Distal Humeral Fracture Fixation-Principles and Techniques

REGIONAL ORTHOPAEDICS & TRAUMA
11th March 2013

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County Durham and Darlington NHS
NHS Foundation Trust

Impending doom !

Questions

- Are there other more urgent injuries(ATLS)?
- Is it open ?
- Is there a neurovascular problem ?
- Is there compartment syndrome ?
- Are there other injuries in the same limb ?
- What are the patient's needs and expectations ?
- Do I need to fix it ?
- Have I got the skills to fix it ?
- Have I got the kit to fix it ?

EXTERNAL FIXATOR- TEMPORISING

- Open and…

Skills or kit not available

Other more urgent injuries/multiple injuries

Need to transfer

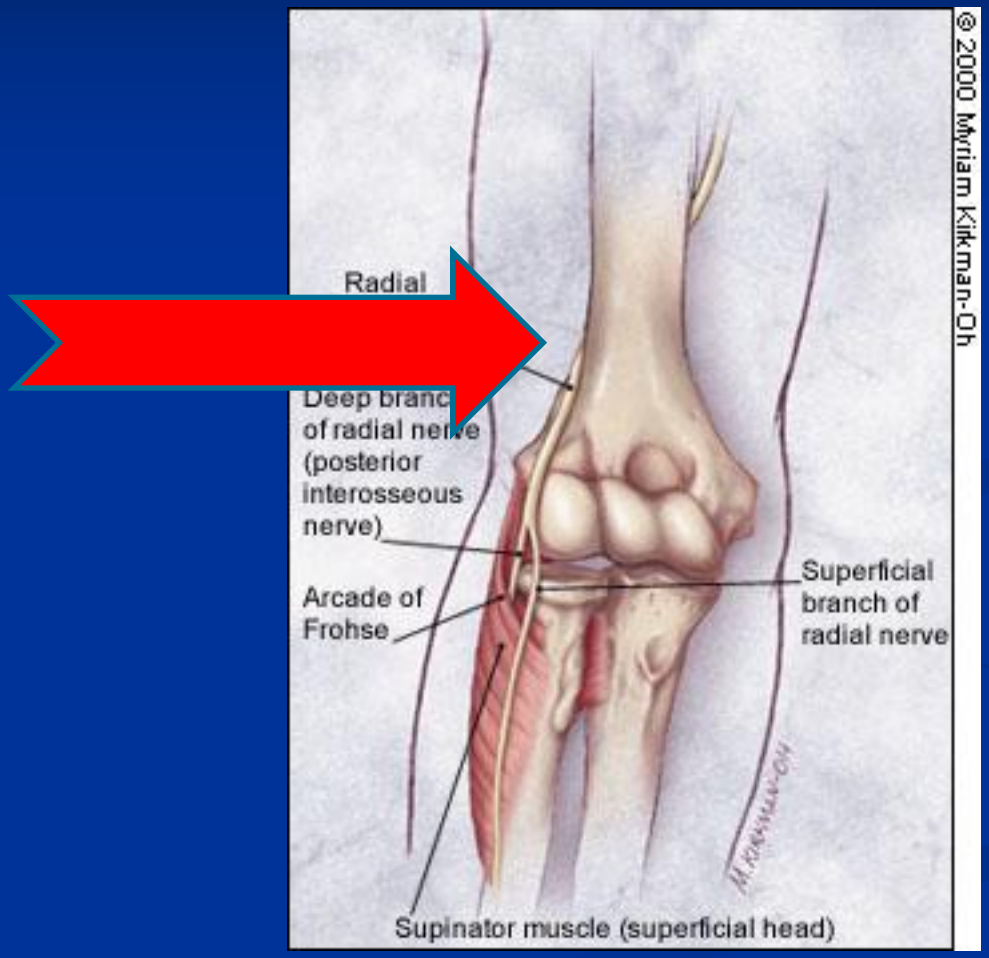
While revascularisation is performed, if cannot wait for ORIF.

Otherwise, a Plaster backslab will do, initially.

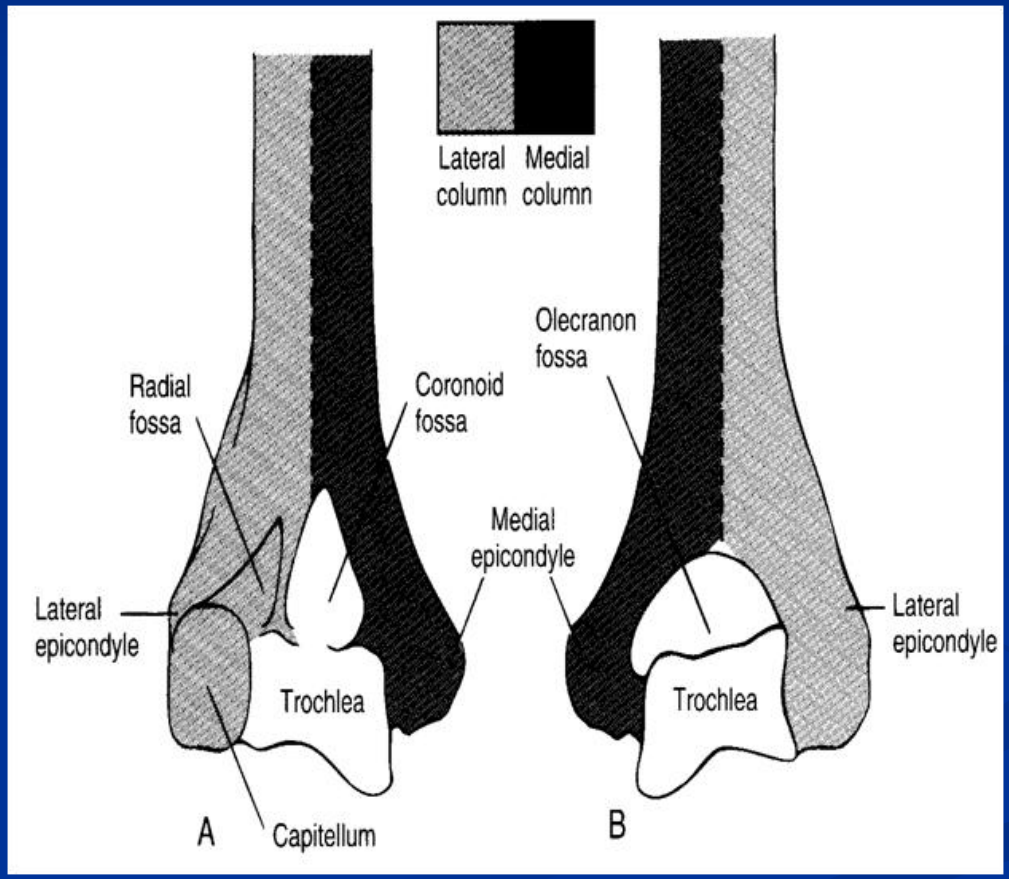
EXTERNAL FIXATOR

- Know your kit
- **Open** technique for pins
- Humerus proximally, ulna distally. Well away from zone of injury.

EXTERNAL FIXATOR



COLUMNS


Lateral column
Medial column
Radial fossa
Coronoid fossa
Olecranon fossa
Medial epicondyle
Lateral epicondyle
Lateral epicondyle
Trochlea
Trochlea
A
Capitellum
B

CLASSIFICATION

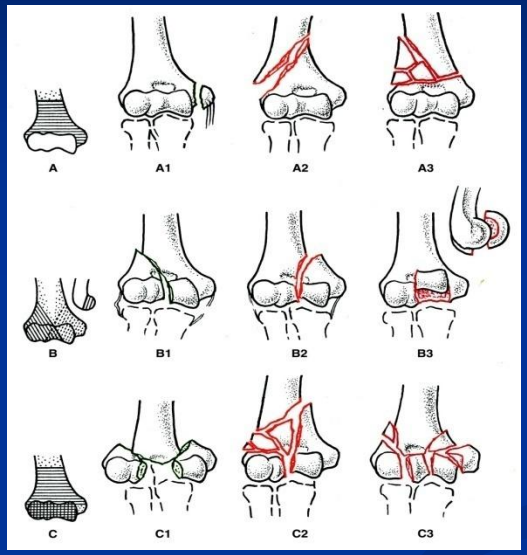
- Horne (**J Trauma 1980;20:71-4**)
- Riseborough & Radin (**JBJS 1969;51A;130-41**)
- Orthopaedic Trauma Association 1987

All do not completely describe the #, prognosis or guide management.

AO classification is better, as at least divides into artic/extraartic and partial artic. Complicated !

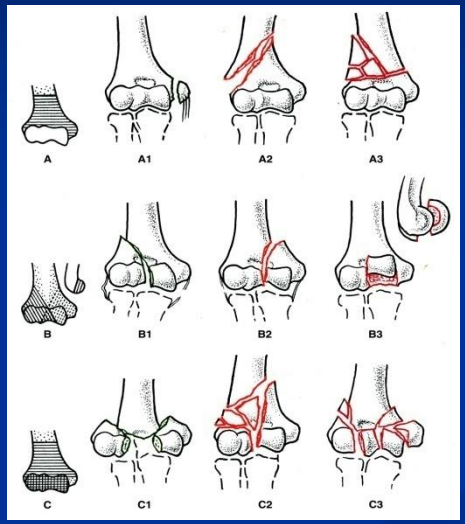
13-A Extraarticular

includes epicondylar

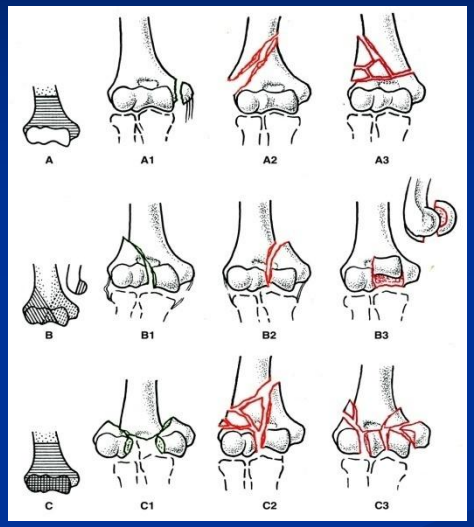


13-B Partial Articular

includes capitellar



13-C Completely Intraarticular



Past Problems

- Conservative treatment (plaster) led to stiffness, even if # reduced .
- Inadequate operative treatment led to failure, infection and stiffness.
- Inadequate operative treatment and plaster led to worst of both worlds
- AO led on adequate implants, accurate reduction and stable fixation with early movement.

1 Epicondyle Fracture

- Lateral rare
- Medial with elbow dislocation (high level of suspicion)

Undisplaced, conservative treatment in brace.

Displaced, ORIF cannulated screw(s)

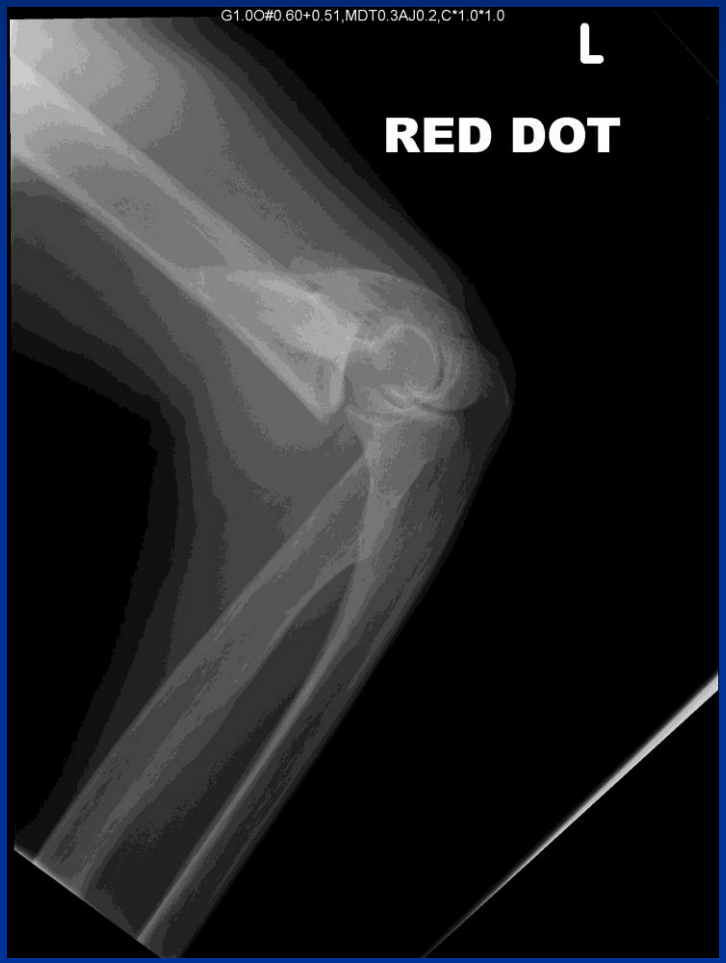
Biepicondylar

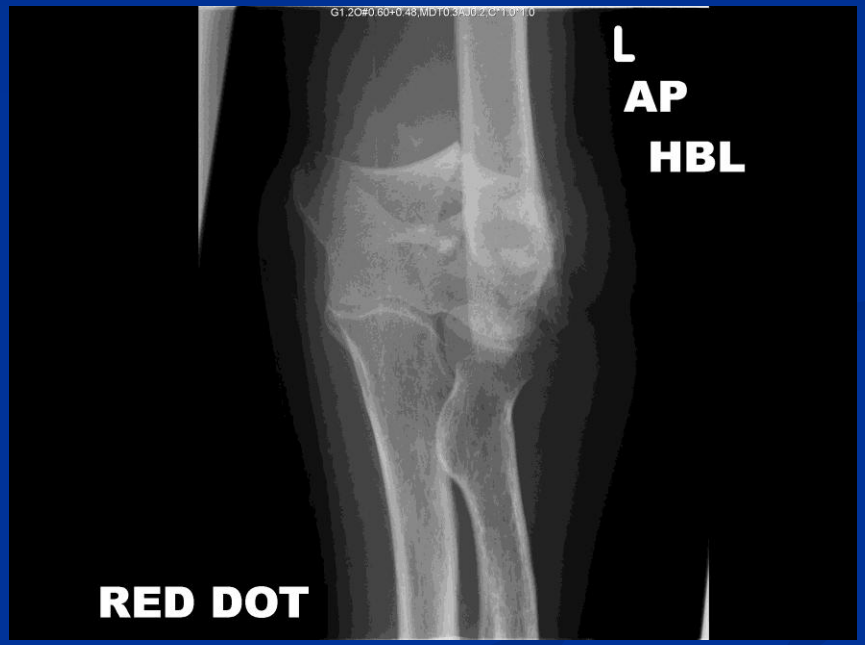
Biepicondylar

2 Extraarticular Supracondylar Fracture

- Unstable/difficult to control (shorten/rotate)
- Dual plate ORIF
- Work either side of triceps-care with radial nerve laterally

Supracondylar





INADEQUATE OPERATIVE TREATMENT

Supracondylar

Supracondylar

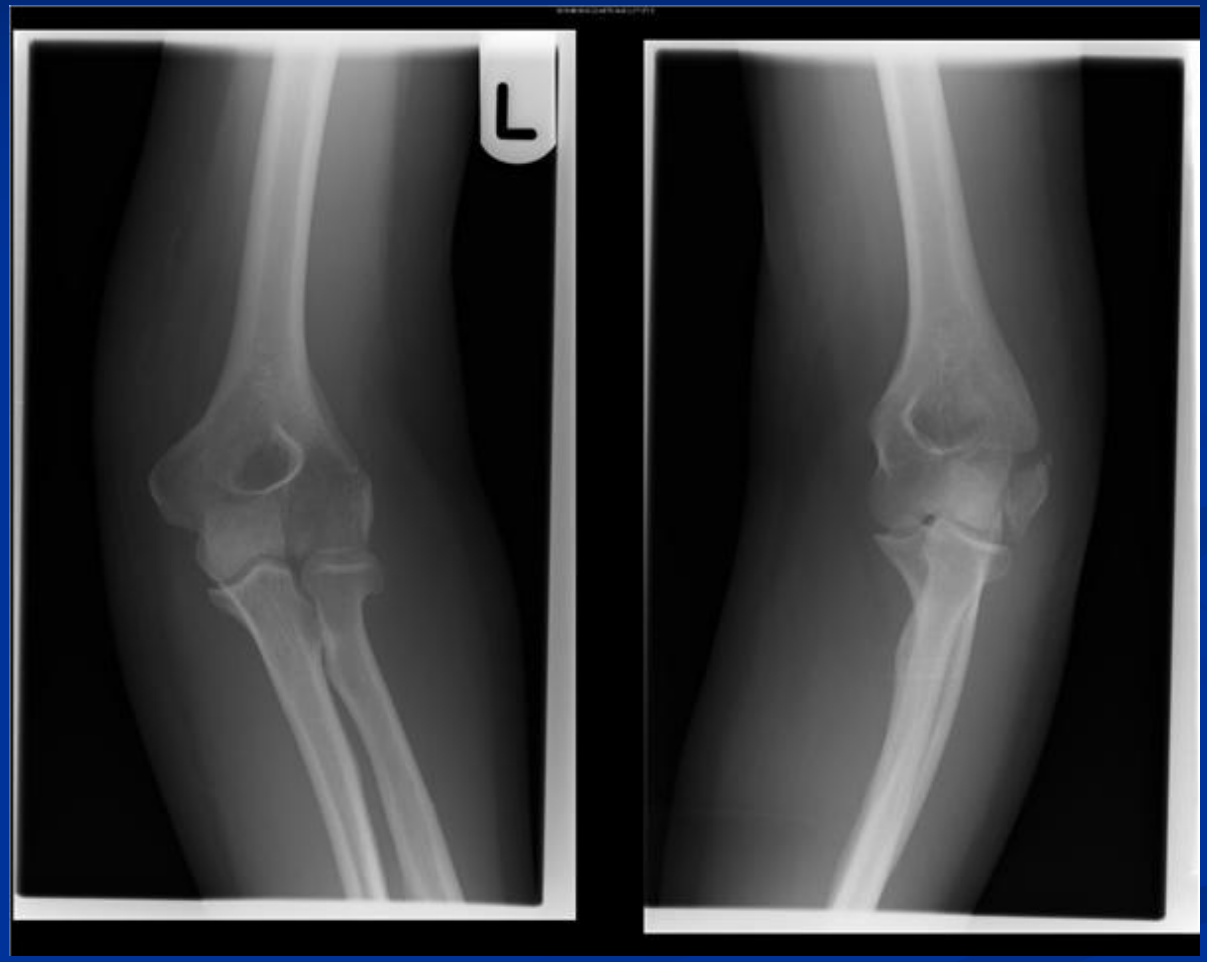
3 Unicondylar Fracture

- Intraarticular, lateral more common.
- Consider CT scan
- Look for collateral ligament injury on opposite side of elbow.
- Usually unstable-rotated/displaced
- Olecranon osteotomy for access/vision
- Single buttress plate ORIF

INADEQUATE OPERATIVE TREATMENT

LATERAL CONDYLE

LATERAL CONDYLE



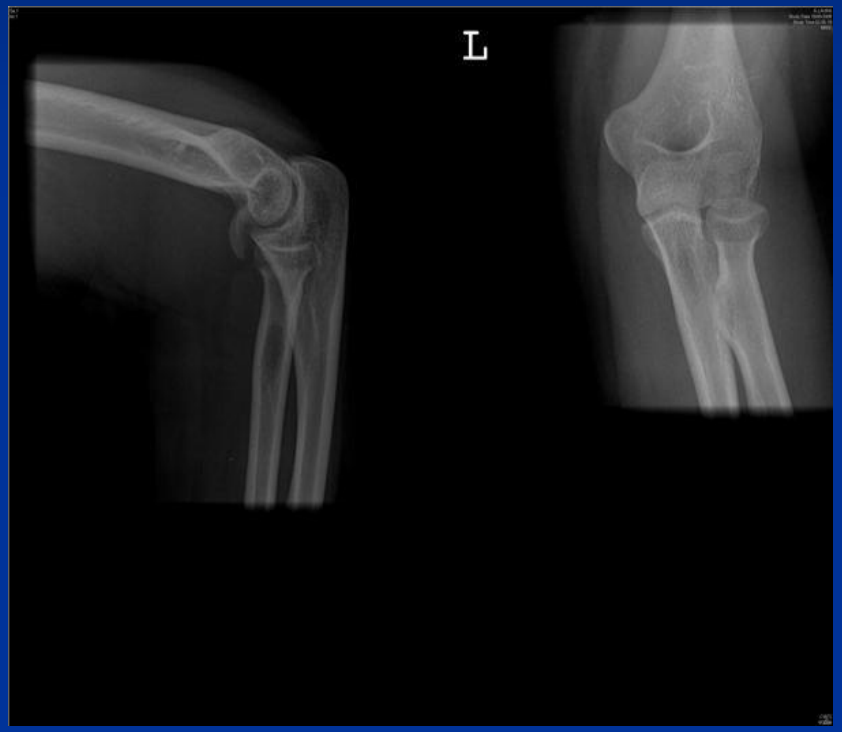
LATERAL CONDYLE

LATERAL CONDYLE

4 Capitellar/Trochlear

- X Rays may be misleading-always consider CT
- Consider ligament injury on opposite side of elbow
- Usually displaced
- ORIF-Lateral approach avoiding LCL or olecranon osteotomy
- Headless screw A-P or P-A
- Discard thin cartilage flakes

Capitellum


L


Se:7
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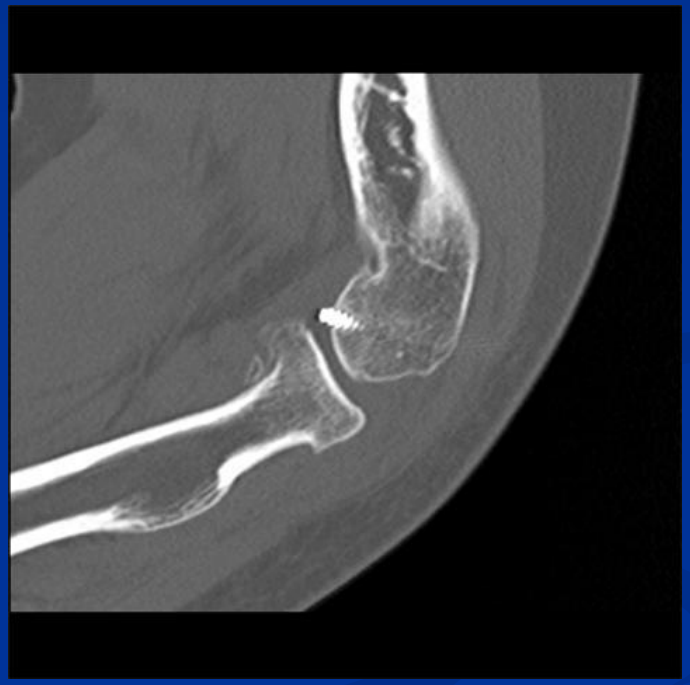
Capitellum

Capitellum



5 Complete Intraarticular

- Consider CT or traction views under II
- Ideally plan surgery with x ray of opposite side/templates
- ORIF for best functional results (**Holdsworth, B. JBJS 1990;72B:362-65. Jupiter, J. JBJS 1985;67A:226-39**.)
- Olecranon osteotomy/(?or triceps sparing approach)

Positioning

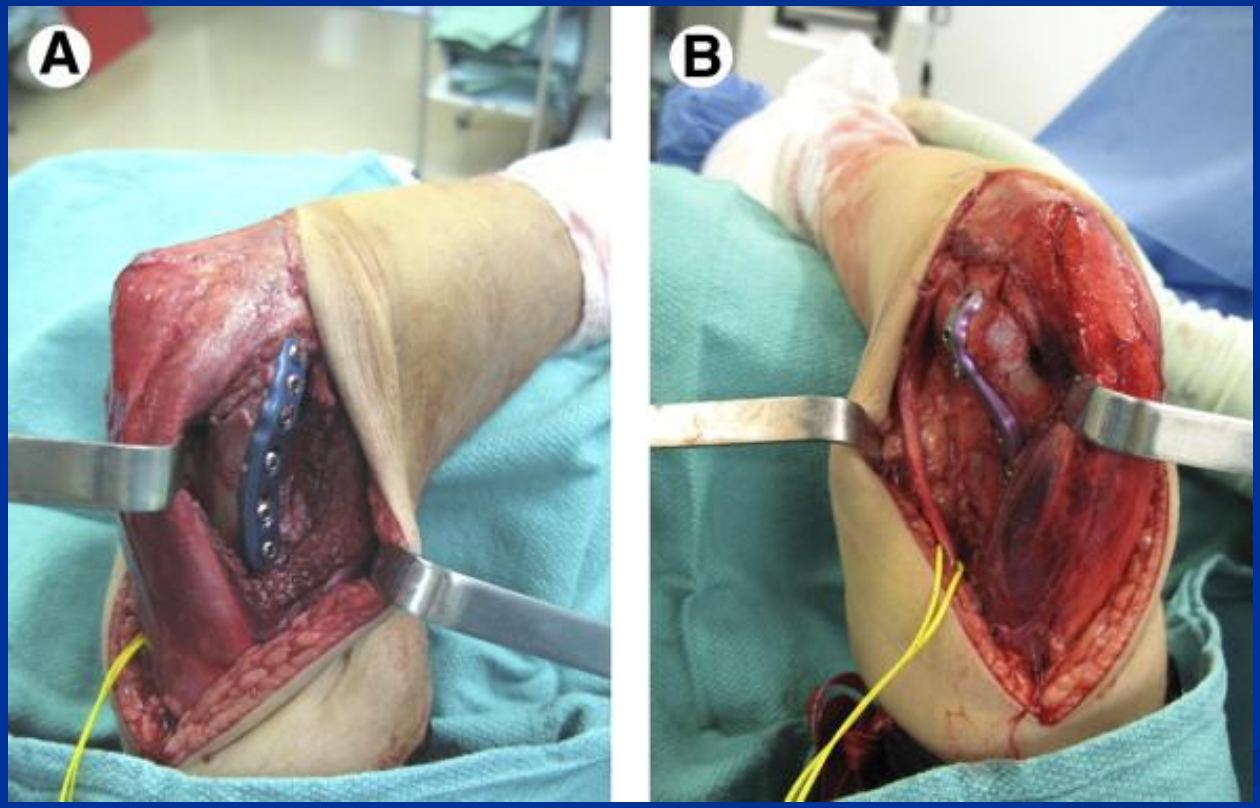
Approaches

- Posterior incision avoiding the olecranon bursa
- Mobilise the ulnar nerve and sloop-DO NOT CLIP TO DRAPES !

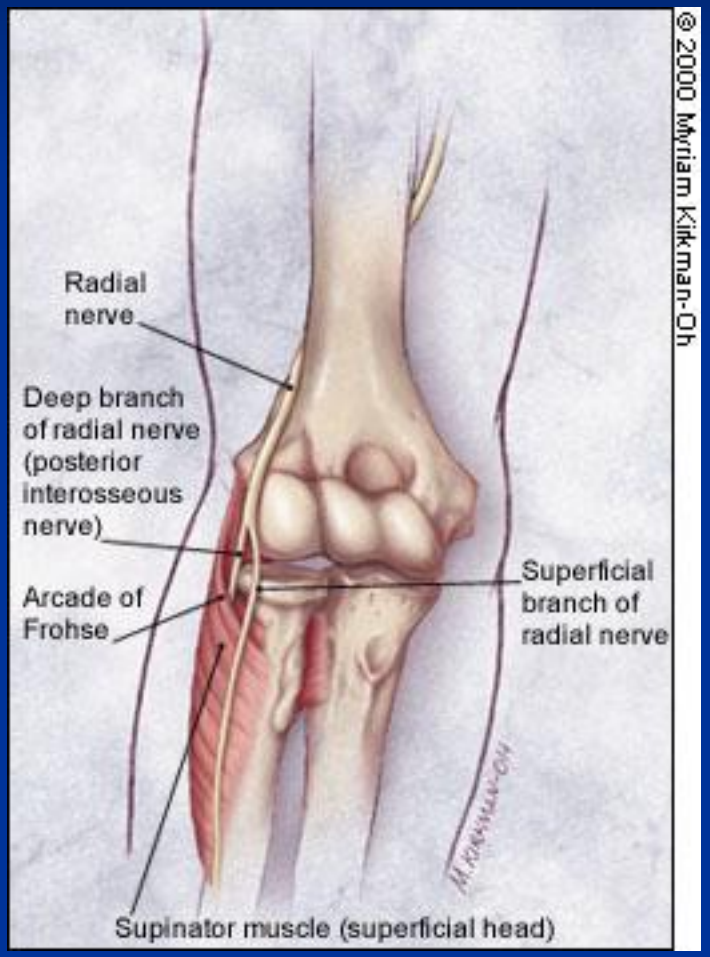
A TYPE APPROACH

- TRICEPS SPARING/MEDIAL AND LATERAL WINDOWS
- Uni or bicolumnar plates

A TYPE APPROACH



A TYPE APPROACH



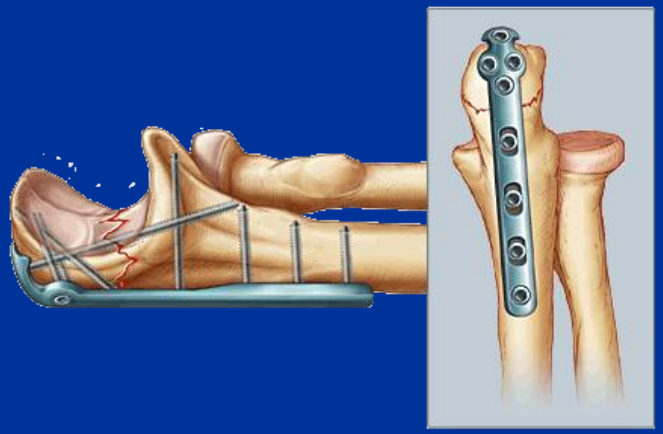
- Care with radial nerve with longer lateral plates
- Find it and sloop it !

B & C TYPE APPROACH

- Olecranon osteotomy for all intraarticular fractures – ?the best/only way to see the articular surface
- Medial and lateral arthrotomy adjacent to triceps
- Osteotomy and continue medial and lateral triceps mobilising incisions (care-radial nerve)

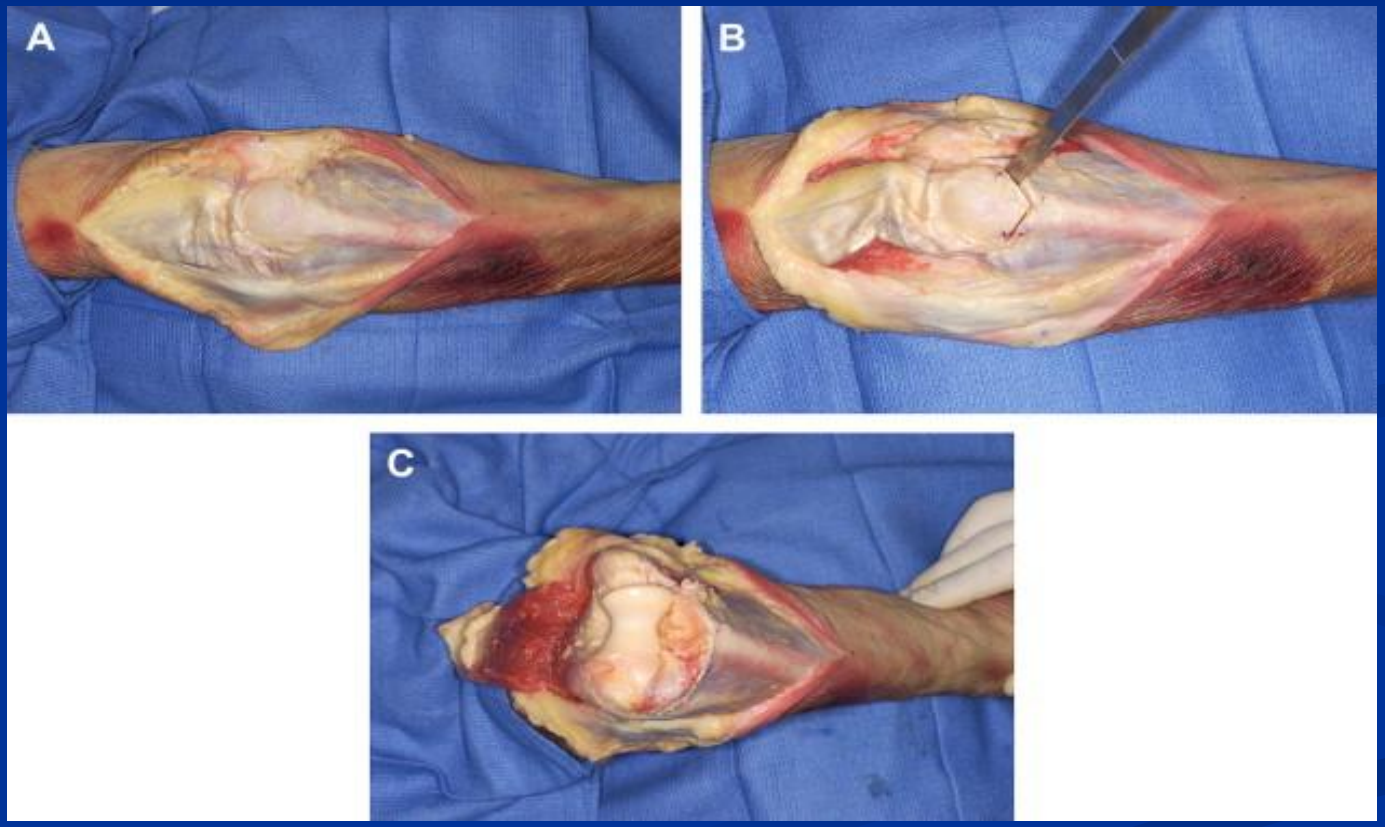
- Uni or bicolumnar plates

Chevron Olecranon Osteotomy

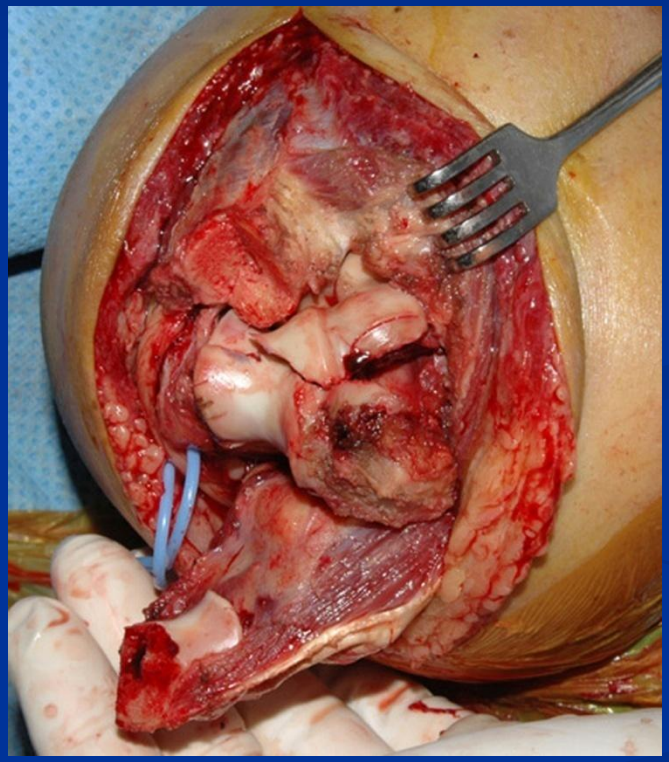


Point to wrist !
Swab/lever across joint
Look into joint for position
Saw
Complete with osteotome
Repair with Tension Band or plate (? Predrill)

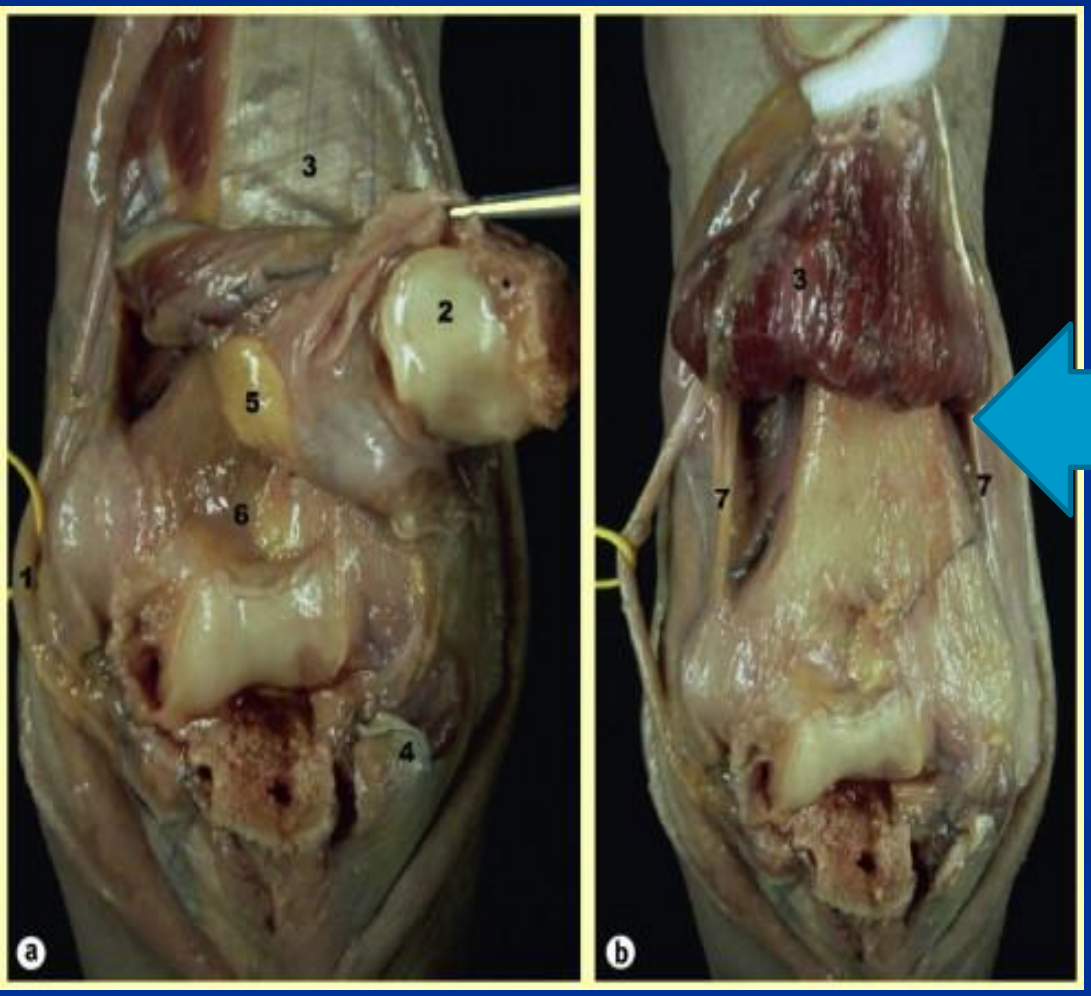
OLECRANON OSTEOTOMY



OLECRANON OSTEOTOMY

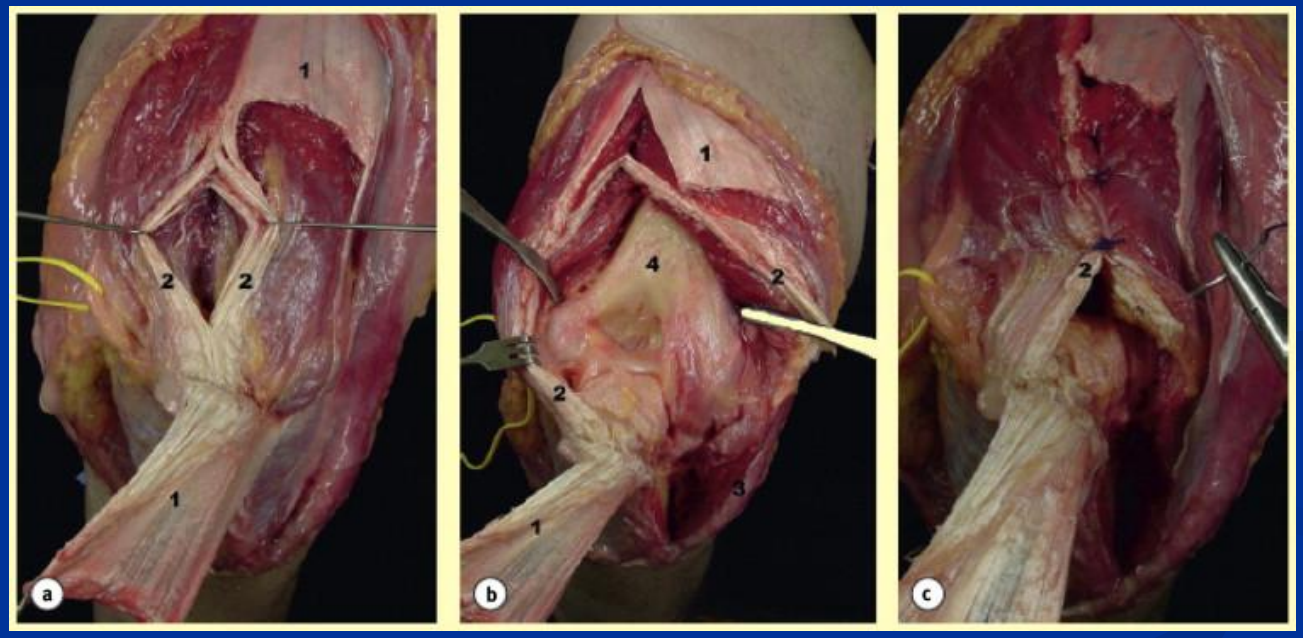


OLECRANON OSTEOTOMY

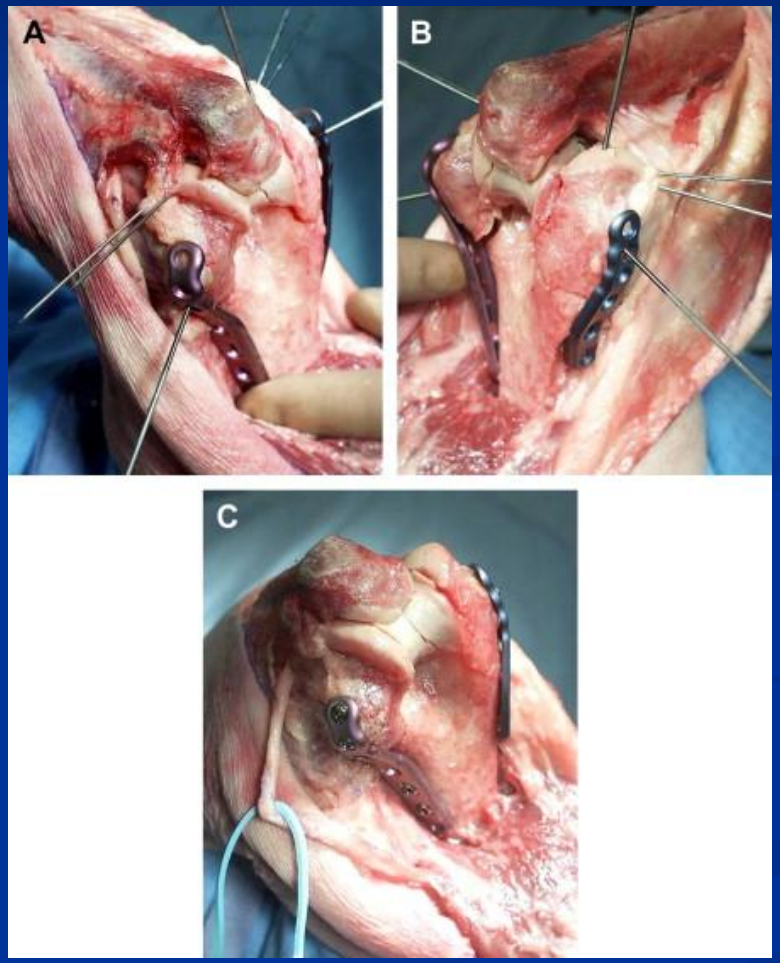


CARE ABOVE THIS LEVEL- RADIAL NERVE LATERALLY !!!

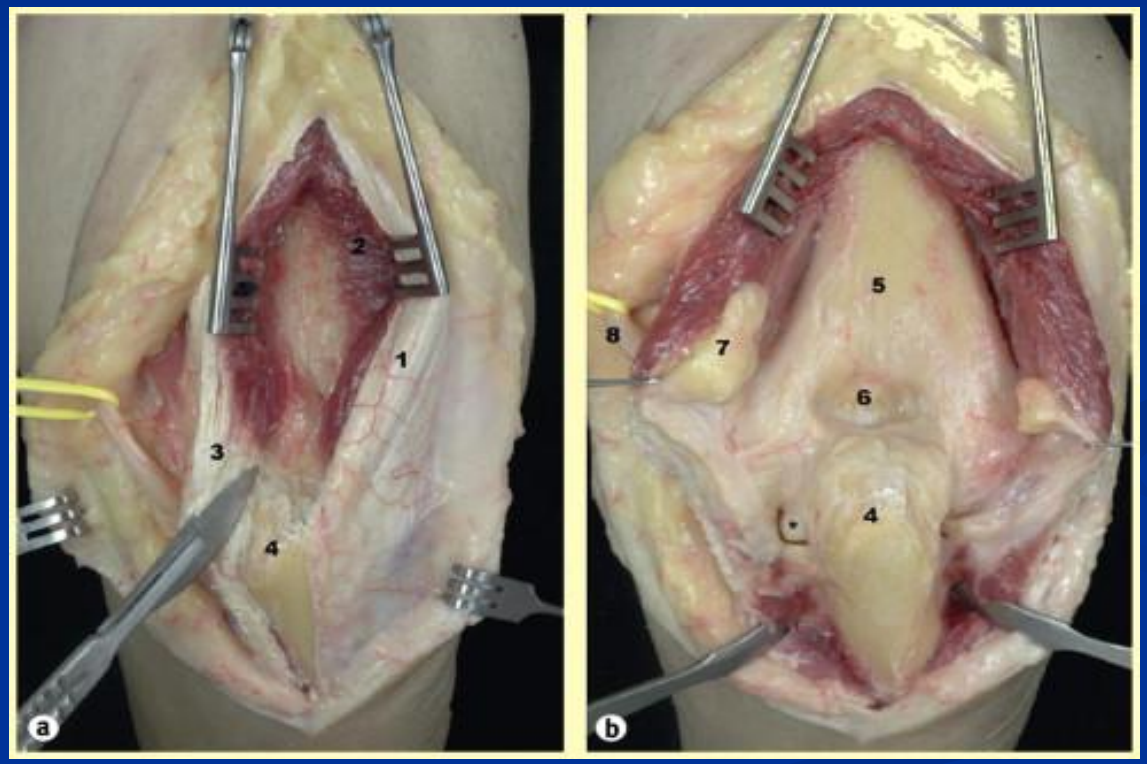
TRICEPS TONGUE



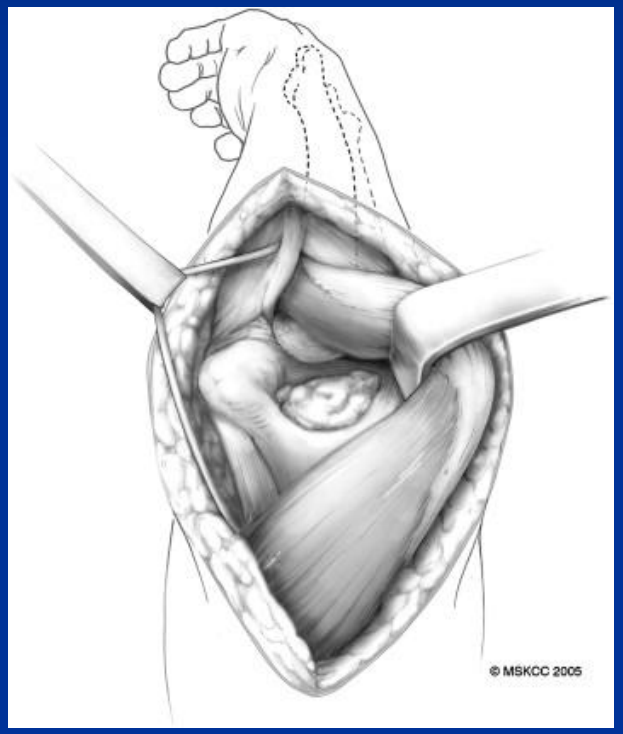
TRICEPS REFLECTING

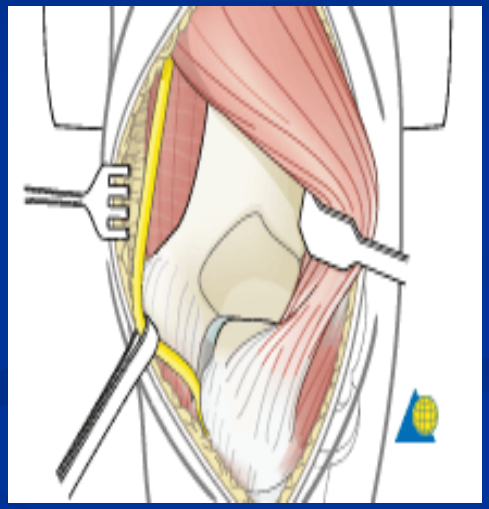


TRICEPS SPLIT



TRICEPS BRYAN/MORREY





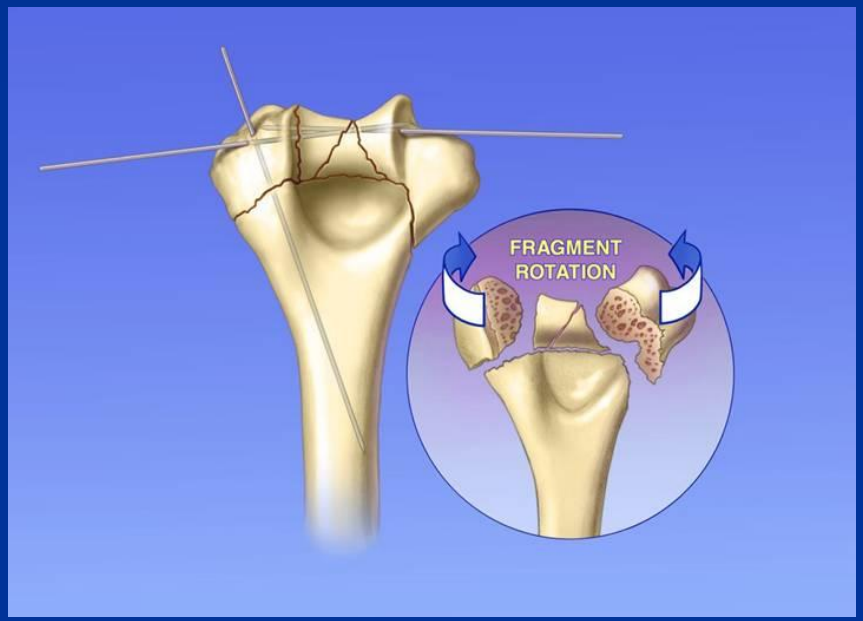
INADEQUATE OPERATIVE TREATMENT

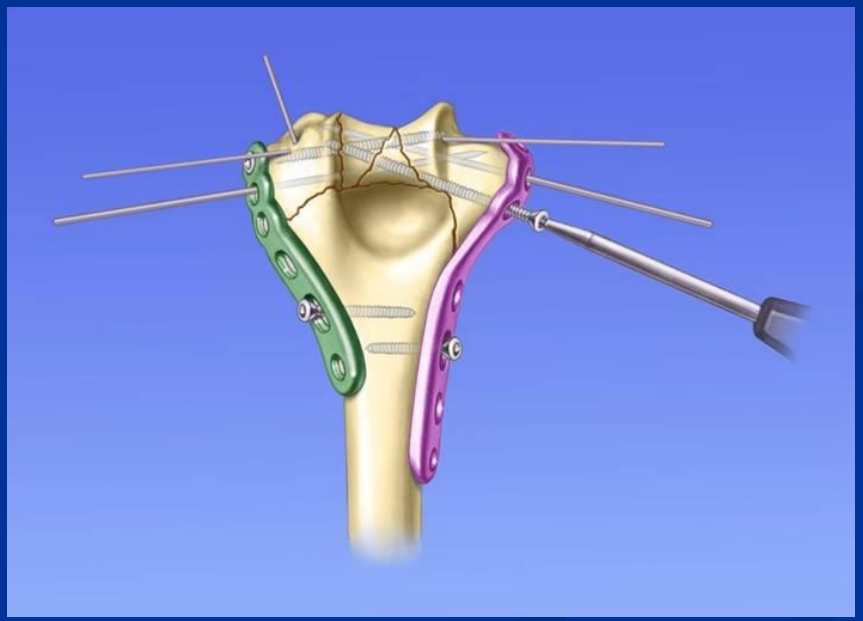
Provisional Fixation

- K wires/forceps for preliminary reconstruction of the articular block
- **THERE IS NO PLACE FOR K WIRES AS DEFINITIVE FIXATION IN THESE FRACTURES !**

Though may be used to hold tiny articular fragments, headless screws are better or 'lock in' with larger fragments.

K wire set-up





FIXATION

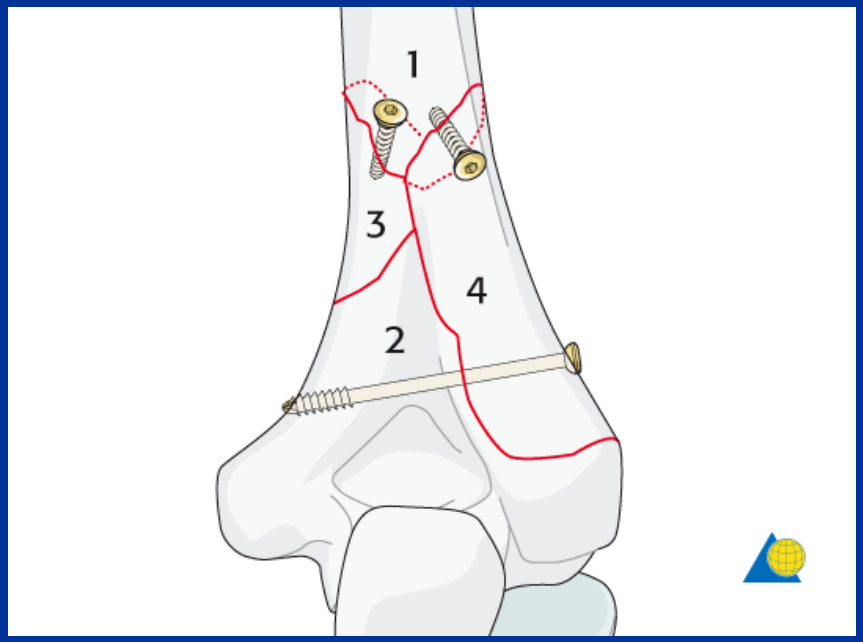
- **THERE IS NO PLACE FOR 1/3 TUBULAR PLATES IN DISTAL HUMERAL # RECONSTRUCTION**
- Either use small fragment set DCP/Recon plate or precontoured periarticular plates
- New locking technology *may* have advantages in soft bone

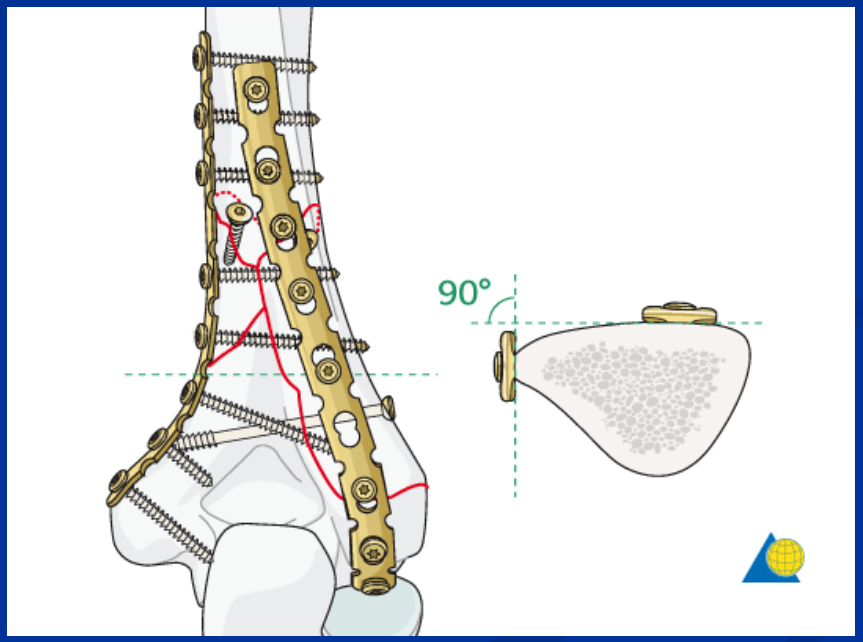
AO 90/90 Plating

- Original AO technique
- Well proven technique
- Reconstruct the articular block first
- Then attach to humerus with compression
- As low as possible with plates but care not to detach ligaments
- Planning required to prevent screw clashes
- **Schatzker & Tile 'The Rationale of Operative Fracture Care.' Springer Verlag Pub.**

AO 90/90 Plating

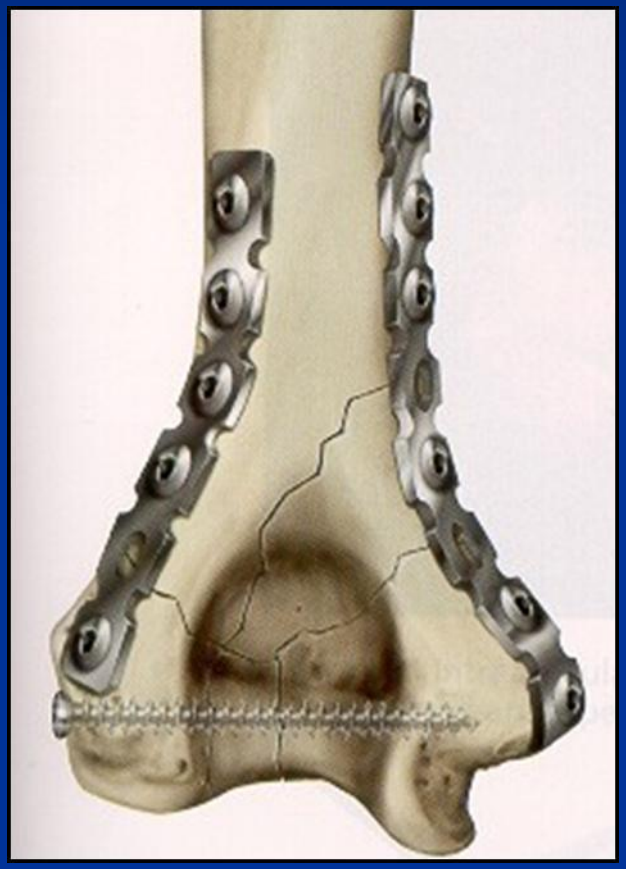
AO 90/90 Plating

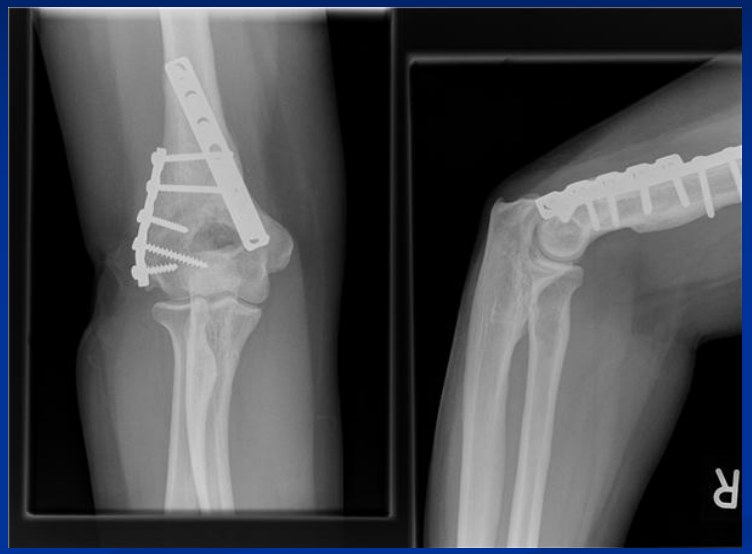




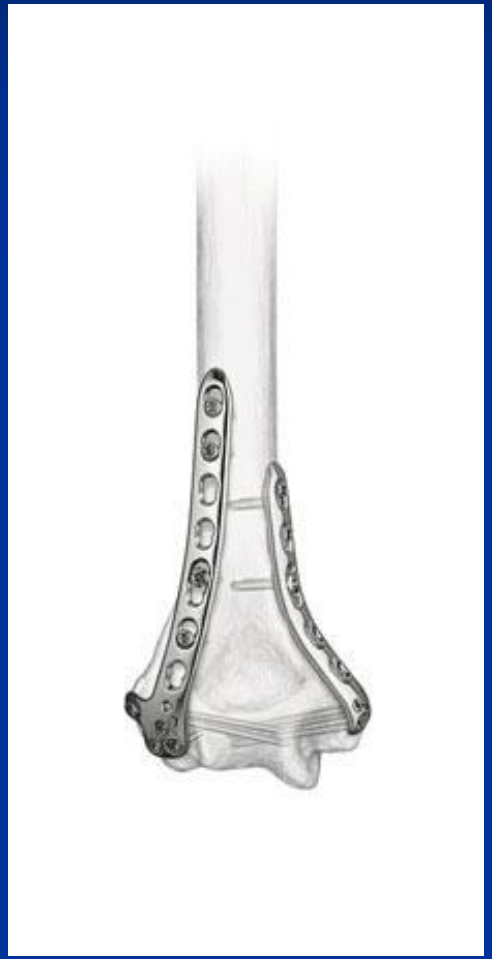
AO 90/90 Plating

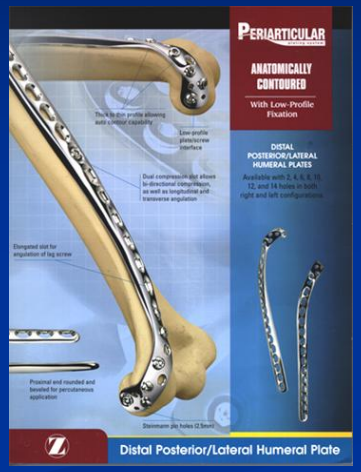
AO 90/90 Plating

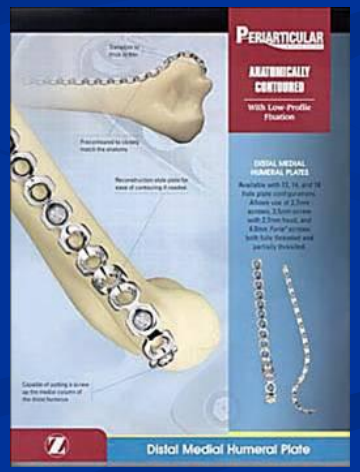




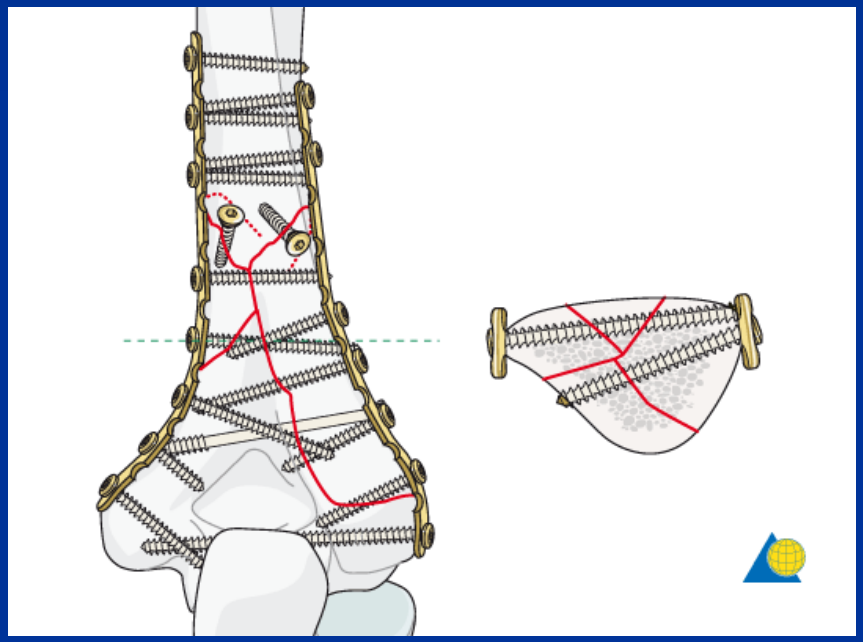
AO 90/90 Precontoured Locking Implants



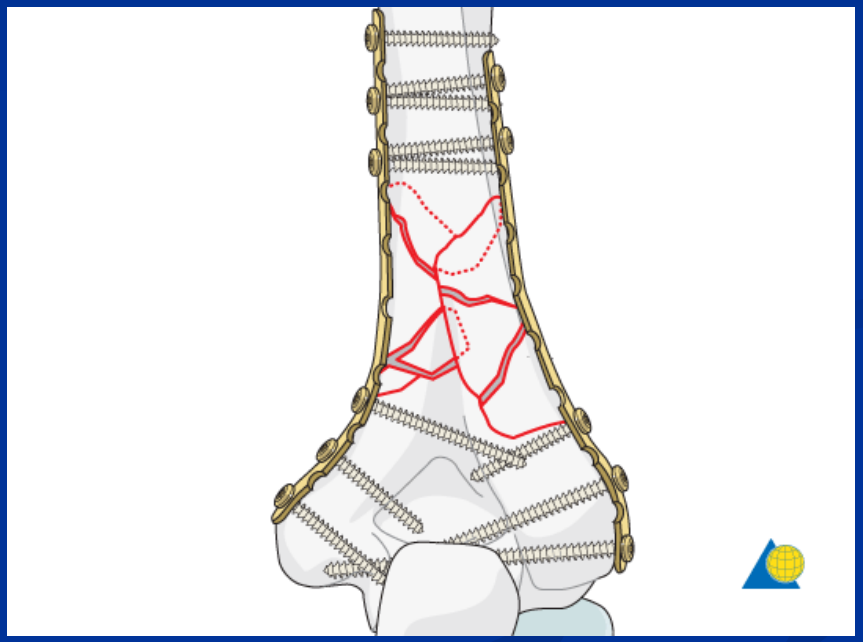




AO VENTURES INTO PARALLEL PLATING



WITH LAG SCREWS



BRIDGING

Mayo/O'Driscoll Parallel Plating

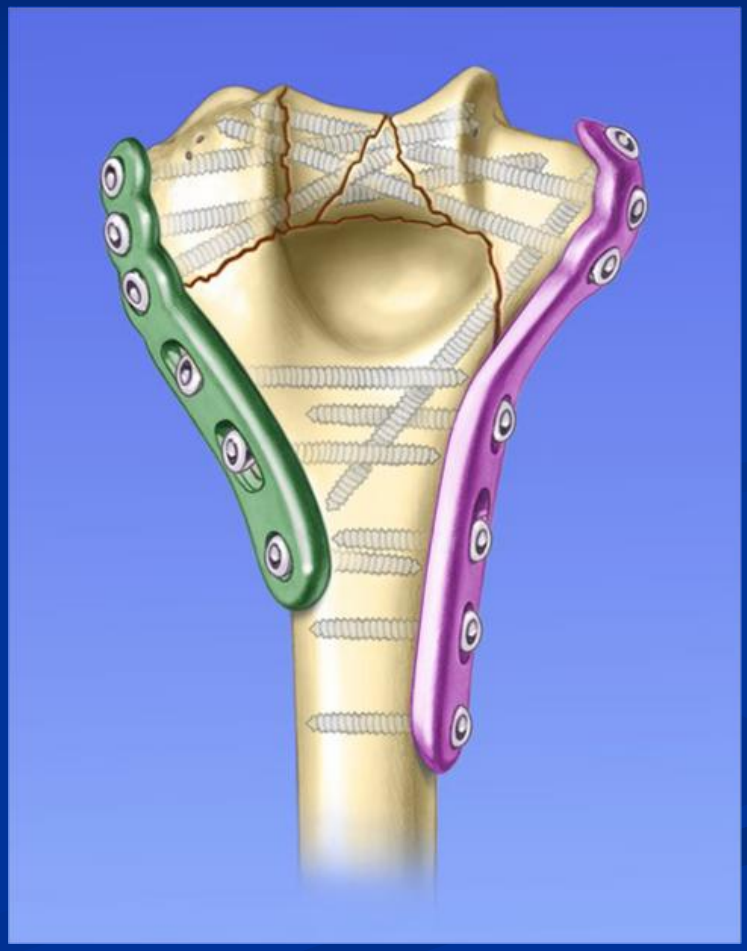
- **Mayo Clinic USA. Shawn O'Driscoll.**

Aims-

- Early movement (@ 3 days)
- Union, especially supracondylar
- Now precontoured plates-save time, improve accuracy, prevent metal fatigue. NOT LOCKING PLATES .
- Stable fixation distally, extra plate holes distally
- Low profile plates with functional variation in thickness for less irritation and greater strength where needed

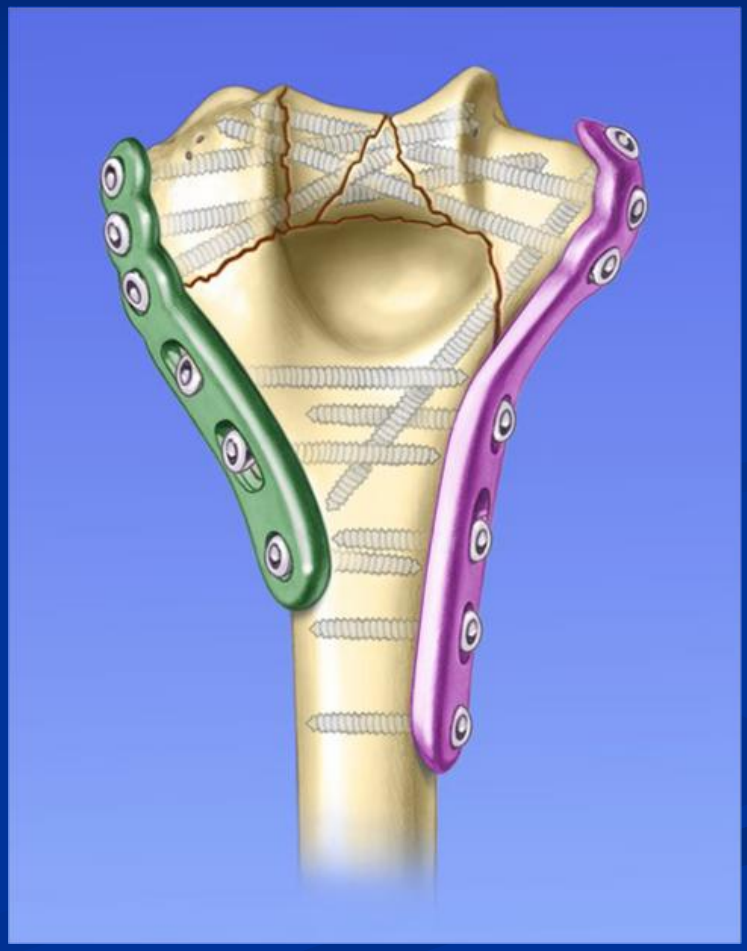
A different philosophy-

- Every screw passes through a plate
- Every screw engages a fragment on opposite side that is held by a plate
- As many distal screws as possible



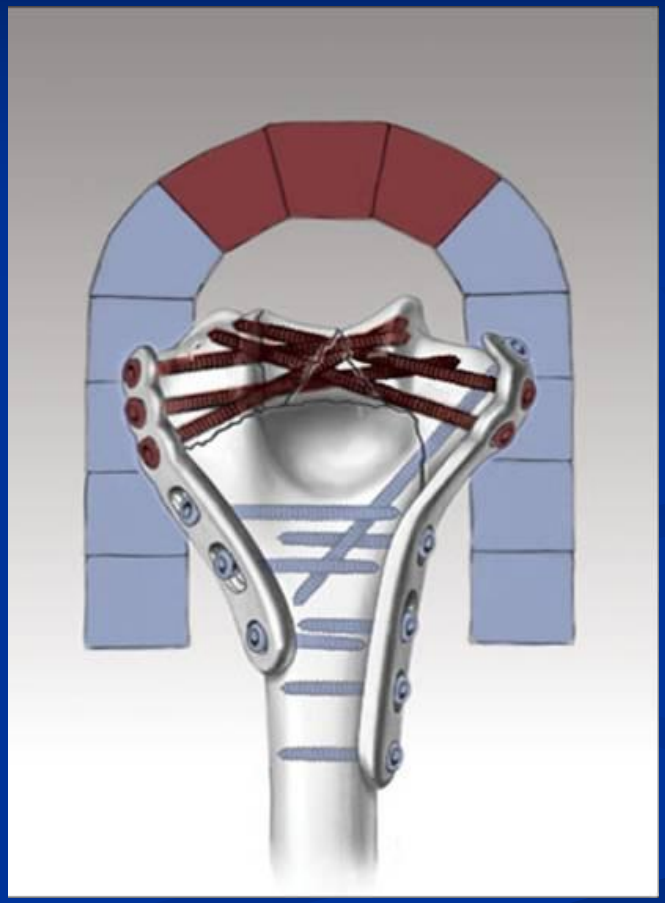
A different philosophy-

- Screws should be as long as possible
- Screws should engage as many articular fragments as possible



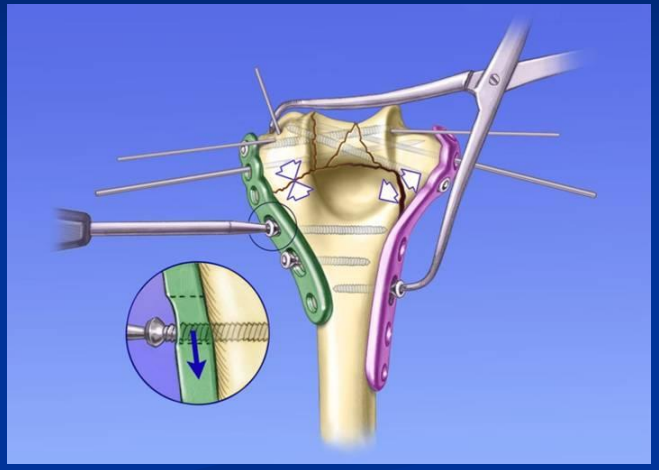
A different philosophy-

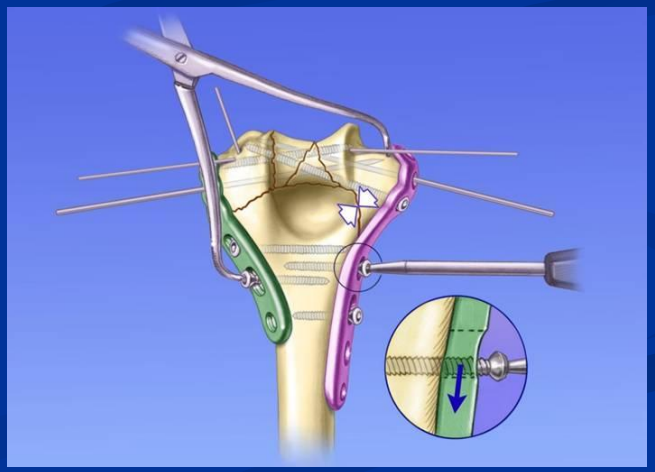
Distally screws should form an interdigitating arch (should not need locking, though available)



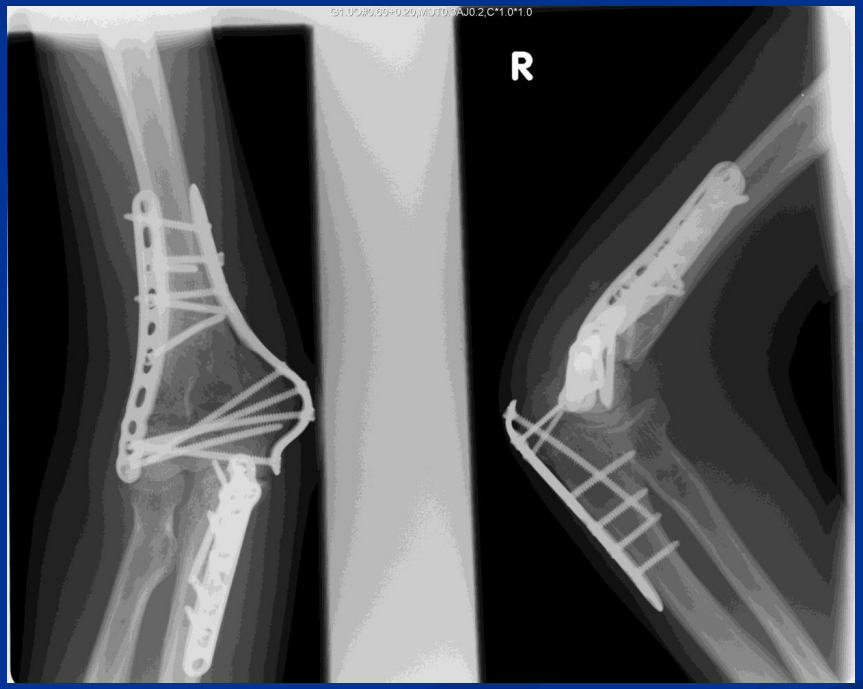
A different philosophy-

Supracondylar compression must be applied





The end result

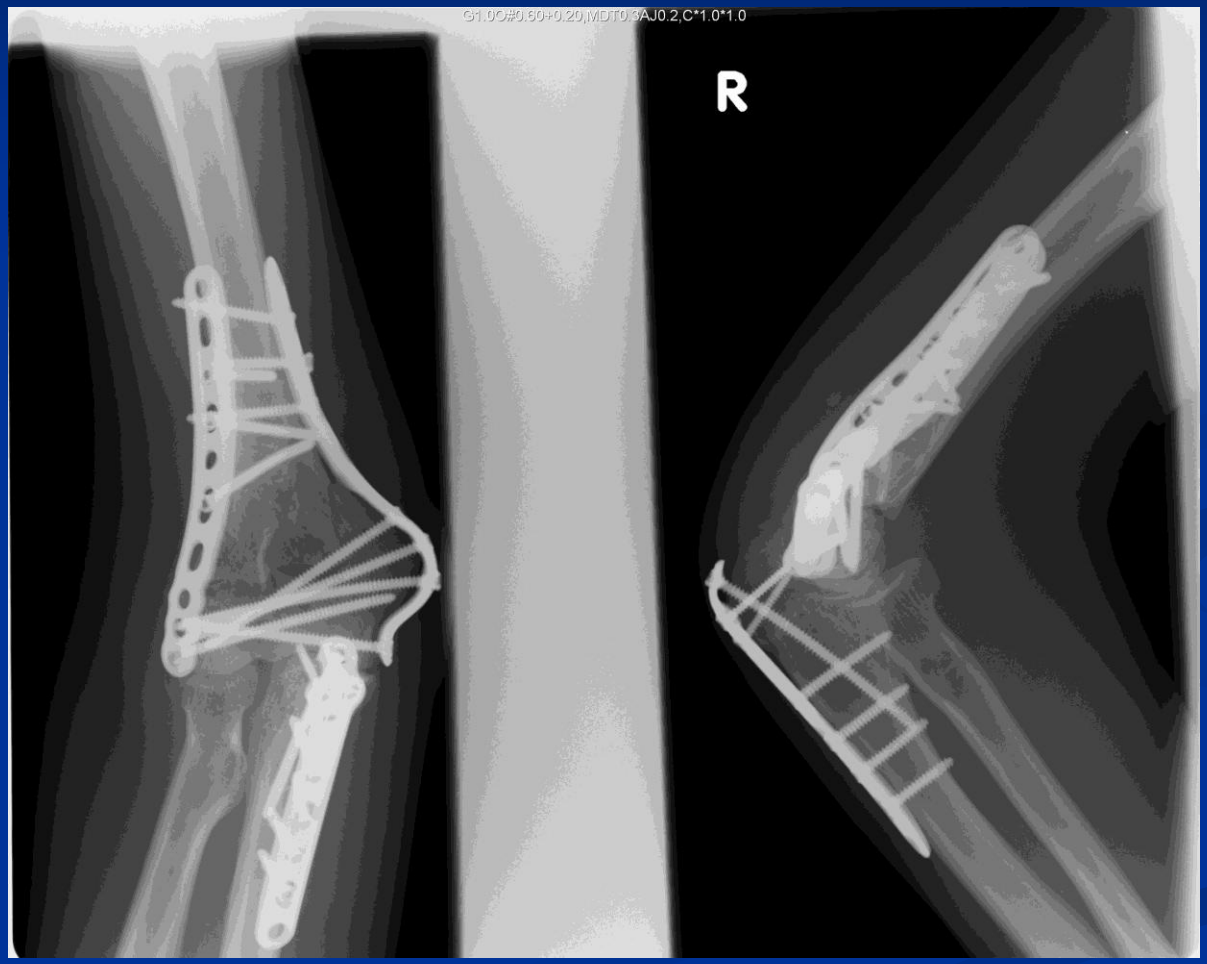



G0.8O#0.60+0.15,MDT0.3AJ0.2,C*1.0*1.0
R


MEDCOM RESAMPLED
Spin: -117
Tilt: 4
L P


MEDCOM RESAMPLED
Spin: 83
Tilt: -16
R

Complete Intraarticular



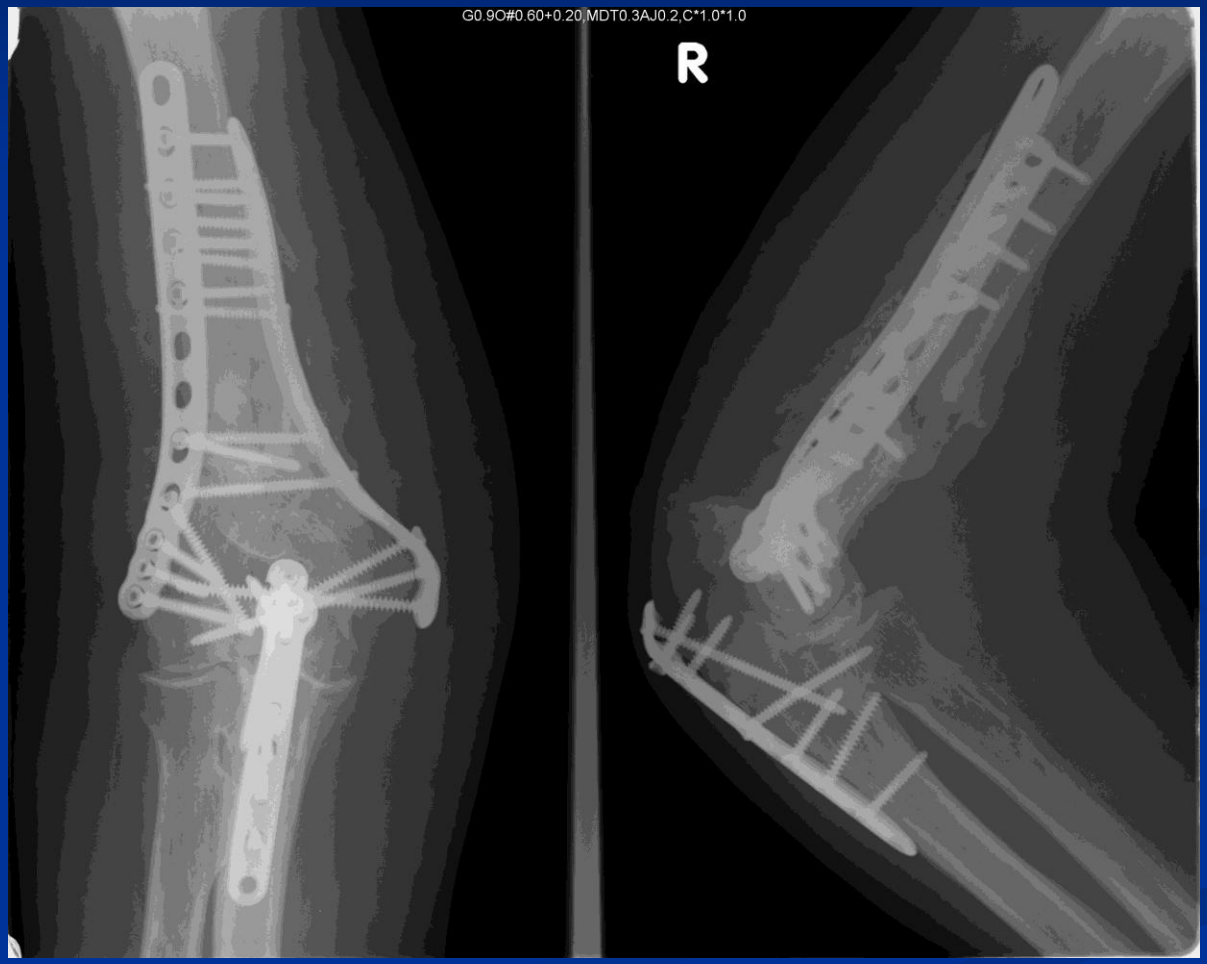
Complete Intraarticular # 2


D/TON MEM HOSPITAL
RADIOLOGY
2
RT
K=1
R=0
W=255
L=127
17:54:37
22-06-07
ZIEHM
51 kV
1.7 mA
5.1 cG

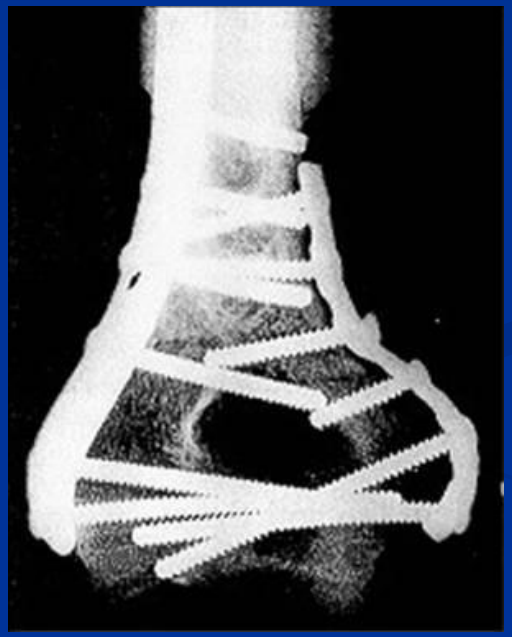

D/TON MEM HOSPITAL
RADIOLOGY
5
RT
K=1
R=0
W=255
L=127
18:06:21
22-06-07
ZIEHM
54 kV
2.2 mA
17.8 cG


D/TON MEM HOSPITAL
RADIOLOGY
6
RT
K=1
R=0
W=255
L=127
18:30:02
22-06-07
ZIEHM
52 kV
2.0 mA
19.7 cG

Complete Intaarticular # 2



Not necessarily Acumed plates !



Technique and references

- Sanchez-Sotelo J, Torcia M, O'Driscoll S.

Complex distal humeral fractures:internal fixation with a principle based parallel plate technique. JBJS 2008; 90A Supplement 2, part 1: 31-46.

Biomechanically superior to 90/90 in resistance to all stress planes, particularly **torsion.**

Few good *clinical comparitive* trials with 90/90 technique.

90/90 vs parallel plating

- JSES JAN 2010
- 17 PERPENDICULAR
- 18 PARALLEL
- NO DIFFERENCE CLINICALLY
- SLIGHTLY INCREASED NON UNION RATE (2 in 90/90, 0 in parallel)

J Shoulder Elbow Surg (2010) 19, 2-9

JOURNAL OF SHOULDER AND ELBOW SURGERY

www.elsevier.com/locate/ymse

ELSEVIER

FEATURED ARTICLES

A clinical comparison of two different double plating methods for intraarticular distal humerus fractures

Sang-Jin Shin, MD*, Hoon-Sang Sohn, MD, Nam-Hoon Do, MD

Department of Orthopaedic Surgery, Ewha Womans University School of Medicine, Seoul, Korea

Background: This study compared clinical outcomes in patients with intraarticular distal humerus fractures treated using 2 different double plating methods.
Method: Seventeen patients were treated by perpendicular plating (group I) and 18 by parallel plating (group II) methods. Arc of flexion averaged 106°±23° in group I and 112°±19° in group II.
Results: Eleven patients in group I recovered full arc of flexion and 13 patients in group II achieved full arc of flexion. All patients obtained bone union, except 2 patients in group I. Nonunion in these patients developed in the supracondylar area. Complications developed in 6 patients in group I and in 8 in group II. No significant differences were found between the clinical outcomes of the 2o plating methods.
Conclusion: Although more patients failed to achieve bony union in the perpendicular plating group, both parallel and orthogonal plates positioning can provide adequate stability and anatomic reconstruction of the distal humerus fractures.
Level of Evidence: 2.

Anatomical restitution of the complex geometry of the distal humerus allowing early mobilization is the goal of distal humerus fracture treatment.[2, 5, 26] Although this goal is necessary for regaining a functional range of elbow motion, stable fracture fixation may be technically difficult, especially in the presence of substantial osteoporosis or comminution. Because the distal humerus offers the unique shapes of articular surfaces, limited space for instrumentation, and lies close enough to neurovascular structures, this may present substantial difficulties during surgery. Furthermore, the elbow joint is intolerant of immobilization, and the rigid fixation of displaced fragments to allow early rehabilitation and successful outcomes is emphasized for distal humerus fractures.

Recently, open reduction and internal fixation using plates have demonstrated satisfactory clinical outcomes for the treatment of distal humerus fractures, and various ways of plating methods have been described to achieve firm stabilization.[4, 6, 18, 19] Among them, several mechanical studies have proved that double plate fixation provides more stable fixation than other methods.[8, 25] However, controversy still exits concerning plate positions in terms of providing optimal stability for distal humerus fractures. The most widely used dual plate fixation method involves placing plates perpendicular to each other, with 1 on the medial supracondylar ridge and the other placed posterolaterally. This orthogonal plating system was reported to provide greater rigidity and fatigue resistance than the single Y plate in a cadaveric study.[8] However, some biomechanical studies have demonstrated that the parallel plating system, whereby plates are placed along each supracondylar ridge at approximately 180° to each other, is significantly stronger and stiffer than the perpendicular plating system in terms of resisting sagittal

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90/90 vs parallel plating

- Zalavras CG et al. J Shoulder and Elbow Surg 2011;20(1):12-20.
- Cyclic loading, intraartic #, metaphyseal defect

J Shoulder Elbow Surg (2011) 20, 12-20

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Biomechanical evaluation of parallel versus orthogonal plate fixation of intra-articular distal humerus fractures

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Background: Orthogonal and parallel plate constructs are used for fixation of intra-articular distal humerus fractures but optimal plate configuration remains controversial. The purpose of this study was to compare the biomechanical properties of orthogonal versus parallel plate constructs in a cadaver distal humerus fracture model.
Material and methods: An intra-articular distal humerus fracture with a metaphyseal defect was created in 14 matched pairs of cadaver elbows. Paired specimens were fixed with either orthogonal or parallel plates from a single elbow plating system using nonlocking screws. Using a novel testing protocol, loading was applied to the forearm and was transmitted to the distal humerus through intact collateral ligaments, olecranon, and radial head. Seven matched pairs were tested under varus loading and seven under axial/sagittal loading. Each specimen underwent cyclic loading first, followed by loading to failure.
Results: Parallel plate constructs had significantly higher stiffness than orthogonal ones during cyclic varus loading ($P = .002$). Screw loosening occurred in all posterior plates of orthogonal constructs but in no plates of parallel constructs ($P = .001$). Parallel constructs had significantly higher ultimate torque in varus loading to failure (20.7 vs 15.9 Nm, $P = .008$), and higher ultimate load in axial/sagittal loading to failure (1287.8 vs 800.0 N, $P = .03$).
Discussion: Parallel plating of intra-articular distal humerus fractures with a metaphyseal defect demonstrates superior biomechanical properties compared to orthogonal plating, and may be preferable for fixation of these fractures.
Level of evidence: Basic Science Study, Biomechanical Study.

Keywords: Distal humerus; fracture; intra-articular; fixation; plate; parallel; orthogonal; biomechanical

Intra-articular distal humerus fractures are complex injuries; satisfactory outcome following open reduction and internal fixation depends on anatomic restoration of the joint surface, stable fixation of the fracture, and initiation of early motion.[6,8,9,12,13,15,16,20-22,24] However, the available area in the distal humerus for application of implants is limited and fixation becomes challenging in the presence of a low fracture pattern, comminution, and/or bone loss. In addition, osteoporosis in elderly patients further compromises stability of fixation,[15,19,26] and as a result primary elbow arthroplasty has emerged as a viable

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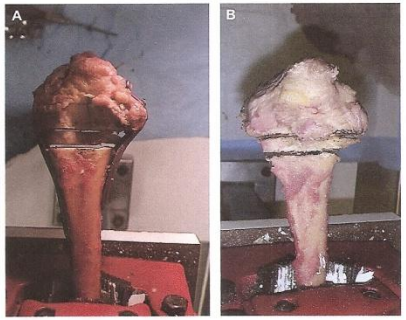

Figure 2 (A) Two transverse osteotomies were marked and initiated at the medial and lateral ridge of the distal humerus, leaving the major central part intact. This allowed positioning of the plates on a distal humerus that was still in continuity and ensured consistent anatomic reduction of the distal humerus. (B) The transverse osteotomies were completed after plating.

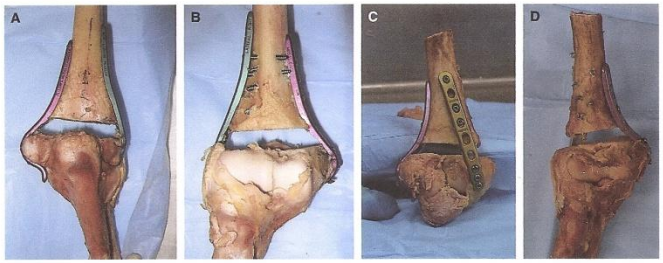

Figure 3 Specimens fixed with a parallel or orthogonal plate construct after completion of the fixation and the osteotomies. (A) Parallel construct, posterior view. (B) Parallel construct anterior view. (C) Orthogonal construct, posterior view. (D) Orthogonal construct, anterior view.

of each specimen were potted in cylindrical tubes. The radius and ulna were potted with the forearm in neutral position. A materials-testing machine (Model 4411; Instron, Canton, MA) was used for biomechanical testing. Loading was applied to the potted forearm and was transmitted to the distal humerus through the intact collateral ligaments, olecranon, and radial head.

In the first part of the study, 7 matched pairs of elbows were tested under varus loading with the elbow flexed at a 50° angle (Figure 4). The varus load was applied to the forearm using a custom-made jig and the moment arm was kept constant at 15 cm. The varus moment generates coronal plane bending with compression on the medial side and tension on the lateral side of the elbow.

Another 7 matched elbow pairs were tested in the second part of the study. The forearm of these specimens was axially loaded with the elbow flexed at a 50° angle, thereby generating axial loading of the distal humerus as well as loading in the sagittal plane in an anterior to posterior direction (Figures 5, *A*, *B*).

For coronal plane cyclic loading each specimen was sequentially tested for 10 cycles each time at 20N, 40 N, and 60 N, at a constant speed of 480 mm/min. For axial/sagittal plane cyclic loading each specimen was sequentially tested for 20 cycles each time at 20N, 40N, 60N, 80N, and 100N, at a constant speed of 240 mm/min. Loosening of the implants was defined as gross displacement (backing-out) of the screws during cyclic loading of the specimens. Load to failure testing was subsequently performed. Failure was defined as either catastrophic fixation failure, ligamentous disruption of the elbow, or fracture of the specimen. Outcome variables for cyclic loading included stiffness at each loading condition. Outcome variables for loading to failure included ultimate torque or load, and energy absorbed.

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- Greater stiffness to parallel construct
- Screw loosening only in 90/90
- Higher torque to failure in parallel
- Higher ultimate load to failure in axial and saggital load in parallel
- All $p<0.05$

Heterotopic ossification

- INDOMETHACIN 25 mg BD if no contraindications
- Radiotherapy only if history of HO

REHABILITATION

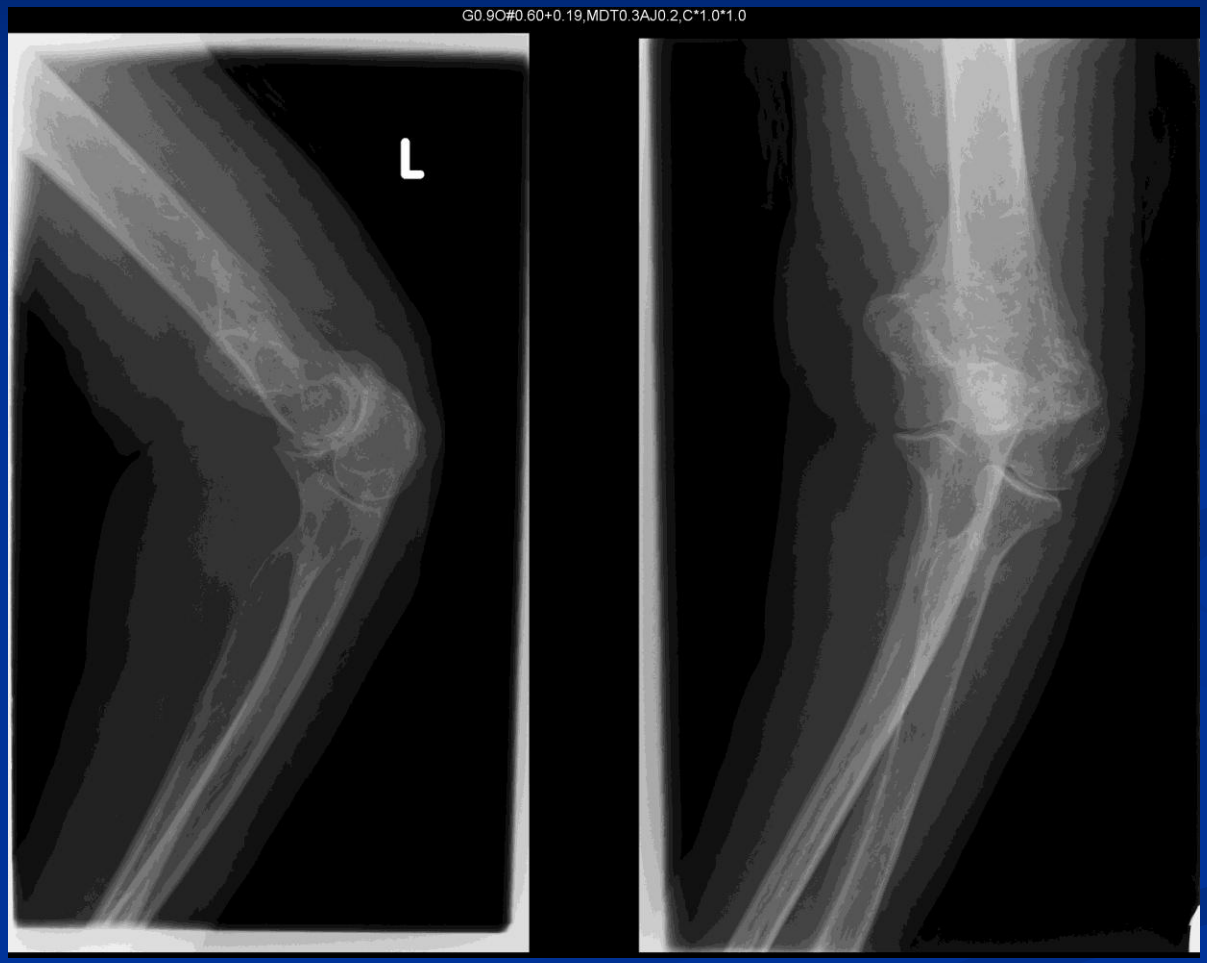
- CAST only for 2-3 days for immediate comfort, I prefer in extension.
- Fixation should allow early movement
- ELEVATE on pillows,+/- hand pump
- ACTIVE/ASSISTED moving to ACTIVE
- NO RESISTANCE UNTIL HEALING ON XRAY

ORIF NOT SAFE

- 'Bag of Bones' approach
- Very frail elderly
- Medically unfit for GA/prolonged lateral decubitus
- Osteopenia
- **Remember TER for trauma** -don't burn bridges with an olecranon osteotomy or infected/loose metalware in poor bone stock.

Bag of Bones

Bag of Bones



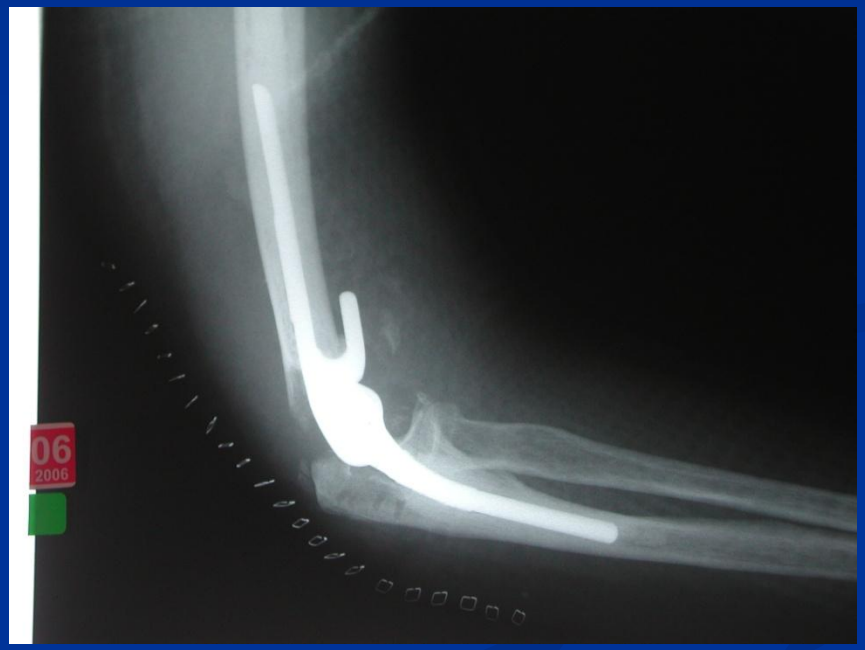
BAG OF BONES

- Eastwood. JBJS 1937;19:364-9, coined the term. Gradual extension from 120 deg flexion after initial 2 weeks in C&C sling.

- Evans. JBJS 1953;35:371-5. Unpredictable results, weakness and deformity.

TER for Complete Intraarticular

TER for Complete Intraarticular



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FEATURED ARTICLES

A multicenter, prospective, randomized, controlled trial of open reduction—internal fixation versus total elbow arthroplasty for displaced intra-articular distal humeral fractures in elderly patients

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Summary We conducted a prospective, randomized, controlled trial to compare functional outcomes, complications, and reoperation rates in elderly patients with displaced intra-articular, distal humeral fractures treated with open reduction—internal fixation (ORIF) or primary semiconstrained total elbow arthroplasty (TEA). Forty-two patients were randomized by sealed envelope. Inclusion criteria were age greater than 65 years; displaced, comminuted, intra-articular fractures of the distal humerus (Orthopaedic Trauma Association type 13C); and closed or Gustilo grade I open fractures treated within 12 hours of injury. Both ORIF and TEA were performed following a standardized protocol. The Mayo Elbow Performance Score (MEPS) and Disabilities of the Arm, Shoulder and Hand (DASH) score were determined at 6 weeks, 3 months, 6 months, 12 months, and 2 years. Complication type, duration, management, and treatment requiring reoperation were recorded. An intention-to-treat analysis and an on-treatment analysis were conducted to address patients randomized to ORIF but converted to TEA intraoperatively. Twenty-one patients were randomized to each treatment group. Two died before follow-up and were excluded from the study. Five patients randomized to ORIF were converted to TEA intraoperatively because of extensive

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Total elbow arthroplasty for distal humeral fractures: Indications, surgical approach, technical tips, and outcome

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Background: Twenty-six consecutive total elbow arthroplasties were performed for comminuted distal humeral fractures between 1995 and 2002. At review, 3 patients had died from unrelated causes, 2 had been lost to follow-up, and 1 could not be assessed due to dementia. The mean age of the remaining 20 patients was 72 years (range, 62-92). There were 4 men and 16 women.
Method: The mean follow-up was 63.2 months (range, 36-108). The mean Mayo Elbow Performance Score was 92 (75-100) with a mean flexion arc of 27°-125°.
Result: One patient had a postoperative superficial infection, which required a course of antibiotic therapy, and 1 patient who had a radial nerve neuropraxia recovered spontaneously after 6 weeks. Radiographs showed 19 implants were well fixed with no evidence of loosening, while 1 patient had a nonprogressive radio-lucent line on the ulna side of the prosthesis. Additionally, 2 patients developed heterotopic ossification without identifying pre-disposing factors.
Conclusion: Total elbow arthroplasty for distal humeral fractures in elderly patients without inflammatory arthritis can be expected to five good results at a mean follow-up of 5 years.
Level of Evidence: Review Article.

Keywords: Distal humeral fracture; Elderly patient; total elbow arthroplasty

Since Cobb and Morrey[3] published their landmark paper on the use of total elbow arthroplasty for distal humeral fractures, it has become accepted that this technique is a treatment option for these injuries. Their paper suggested that in elderly patients who had sustained comminuted distal humeral fractures, total elbow arthroplasty could be expected to give good clinical results. However, their study population included 48% of patients with rheumatoid arthritis, and, as such, this group might be expected to benefit from this procedure.

More recently, other publications[4-6,8,11,12] have noted similar results; although a number have also included patients with rheumatoid arthritis. In a previously published study,[6] we have reported satisfactory results in a non-rheumatoid population with a mean 3-year follow-up.

We now present the results of a total elbow arthroplasty for distal humeral fractures with a minimun 3-year and mean 5-year follow-up.

Indications for total elbow arthroplasty

As the original publication on this technique was in 1997, we felt it appropriate to revisit the indications for total

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- JSES 2010;19;53-58

INDICATIONS FOR TER

- AGE >65
- COMMINUTED
- DISTAL FRACTURE
- POOR QUALITY BONE
- CONCERNS OVER ORIF QUALITY AND EARLY MOVEMENT

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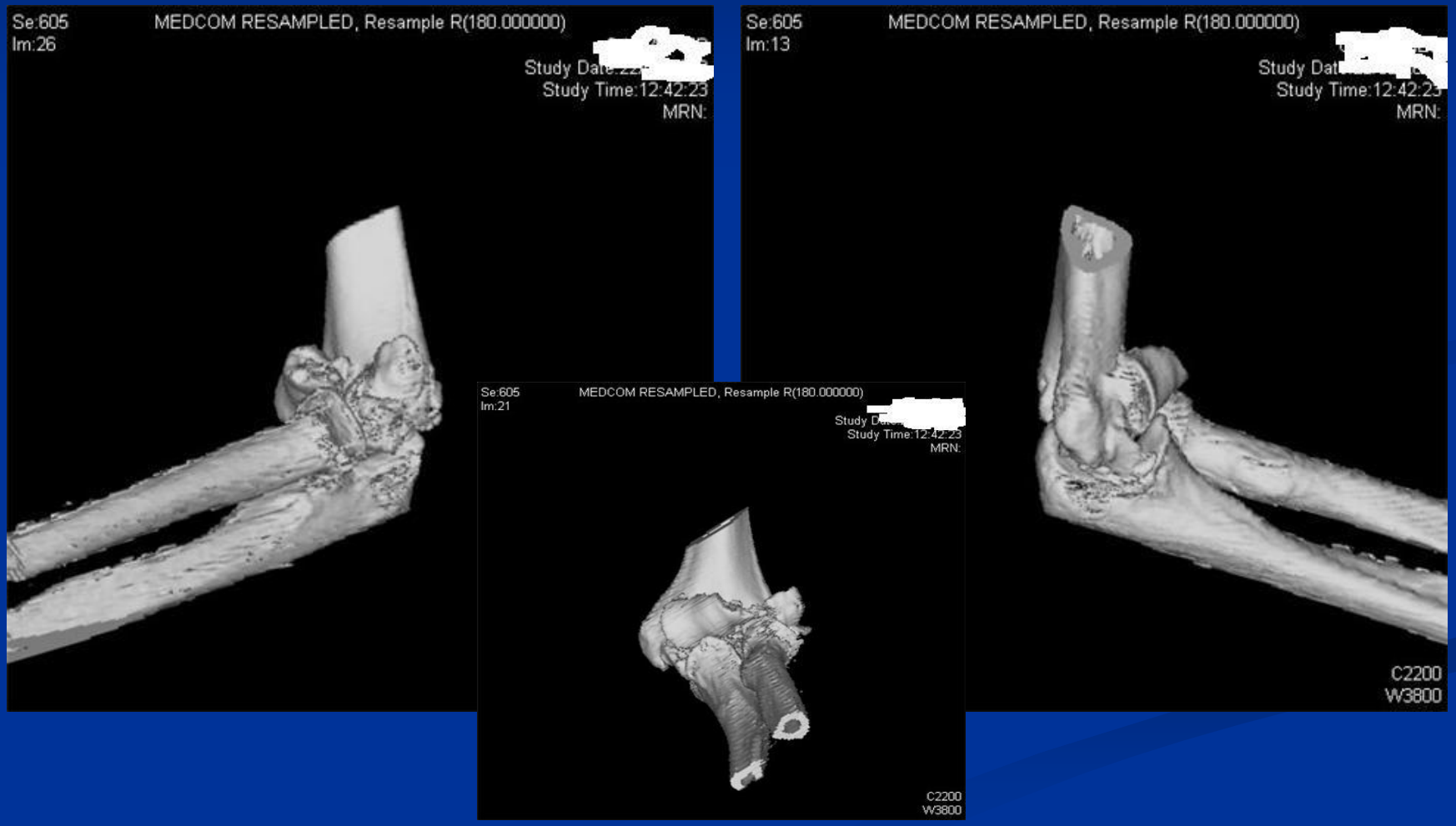

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Thankyou