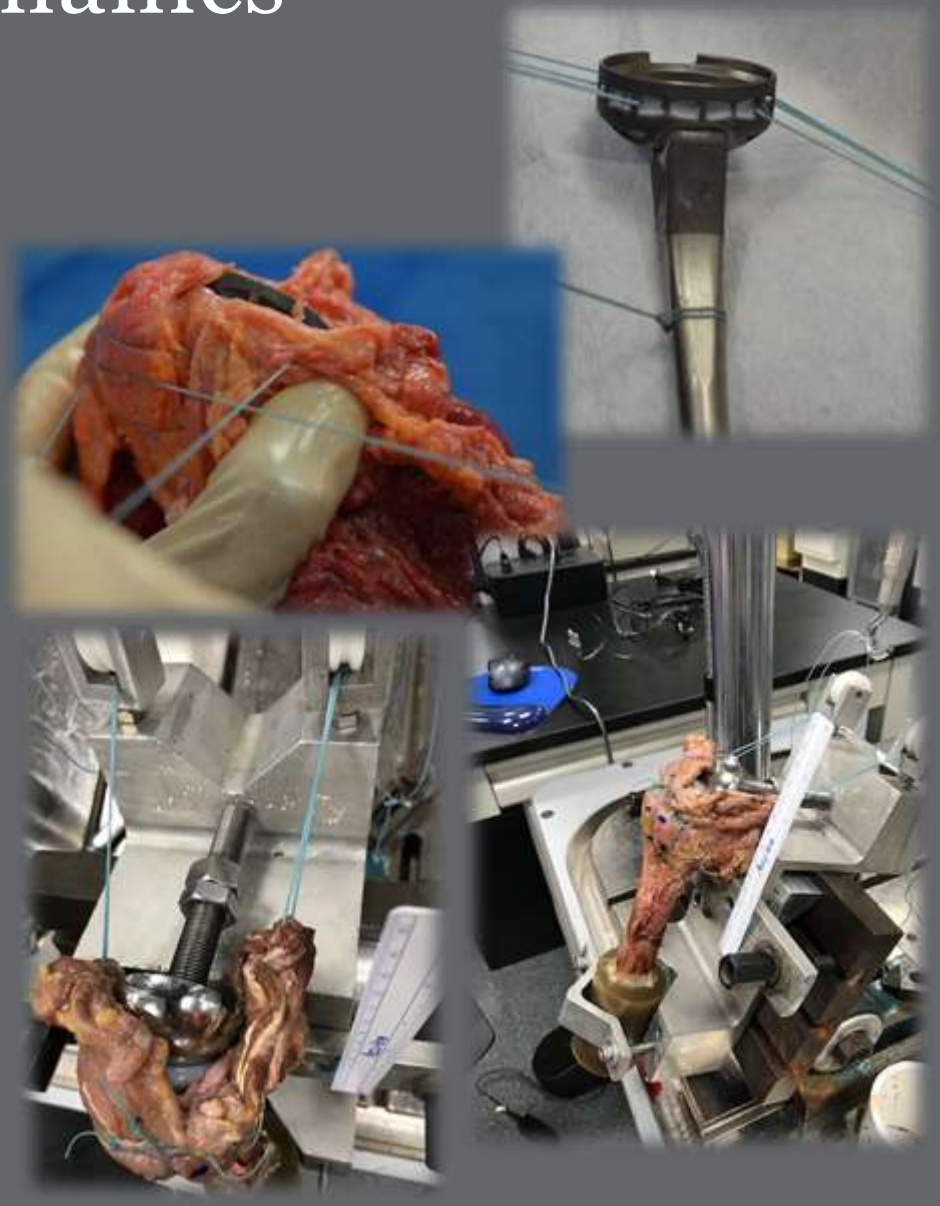






Boileau vs. Suture Bridge…..Biomechanics

- The specimens were prepared with the simulated fracture, implants and sutures.
- #2 sutures (FiberWire) were stitched to the tendonus portion of the infraspinatus and subscapularus
- Mechanical testing was performed using Instron Electropuls E10000 (Instron Corp., Norwood, MA) with a 10kN load cell
- The glenosphere was mounted directly to the fixture via a threaded rod.
- The #2 sutures attached to the rotator cuff tendons were strung through pulleys and tied off over hook fixtures that were suspended from the Instron cross-head via a clevis and dowel fixture.
- Cyclic loading of the samples was performed between 10 and 100N for 500 cycles at 1Hz.
- This was followed by a static pull to failure at 33mm/sec. Load and displacement data were recorded at 1000Hz through the Instron software.



Results

Dr. Gobezie RTSA Fracture Study - "Arthrex" Samples

Donor	Side	Gender	Age	Stem Size (mm)	Cup Size (mm)	Ultimate Load (N)	Cyclic Displacement (mm)		Average Cyclic Disp. (mm)	Mode of Failure
							Superior	Inferior		
F190123	R	Male	58	9	36N	577	0.39	0.23	0.31	fracture opened at anterior fragment
F190340	R	Male	61	7	36 +2R	720	1.69	2.75	2.22	fracture opened at anterior fragment
F190126	L	Male	61	12	36N	782	0.06	0.92	0.49	fracture remained closed, small fragment motion
F182176	R	Male	74	11	39 +2R	571	0.80	0.16	0.48	fracture opened at anterior fragment
F190290	L	Male	50	10	39 +2L	768	0.62	0.39	0.51	fracture remained closed, small fragment motion
F190257	R	Male	60	11	39N	582	0.71	0.17	0.44	fracture opened at anterior fragment
F190336	L	Male	67	10	36 +2L	408	1.11	0.30	0.71	fracture opened at anterior fragment
F190332	R	Male	71	6	36N	933	0.05	2.89	1.47	fracture opened at anterior fragment
Average			**63**			**668**	**0.68**	**0.98**	**0.83**	
Standard Deviation			**8**			**164**	**0.55**	**1.16**	**0.67**	

Dr. Gobezie RTSA Fracture Study - "French" Samples

Donor	Side	Gender	Age	Stem Size (mm)	Cup Size (mm)	Ultimate Load (N)	Cyclic Displacement (mm)		Average Cyclic Disp. (mm)	Mode of Failure
							Superior	Inferior		
F190123	L	Male	58	9	36 +2L	521	2.57	5.35	3.96	fracture opened at anterior fragment
F190340	L	Male	61	7	36N	486	4.94	7.18	6.06	fracture opened at anterior fragment
F190126	R	Male	61	8	36N	574	3.08	1.06	2.07	fracture opened at anterior fragment
F182176	L	Male	74	9	39N	521	6.59	8.77	7.68	fracture opened at anterior fragment
F190290	R	Male	50	10	39N	399	0.51	1.85	1.18	fracture opened at anterior fragment
F190257	L	Male	60	12	39N	393	2.26	2.60	2.43	fracture opened at anterior fragment
F190336	R	Male	67	9	36N	535	2.70	1.20	1.95	fracture opened at anterior fragment
F190332	L	Male	71	6	39N	434	1.77	1.25	1.51	fracture opened at anterior and posterior fragments
Average			**63**			**483**	**3.05**	**3.66**	**3.36**	
Standard Deviation			**8**			**67**	**1.90**	**3.03**	**2.36**	
				Significance		**p = 0.032**			**p = 0.017**	

The ultimate load to failure for the stem based subscapularis repair technique was significantly higher than the French technique (668 +/- 164N vs. 483 +/- 67N; p=0.032).

The average cyclic displacement for the stem based subscapularis repair technique was significantly less than the French technique (0.83 +/- 0.67mm vs. 3.36 +/- 2.36mm; p=0.017)

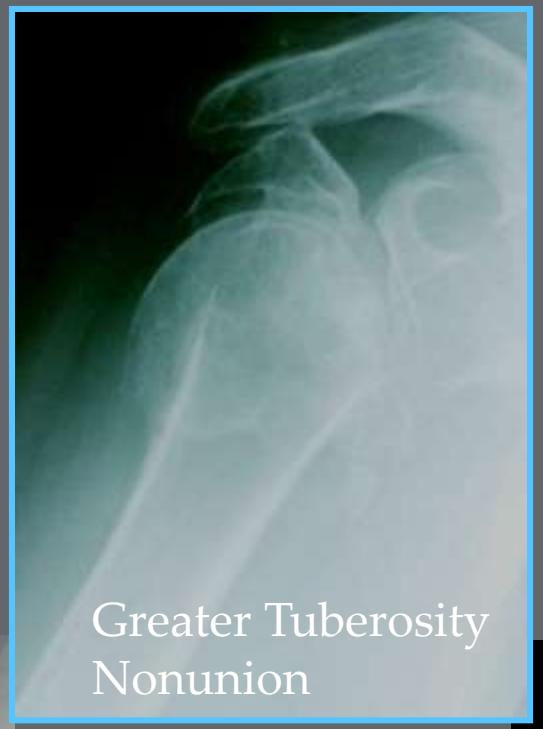
Surgical Video

77 female fall at home

14 weeks p.o.

14 Weeks post op

What about the sequela of Proximal Humerus Fractures?



Greater Tuberosity Nonunion

Non-union

Failed ORIF

Complex

CLINICAL ORTHOPAEDICS AND RELATED RESEARCH
Number 442, pp. 121–130

Proximal Humerus Fracture Sequelae

Impact of A New Radiographic Classification on Arthroplasty

Pascal Boileau, MD*; Christopher Chuinard, MD*; Jean-Charles Le Huec, MD†; Gilles Walch, MD†; and Christophe Trojani, MD*

TABLE 1. Postoperative Mobility after a Nonconstrained Shoulder Prosthesis

	Active Elevation		External Rotation	
Fracture Sequelae	*Preoperative → Review*	*Gain (p)*	*Preoperative → Review*	*Gain (p)*
Cephalic collapse or necrosis (n = 137)	85° → 125°	40° (> 0.05)	3° 32°	29° (> 0.05)
Locked dislocations or fracture–dislocations (n = 25)	73° → 117°	44° (> 0.05)	−8° → 28°	36° (> 0.05)
Surgical neck nonunions (n = 22)	53° → 63°	10° (0.02)	13° → 28°	15° (0.01)
Severe tuberosity malunions (n = 19)	61° → 81°	20° (0.02)	1° → 12°	11° (0.05)
Series (n = 203)	80° → 112°	32°	2° → 30°	28°

TABLE 2. Pain and Functional Results (Constant Score) after a Nonconstrained Shoulder Prosthesis

	Pain (15 point scale)		Constant Score (100 points)	
Fracture Sequelae	*Preoperative → Review*	*Gain (p)*	*Preoperative → Review*	*Gain (p)*
Cephalic collapse or necrosis (n = 137)	5 → 12	7 (> 0.05)	28 → 62	34 (> 0.05)
Locked dislocations or fracture–dislocations (n = 25)	5.5 → 12.5	7 (0.001)	28 → 61	33 (0.001)
Surgical neck nonunions (n = 22)	3 → 9	6 (0.001)	21 → 36	15 (0.001)
Severe tuberosity malunions (n = 19)	5 → 11	6 (0.05)	20 → 42	22 (0.005)
Series (n = 203)	4.5 → 11.5	7	27 → 57	30

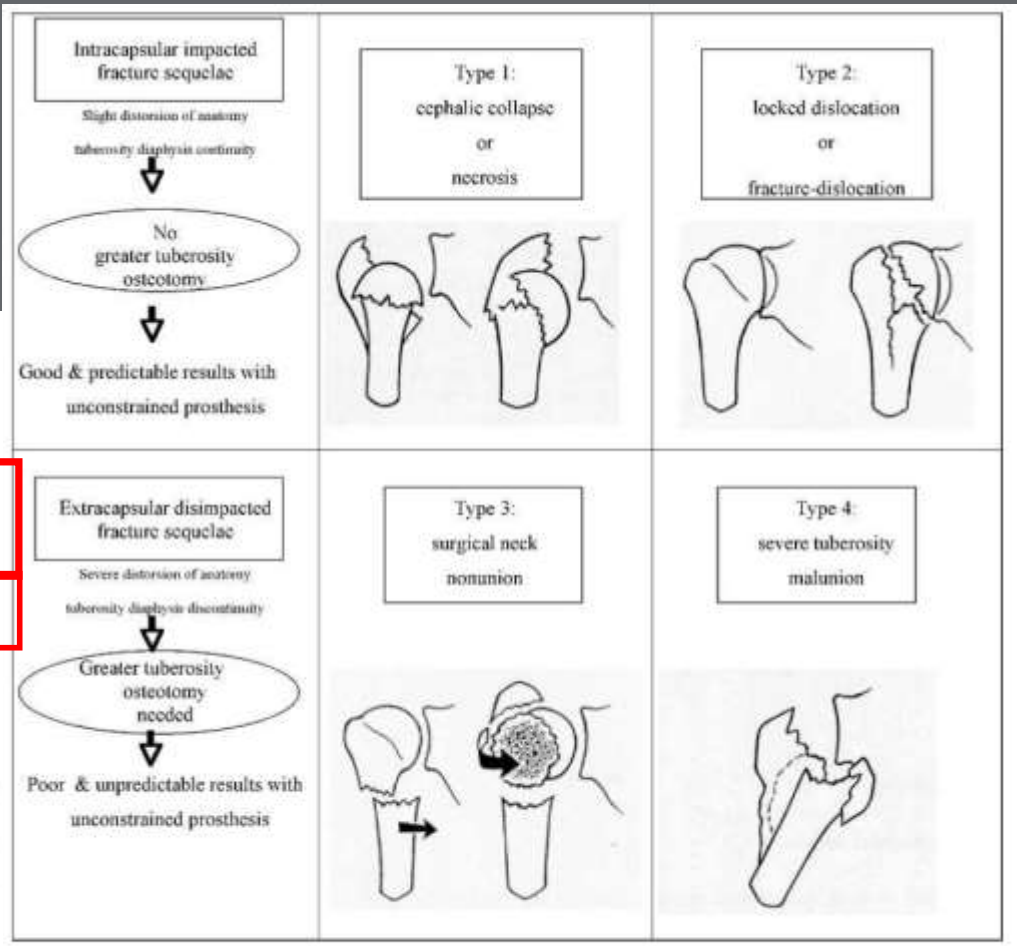


Fig 1. An illustrated diagram shows the surgical classification of sequelae of proximal humeral fractures.

5 months post-op

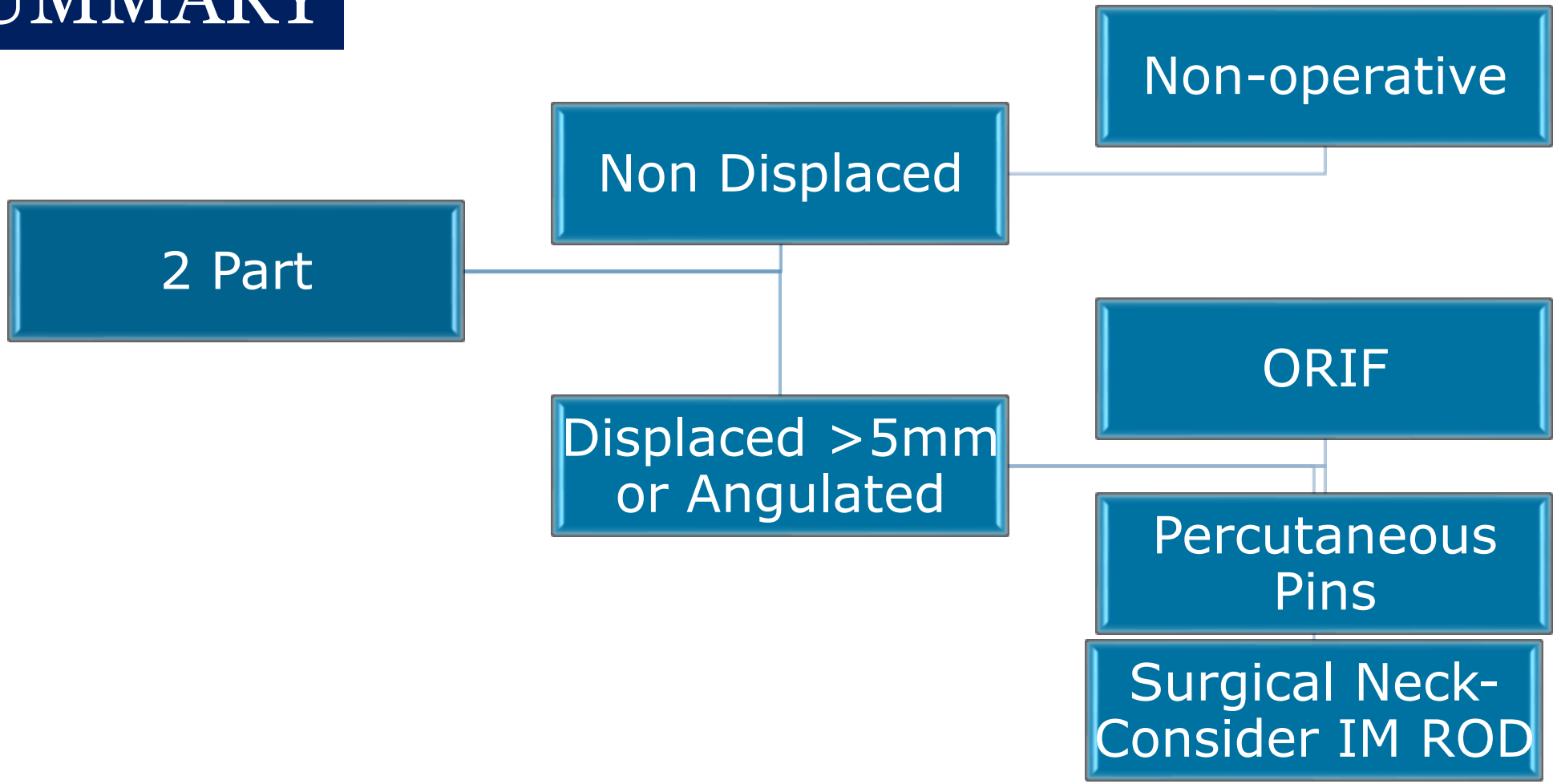
6 months post op. Pain 0/10


R


R

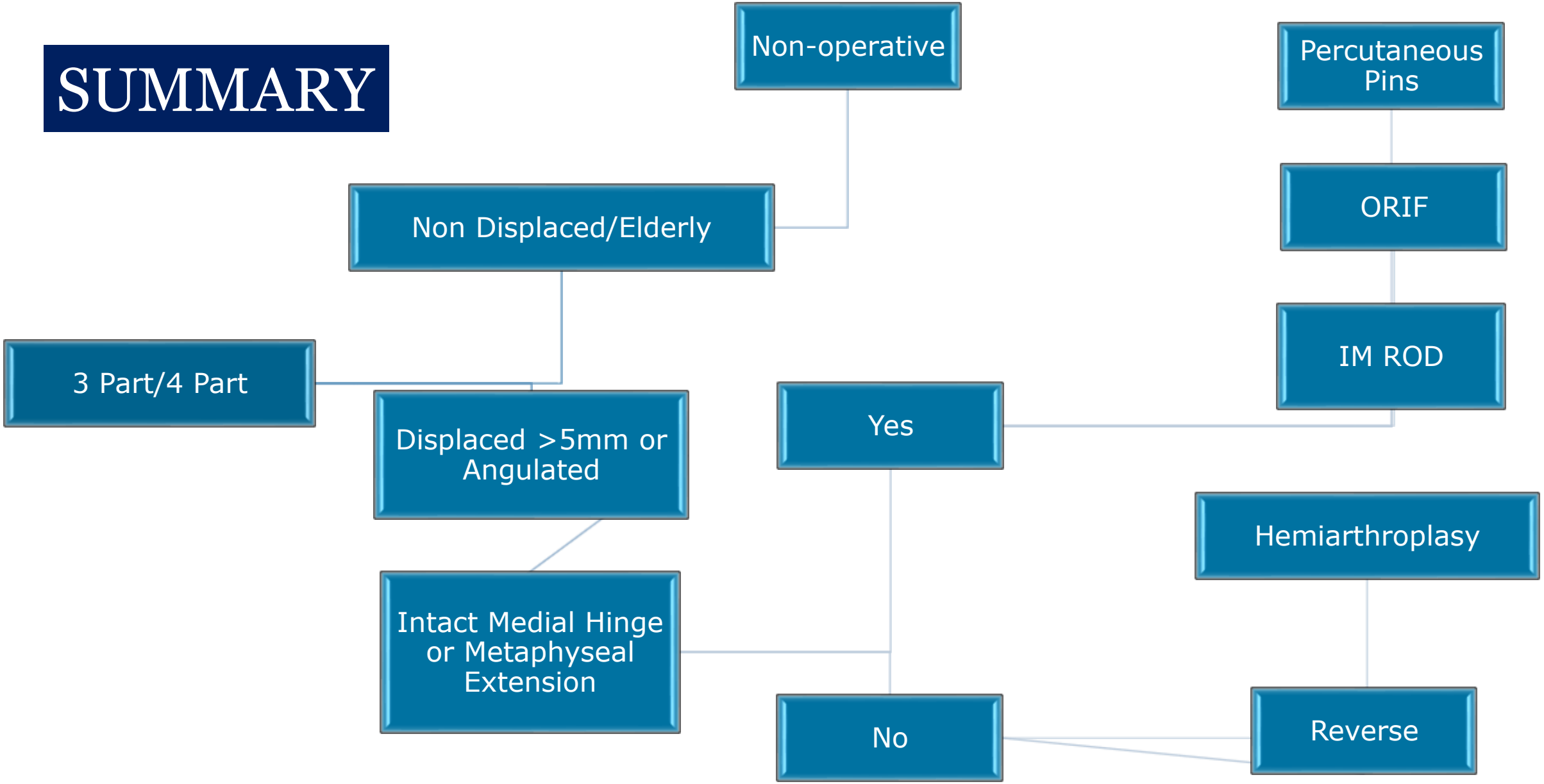
Banner Health

SUMMARY



Banner Health

SUMMARY



Verdict…

- **In my practice, complex proximal humerus fractures in:**
  - **Female over 65 years of Age**
  - **Males over 70 years of Age**

Reverse Total Shoulder

SUMMARY

- Minimally displaced and fractures in the elderly can be treated non-operatively
- ORIF
  - Good potential for healing
  - Fx pattern suggests and intact blood supply
  - Younger age

SUMMARY

- 3-4 part fracture
- Disrupted blood supply/Head Split
- Hemiarthroplasy
  - Younger active patient
- Reverse TSA
  - Older/Poor prognosis for tuberosity healing
  - Use a 135 Implant
  - Good Tuberosity Repair

Thank you

Evan S Lederman, MD

Evan.lederman@bannerhealth.com

Banner Sports Medicine | Banner University Medicine