



2017 SPECIALTY DAY

MARCH 18, 2017 | SAN DIEGO, CALIFORNIA



Combined Session: Orthopaedic Trauma Association and American Shoulder and Elbow Surgeons

The Use of Evidence-Based Medicine for Proximal Humeral Fractures and Their Complications

3:00 pm – 3:50 pm

Moderators: Mohit Bhandari, MD, PhD, FRCSC (OTA) and Jon JP Warner, MD (ASES)

- | | |
|-------------------|--|
| 3:00 pm – 3:10 pm | Locking Plate Fixation: Can We Do Better?
<i>Emil H. Schemitsch, MD (OTA)</i> |
| 3:10 pm – 3:20 pm | Displaced Proximal Humeral Fractures in the Elderly: Indications for Fixation
<i>Brett D. Crist, MD (OTA)</i> |
| 3:20 pm – 3:30 pm | Hemiarthroplasty versus Reverse for Acute Fractures
<i>Pascal Boileau, MD (ASES)</i> |
| 3:30 pm – 3:40 pm | Greater Tuberosity Fractures: New Indications?
<i>Dominique Rouleau, MD (ASES)</i> |
| 3:40 pm – 3:50 pm | Discussion |

The Use of Evidence Based Medicine for Proximal Humeral Fractures and Their Complications

Locking Plate Fixation: Can we do better?

Emil H Schemitsch MD FRCS(C)

Richard Ivey, Professor and Chairman, Department of Surgery

Western University, London, Ontario

General problems

- We still aren't sure who benefits from an operation, especially in the elderly
- High failure rate with conventional fixation
- Locked plating not as successful as was hoped
- Secondary reconstruction (hemiarthroplasty) not as good as primary intervention
- Few high quality studies to guide treatment

Technical problems

- Osteoporotic bone
 - Screw penetration
 - Plate pull-off
 - Varus collapse
- Tuberosity pull-off
- Avascular necrosis
- Nonunion (plate failure)

How to maximize success with ORIF

- Calcar reduction
- No varus
- Calcar screw
- Suture greater tuberosity

Conclusions

- Most patients (especially the elderly) can and should be treated non-operatively
- Several well – established principles are important to maximize success with the use of PHLP's
- There are some improvements that can be made to current plating strategies
- Reverse TSA may be beneficial in primary treatment of severe proximal humeral fractures

Displaced Proximal Humerus Fractures in the Elderly: Indications for Fixation
Brett D. Crist, MD

Learning Objectives

1. Identify indications for ORIF of elderly proximal humerus fractures
2. Utilize surgical techniques/adjuncts to minimize risk of postoperative failure
3. Recognize contraindications for proximal humerus ORIF in the elderly

What is considered elderly?

What proximal humerus fractures are we talking about?

What are the indications for ORIF?

1. _____
2. _____
3. _____
4. _____

What are the contraindications to ORIF?

1. _____
2. _____
3. _____
4. _____

What are the techniques/adjuncts that can be used to decrease risk of failure?

1. _____
2. _____
3. _____
4. _____

**Hemiarthroplasty or
Reverse Shoulder Arthroplasty
For Proximal Humerus Fractures**

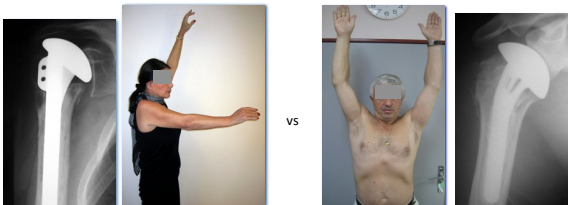
Pascal Boileau, MD
France

Charles S. Neer, 1955



"... results of hemiarthroplasty for acute proximal humerus fractures are good ..."

HA for Fx = Unpredictable Results



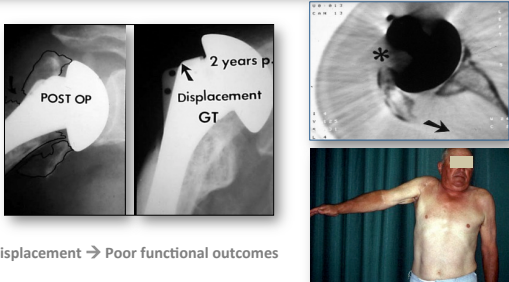
No average results (Rule of 'all or nothing')

Boileau et al., JSES 2002

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

JOURNAL OF SHOULDER AND ELBOW SURGERY

P. Boileau, S. G. Krishnan, L. Tinsi, G. Walch, J. S. Coste, and D. Molé, Nice, France **2002**

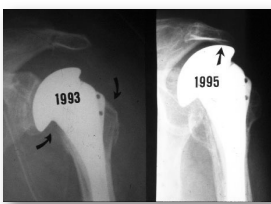


GT displacement → Poor functional outcomes

Tuberosity Complications

= 50% !!

- Initial Malposition 35%
- Migration 24%
- Nonunion / Malunion 53%



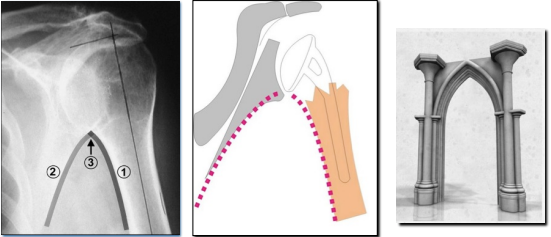
Boileau et al., JSES 2002

The Problems

- Improper Prosthesis Positioning
- Poor Prosthetic Design
- Poor Suture Fixation Technique
- Improper Post-op Management

Prosthesis Malpositioning

Too Proud → GT pull out / migration



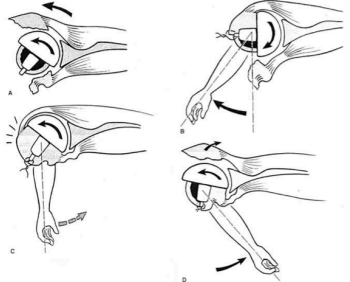
The image contains three sub-panels: 1) A lateral radiograph of a shoulder with a humeral head prosthesis, showing three points labeled 1, 2, and 3 along the humeral shaft. 2) A schematic diagram of a Gothic arch with a dashed red line representing the intended arch height and a solid orange line representing the actual arch height. 3) A photograph of two Gothic arches, one taller than the other, illustrating the concept of 'restoration of the Gothic arch'.

Restoration of the Gothic arch

Krishnan et al., JSES 2005

Prosthesis Malpositioning

Too Retroverted → GT pull out / migration

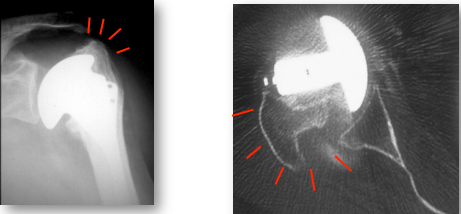


The image contains four schematic diagrams of a shoulder joint, labeled A, B, C, and D. Diagrams A and B show the humeral head in different positions of retroversion, with arrows indicating the direction of movement. Diagrams C and D show the corresponding positions of the glenoid and the resulting malpositioning of the glenoid track (GT).

Boileau et al, JSES 2002

Tuberosity Malpositioning

→ GT pull out / migration



The image contains two radiographs of a shoulder joint. The left radiograph shows a tuberosity that is either too high or too low, with red dashed lines indicating the malposition. The right radiograph shows a tuberosity that is too posterior, also with red dashed lines indicating the malposition.

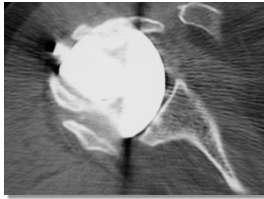
GT = Too High
...or too Low

GT = Too Post ...

Boileau et al JSES 2002

Bulky Prostheses Don't Help!

Excess of Metal+++



= Obstacle to
GT positioning



= Barrier for
bone healing! ...

Type of Prosthesis Does matter!

• *Loew et al., JBJS Br 2006*

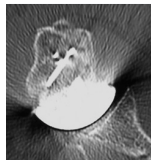
Tuberosity healing:
50% with a *Fracture Prosthesis* vs
29% with a *Standard prosthesis*



• *Krishnan et al., CORR 2011*

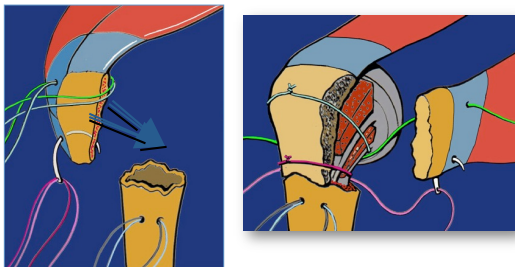
58 *Conventional Prostheses*
112 *Fracture Prostheses*

→ Use of fracture-specific stems did improve
shoulder function and tuberosity healing
compared with conventional stems



Poor Tuberosity Fixation

→ Separate fixation of GT & LT +++

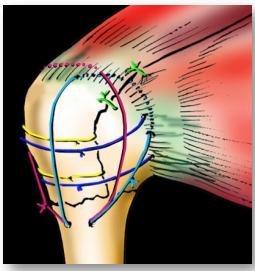


Boileau et al, TSES 2002

Poor Tuberosity Fixation

→ Cerclages + Tension-Band

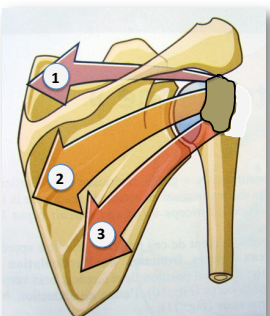
4 Horizontal Cerclages



2 Vertical Tension Band Sutures

Boileau et al, TSES 2002

Over Aggressive Rehabilitation



→ GT fragment Detachment!!

Protection of GT Repair

→ Neutral Rotation brace++



Pendulum exercises ONLY
for the first 4 weeks

HA for Fractures


How to maximize outcomes?...

Does the prosthesis matter?...

Can surgeons predict what makes a good hemiarthroplasty for fracture? JOURNAL OF SHOULDER AND ELBOW SURGERY 2013

Pascal Boileau, MD^{*,*}, Matthias Winter, MD[†], Alec Cikes, MD[‡], Yung Han, MD[§], Michel Carles, MD, PhD[¶], Gilles Walch, MD[¶], Daniel G. Schwartz, MD[¶]

61 Fractures
Two Types of Implants

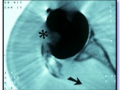


Standard stem
N = 31
(1991-1997)

Fracture stem
N = 30
(1998-2006)

Type of implant does matter!

Use of a Standard (bulky) Implant



- decreased GT adequate positioning 52% vs 97% p=0.0001
- decreased GT healing+++ 45% vs 87% p=0.0001
- decreased Functional outcome++
AAE 113° vs 136°
CS 58 vs 68 p=0.0001

Patient's age & gender also matter!

Patients over 75 years & Women have:

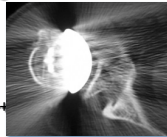
- Higher rate of tuberosity complications
- Lower functional results

(Regardless of the type of implant used)

Reverse prosthesis is probably a better option in the elderly (> 75yo) female patients



In Summary **HA for Acute Fractures**

- Still unpredictable results
"All or Nothing"
- Prosthesis / GT malpositioning
- Poor technique & prosthetic design
"Low Profile" fracture Prosthesis+++
- Influence of patient's age & Gender
poor results in the elderly women+++



**Can RSA be an
alternative to HA
in elderly patients?...**


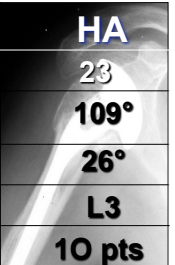
Prospective Randomized Study

RSA	HA
	
28 cases 79 yo	28 cases 76 yo

Patients > 70 y
Reverse / Aequalis-Fx
> 12 months FU
38 cases

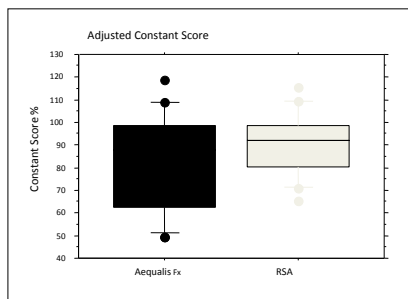
Sirveaux & Molé, Nice Shoulder Course 2008

Functional Outcomes

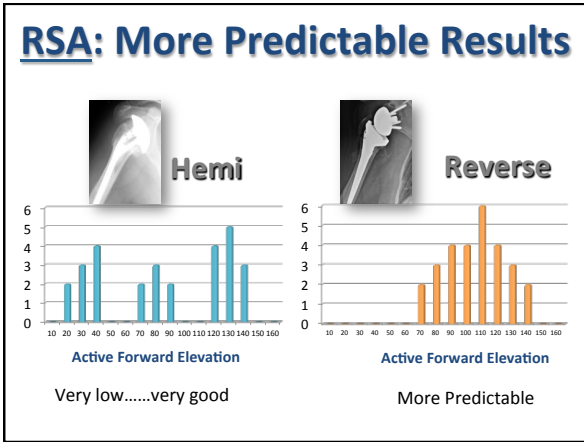
RSA	33 months F.U	HA
	Cases	
20 122° 18° Sacrum 12 pts	23 AFE <small>(p=0,07)</small> Active ER Active IR Pain	23 109° 26° L3 10 pts

Sirveaux & Molé, Nice Shoulder Course 2008

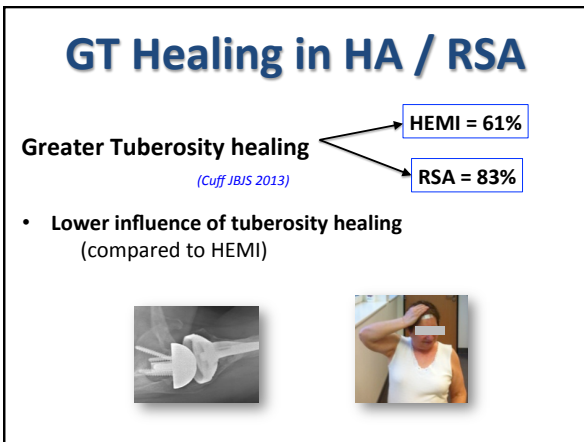
RSA: More Predictable Results



Sirveaux & Molé, Nice Shoulder Course 2008



Do Tuberosities Heal better in RSA?...



Comparative Study: HA vs RSA

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

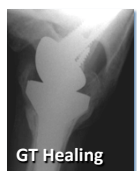
OTSR 2016

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

	HA (N=57)	RSA (N=41)	P
Constant	54	57	NS
Adj. Constant	73%	83%	0.02
AFE	112°	130°	0.01
AER	28°	23°	NS
AIR	L3	Sacrum	0.03
GT Healing	70%	70%	NS
Complications	24%	10%	0.01
SSV	66%	75%	NS

Is Absence of Tuberosity Healing a Problem in RSA for Fracture?...

The Importance of GT Healing




	AFE	AER1	AER2
GT Healing	127° 	25° 	50°
Absence of GT Healing	114° 	2°* 	15°**

Sirveaux & Molé, Nice Shoulder Course 2008

Absence of GT Tuberosity Healing in RSA

- Poor External Rotation
- Decreased ADLs
- Decreased patient's satisfaction



Evidence

- RSA outcomes are more predictable
- Rotator cuff is not essential for proper function of a RSA, the deltoid function is sufficient
- Improved ER when tuberosities reconstructed
- Preservation of the rotator cuff can help maintain stability and ultimately improve shoulder function

Sufficient arguments for NOT Excising tuberosities in RSA

**Are Results better
in RSA?...**

Comparative Study: HA vs RSA

Reverse Total Shoulder Arthroplasty Versus Hemiarthroplasty for Proximal Humeral Fractures: A Systematic Review

Ferrel, Jason R. MD; Trinh, Thai Q. MD; Fischer, Richard A. MD 2015 **JOT**


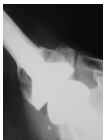
→ **Meta-analysis** : 30 studies (2004-2014, min. 1y FU)

HA		RSA
63	ASES score	65
58	Constant score	55
108°	Active AE	118°
30°	Active ER	20°
30% (26% tub)	Complications	10%
5.7%	Reoperation	5%

In Summary **RSA for Acute Fractures**

- AFE is more predictable in RSA than in HA, and complication rate is lower
- But, IR is decreased in RSA
- GT healing is needed to restore active ER and improves ADL++

→ **Tuberosities in RSA should NOT be excised, but repaired+++**

Take-Home Messages

GT Healing is Needed in HA

In order to get good functional outcomes



Preop 3y po

Absence of GT Healing in HA

is catastrophic!!....

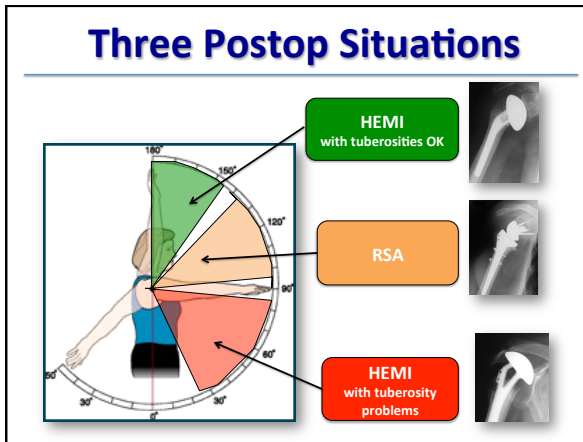


GT Healing is Not Needed in RSA

But, tuberosity healing improves :

- Constant score
- Active ER++
- ADLs





A RSA without ER muscles is a bad RSA!

Absence of GT fixation/healing:

- Hornblower sign/ Lag Sign
- Decreased ADLs
- Increased Humeral loosening

→ NO Tuberosity excision+++

Prosthesis Design & Surgical Technique Do matter for both HA / RSA

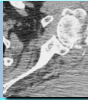
Indications for RSA in Acute Fractures



Patient's Age (>75)
Women (osteopenia+++)
Poor blood supply (Diabetes, smoking)
Poor compliance with Rehabilitation (Dementia)



Greater Tuberosity comminution
Poor bone quality (cortical thickness)
Combined Humerus & Glenoid fracture



Preliminary Rotator Cuff pathology (up to 5%)
Severe Fatty infiltration of RC muscles (Goutallier stage 3 or 4)

Greater Tuberosity fractures

New indications for fixation?

Jonah Hebert-Davies

Harborview Medical Center

Dominique M Rouleau

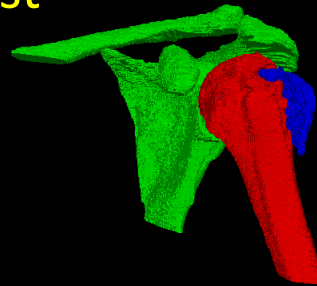
Hôpital du Sacré-Coeur de Montréal



Conflicts of interest

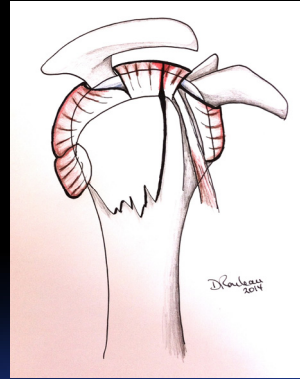
Senior Author

- Consultant for Wright
 - Design team on PHF plate
- Consultant for Bioventus
- Research or teaching funding's from: Arthrex, Conmed, Depuy-Synthes, Smith and Nephew, Stryker, Wright, Zimmer
- Associate editor OTSR-RCO



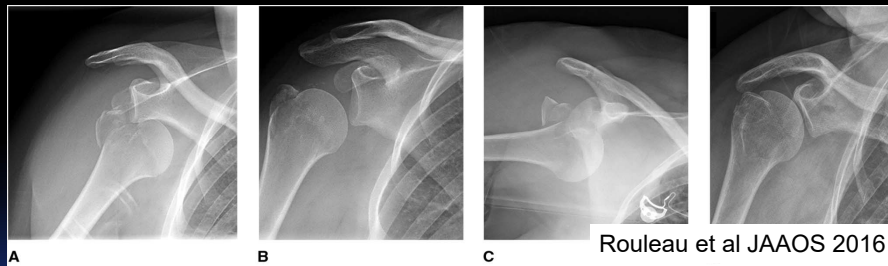
Outline

- Classification
 - Updates for 2017
- Displacement measurement
- Treatment algorithms
- Surgical tips and tricks



GT fracture

- ~20% of all Proximal Humerus Fractures
- Young men
- Occur in 15-30% of GH dislocation



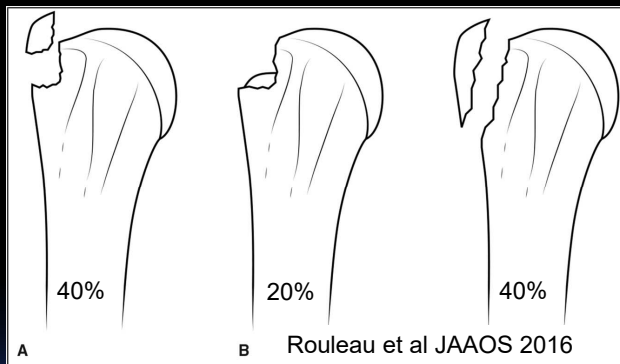
Classification...s

- AO and Neer classifications
 - Split type only
 - Poor Reliability
- AO inter/intraobserver
 - 0.35/0.65
- Neer inter/intraobserver
 - 0.35/0.63

Mutch et al BJJ 2014
Bahrs JSES 2006

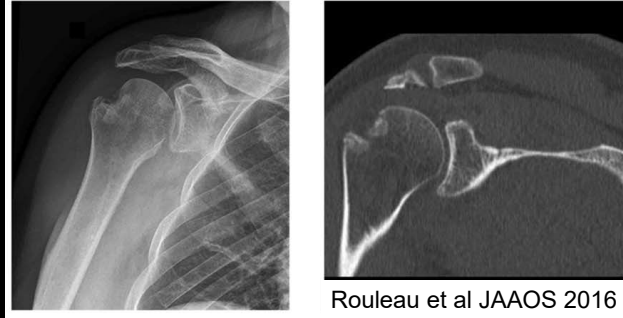
Classification...s

- 3 specific types of GT fractures
 - Avulsion
 - Impaction
 - Split



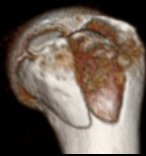
Mutch et al BJJ 2014
Bahrs JSES 2006

Impaction fractures are real!



- Associated with glenohumeral dislocation
 - Up to 46% of cases

Mutch et al BJJ 2014
Davies Injury 2000
Kaspar JSES 2004



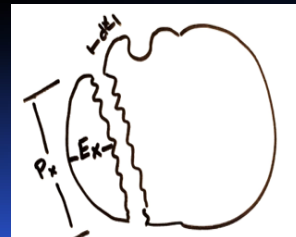
GT split sizes CT scan

Thickness 15 mm

Height 34 mm

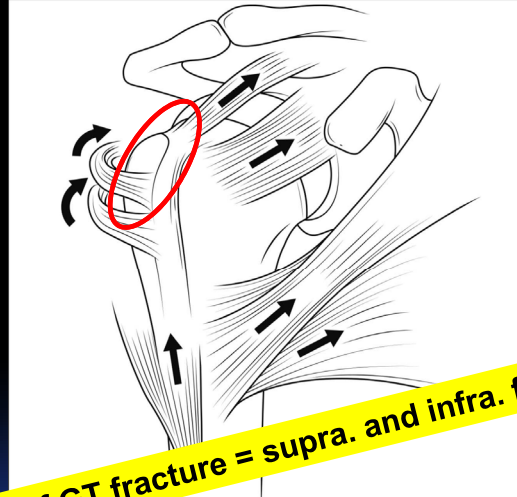
Fx angle 37°

AP diameter 31 mm



Boaretto, Rouleau et al, submitted JSES

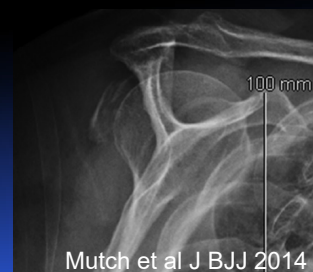
Displacement



Rouleau et al JAAOS 2016

Displacement

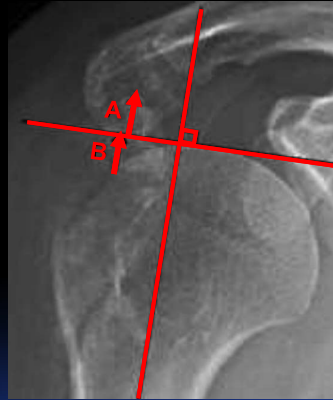
- >5 mm displacement = worse outcomes
 - Either posterior or superior
- Severe RC muscular atrophy is seen when displacement is of > 7mm
 - Rouleau et al. SE UK 2016



Mutch et al J BJJ 2014

GT Ratio on AP x ray

- **Ratio = A+B / B**
 - <0 : Conservative
 - 0-0.5 : CT scan
 - >0.5 : Surgery
- **High correlation with CT**
R=0.852
- **less radiation**



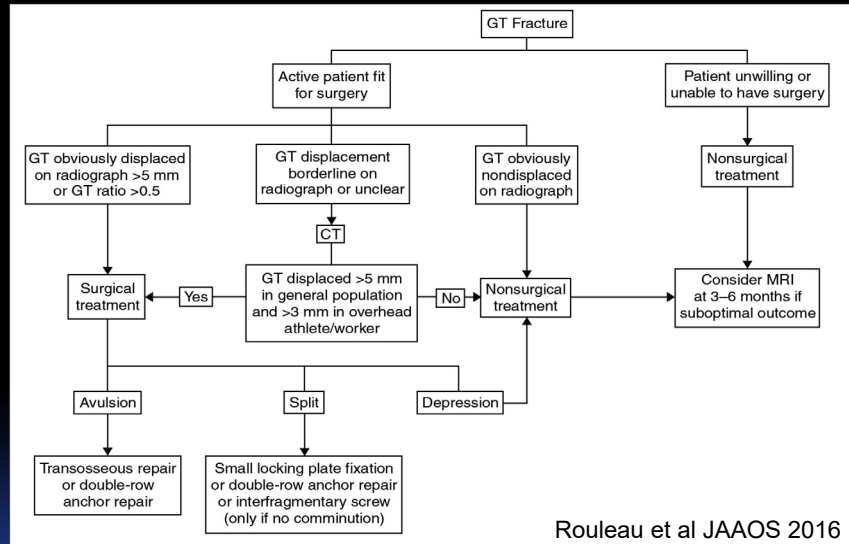
Mutch, Rouleau et al JOT 2014
Rouleau et al JAAOS 2016

Associated Dislocation

- Hebert-Davies et al 2015 JOT
- “Undisplaced” fractures after reduction
 - 20% will displace
 - Close follow-up warranted

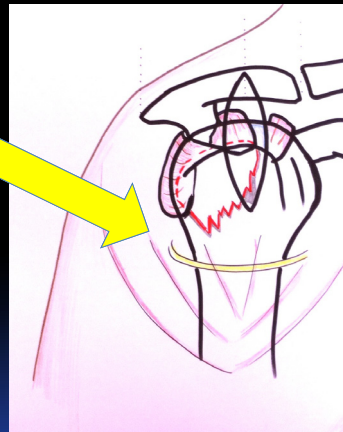


Treatment algorithm

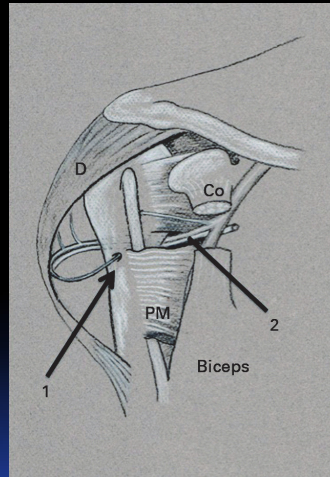


Surgical Treatment

- Standard Deltoid-Split Mini-open approach
- Axillary Nerve
– ≥ 5 cm from acromion



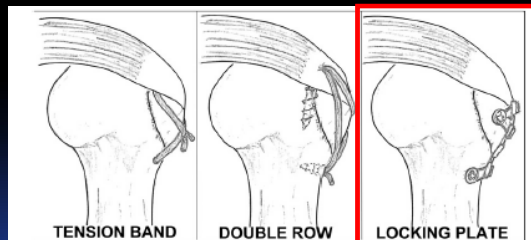
Posterior circumflex artery



Smith BJJ 2016

Displaced GT Split Fracture

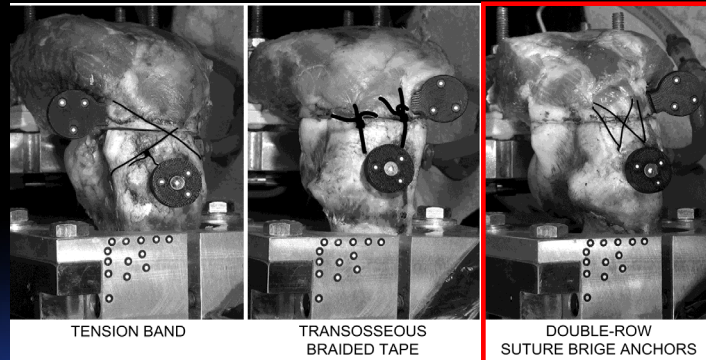
- Displaced Split combined treatment
- Biomechanical : Gaudelli et al 2014
- **Plate vs double row for SPLIT =**
 - 3x stronger
 - 5x stiffer



Gillespie RJ AJO 2015

Displaced GT avulsion fracture

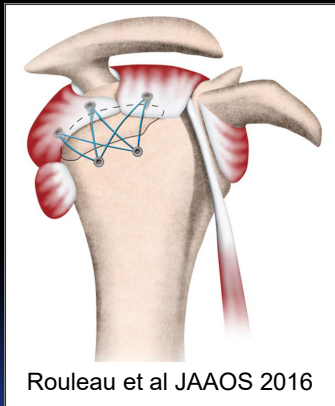
- Biomechanical study Brais et al 2015
 - Double Row = less displacement



Brais Rouleau et al, Injury 2015, Cheng-Li JSES 2015

Displaced GT avulsion fracture

- Preferred method of treatment
- Open or Arthroscopic



Arthroscopy vs open

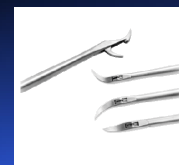
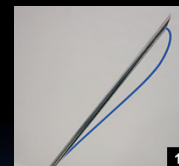


	Arthroscopy N=15	ORIF N=17	p
OR time (min)	95	62	<0.05
Flexion	153	138	<0.05
Abduction	146	132	<0.05
ASES	92	87	0.02

Liao et al CORR 2016

GT avulsion arthroscopic fixation

- Associated more blood
- Medial anchors in **normal** bone
- Suture passer **fracture/compress** the fragment
- Needle passer more precise



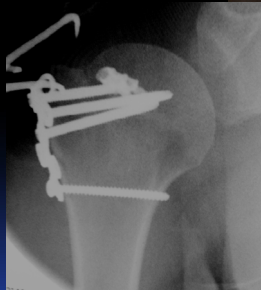
GT depression fracture

- Rarely displaced
- If displacement :
 - treat as avulsion
- Advanced imaging
 - R/O Cuff tear



GT outcomes?

- Not Always disappointing
- 80-100% good to excellent outcomes
- Identifying type + treatment = key
- Complications often treated with injections



- Rouleau et al SE UK 2016
- Maman E Orthop. 2014

GT outcomes?

- Residual Symptoms
 - Adhesive Capsulitis
 - Malreduction/displacement > 5mm
 - Rotator cuff tear (15%-30% full tear)
 - Long head of the biceps
 - Bursitis (57%)*
 - Previous surgery... P acnes

- Rouleau et al SE UK 2016
- Maman E Orthop. 2014

Conclusion

- Displacement of GT fracture
 - Difficult to quantify on X-ray
 - Superior, posterior or combined
- Indications for Surgery
 - 5 mm of displacement
 - GT ratio >0.5

Conclusion

- Avulsion fractures
 - Double row or suture bridge construct
 - Arthroscopic or open
- Split fracture
 - ORIF with plate
 - Combined with suture fixation
- Depression fracture
 - Mostly Non-operative treatment