PROXIMAL HUMERUS FRACTURES: CURRENT STRATEGIES

ANIL K DUTTA, MD
Associate Professor
Shoulder & Elbow Service
UTHSCSA Orthopaedic Surgery

UT Health
San Antonio
Orthopaedics

Disclosures

Consultant LIMA

Speaker’s Agreement Skeletal Dynamics

UT Health San Antonio Orthopaedics

EIDEMIOLOGY

3-4% of all fractures

60% over 60 and 50% over 70

2-1 F:M ratio

Bimodal with young males as high energy group

UT Health San Antonio Orthopaedics

MECHANISMS

- Fall on outstreched hand
- MVA
- Hyper-external rotation
- Direct Blow
- Seizure

UT Health San Antonio Orthopaedics

MUSCLE FORCES

Subscapularis-lesser tuberosity

Supraspinatus/ Infraspinatus/ Teres Minor- greater tuberosity

Pec Major – shaft(pulls it into flexion and adduction)

Deltoid pulls on proximal shaft

UT Health San Antonio Orthopaedics

ANATOMY

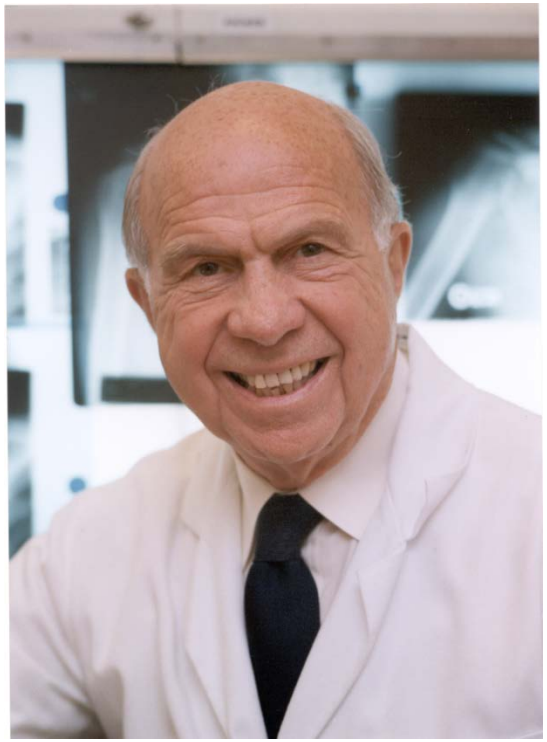
4 PARTS

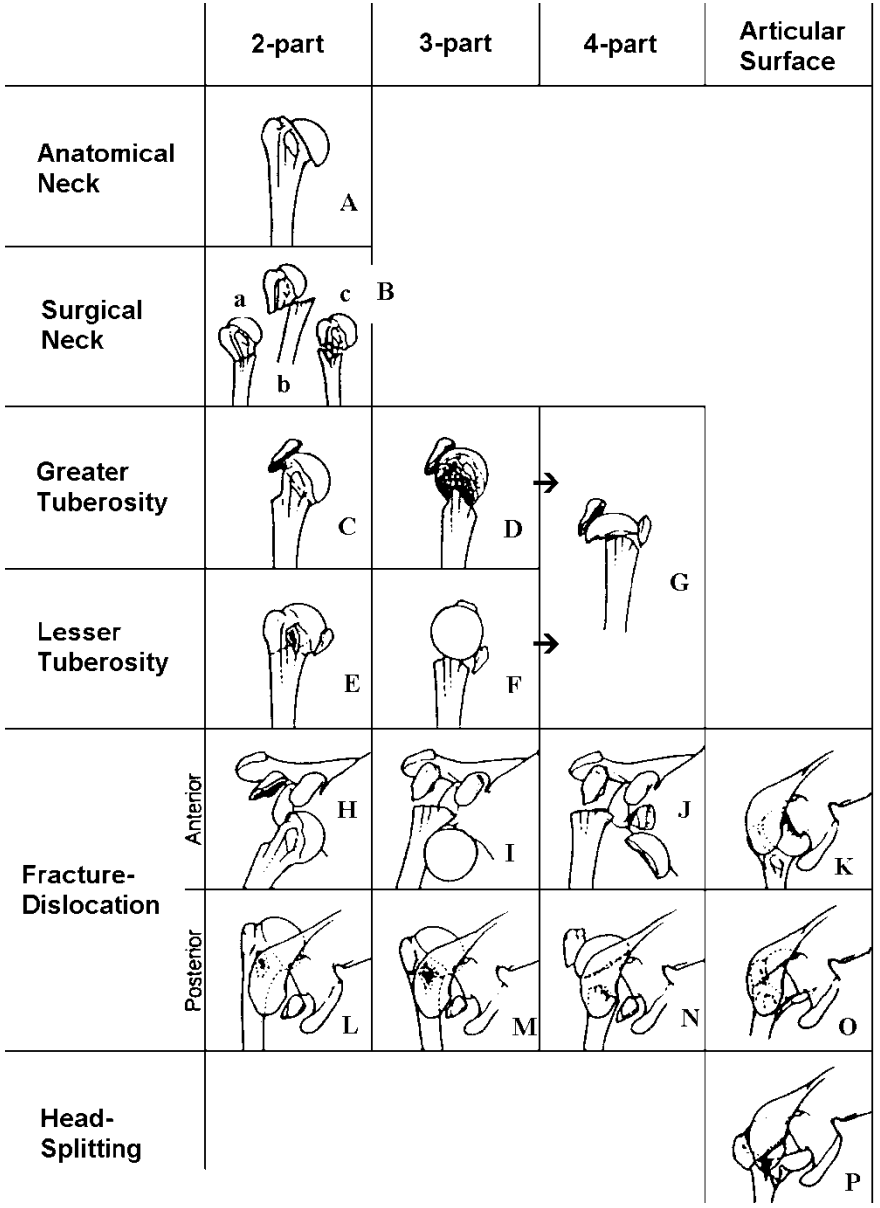
DEFINED BY 1 CM DISPLACEMENT AND 45 DEGREES OF ANGULATION

UT Health San Antonio Orthopaedics

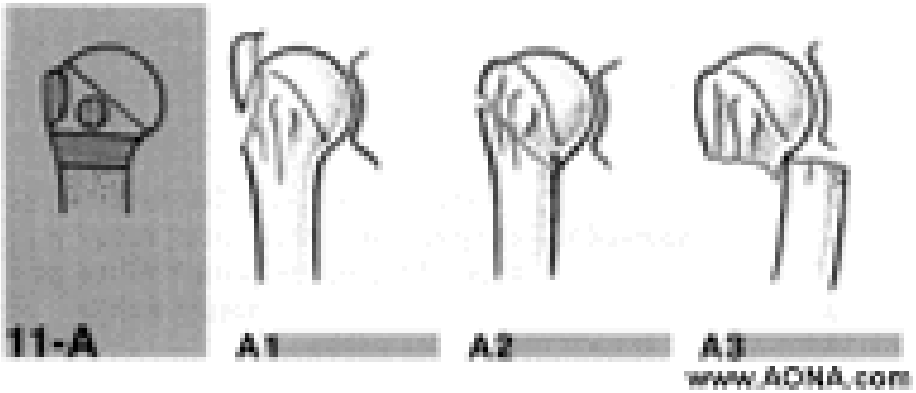
Fracture Classifications

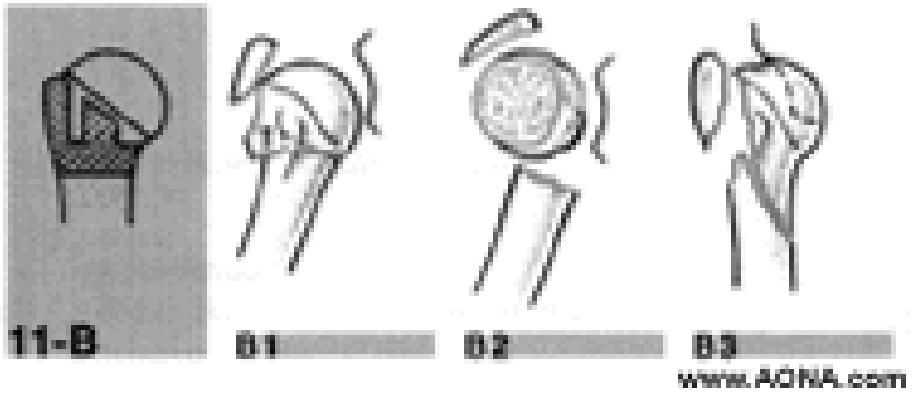
NEER Classification

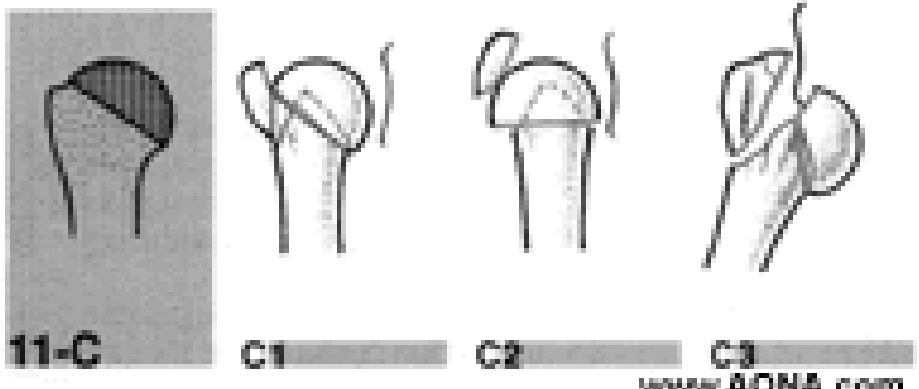




AO CLASSIFICATION







2-Part Fractures

28% of proximal humeral fractures

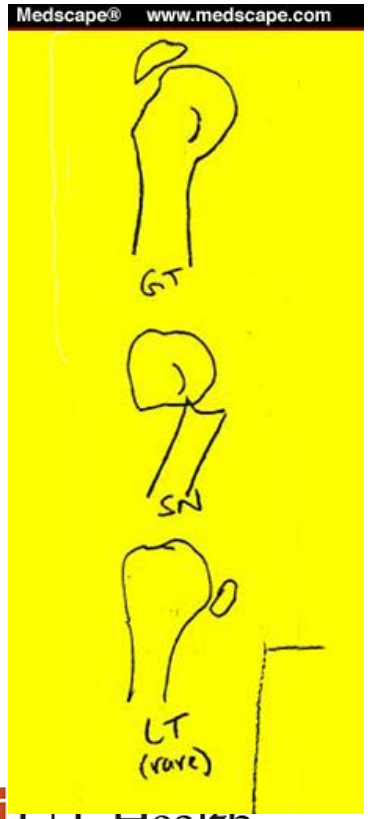
Fractures at either:
- Greater Tuberosity
- Surgical Neck
- Lesser Tuberosity

More common in elderly

<u>Treatment options</u>

ORIF
- Plate
- Intramedullary Nail

CRIF
- Percutaneous Pins

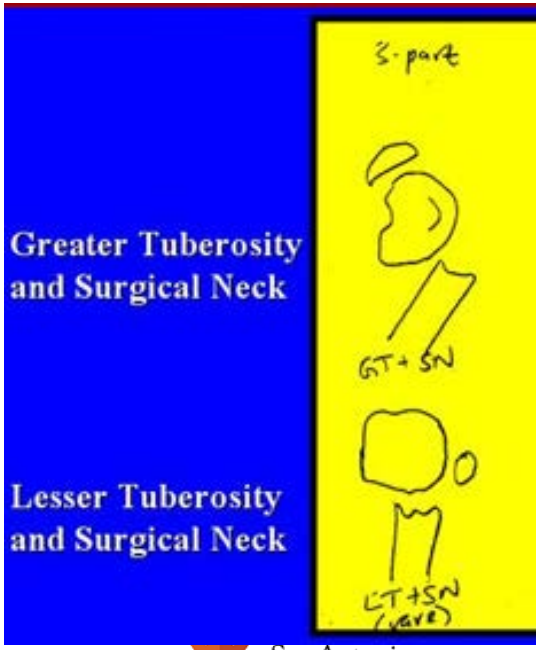


UT Health San Antonio Orthopaedics

3-Part Fractures

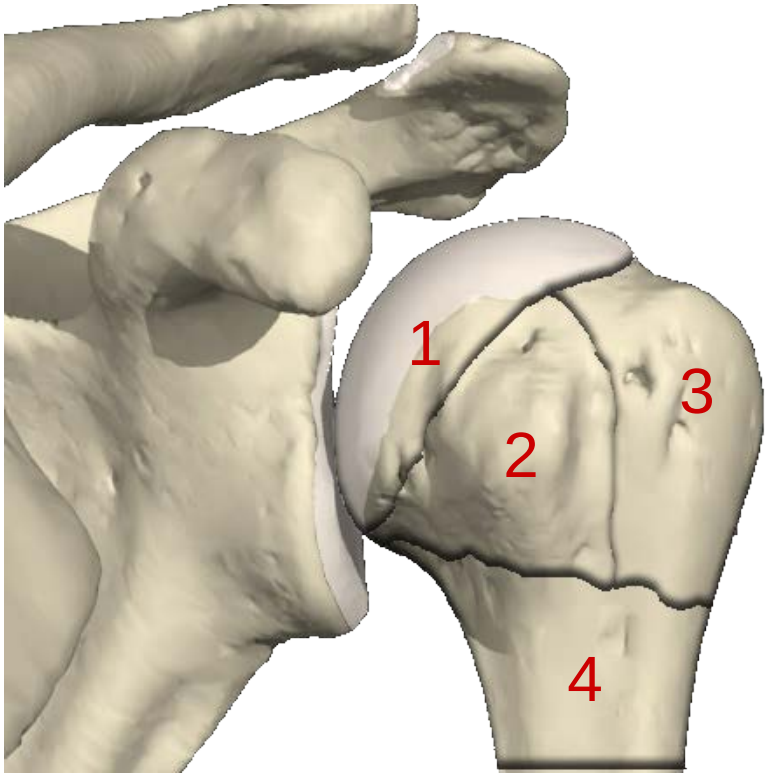
Treatment Options

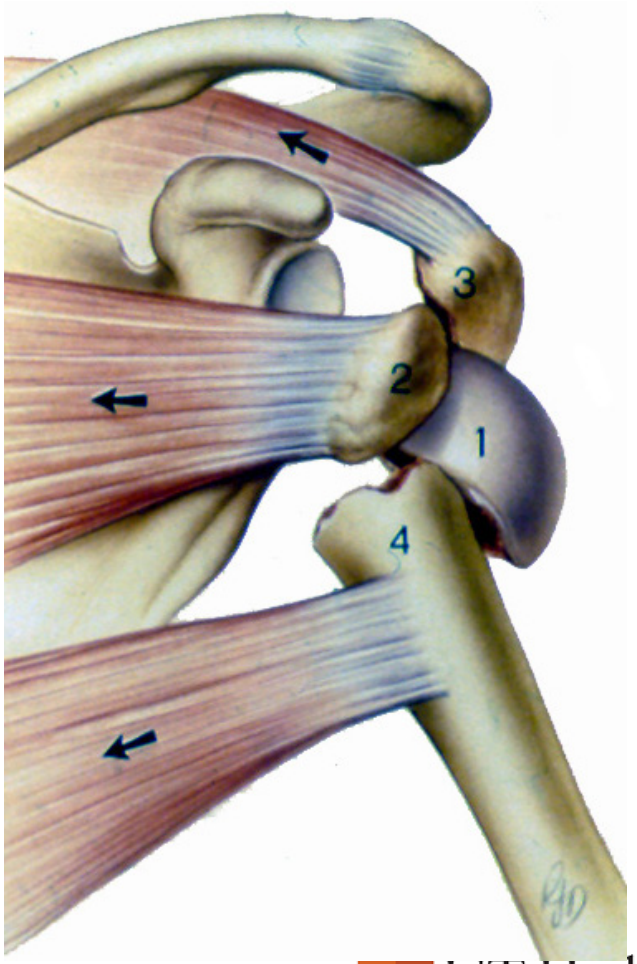
1. CRIF
2. ORIF
   - Proximal Humeral Plates and Screws
   - Cerclage Wires
   - Intramedullary Nails
   - Hemiarthroplasty or Reverse
     - elderly with poor bone stock
     - Extreme comminuted fragments



San Antonio Orthopaedics

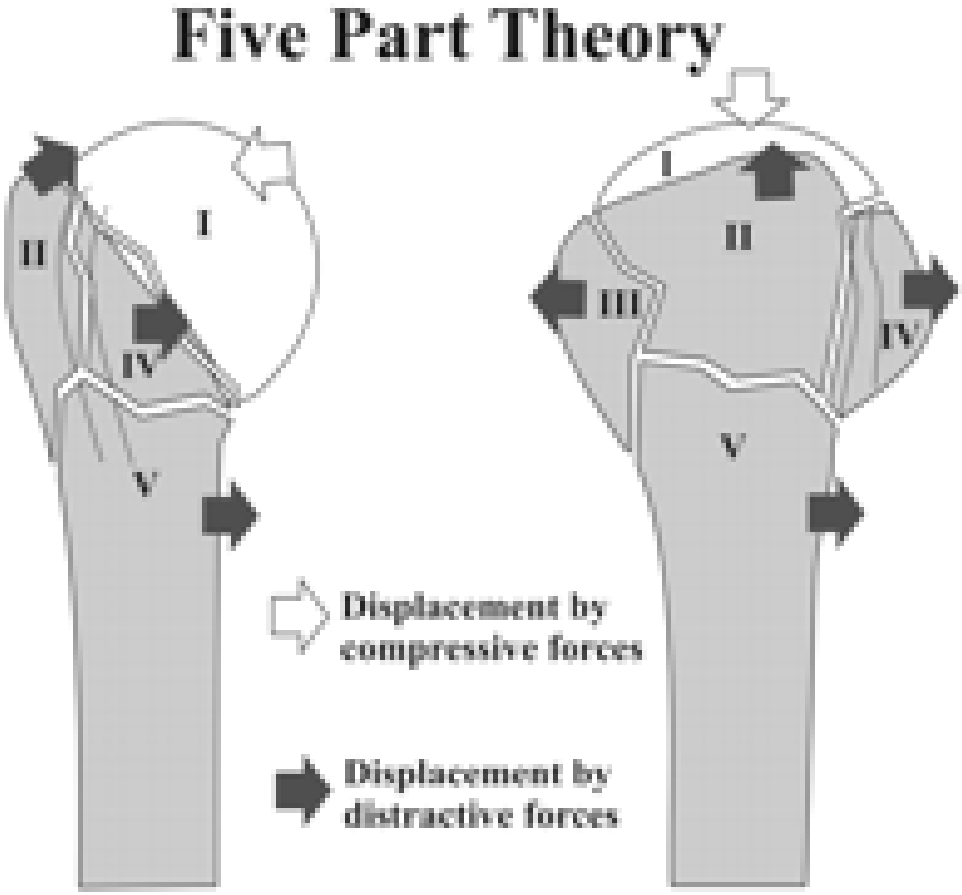
4-Part Fracture





UT Health
San Antonio
Orthopaedics

Alternative Descriptions



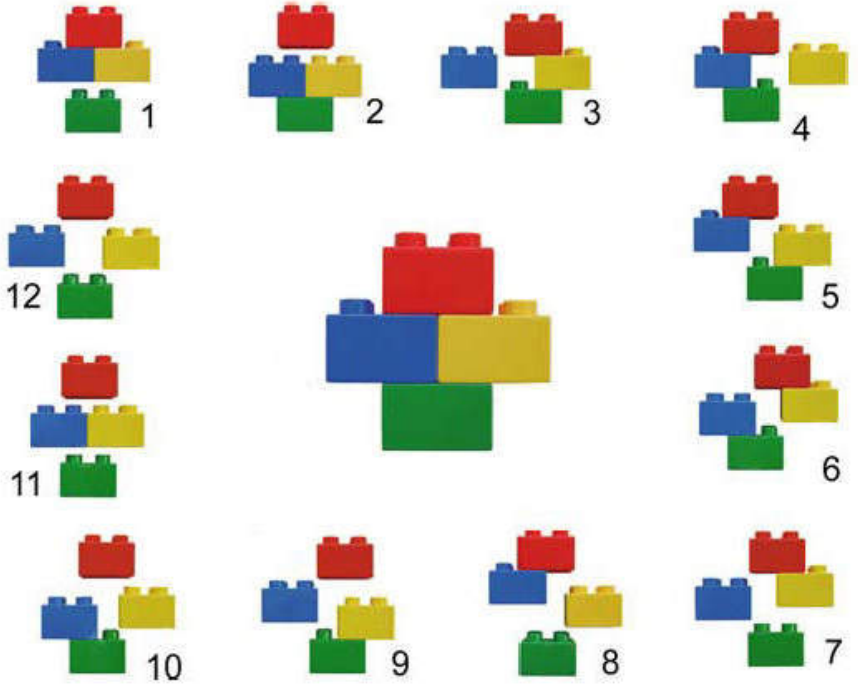
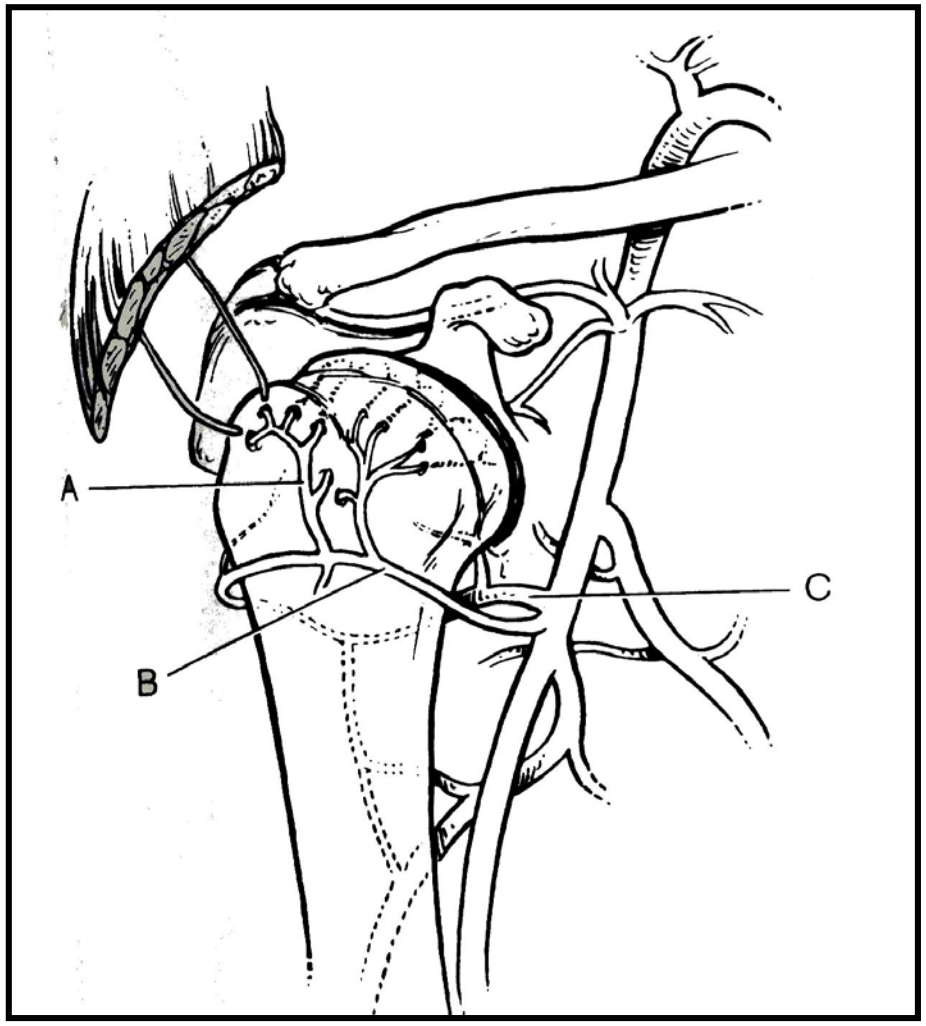


Fig. 1 Binary or "LEGO" description system. Combination of the five basic fracture planes results in 12 basic fracture patterns. Basic fracture planes lie between the greater tuberosity and the head, the greater tuberosity and the shaft, the lesser tuberosity and the head, the lesser tuberosity and the shaft and between the lesser and the greater tuberosity

PROXIMAL HUMERUS VASCULAR ANATOMY



Anterior humeral circumflex artery : Gerber

Posterior humeral circumflex: Helfet

UT Health San Antonio Orthopaedics

Vascularity

Anterolateral Branch of Anterior Humeral Circumblex

Arcuate artery

Posterior Cuff from Posterior Hum Circ and suprascapular anastomisis

Thoracoacromial and subscapular artery

UT Health San Antonio Orthopaedics

Plain Radiographs

SCAPULAR AP, Y,AND AXILLARY OR VELPEAU

20 ER AND 15 CAUDAL BEST FOR GT

Radiographic Evaluation

Poor interobserver reliability

Bernstein JBJS, Sjoden Acta Scan

OTHER CONSIDERATIONS

Vascular injury

increased risk at trifurcation and with displaced medial shaft spike

Nerve Injury (Axillary Suprascapular)

CT

Dislocation

Arteriogram

UT Health San Antonio Orthopaedics

TREATMENT

NON SURGICAL : 90% satisfaction

SURGICAL: NO CLEAR WINNER

UT Health San Antonio Orthopaedics

N

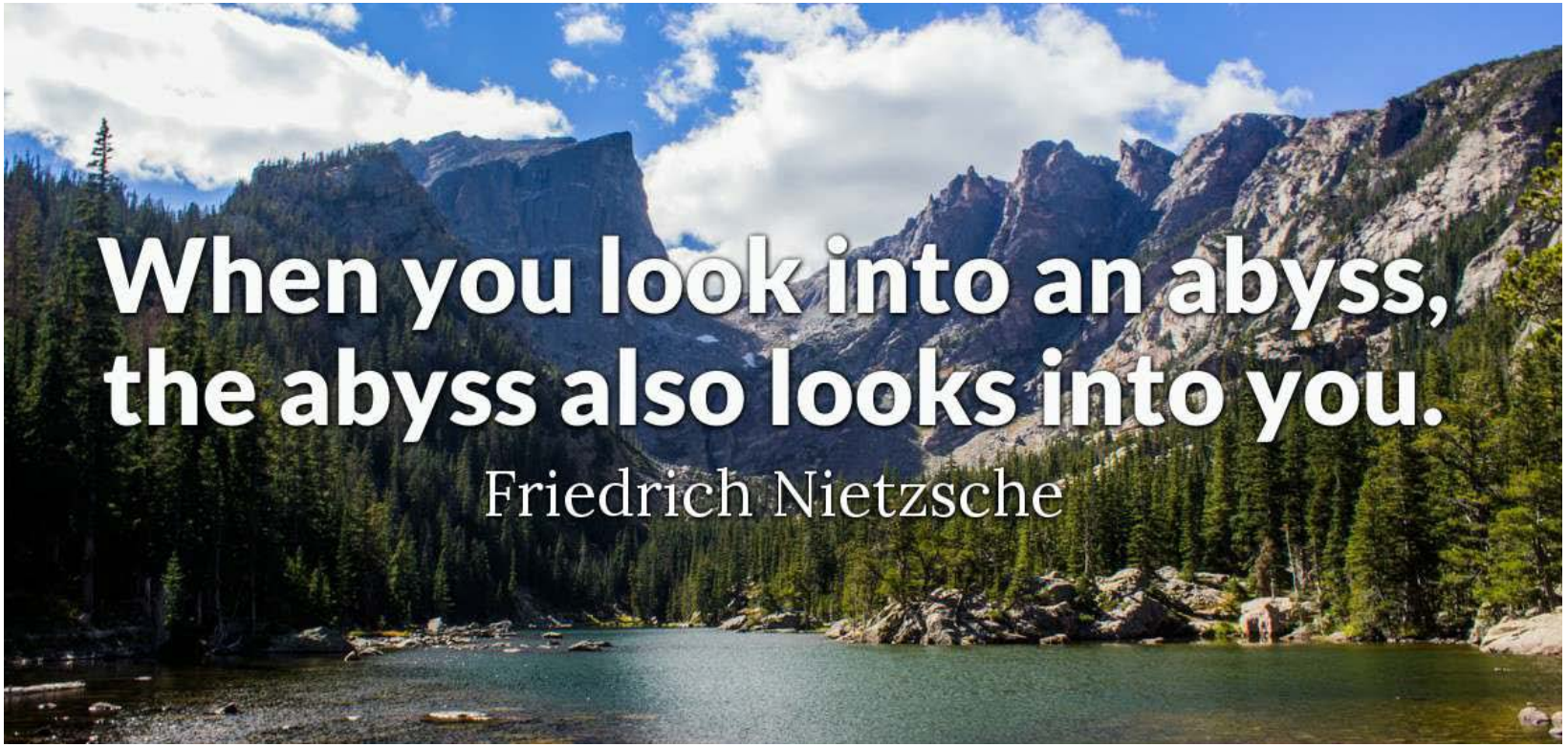
2

N

N

N

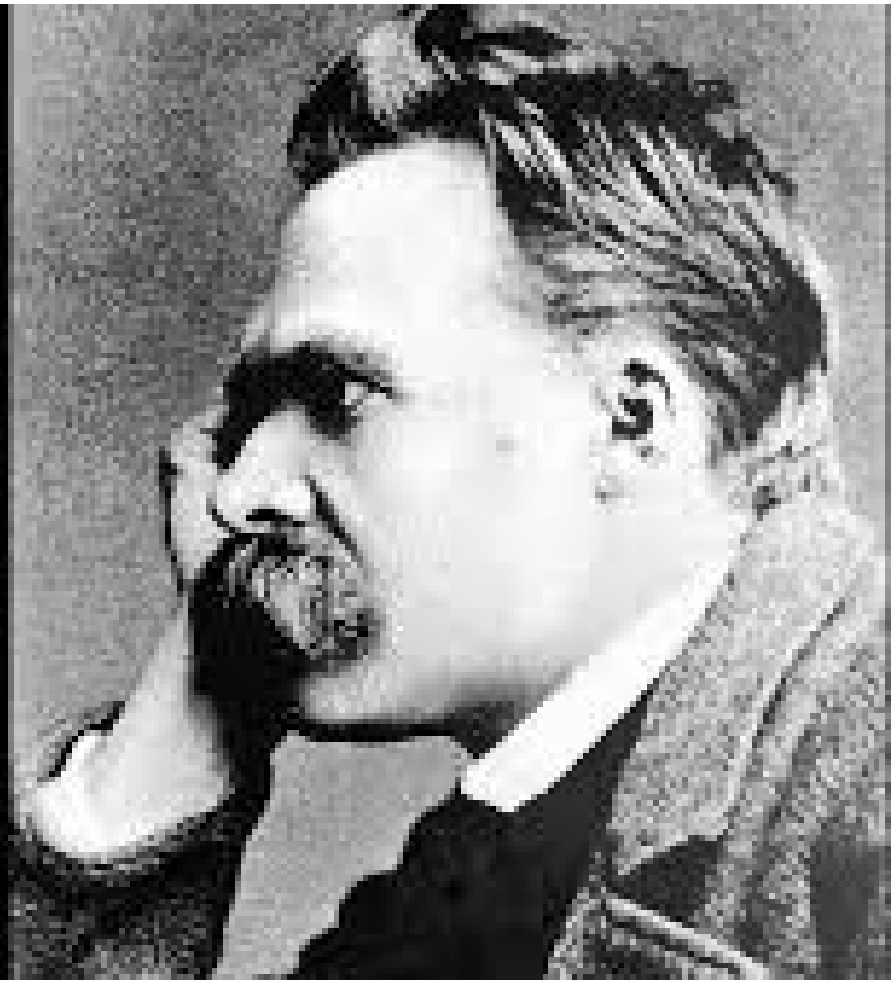
UT Health
San Antonio
Orthopaedics



UT Health
San Antonio
Orthopaedics

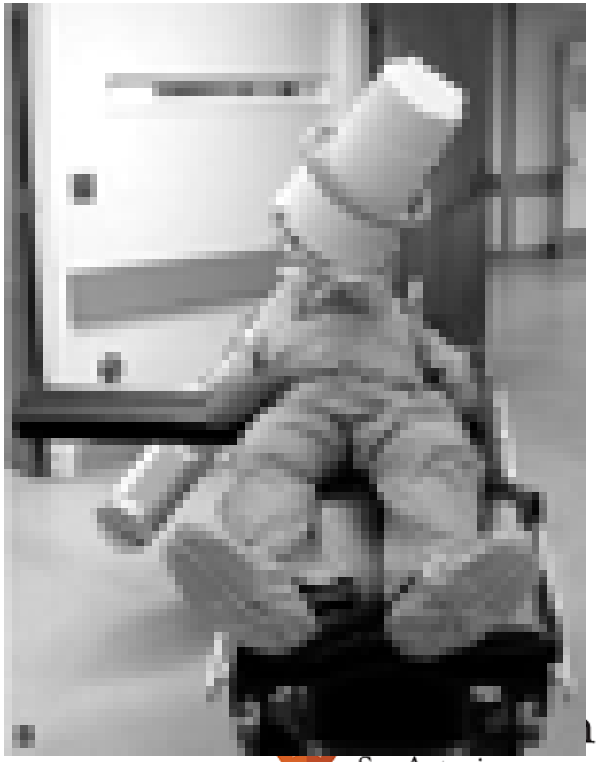
"Battle not with monsters, lest ye become a monster, and if you gaze into the abyss, the abyss gazes also into you."

-Friedrich Nietzsche, Philospher



UT Health San Antonio Orthopaedics

SET-UP



San Antonio
Orthopaedics

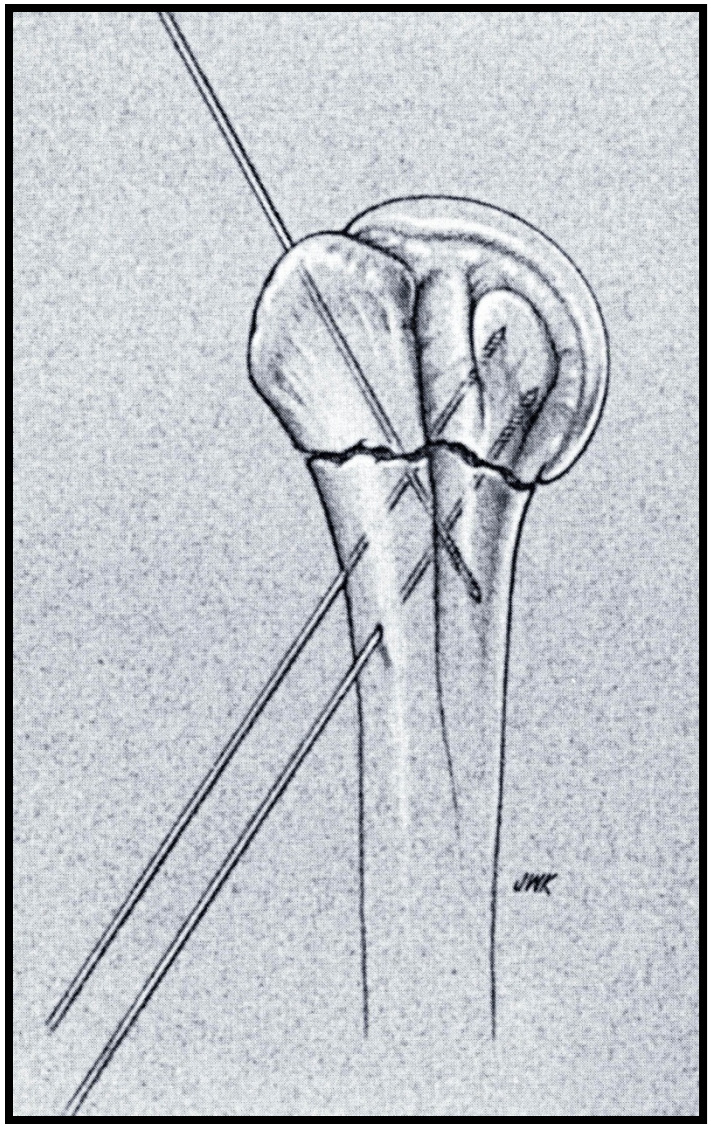
POSITIONING

UT Health
San Antonio
Orthopaedics

ALTERNATIVES

UT Health San Antonio Orthopaedics

PINNING



Jaberg,Warner, and Jakob JBJS 92 34/48 good – excellent

Fenischel Int Orthop 70% good or excellent

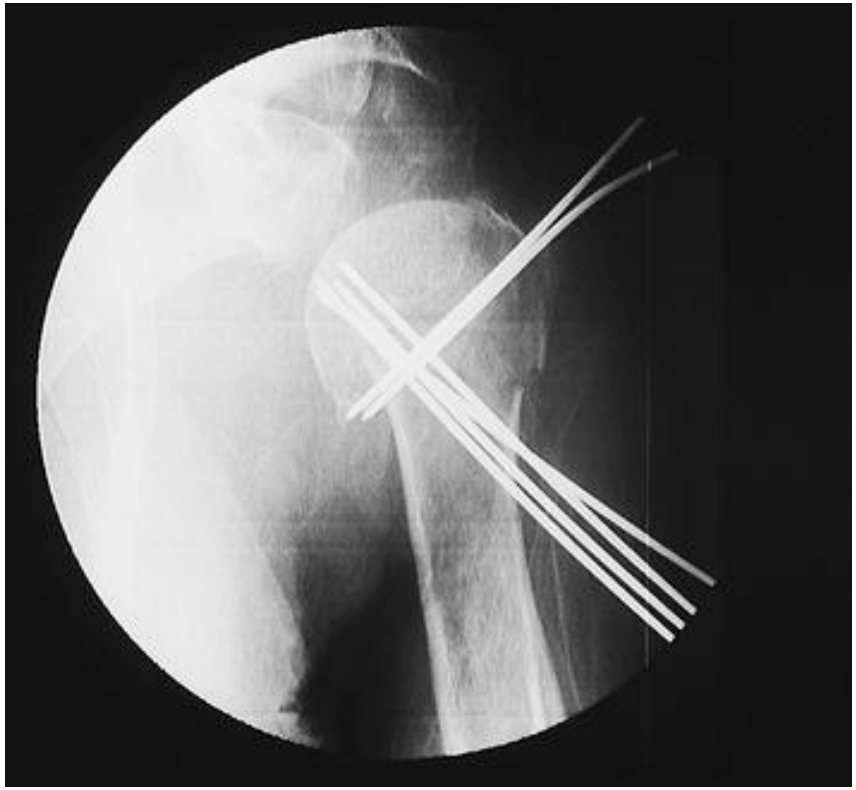
UT Health San Antonio Orthopaedics

Pinning

2 pins from Greater Tuberosity and 2 from shaft best biomechanical (Orthop Trans96)

Tuberosity pins stop 2 cm or greater from the head

8cm distal to acromion for shaft pins

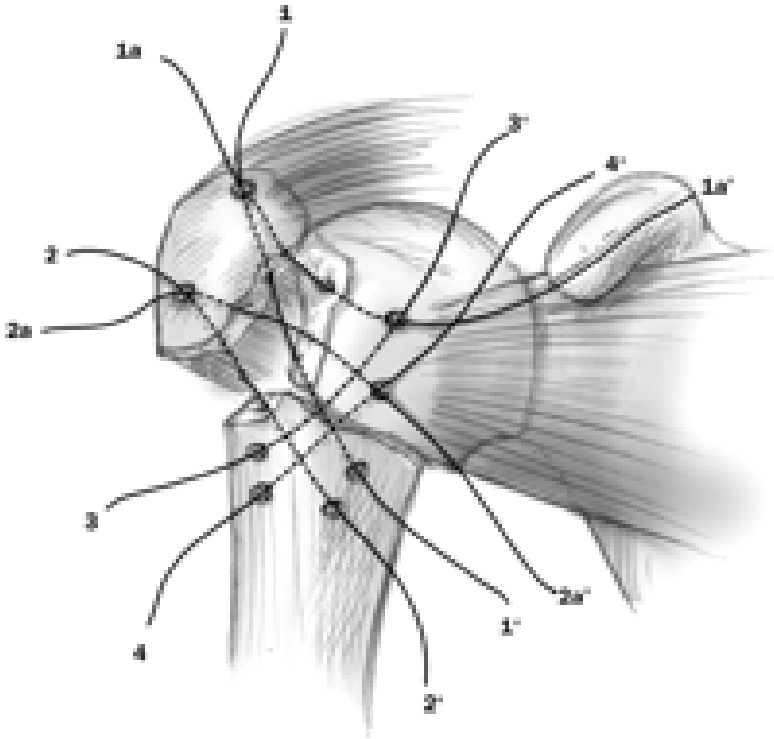


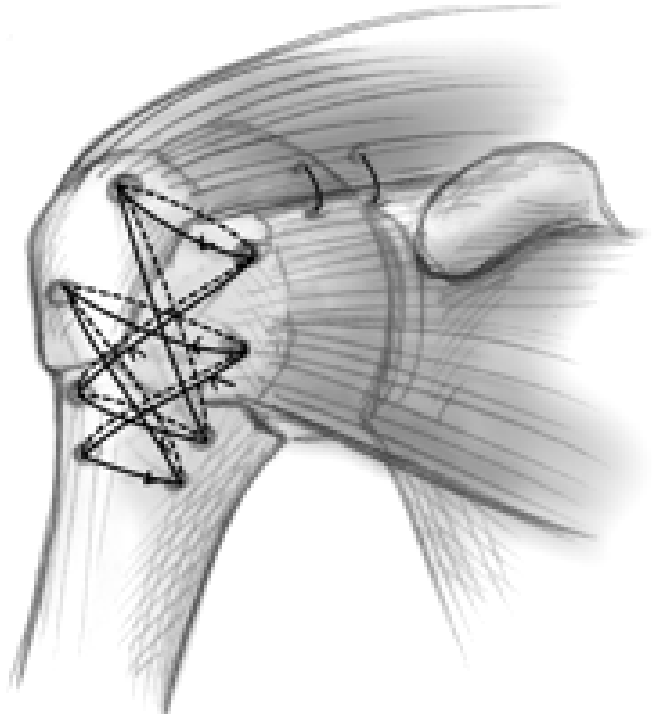
UT Health San Antonio Orthopaedics

Humerusblock

UT Health San Antonio Orthopaedics

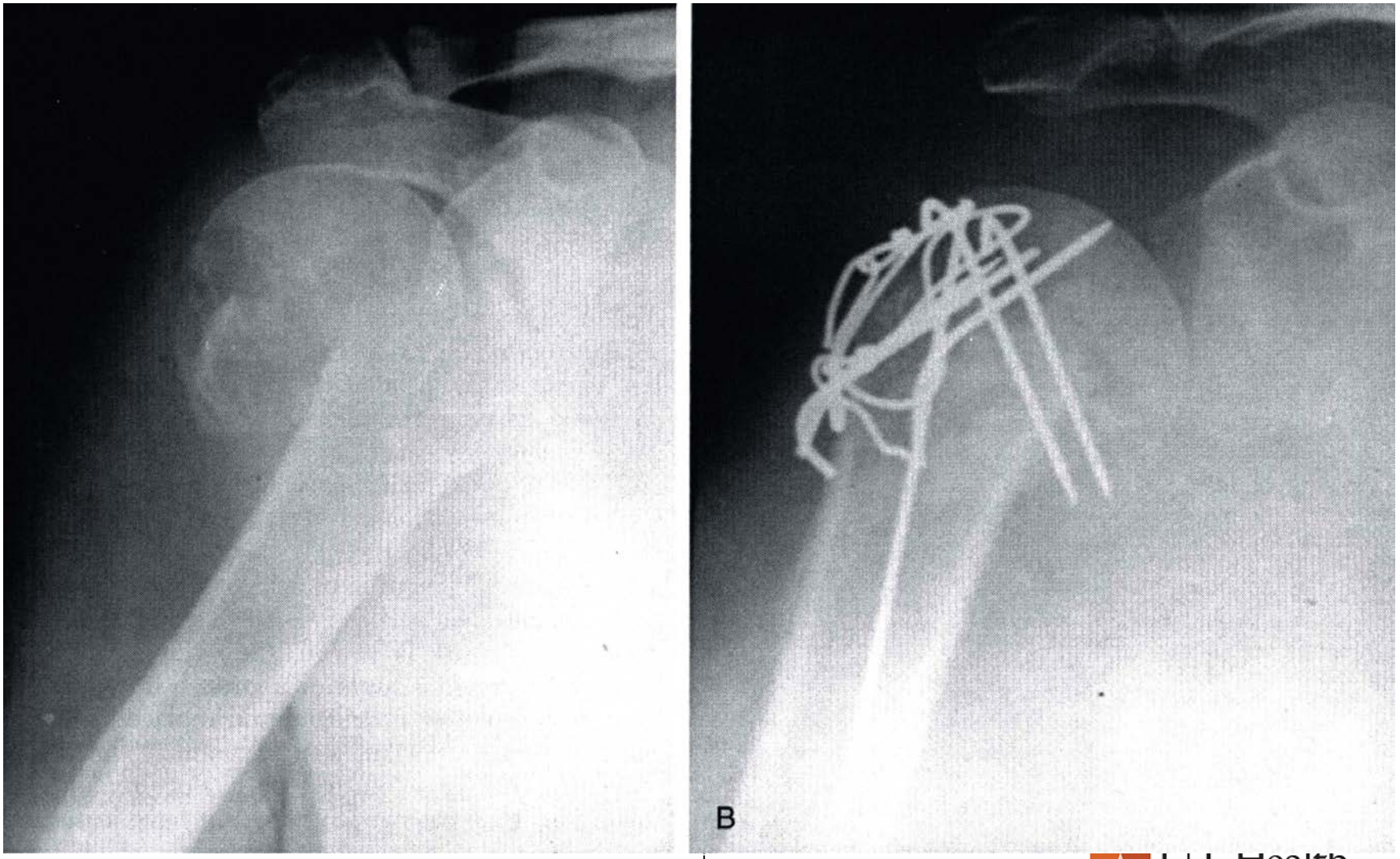
Osseous Wiring





Park, JOT 2003 2 or 3 parts did well

UT Health San Antonio Orthopaedics

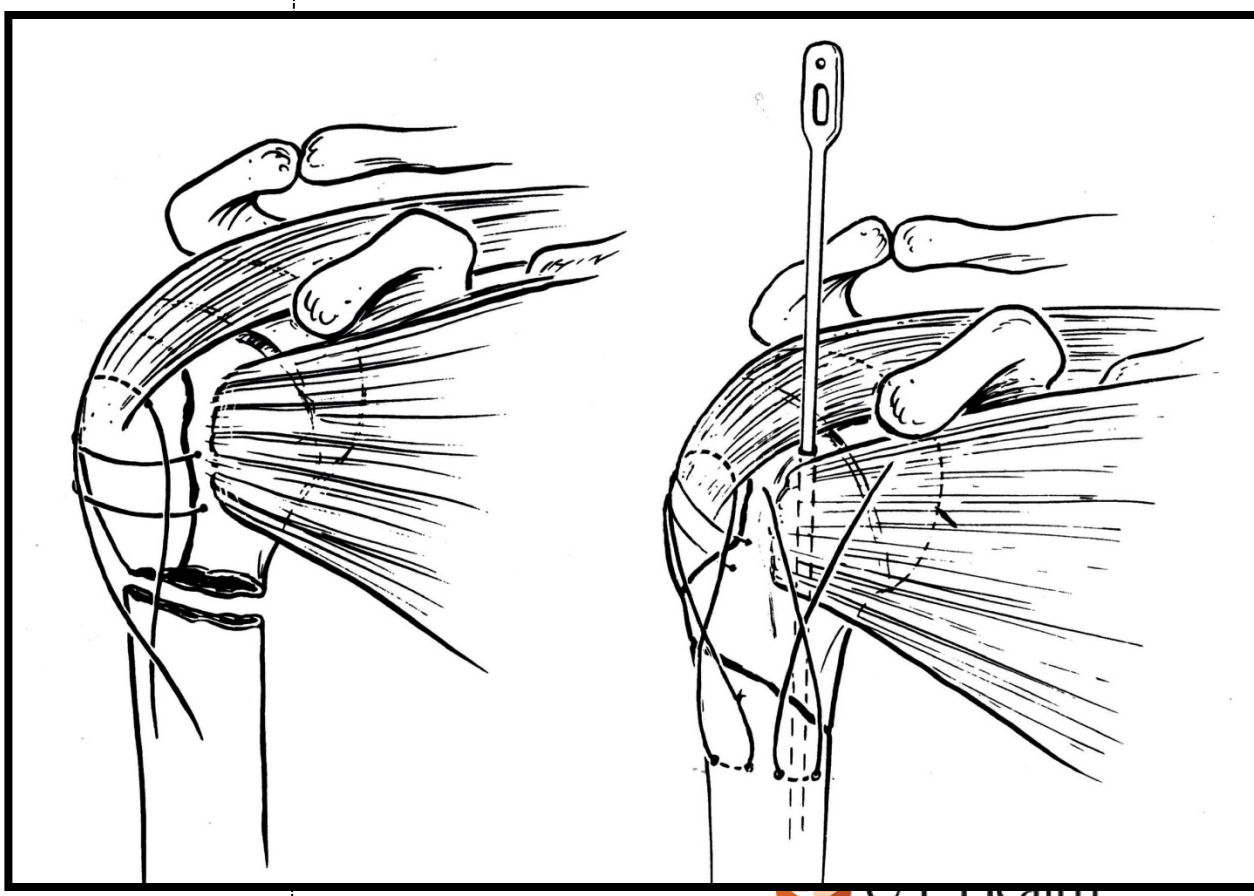


UT Health
San Antonio
Orthopaedics

ENDERS NAILS

Williams: adds

1.5 factor of stability

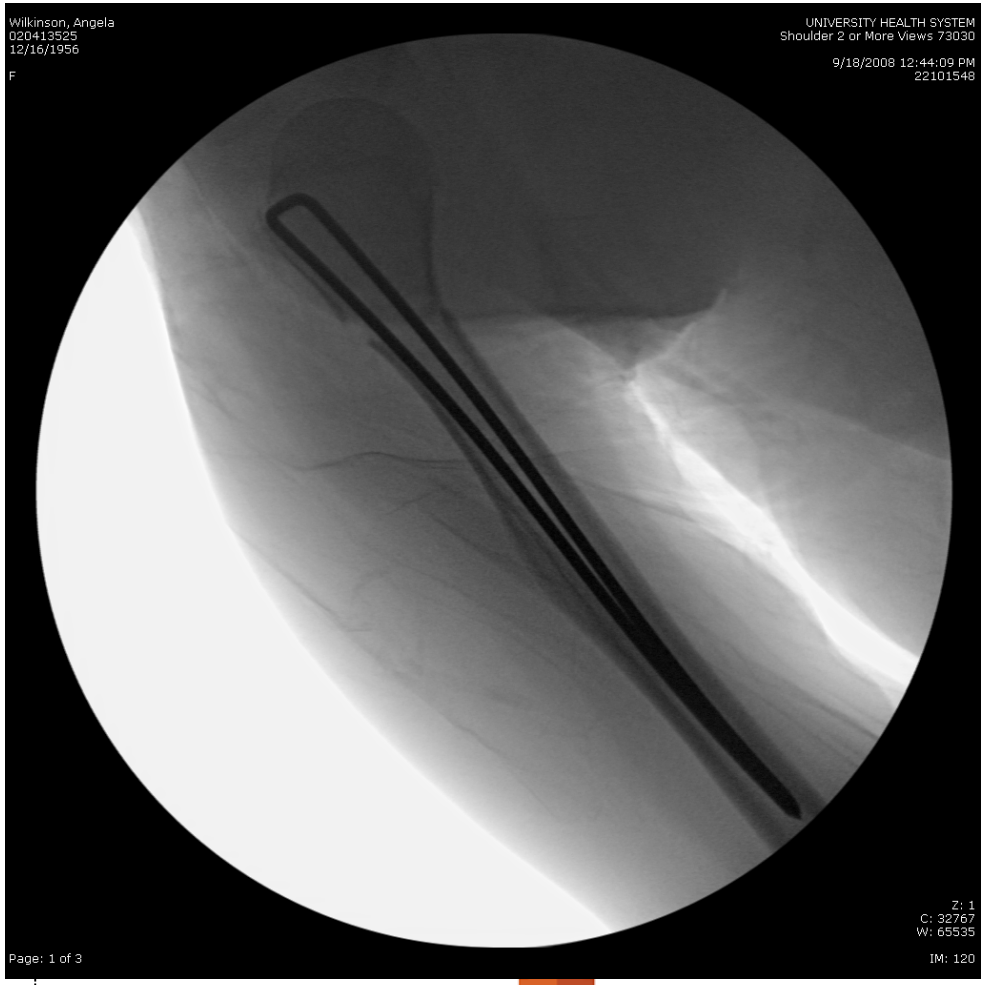


UT Health San Antonio Orthopaedics

Flexible Nails

UT Health
San Antonio
Orthopaedics

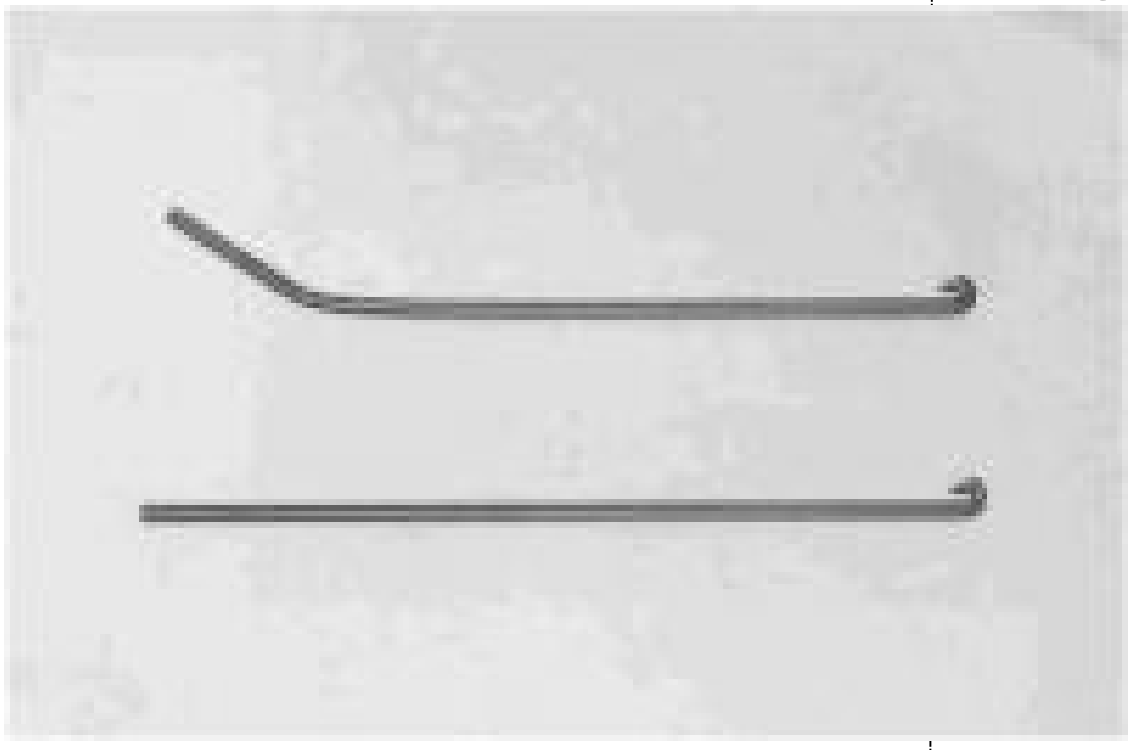
Evans Staple



UT Health San Antonio Orthopaedics

J nails

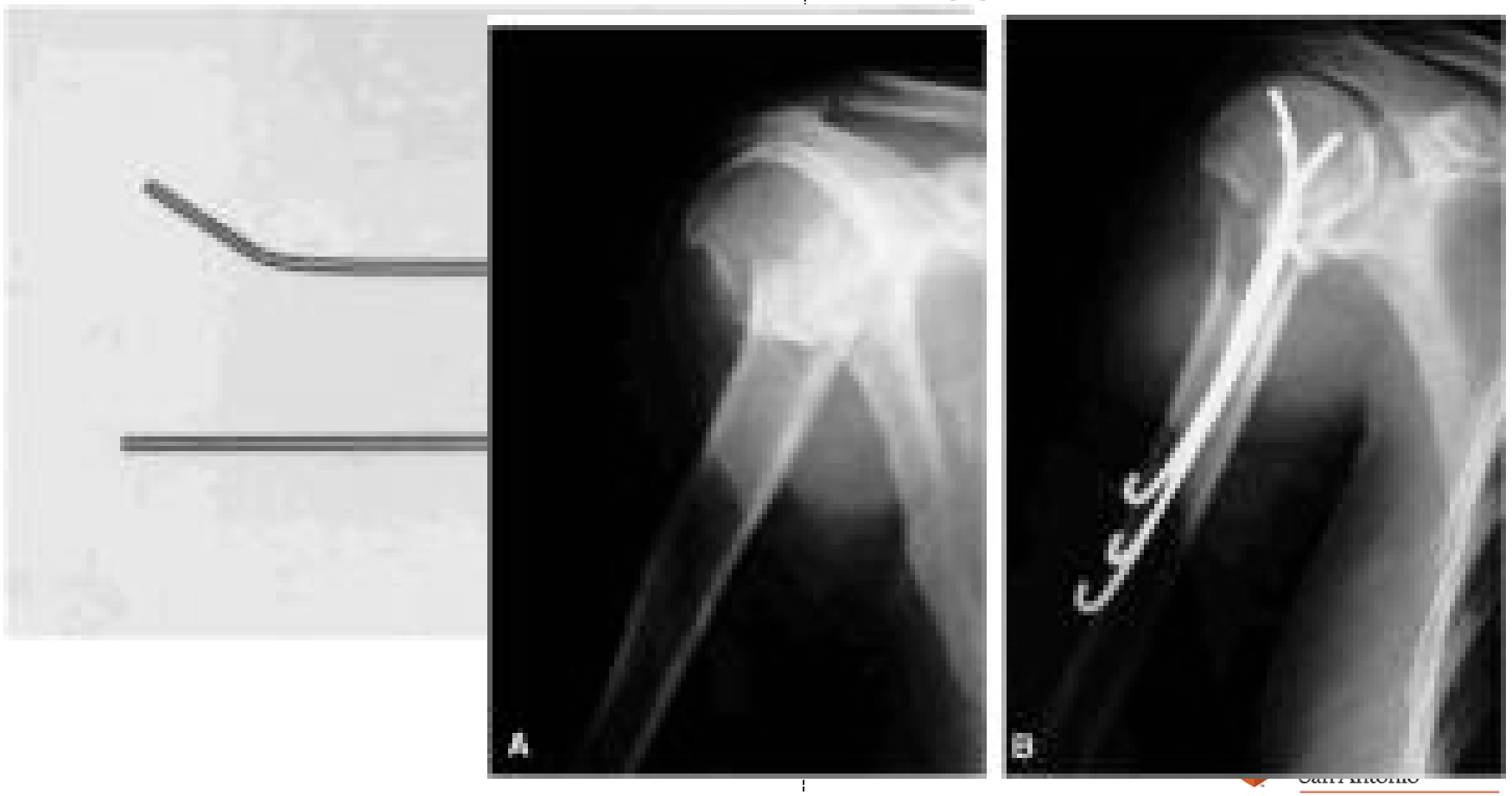
Bent 2.4 mm threaded wires



UT Health San Antonio Orthopaedics

J nails

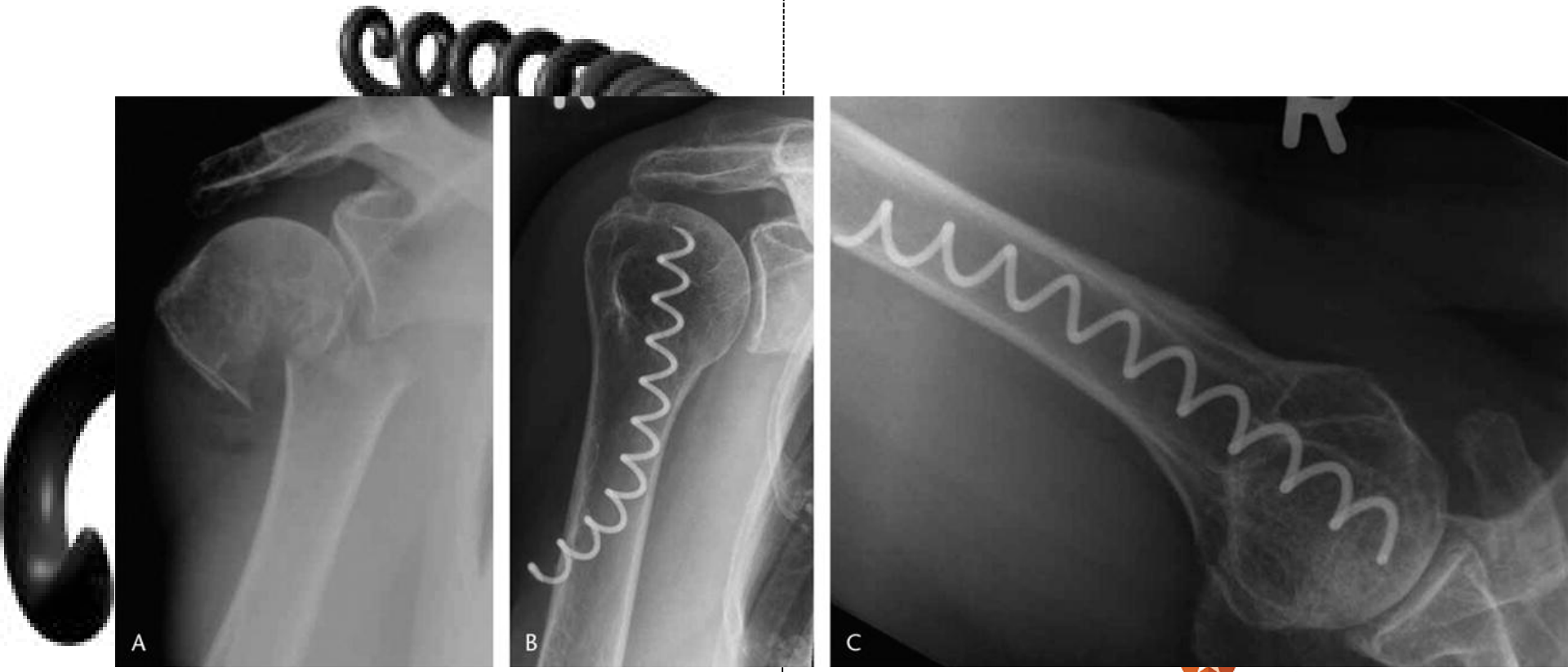
Bent 2.4 mm threaded wires



Helix wire

UT Health
San Antonio
Orthopaedics

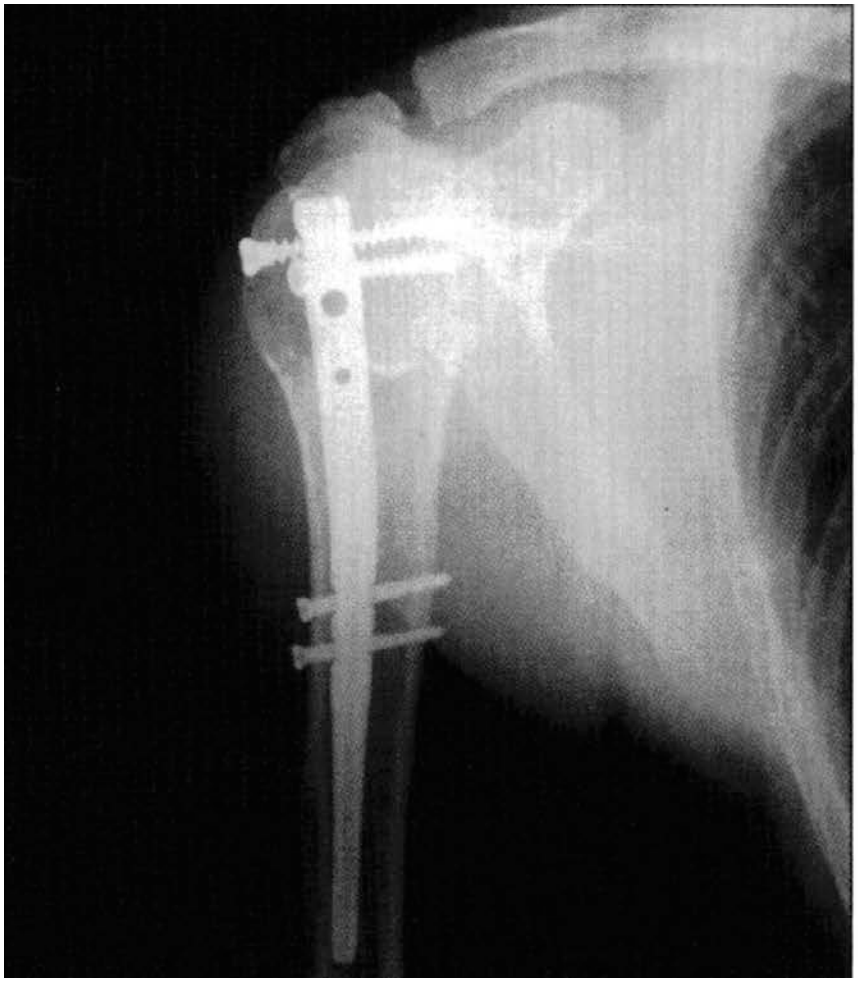
Helix Wire



San Antonio
Orthopaedics

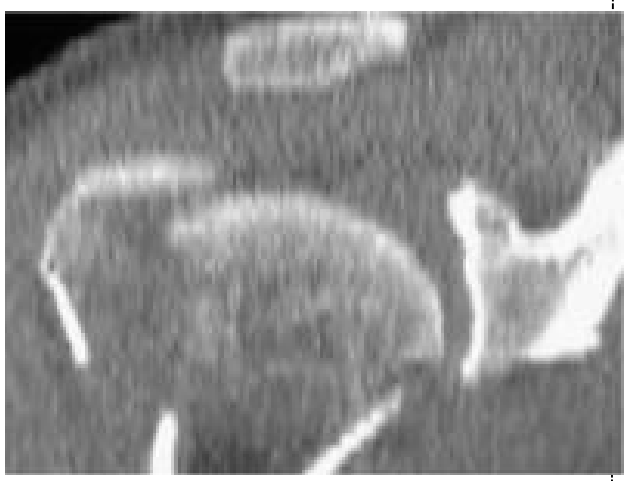
NAILS

POLARUS

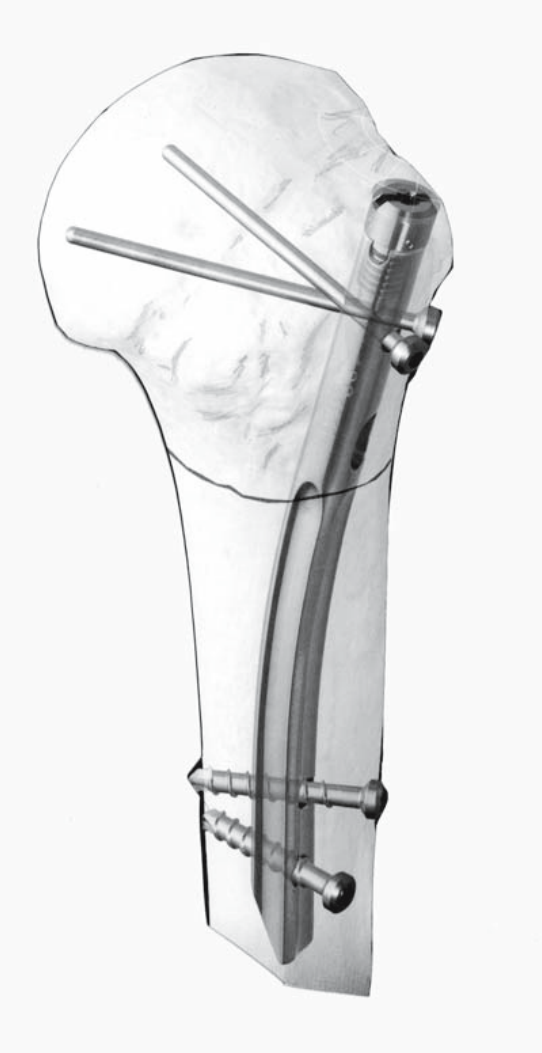


San Antonio
Orthopaedics

Telegraph Nail



Nail Variations



Targon

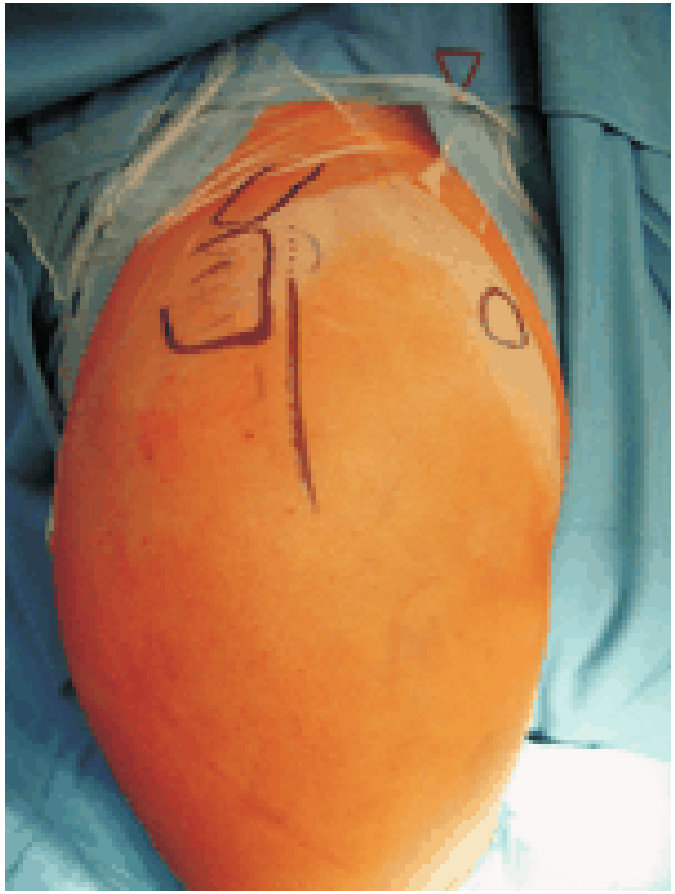
Lock Pin

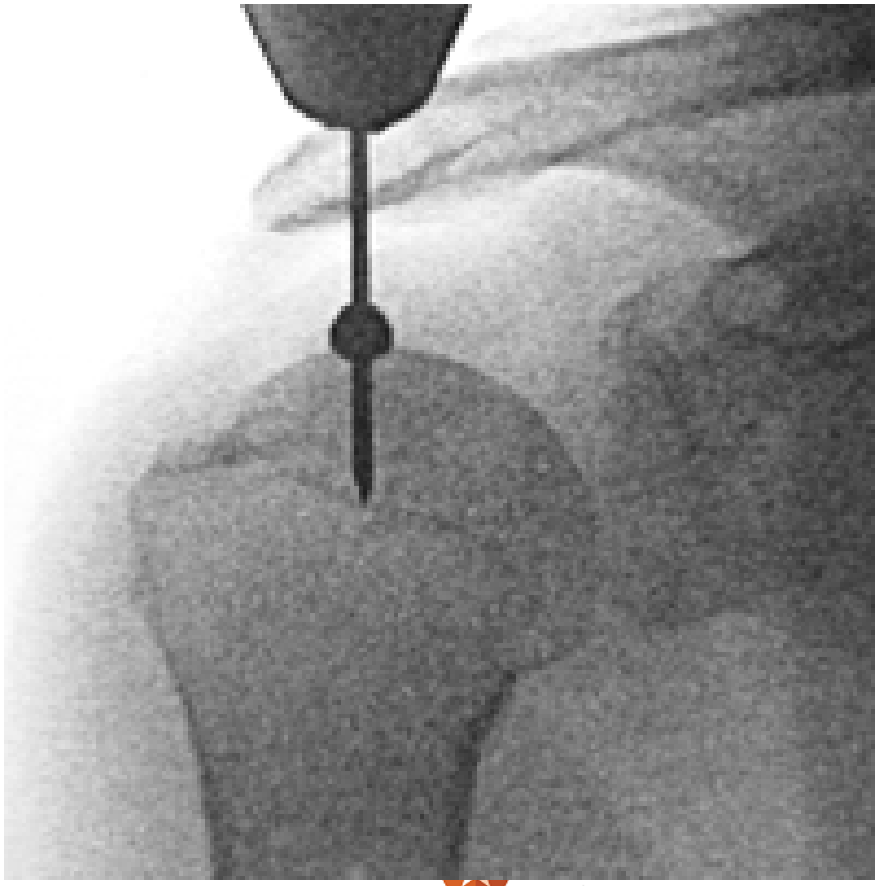
ACE

Synthes Helical Blade

UT Health San Antonio Orthopaedics

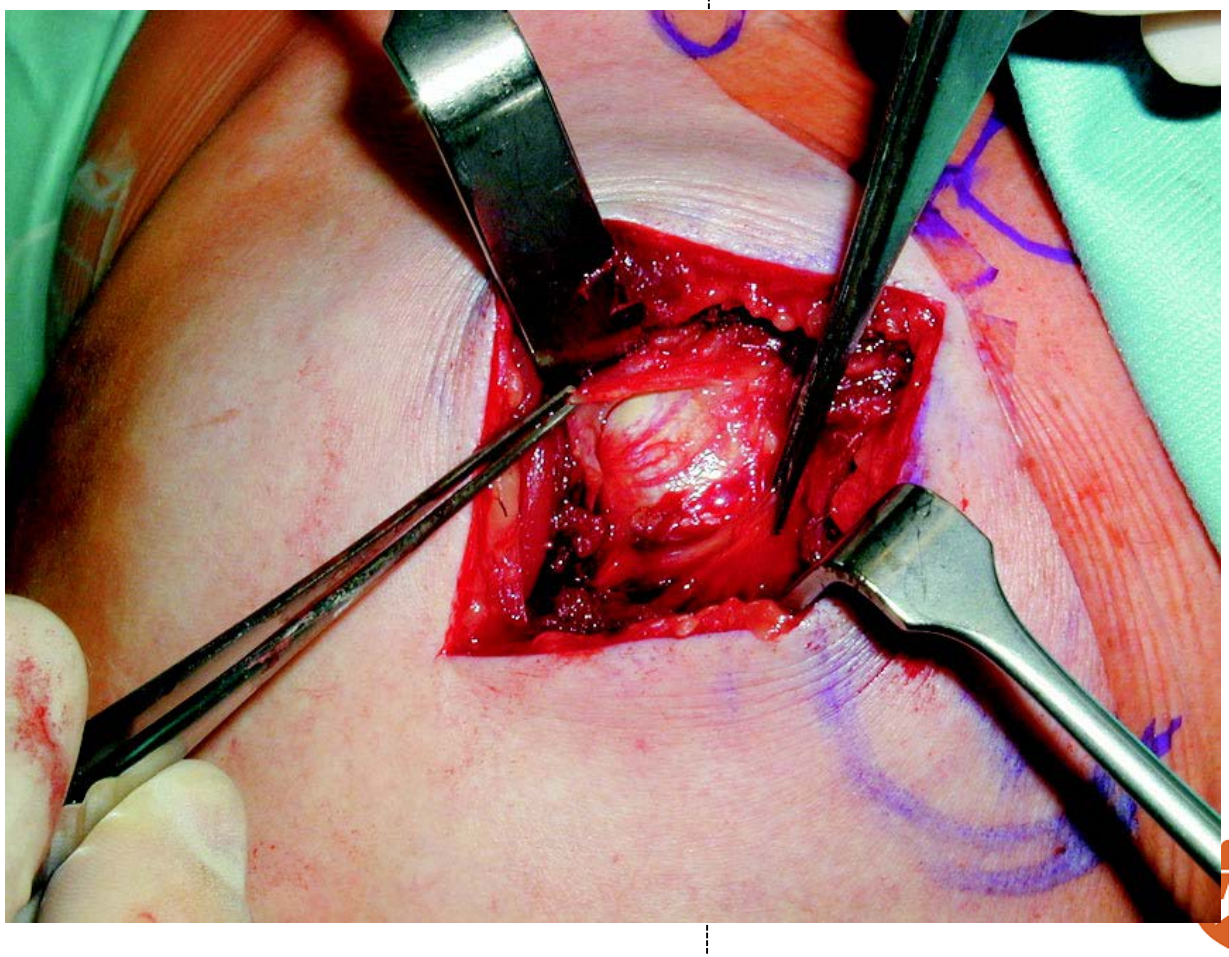
Nail Technique Dependent





San Antonio
Orthopaedics

Entry point



UT Health
San Antonio
Orthopaedics

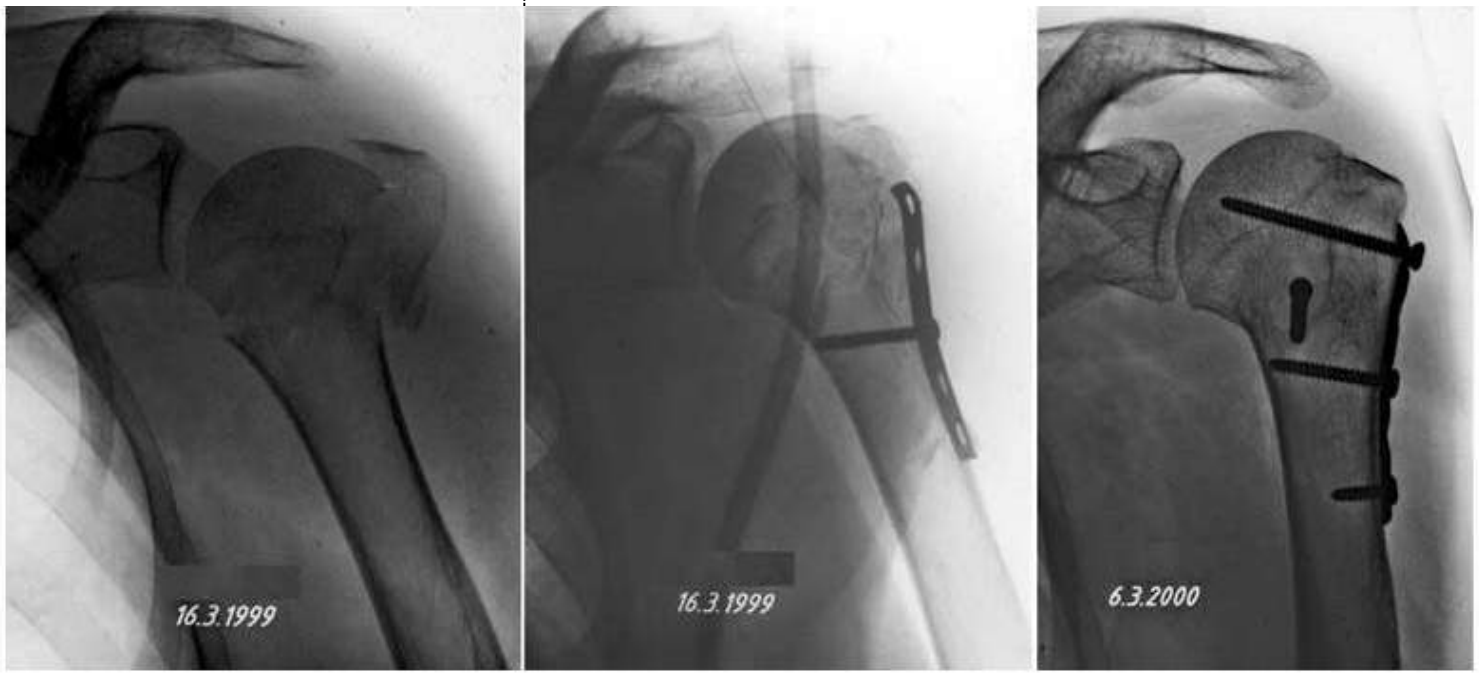
PLATING

Plate Failure

San Antonio
Orthopaedics

Plating

Hertel: No purchase in head- Tubersosites entrap the head.

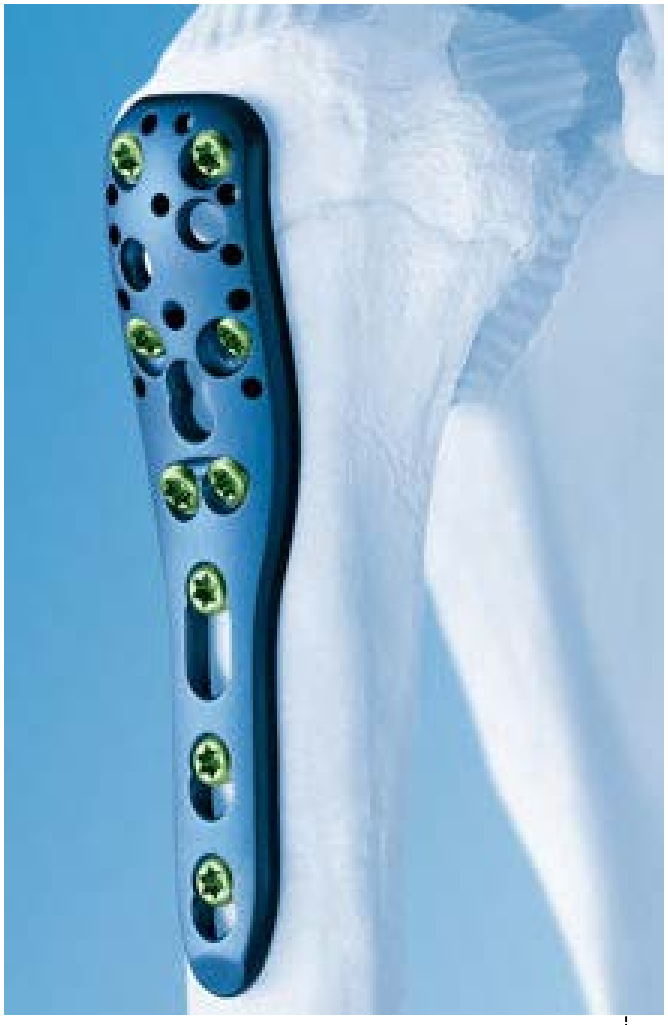


One third tubular double plating

Wanner: equivalent to locked plating

UT Health San Antonio Orthopaedics

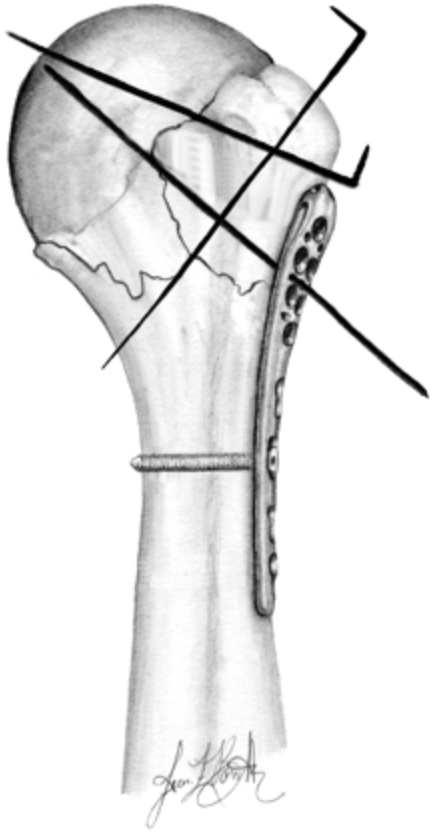
AO LOCKED PLATE

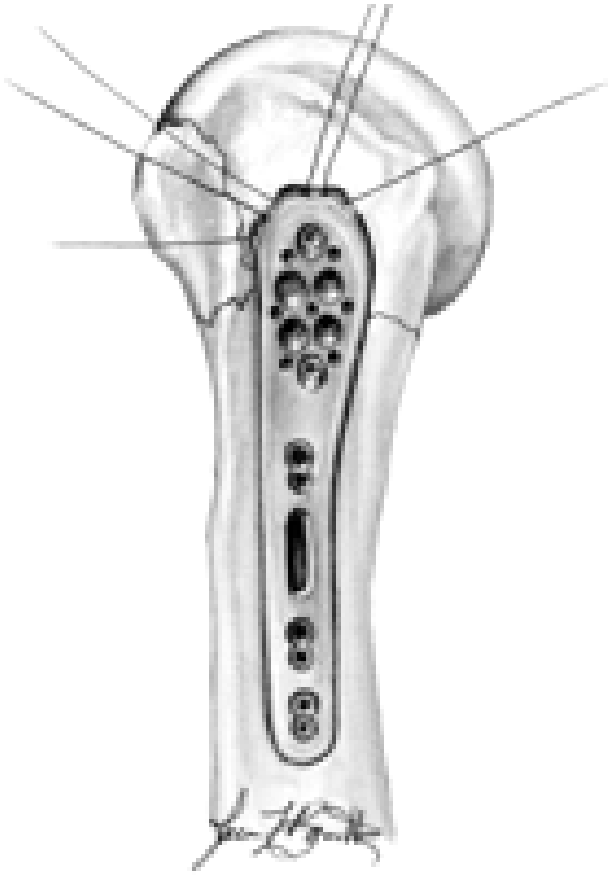


- Anatomic reduction gives good results with even if AVN
- Varus poor predictor of success
- Intact medial hinge

UT Health San Antonio Orthopaedics

AO LOCKED PLATE





UT Health San Antonio Orthopaedics

Locked Plating Advantages

Siffri JOT 06: Better torsional stiffness than blade plates, equal bending

Edwards JBJS 06 Better in cyclical torsion than nails

UT Health San Antonio Orthopaedics

Suture Plate to avoid impingement

UT Health San Antonio Orthopaedics

Complications

49% TOTAL

Varus malunion 16%

AVN 10%

Screw Penetration 8%

Impingement 6%

Infection 4%

Sproul Injury 2011

UT Health San Antonio Orthopaedics

Complications

34% Complication

14% Screw Penetration

Sudamp JBJS 2009

UT Health San Antonio Orthopaedics

Superior Approach :Gardner

JOT 2006: vasc status

CORR 2005: axillary nerve

Hussey and Reyes

UT Health San Antonio Orthopaedics

Objectives

Supplement our current surgical treatment strategies

- Less invasive option
- Less periosteal stripping
- Less risk of iatrogenic osteonecrosis
- Popularize this approach as a relatively safe option

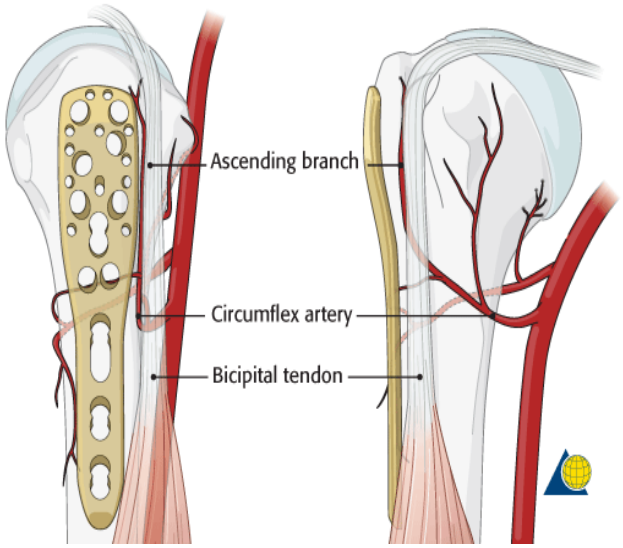


Image courtesy of AO Foundation

UT Health San Antonio Orthopaedics

Early results

Roderer JOT 2011 : Screw penetration 17%, AVN 5.5% (NCB plate)

Gardner JOT 2008 : 52 pts no nerve injury, quick DASH 25.

JOT 2007 Gardner : Medial Support

UT Health San Antonio Orthopaedics

Malunion/Nonunion

Intramedullary Fibula strut graft with locked plate

90 degree blade plate

UT Health San Antonio Orthopaedics

Malunion/Nonunion

Boileau JSES 01:

Worst outcomes if Greater tuberosity osteotomy performed

Better Results with Acute Hemi than conversion

Antuna JSES 02

Norris JSES 95

UT Health San Antonio Orthopaedics

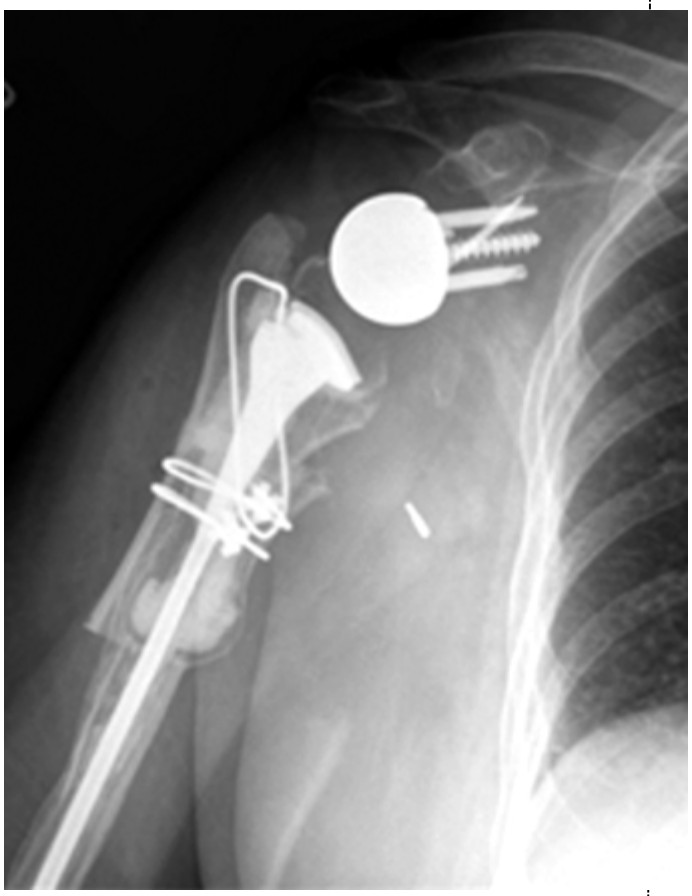
Bilboquet

Hemiarthroplasty

- Better if index procedure
- Early results better than tx for nonunion
- Tuberosity osteotomy = poor results

UT Health San Antonio Orthopaedics

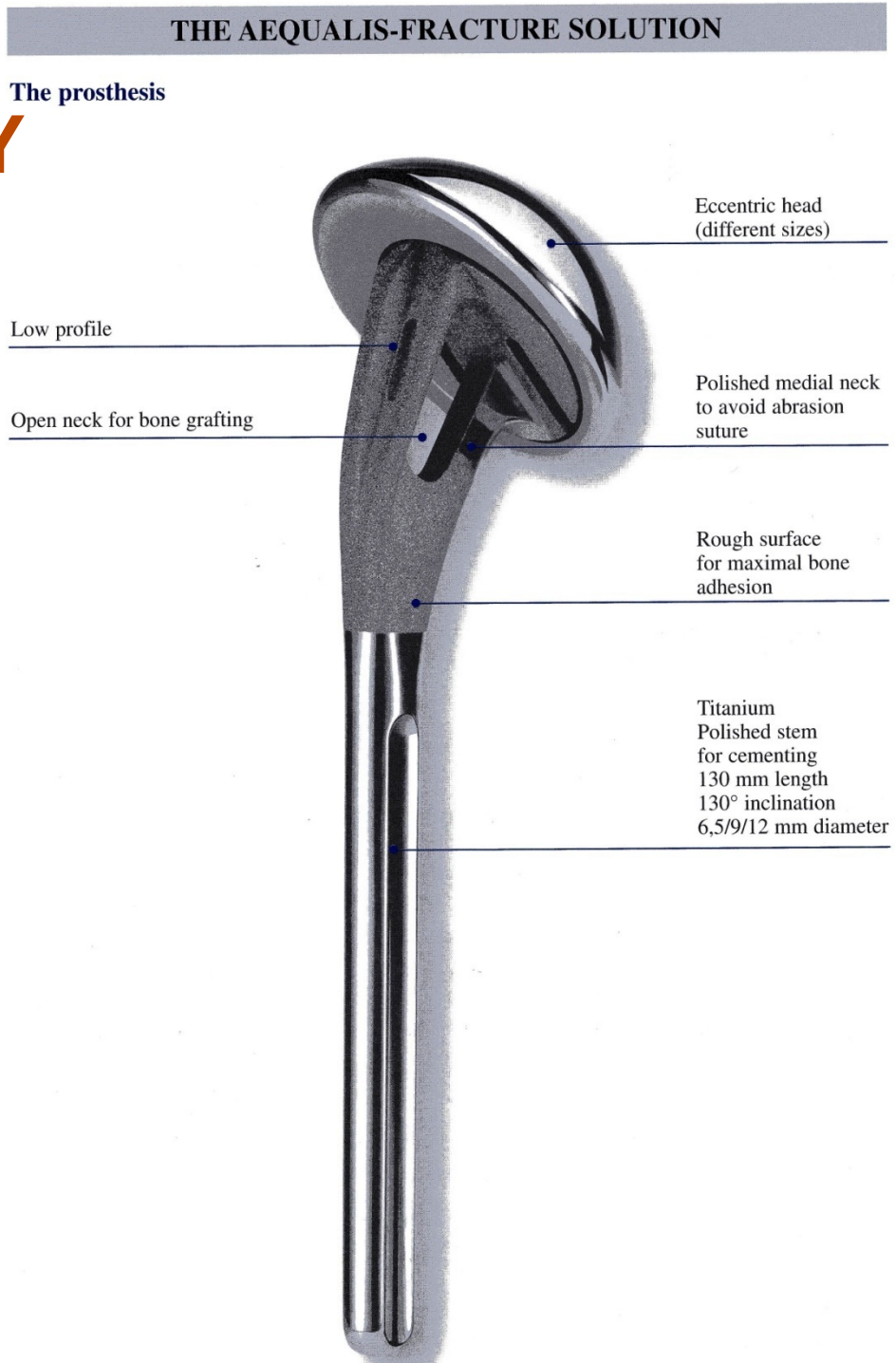
Ultimate Revision?



UT Health San Antonio Orthopaedics

HEMIARTHROPLASTY

AEQUALIS



Indications for Hemiarthroplasty

True four-part fractures and fracture-dislocations

Selected three-part fractures

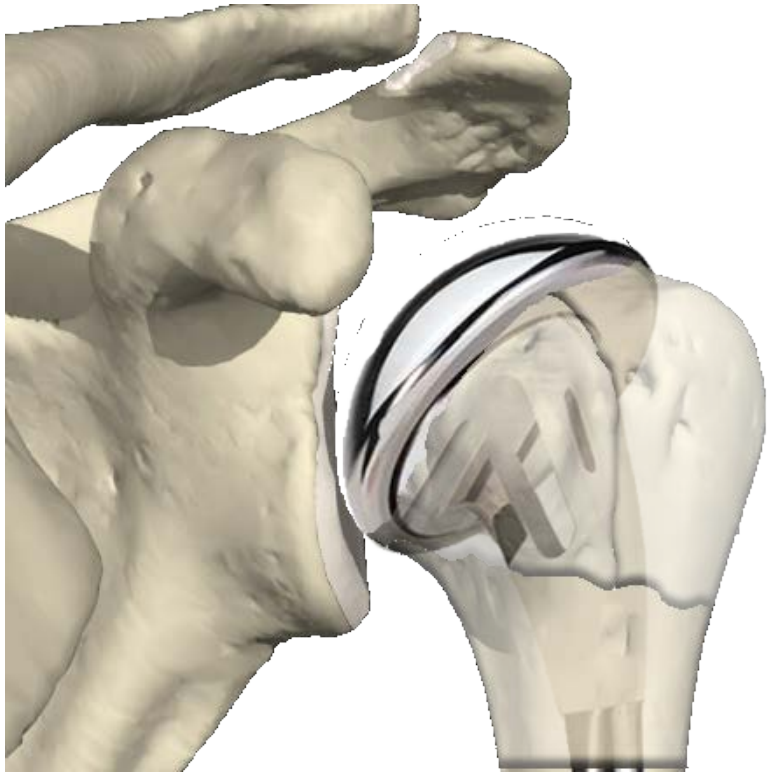
- Elderly/low demand, osteoporosis, comminution

Head-splitting fractures

Anatomic neck fractures that cannot be adequately reduced and internally fixed

Impression fractures

- >40% of the articular surface

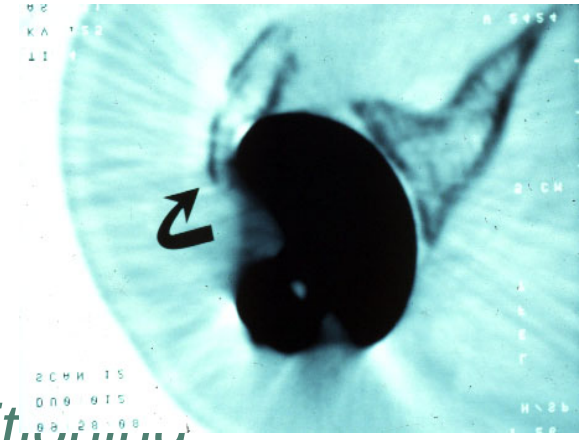


UT Health San Antonio Orthopaedics

Concerns with HHR in Proximal Humerus Fractures

Factors associated with a poor functional result:

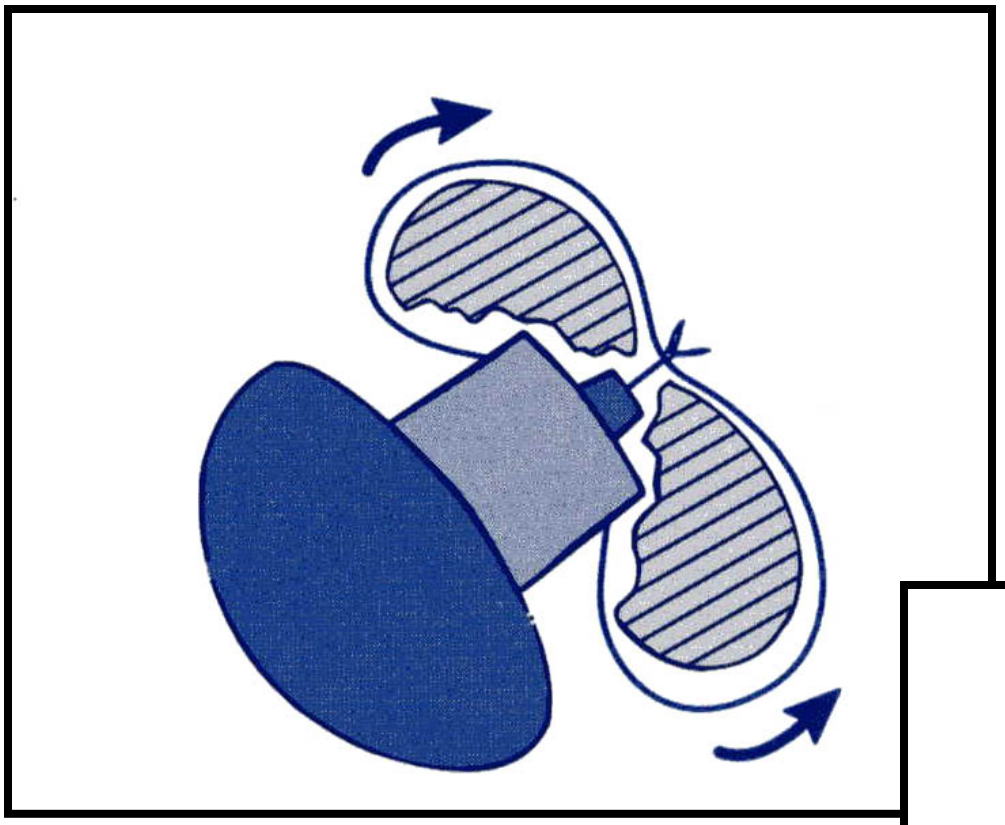
- Malposition of the prosthesis
  - Too proud (15%)
  - Too low (29%)
  - Excess retroversion (14%)
- Migration of the GT
  - Posterior (29%)
  - Superior (17%)

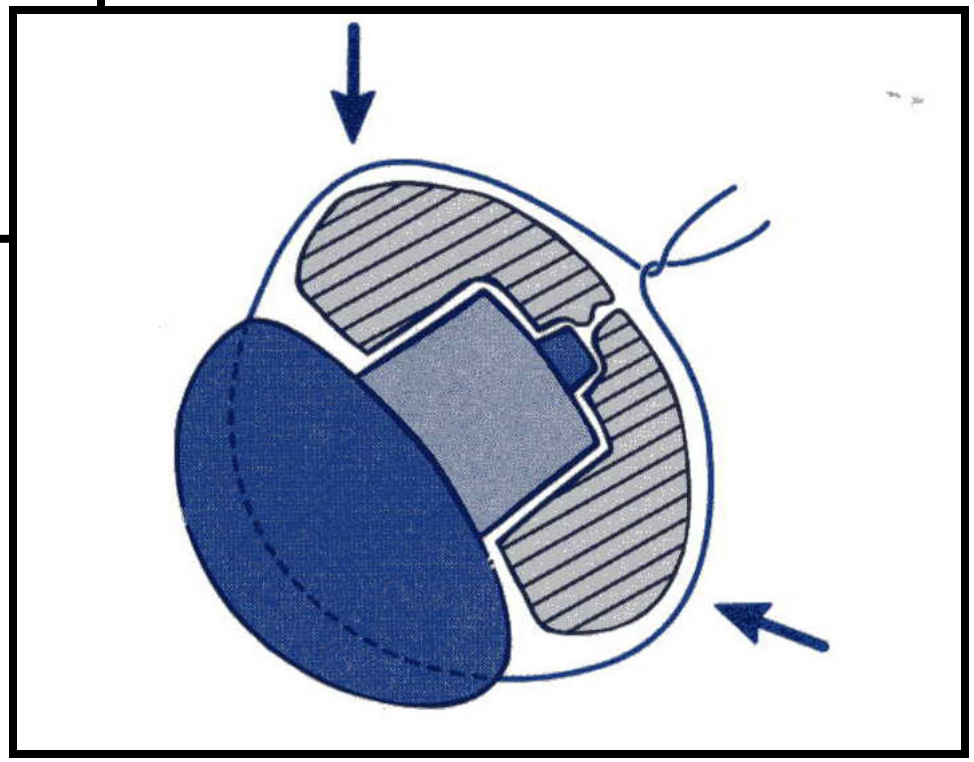


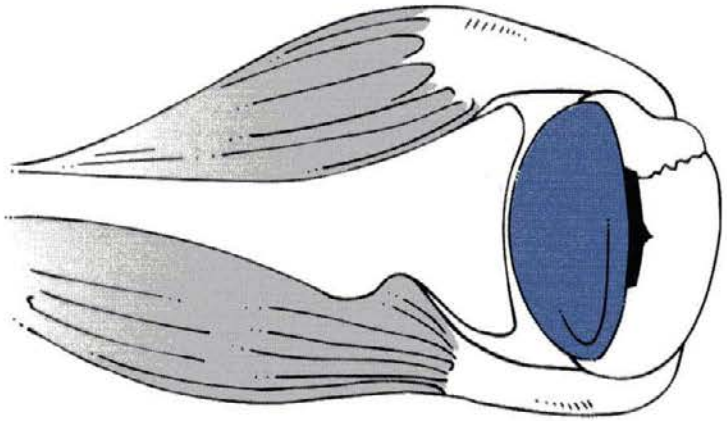
Correlation between prosthesis positioning and tuberosity migration.

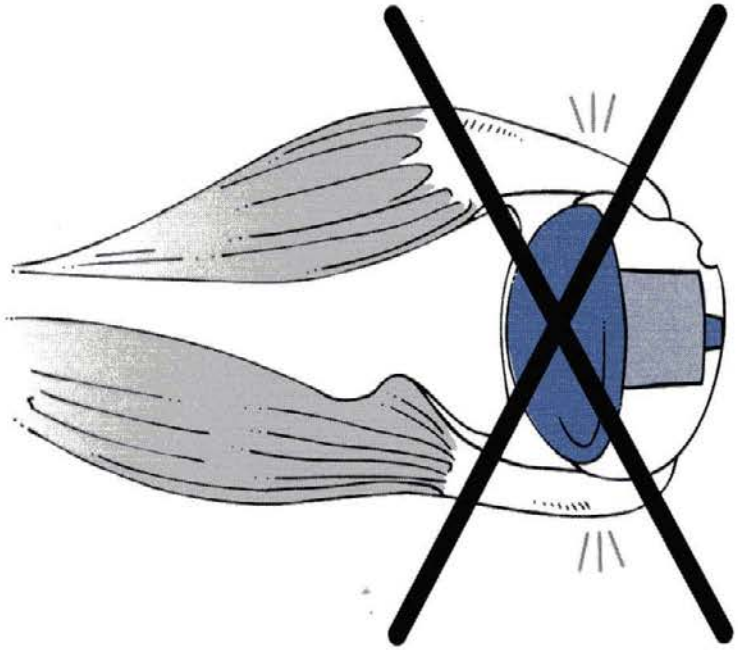
Boileau, Walch, Trojani, Romeo, et al-1998

UT Health San Antonio Orthopaedics









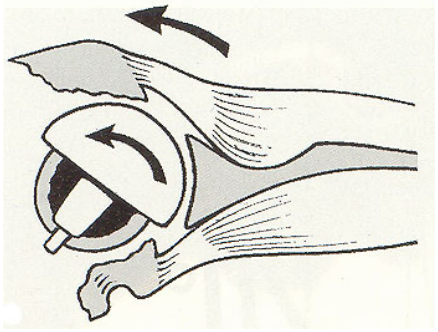
UT Health
San Antonio
Orthopaedics

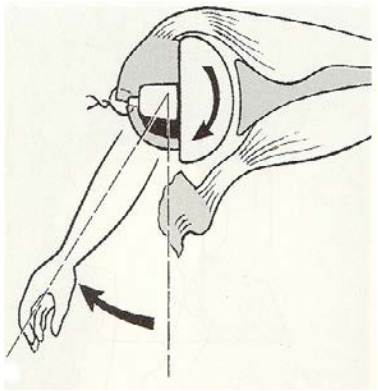
Concerns with HHR in Proximal Humerus Fractures

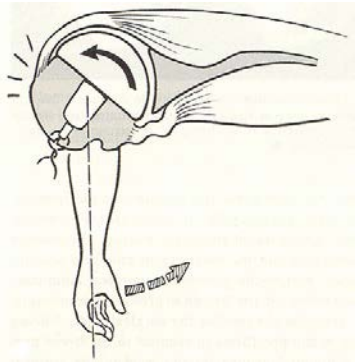
Prosthesis Positioning and GT Migration

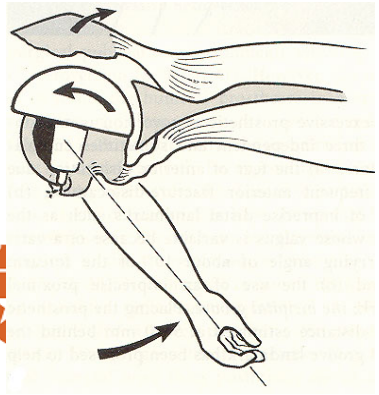
Too much retroversion…

1. GT over tensioning
2. Suture breakage
3. GT malunion/nonunion









The Results:

Malposition / malunion of greater tuberosity:

	Aequalis-Standard Prosthesis	Aequalis-Open Prosthesis	Aequalis-Fracture Prosthesis
Number of cases reviewed	300	52	31
Initial malposition of the greater tuberosity	30%	24%	22%
Migration of the greater tuberosity	26%	13%	10%
Nonunion/Malunion of the greater tuberosity	49%	36%	25%

UT Health San Antonio Orthopaedics

Conclusions about positioning:

Malposition of the prosthesis is associated with tuberosity complications.

Tuberosity complications were then associated with poor functional results.

Patients who were not immobilized were two times more likely to have tuberosity migration.

- U.S. surgeons traditionally use different rehab program.
- “Frozen shoulder” has treatment, failed fracture does not.

UT Health San Antonio Orthopaedics

Tornier's Answer to the disadvantages of Hemiarthroplasty

A Stem Specifically Designed for Fractures

- Low profile metaphyseal body.
- Metaphyseal window for bone grafting.
- Polished medial neck to prevent suture breakage
- Hydroxyapatite coated = faster bony ingrown

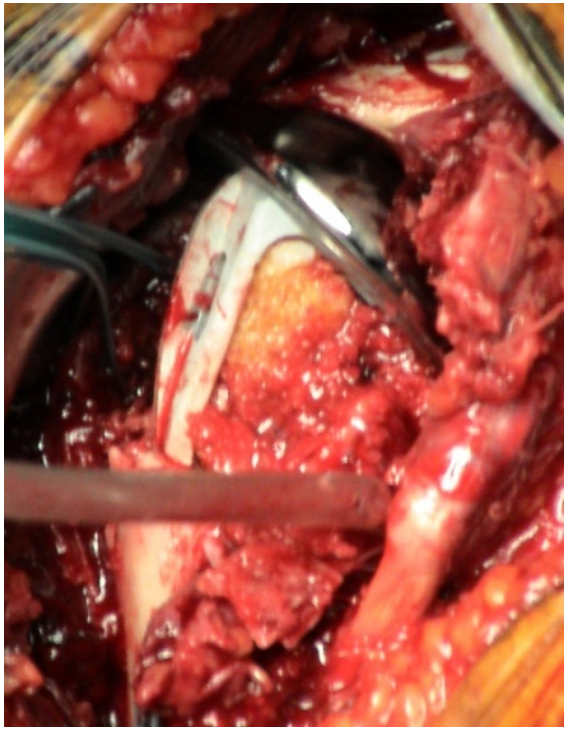
UT Health San Antonio Orthopaedics

Fracture Hemi Designs

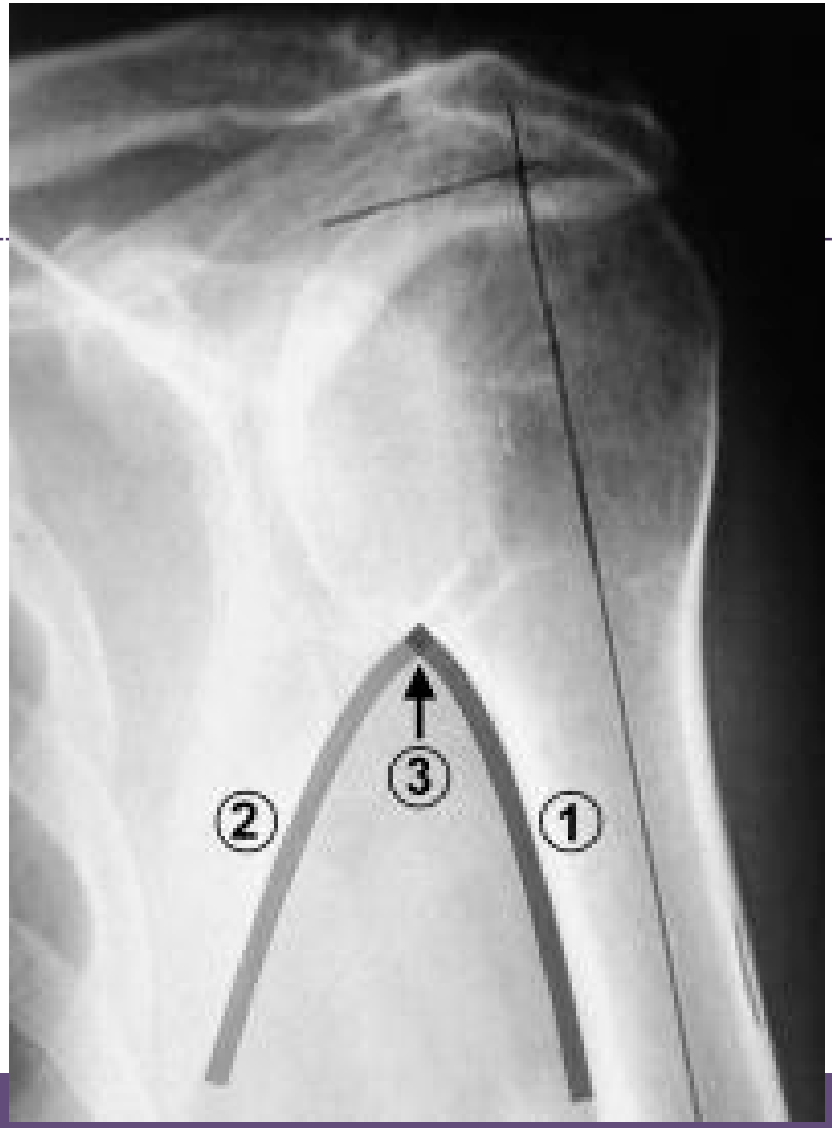
Metaphyseal Window for Bone Grafting

Create graft from HH.

Pack bone around prosthesis, avoid cement in metaphysis



GOTHIC ARCH TECHNIQUE



GUIDES TO RECONSTRUCTION

Estimation

Kerlix

Jigs

Trial and Implant markings

San Antonio
Orthopaedics

Planning :4 measurements

2 pre-op

- H(fracture height)
- G(GT height)

2 intra-op

- Gothic Arch visual
- Measurement of actual GT height

UT Health San Antonio Orthopaedics

Gothic Arch radiographs

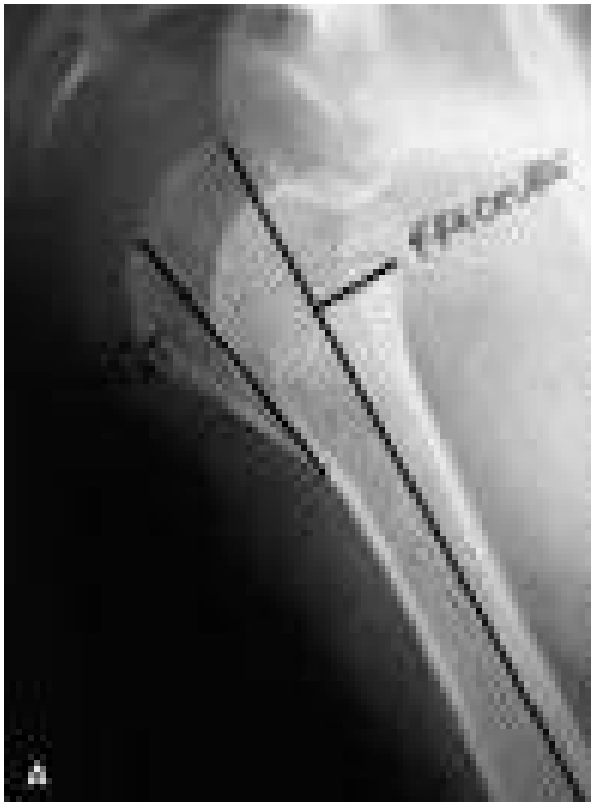
N= med epicondyle to top of head on normal arm

F=med epic to medial calcar on fx arm

H=N-F

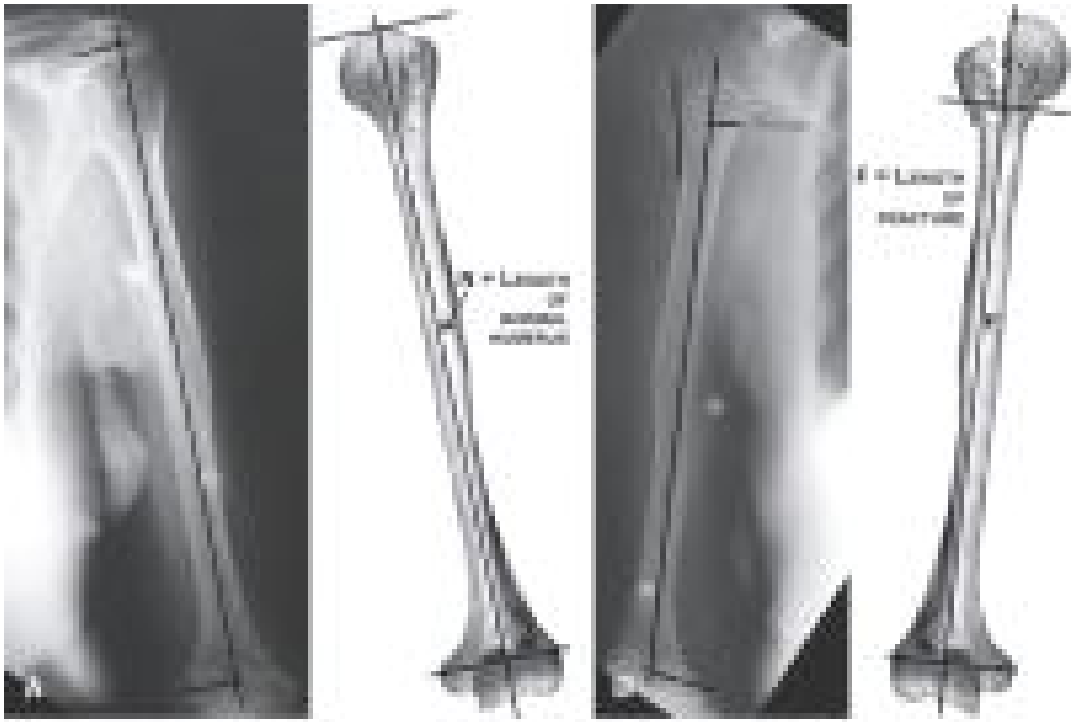
UT Health San Antonio Orthopaedics

Gothic arch technique



G= Greater Tuberosity height on Fractured arm

UT Health San Antonio Orthopaedics



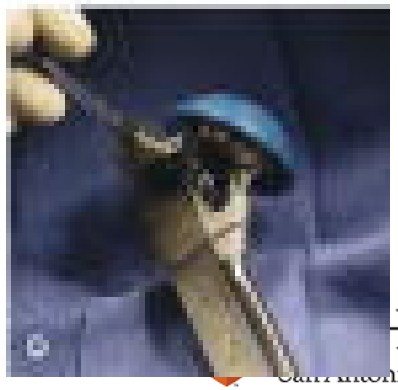
Calculations to Restore Gothic Arch

Normal side		Fracture side	
Ruler		Ruler	
X-ray	10.5 cm	X-ray	12.1 cm
Actual	12.5 cm	Actual	13.0 cm
Magnif.	1.19 cm	Magnif.	1.21 cm

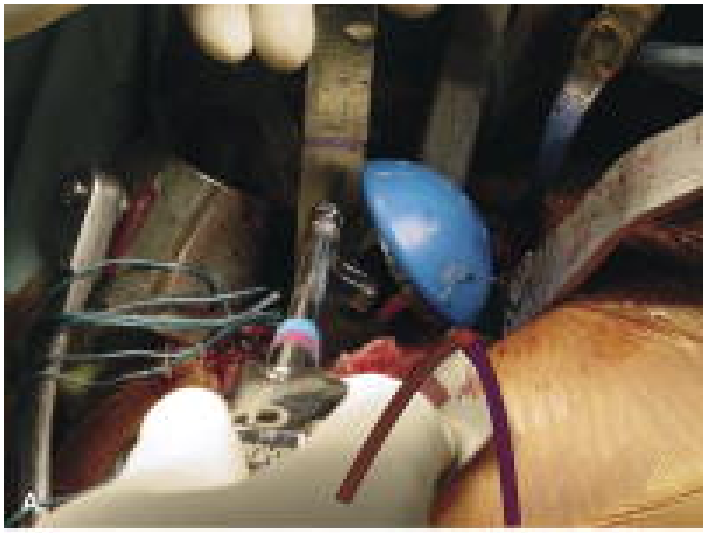
Humeral length (N)		Fx length (F)	
X-ray	25.0 cm	X-ray	30.0 cm
Actual	27.3 cm	Actual	28.8 cm

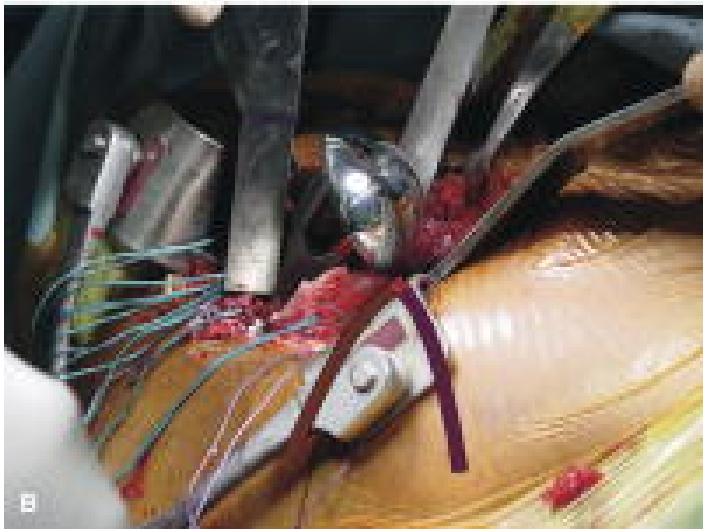
Step 1. Fx to top of head: N - F = H

Actual N (27.3 cm) Minus Actual F (28.8 cm) Equals H (4.5 cm)



Gothic Arch technique





Errors that distort this arch

-Incorrect height (too high)

-No reconstruction of medial calcar

-Incorrect medial eccentricity of head or head sizing too big

UT Health San Antonio Orthopaedics

Gothic Arch

Intra-op Greater tuberosity measurent should be within 5mm of x-ray

Greater Tuberosity 3-5mm below head.

UT Health San Antonio Orthopaedics

Restored Arch

The Results

TABLE 1. *Results of shoulder replacement for fractures for two groups divided based on mean active anterior elevation either above or below 120°*

No.	Age	Mean ASES Score	AAE	GT healed?	Mean time from injury to surg	Pain (0–10 scale)
14	79 yrs	42	96°	9 (64%)	36 days	3.6
18	65 yrs	66	140°	18 (100%)	6 days	1.7

$P < 0.03$ for all parameters.

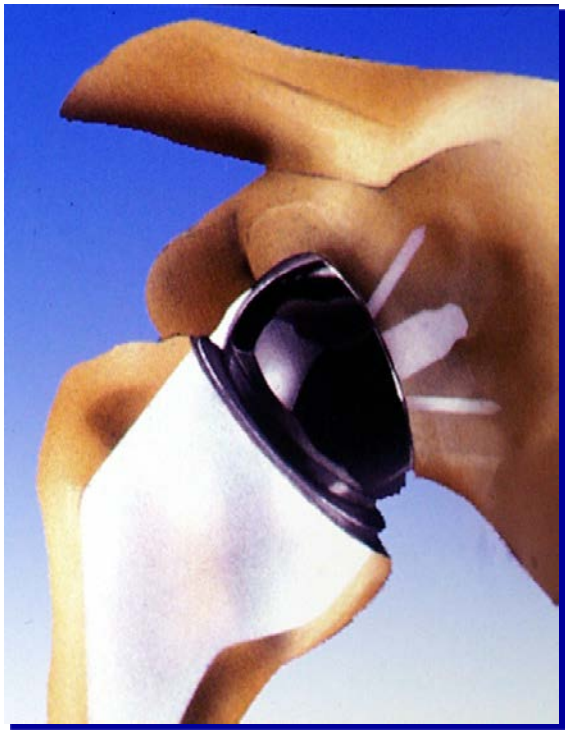
57-605

UT Health San Antonio Orthopaedics

REVERSE TOTAL SHOULDER

UT Health
San Antonio
Orthopaedics

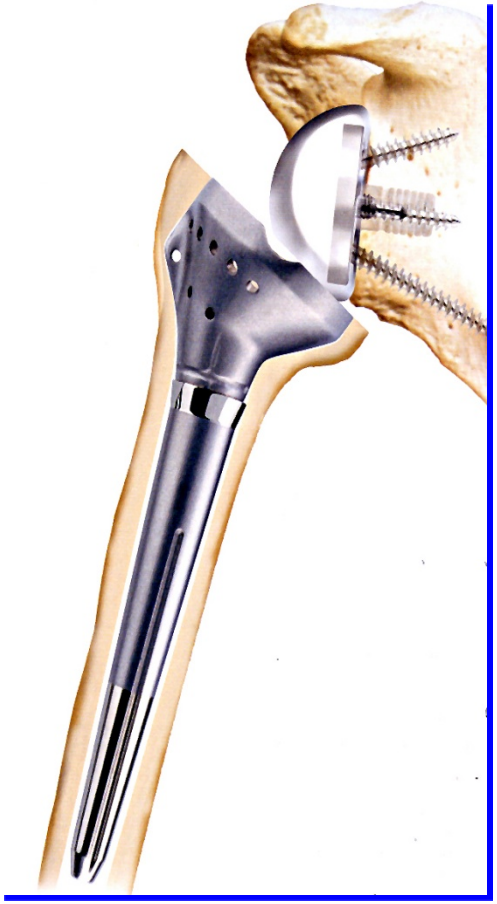
The idea : “ a prosthesis which relied solely on the deltoid for both movement and stability ”



Reverse ball & socket Prosthesis
…but with a large ball & no neck

Grammont Design Reversed Prosthesis

The Concept

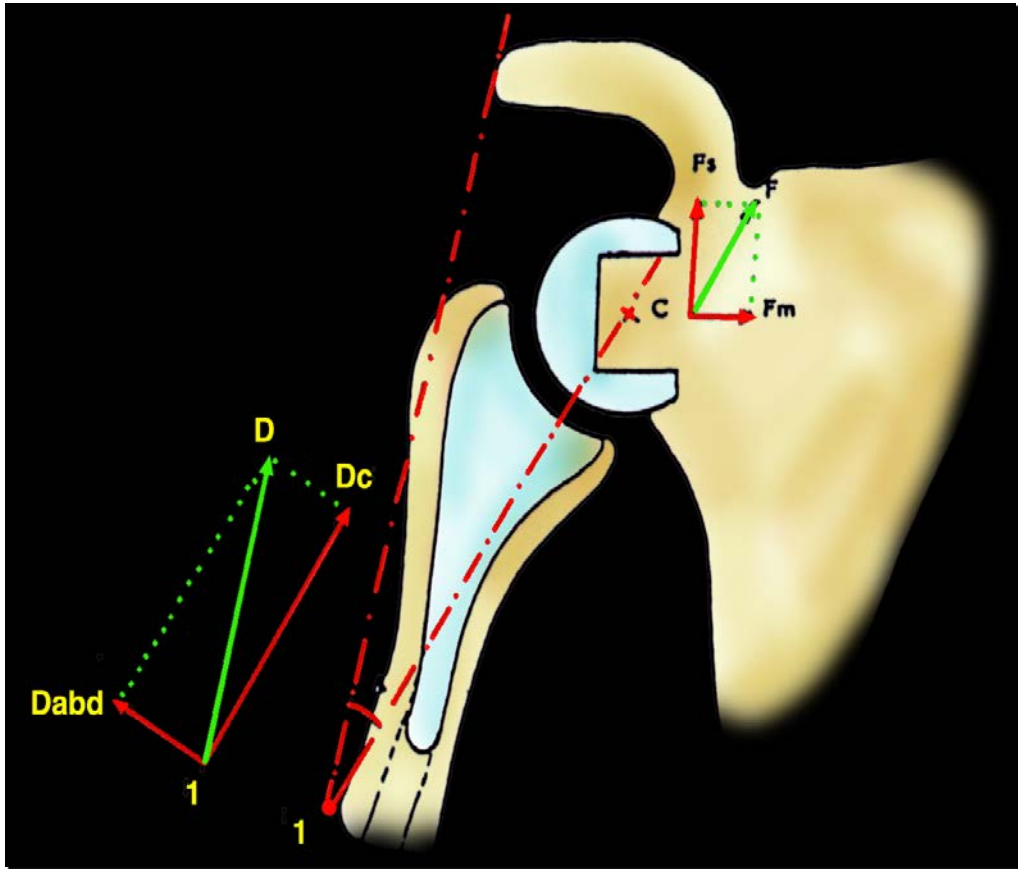


A prosthesis designed

- to function only with the Deltoid
- to be self-stable
- to eliminate the risk of glenoid loosening

Grammont Design Reversed Prosthesis

Designed to function only with the Deltoid



Increasing the deltoid power to overcome weakness of other muscles

REVERSE FOR ACUTE FX

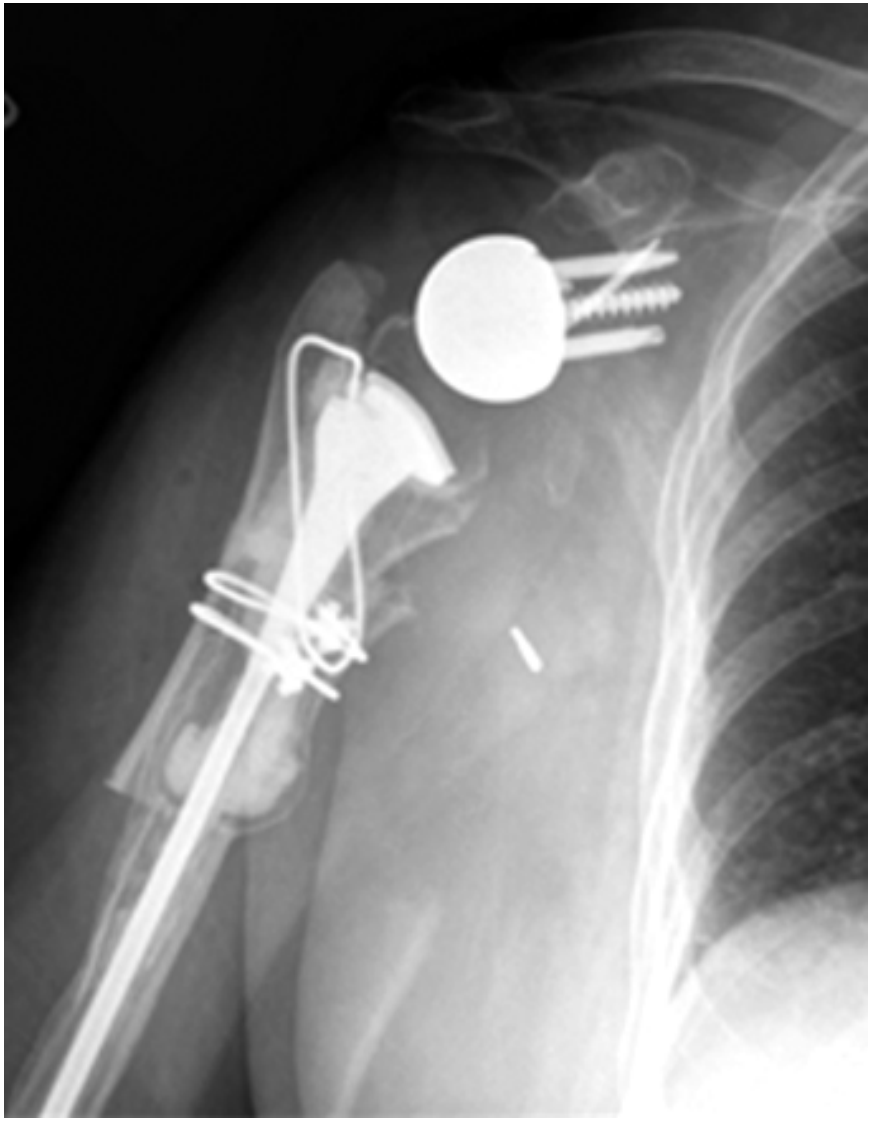
Gallinet et al, OrthopTrSurgRes09: 40 pts, restrospective, 21 Hemi, 19 Reverse. Better results with reverse but hemi results worse than literature

Young, Poon, et al. ANZ J Surg 10 : equivalent results with reverse and hemi

REPAIR tuberosities if possible

UT Health San Antonio Orthopaedics

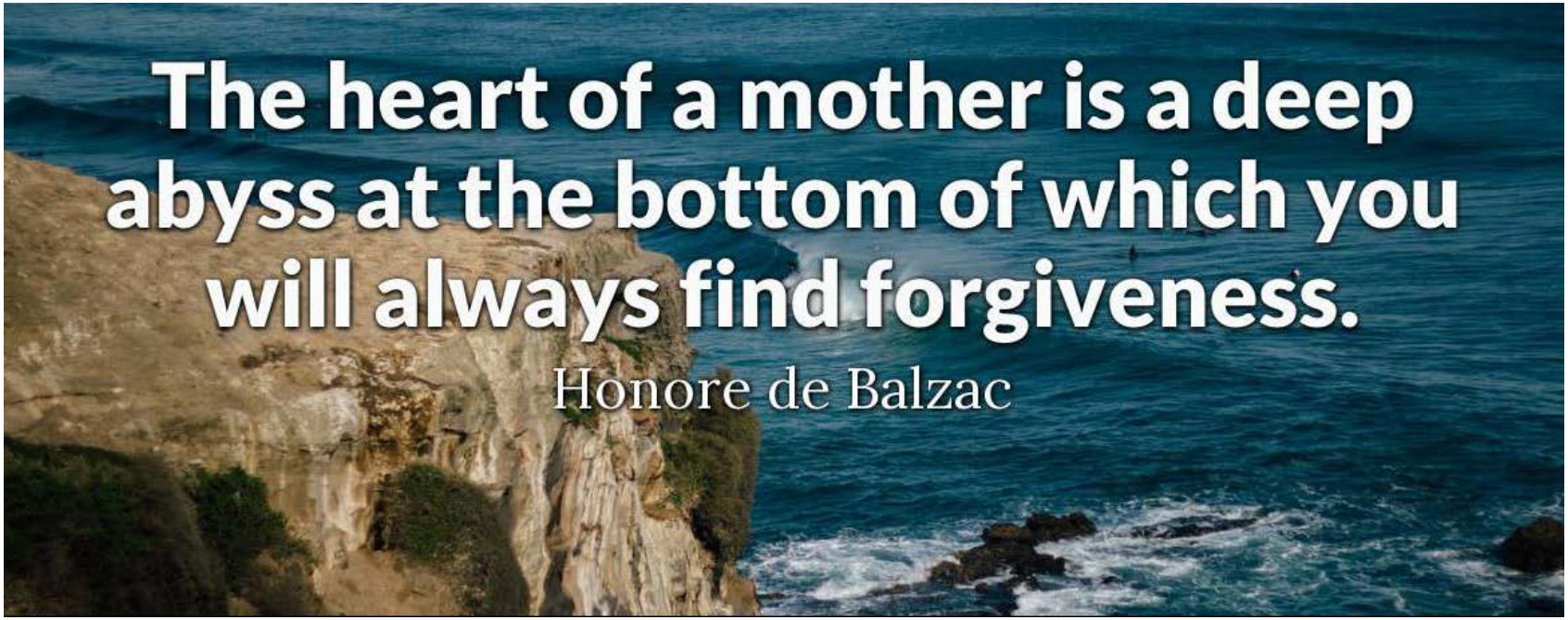
CONVERSION OF FAILED HEMI TO REVERSE



Levy, Frankle et al. JBJS 07 :Convert failed hemi to reverse : Add allograft improves results

UT Health San Antonio Orthopaedics

PLATFORM



It is by going down into the abyss that we recover the treasures of life. Where you stumble, there lies your treasure.

Joseph Campbell

THANK YOU

UT Health
San Antonio
Orthopaedics