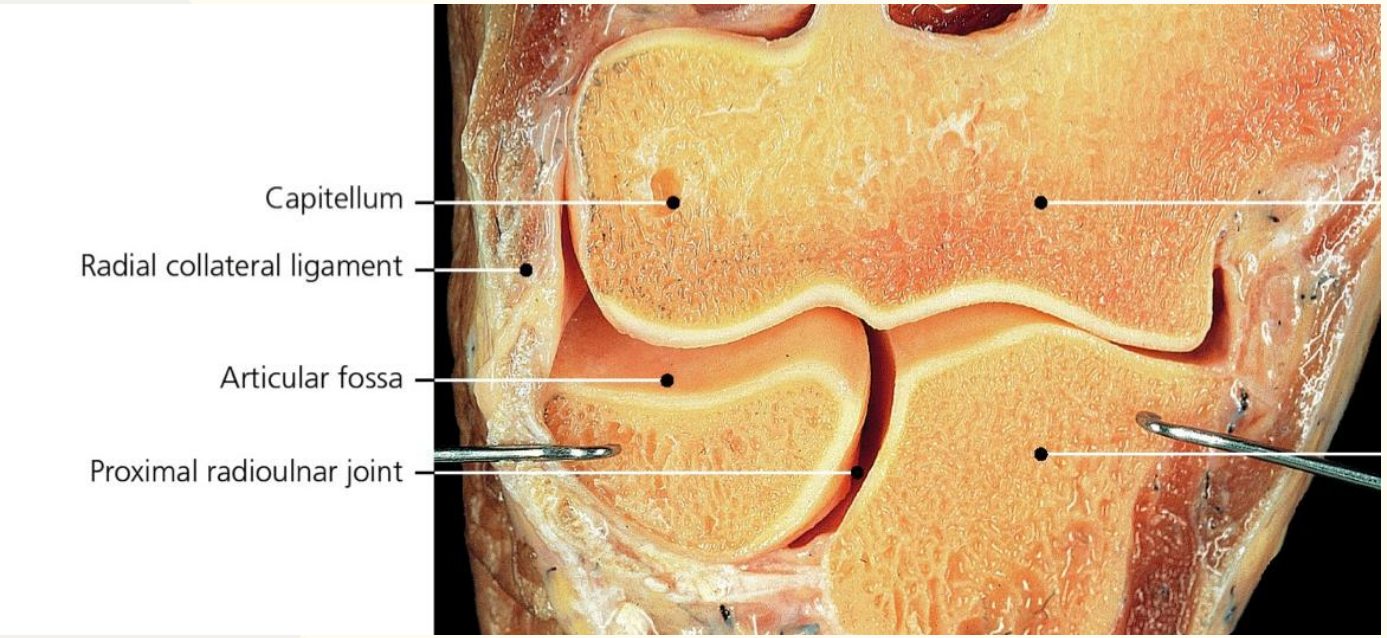
Radial Head Arthroplasty: Current Concepts

Gregory Rafijah, MD

UC Irvine Hand Surgery

No Disclosures

Radiocapitellar Joint / PRUJ

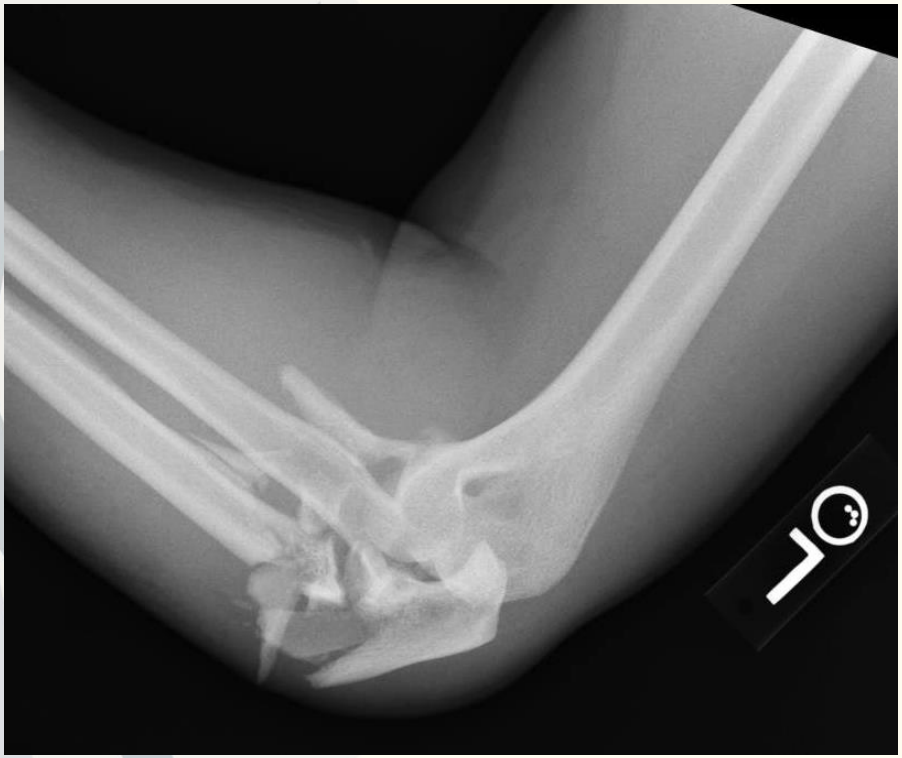


- Radial head articulates with ulna and humerus
- Force transmission ≤ 60% of load during ROM

Type 3 Radial Head Fracture

- Comminution
- Options
  - ORIF
  - Excision + / - arthroplasty

Associated Injuries

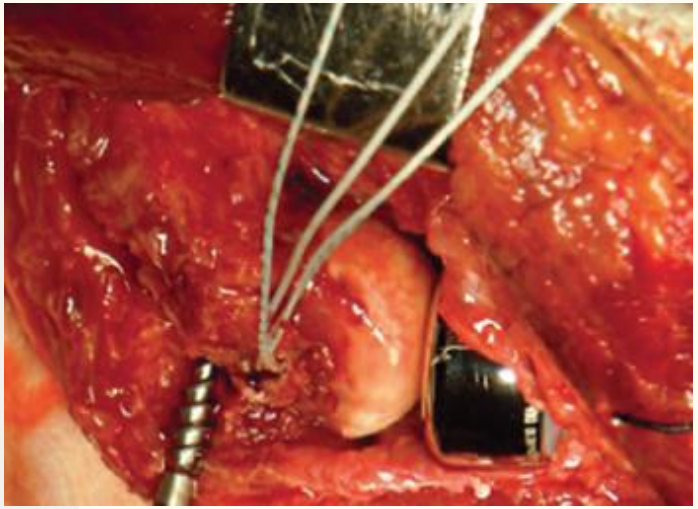


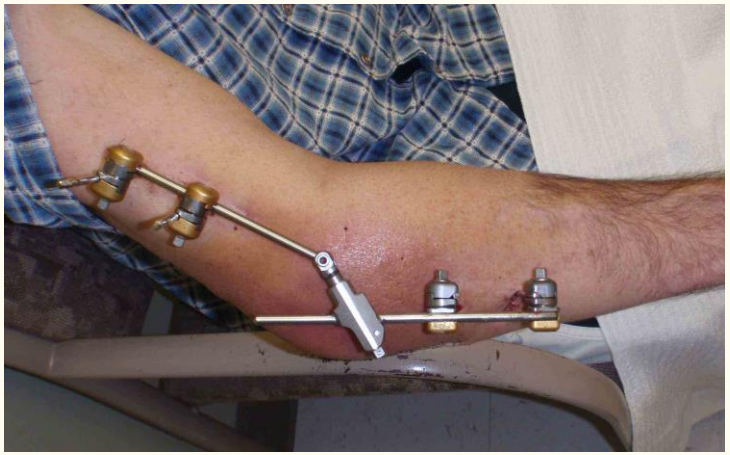
- Ligament injury
  - MCL / LUCL
  - IOM
  - TFCC
- Chondral injury
- Ulna fracture
  - Coronoid
  - Olecranon

Associated Injuries

- Kass 2010
- Correlated fracture type with frequency of associated injuries
- Type 1 and Type 2 fractures: 73-76%
- Type 3 fracture: 100%

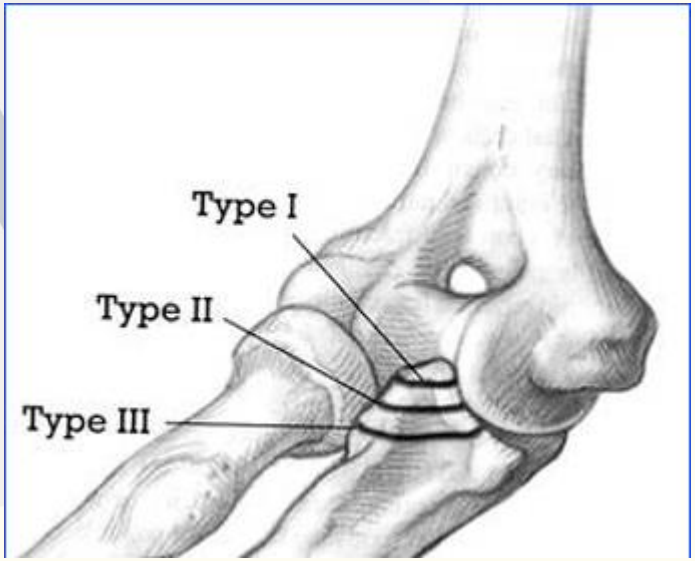
Type 4 Radial Head





- Stabilization procedures
  - LUCL
  - MCL
  - ORIF coronoid
  - TFCC / IOM
  - External fixation

Terrible Triad



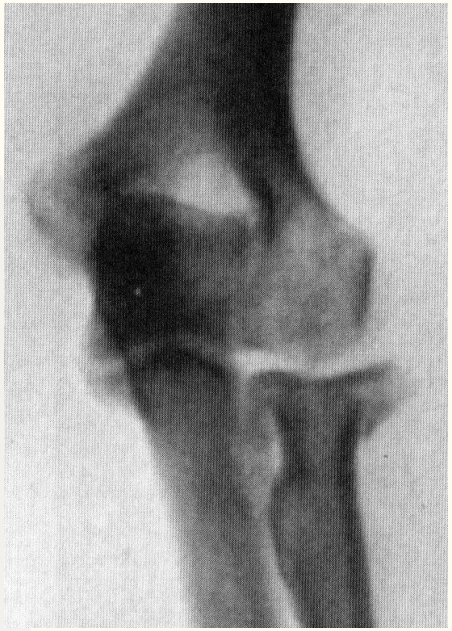
- Radial Head Fracture
  - typically comminuted
- Coronoid fracture
  - typically type 1
- Elbow dislocation
  - LUCL
  - MCL

Terrible Triad

- Recurrent instability
- Heterotopic ossification
- Radial head reconstruction essential

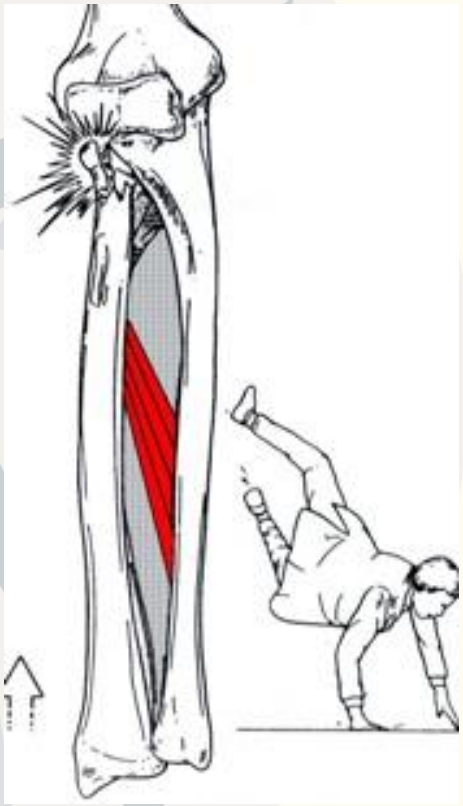
Essex-Lopresti Lesion

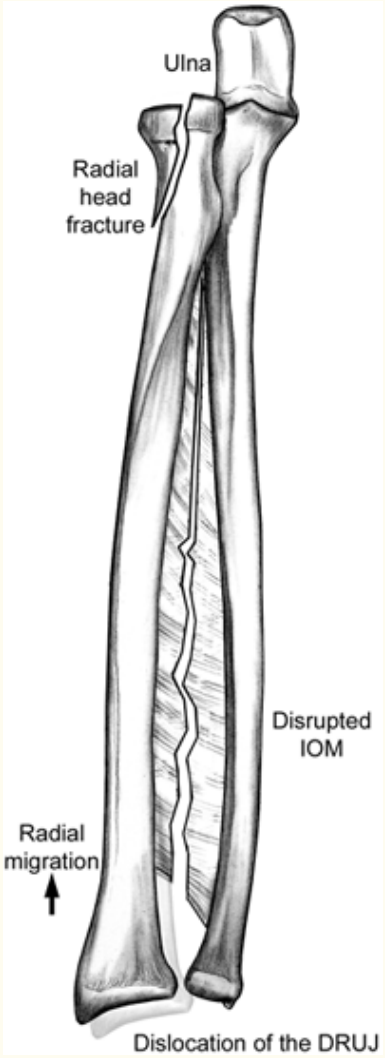
FIGURE 2: Peter Essex-Lopresti (1915–1951). (Photograph



- Essex-Lopresti JBJS Br 1951
  - "Fractures of the Radial Head With Distal Radioulnar Dislocation"

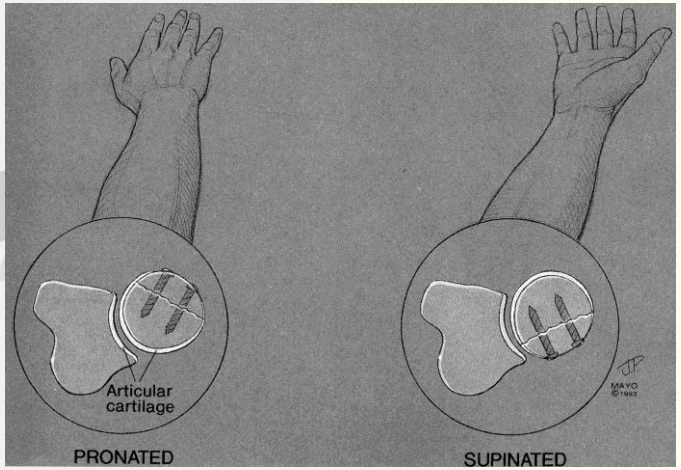
Essex-Lopresti Lesion

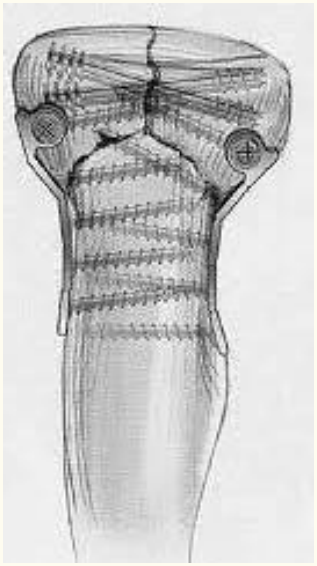


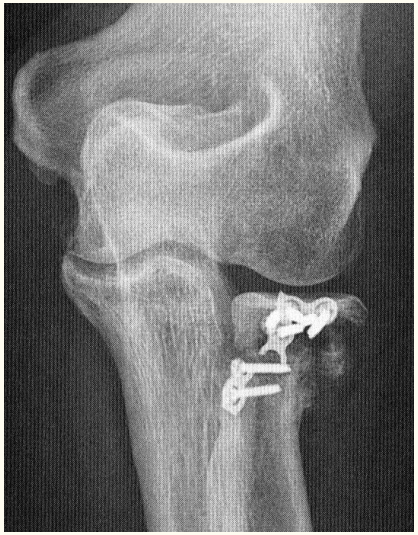


- Loss of longitudinal forearm stability
  - TFCC
  - IOM
  - Radial Head fracture
- May occur in 20-90% of radial head fractures

ORIF Type 3 RH Fracture





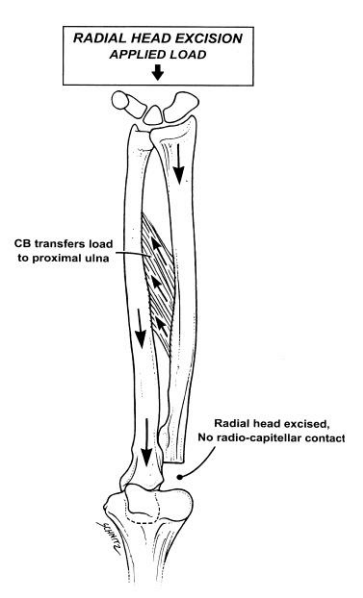


- Limited access for implant application
- Comminution / impaction
  - Secure rigid fixation may be difficult to achieve
  - Possible bone graft
- Nonunion / AVN

ORIF Type 3 RH Fracture

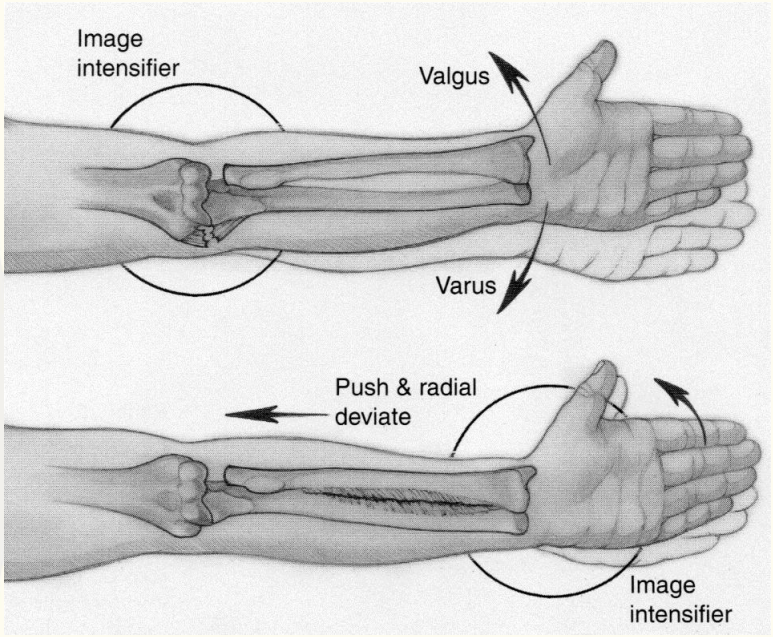
- Tenuous fixation may delay rehabilitation
  - Sub-optimal outcome

Type 3 Radial Head Fracture



- Excision alone
  - Effective if no instability / lower demand

Stability Testing



- May be difficult to detect
- Radial head repair or reconstruction essential if instability suspected

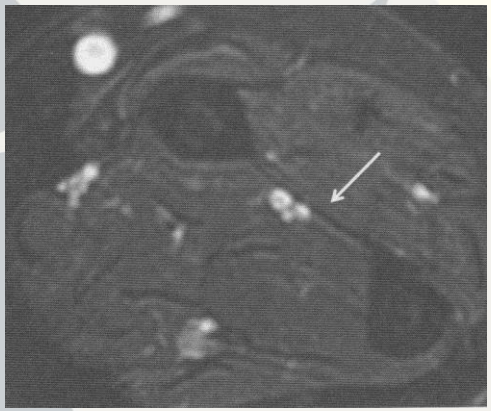
MRI Detection of Forearm Soft Tissue Injuries with Radial Head Fractures

Joseph C. McGinley · Garry Gold · Emilie Cheung · Jeffrey Yao

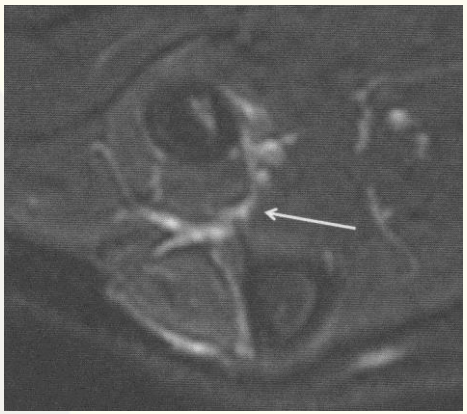
- Hand 2014
- Prospective review of 18 patients with radial head fracture
  - Mason I: 13 patients
  - Mason II / III: 5 patients
- Evaluated with x-rays and MRI

MRI Detection of Forearm Soft Tissue Injuries with Radial Head Fractures

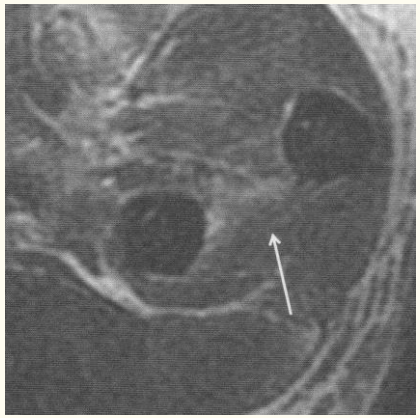
Joseph C. McGinley · Garry Gold · Emilie Cheung · Jeffrey Yao



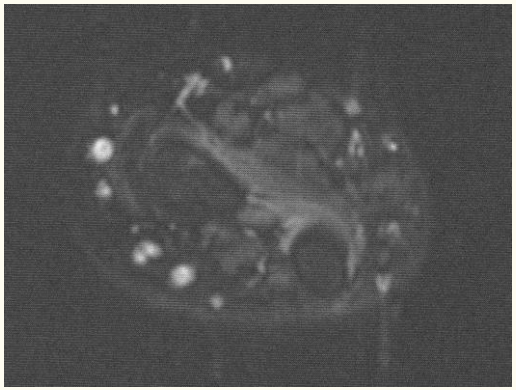
Intact



IOM injury



IOM injury



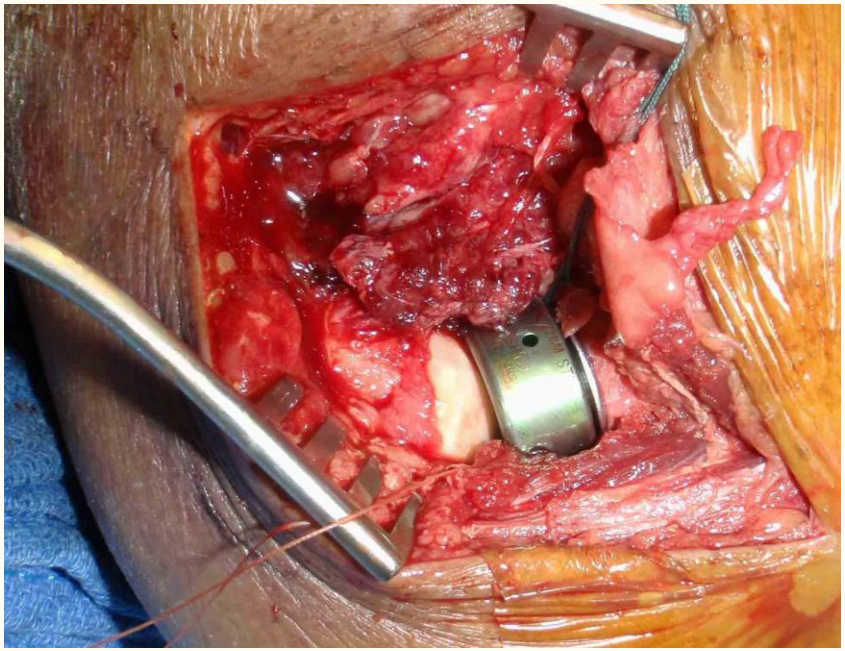
PQ edema

- Hand 2014
- IOM intact in all Mason 1
- IOM injured all Mason II / III fractures
- 6/13 Mason 1 with PQ muscle edema
  - PQ edema in all Mason II / III

Radial Head Excision

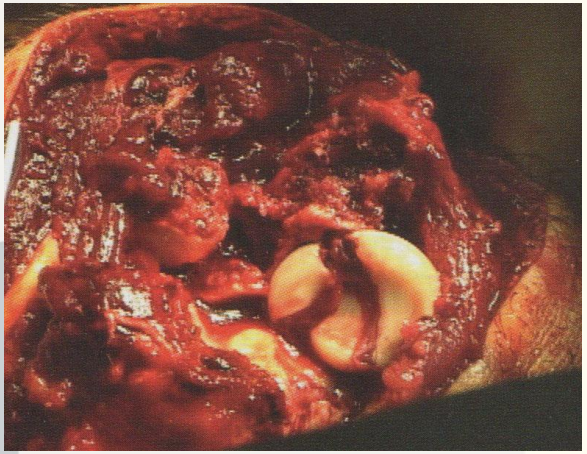
- Radial head excision in trauma is historical
  - status MCL and IOM difficult to determine in acute trauma
  - excision may result in chronic instability

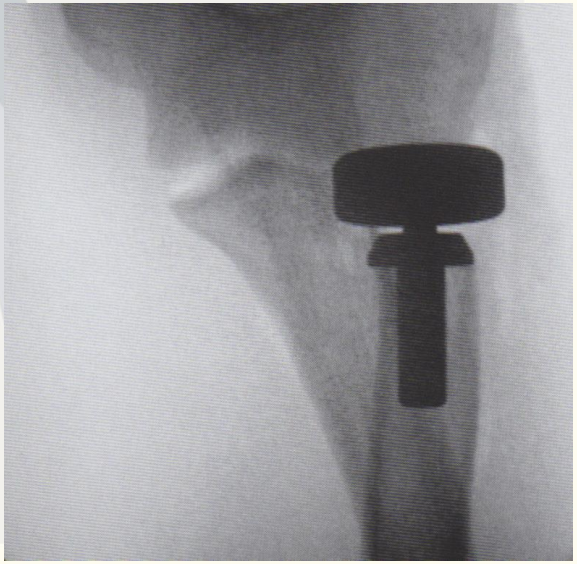
Type 3 / 4 Radial Head Fracture



- Arthroplasty
  - Reduces concerns about undetected instability
  - Simplifies surgery
  - Early rehabilitation possible

History of Radial Head Arthroplasty





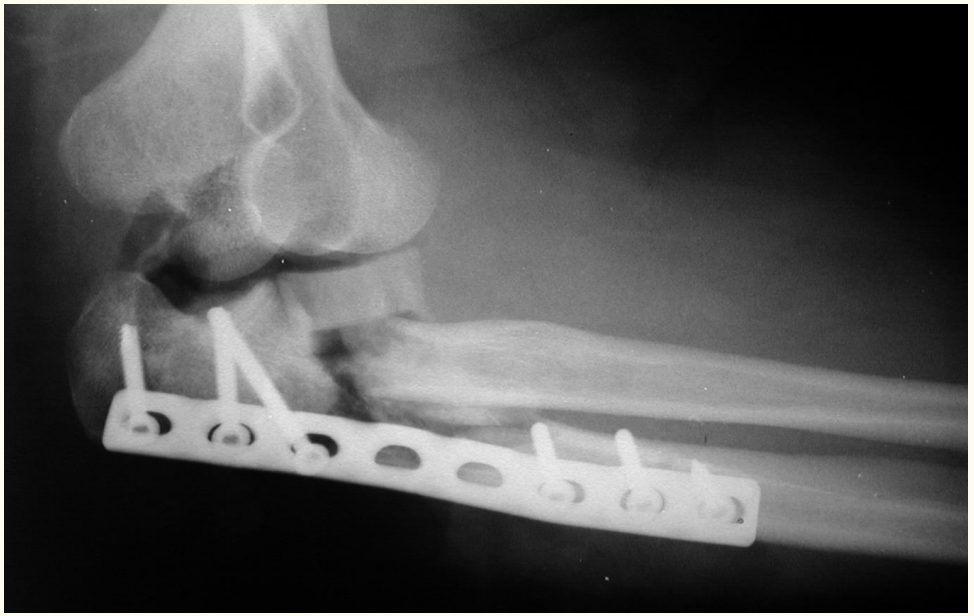
- Ferrule cap
  - Speed 1941
- Acrylic Implant
  - Cherry 1953
- Silastic Implant 1970s
  - Instability, synovitis, fragmentation
- Vitallium implant
  - Knight 1993 31
  - Effective in cases with instability
- Metallic implants
  - Since 2000, numerous favorable reports

Prototype RH Implant: Silastic



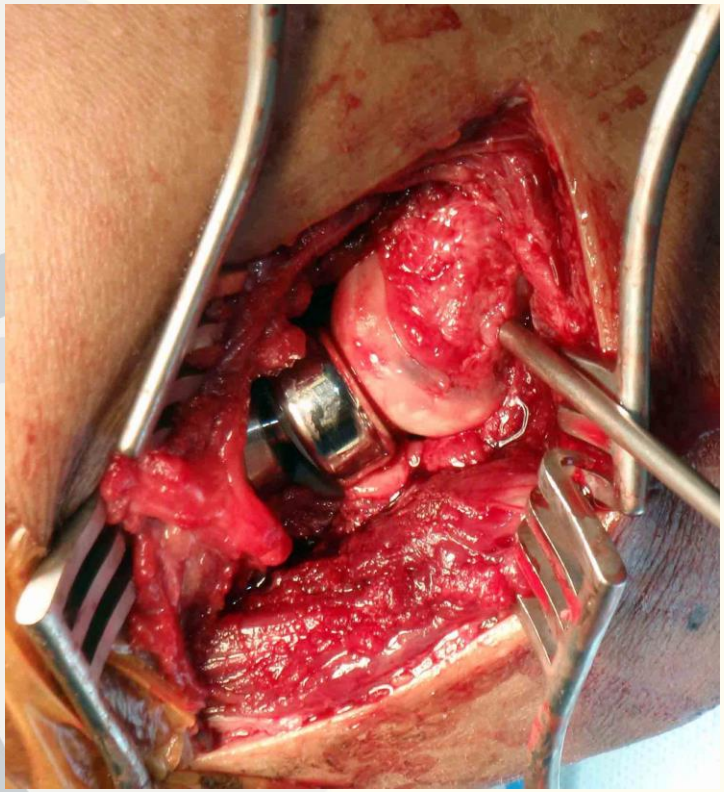
- Improves stability over simple excision
- Technical ease of insertion
- Cushion load
- Fragmentation and synovitis

Prototype RH Implant: Silastic



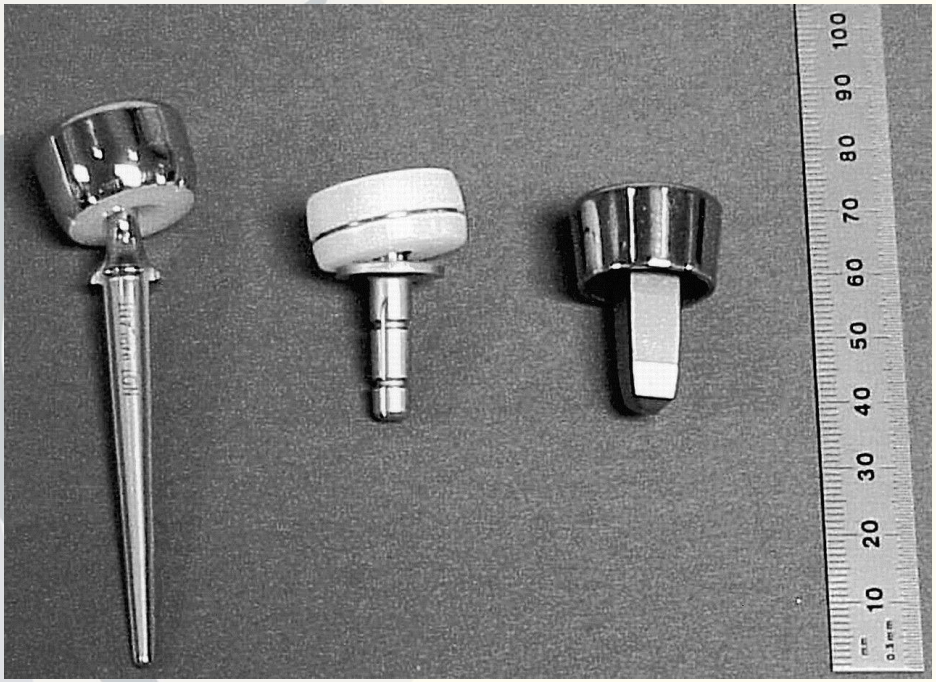
- Deformation may result in instability

Metallic Radial Head Implants



- Offers immediate stability / early ROM
- Accurate insertion and sizing critical
- Modular prosthesis improves insertion accuracy

Types of Metallic Radial Head Implants



- Monoblock
  - Simple
  - Difficult insertion?
  - Load transferred to capitellum
- Bipolar
  - May off-load force

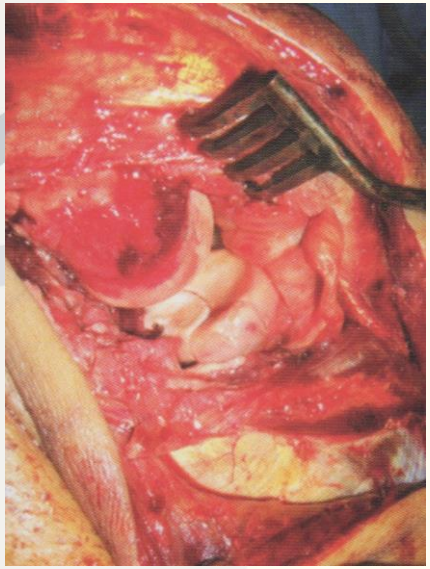
Types of Metallic Radial Head Implants

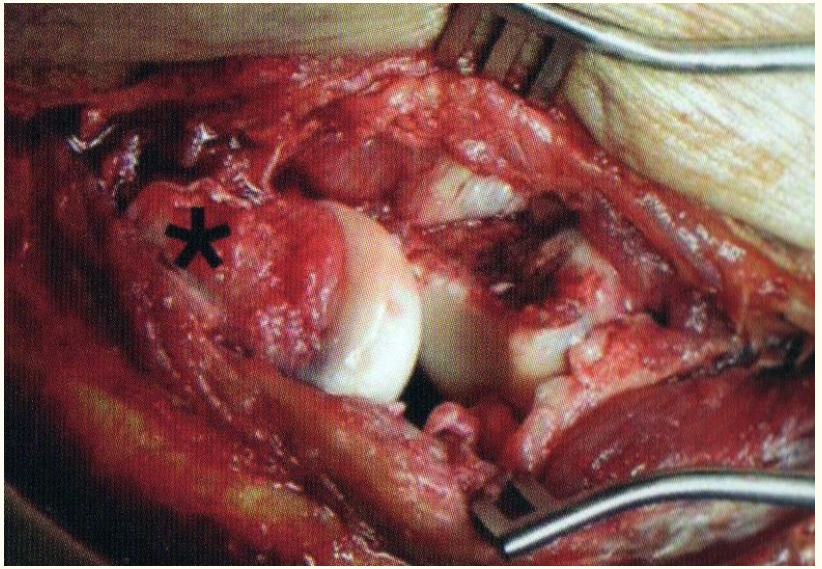
- Modular
  - Improved sizing
  - Easier to insert

RH Implants: Stems

- Smooth stem
  - Bipolar effect
    - Off load force?
- Porous ingrowth
  - Loosening
  - Difficult to remove
- Cement
  - Useful in revision
    - bone loss

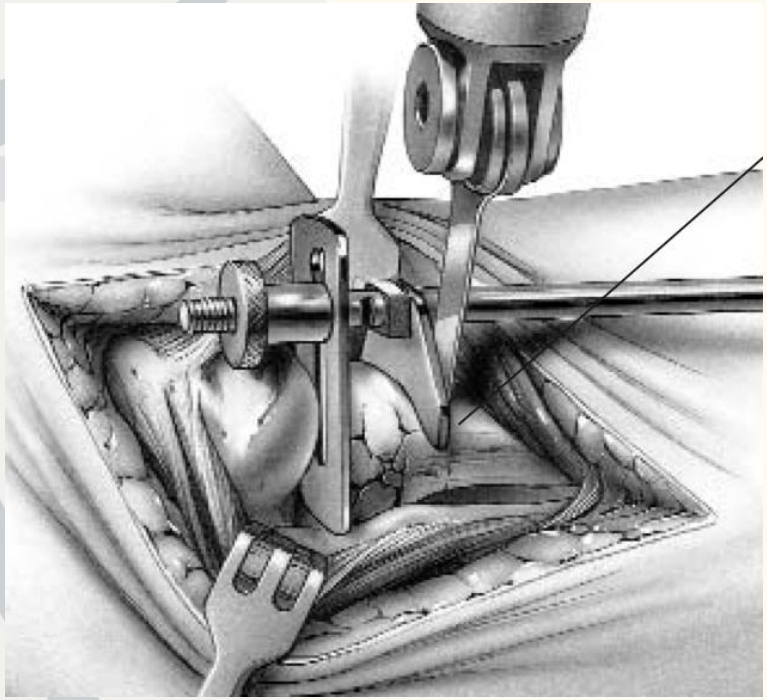
Assess Fracture / Soft Tissue

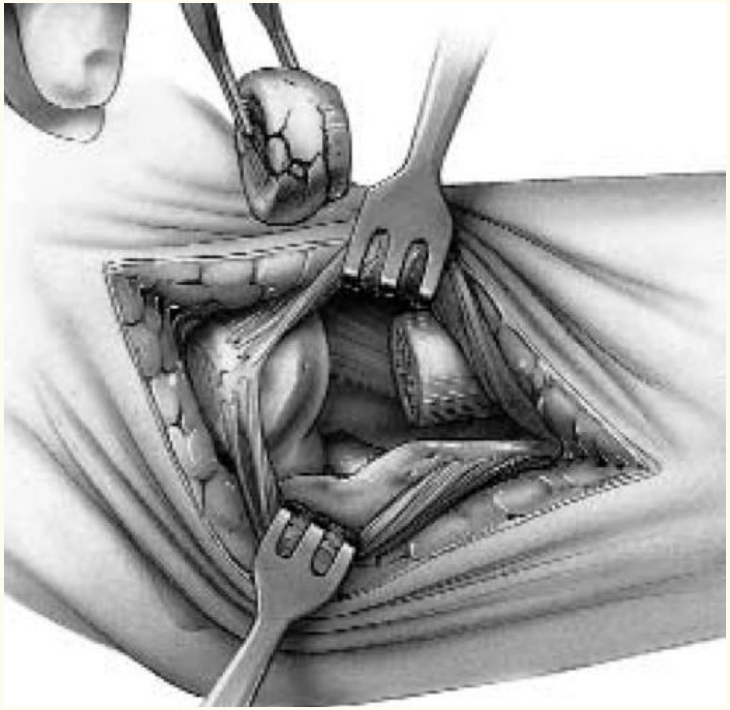




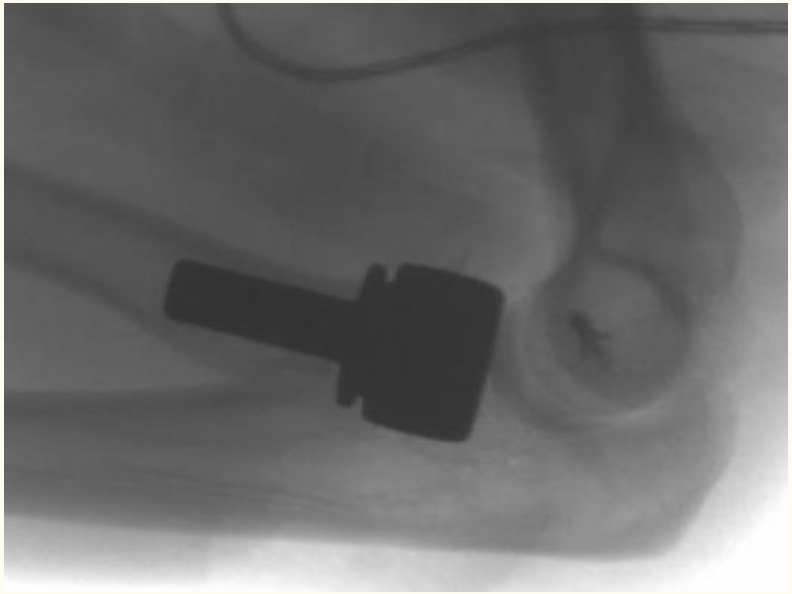
- Fracture pattern
- Soft tissue avulsion
  - Lateral epicondyle
    - RCL / LUCL / tendons

Resection



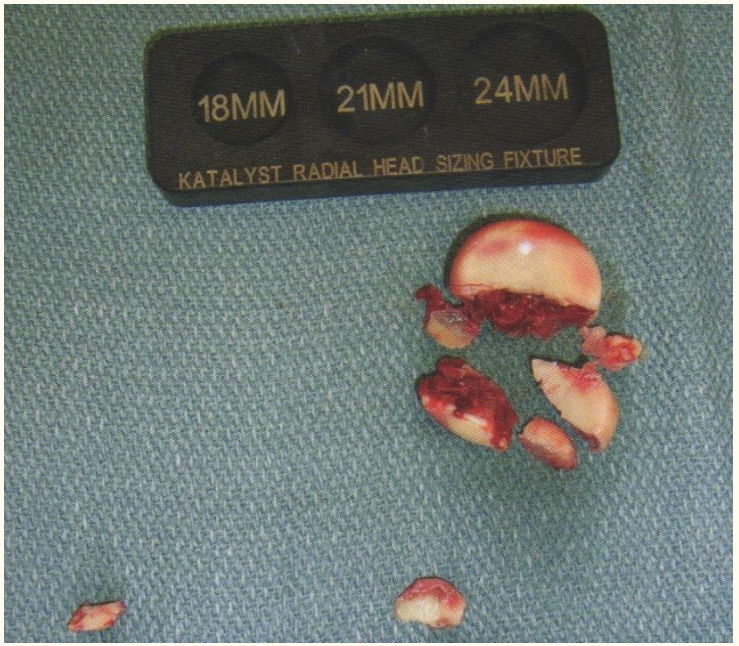


Sizing Implant



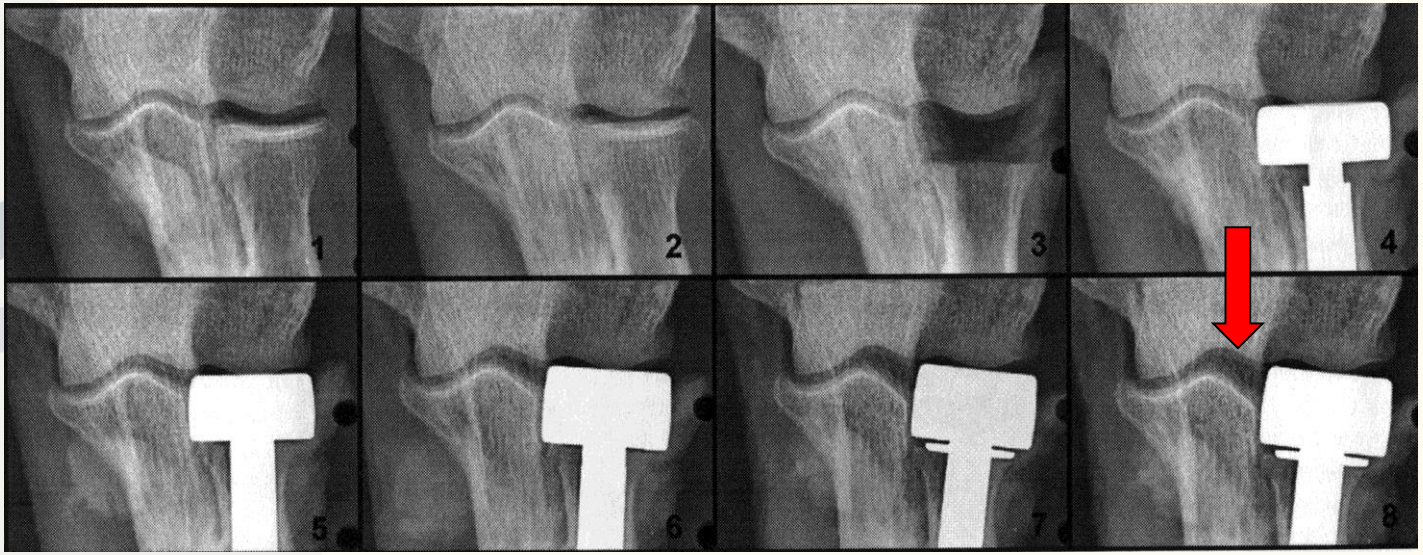
- Reassemble excised RH
  - Account for all loose fragments
- Measure width and length
- Alolabi JSES 2015
  - direct measurement of the radial head is the most accurate method of sizing

Sizing Implant



- Abdulla JSES 2015
  - Inner diameter more accurate and easier to reconstruct when comminuted

Sizing Radial Head Implants



- Undersize
  - Instability
- Overstuffing
  - Varus alignment
  - Pain
  - Limited ROM
  - Cartilage wear

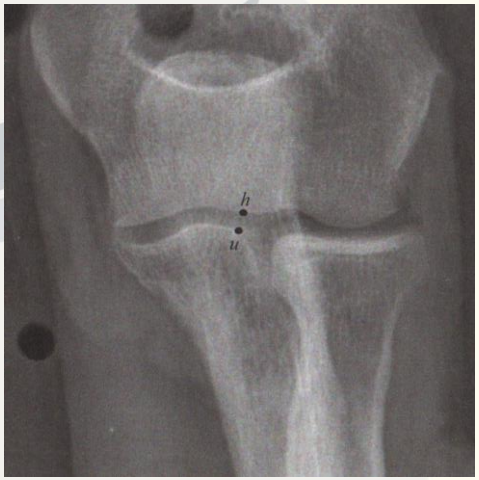
Contralateral Elbow Radiographs Can Reliably Diagnose Radial Head Implant Overlengthening

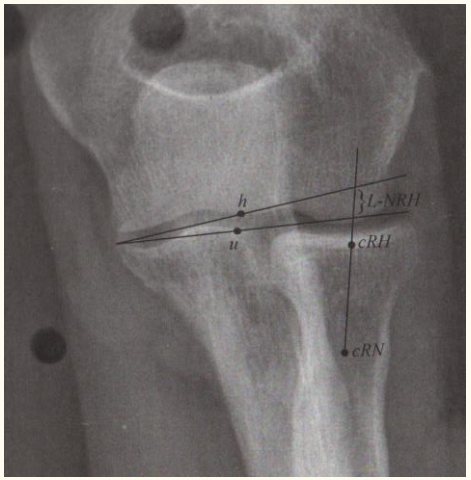
George S. Athwal, MD, FRCSC, Dominique M. Rouleau, MD, MSc, FRCSC,
Joy C. MacDermid, BScPT, MSc, PhD, and Graham J.W. King, MD, MSc, FRCSC

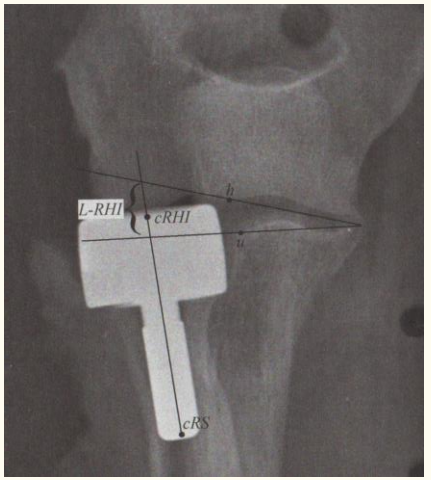
- JBJS 2011
- Part I: reviewed 100 adult right /left elbows
  - No significant side-to-side differences
- Part II: inserted radial head implants of varying lengths (0, +2, +4, +6, +8mm) in cadaver elbows
- X-rays reviewed by 2 blinded examiners to determine the implant size and the degree of overstuffing using contra-lateral radiographs
- Determined inter / intra observer reliability and diagnostic accuracy.

Contralateral Elbow Radiographs Can Reliably Diagnose Radial Head Implant Overlengthening

George S. Athwal, MD, FRCSC, Dominique M. Rouleau, MD, MSc, FRCSC,
Joy C. MacDermid, BScPT, MSc, PhD, and Graham J.W. King, MD, MSc, FRCSC



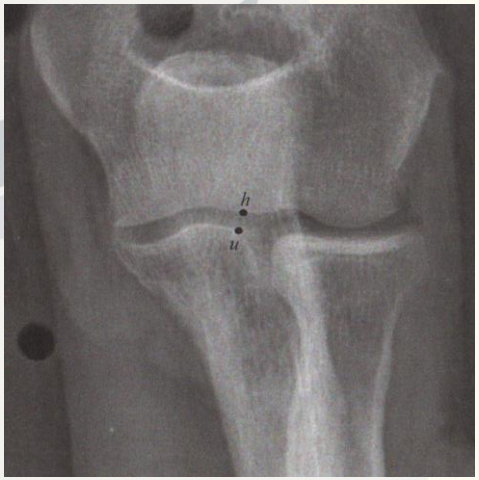


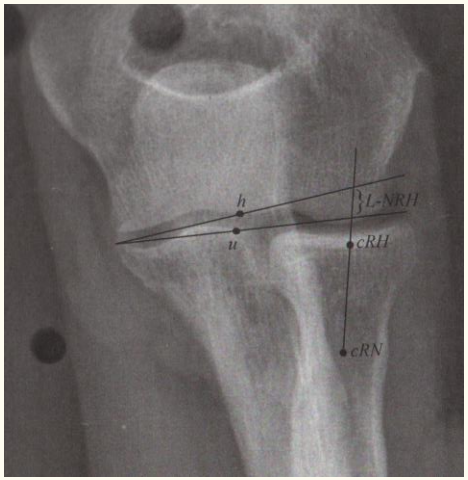


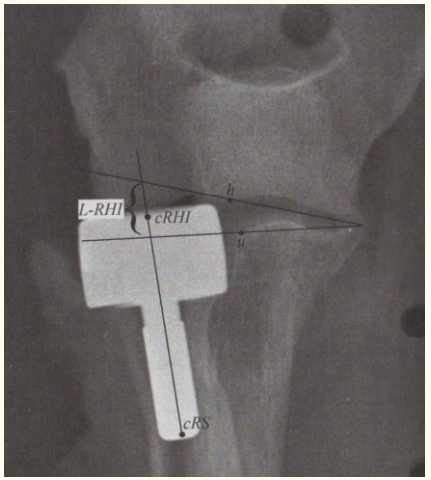
- JBJS 2011
- h= lateral ulnohumeral joint on humerus
- u= lateral ulnohumeral joint on ulna
- Lines drawn through these points from medial joint, longitudinal axis of the RH implant
- L-RHI – L-NRH = degree of overlengthening

Contralateral Elbow Radiographs Can Reliably Diagnose Radial Head Implant Overlengthening

George S. Athwal, MD, FRCSC, Dominique M. Rouleau, MD, MSc, FRCSC,
Joy C. MacDermid, BScPT, MSc, PhD, and Graham J.W. King, MD, MSc, FRCSC

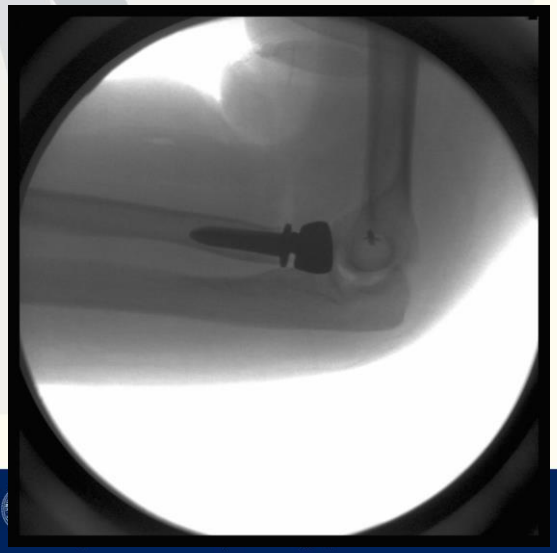






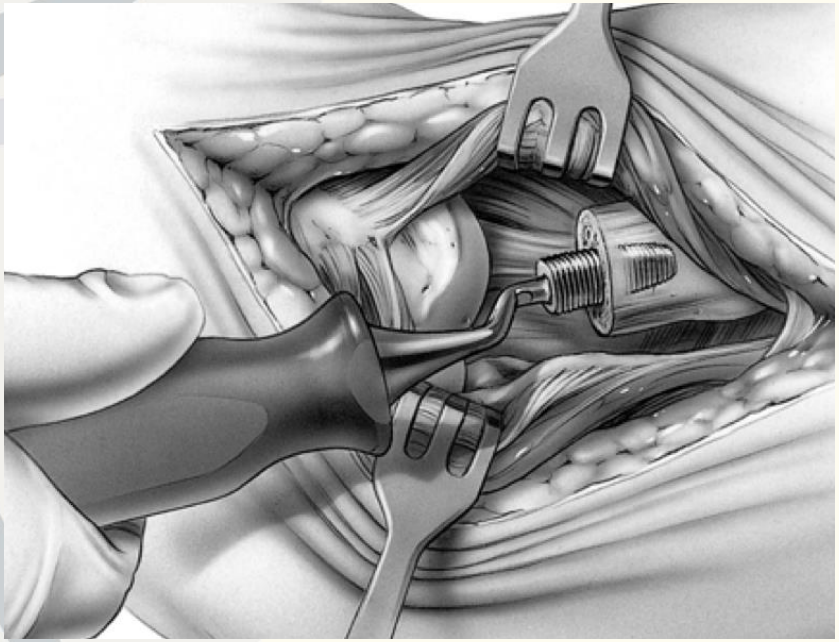
- JBJS 2011
- Implant size was accurately predicted to with 1mm in 87% of the elbows (104/120), 98% sensitivity
- Inter / intra observer reliability excellent
- Contralateral radiographs accurately predict implant size and quantify the degree of over lengthening

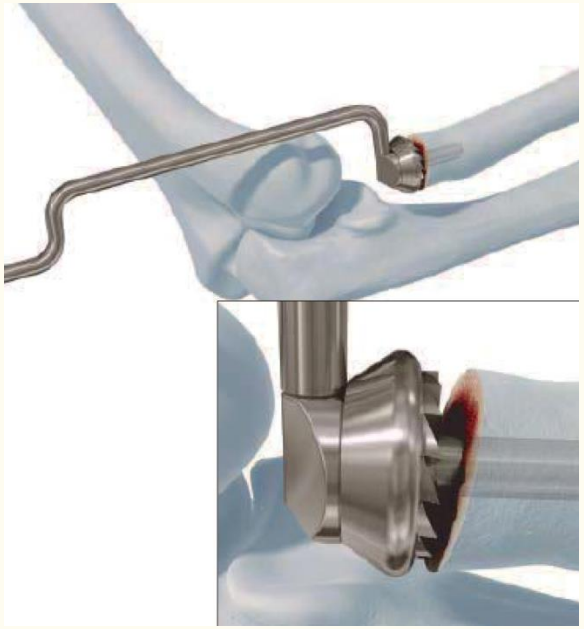
Kwon JHS 2014



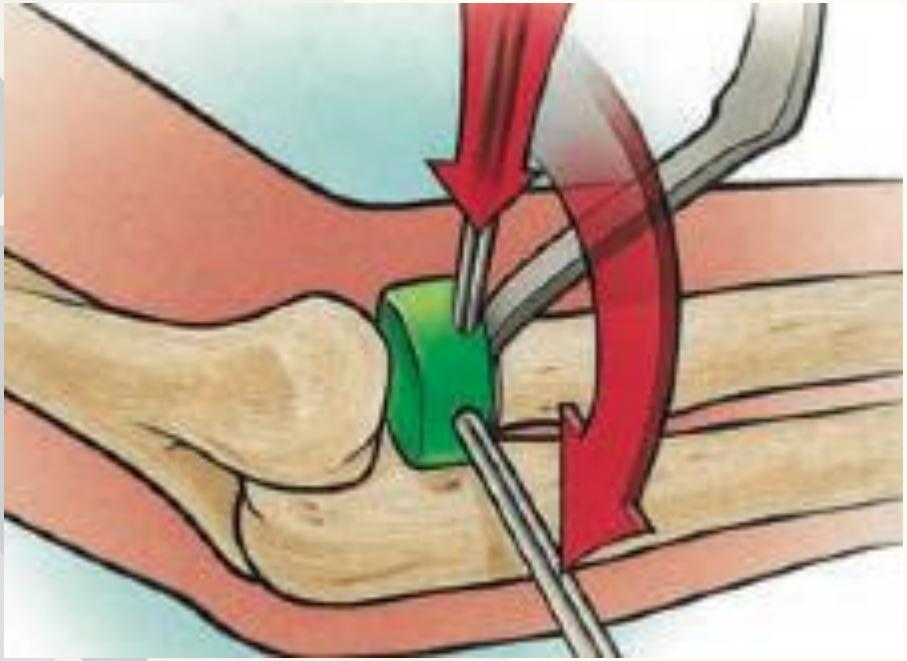
- Cadaver study
- Up to 2 mm overlengthening did not change loading parameters significantly
- likely to be well tolerated

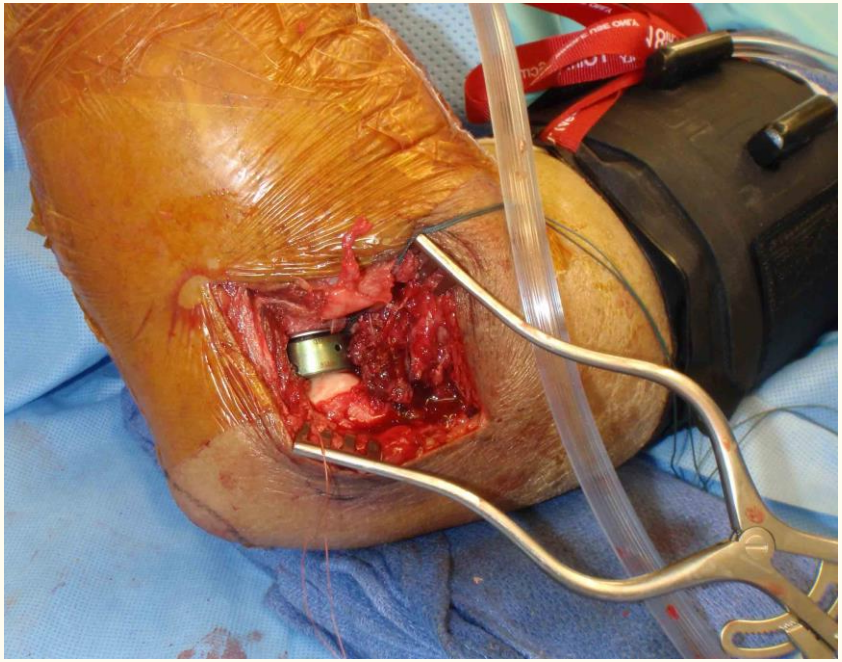
Preparation





Trial and Final Sizing



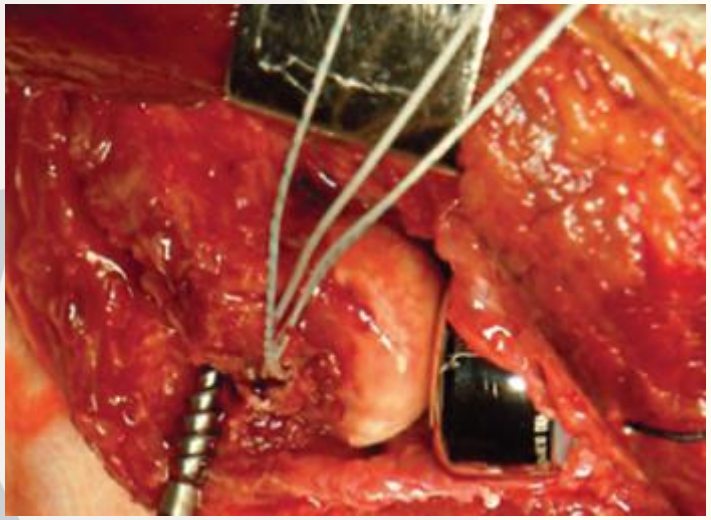


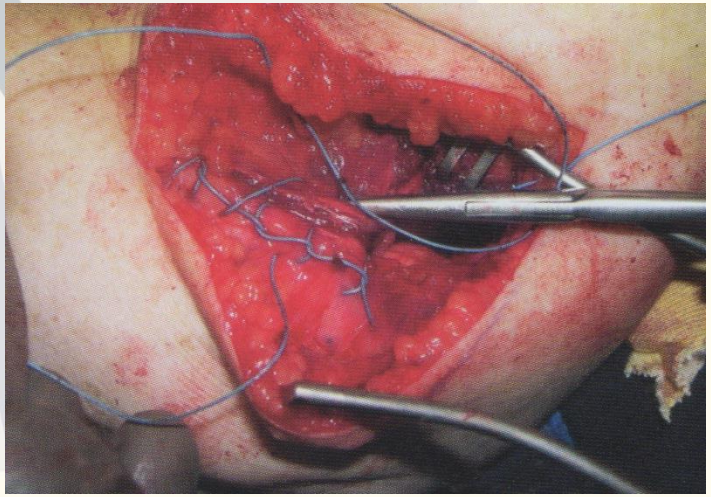
- Concentric articulation
- Flush with coronoid face
  - Useful with instability

Insertion

- Usually straight forward
- Easy in unstable elbow
- Difficult if ligaments intact
  - Modular stem allows in-situ assembly

Closure / Ligament Repair





- Ligament repair
  - LUCL at isometric midpoint
  - Anterior capsule / coronoid ORIF
- Solid fascial closure

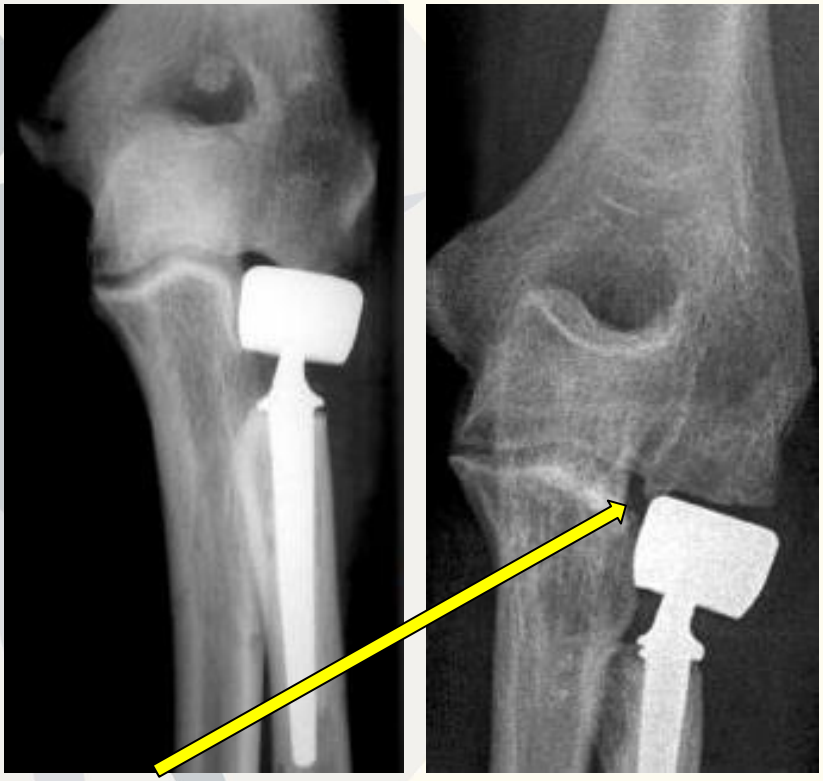
Final Check

- Evaluate flexion extension arc and document zone of stability

Immobilization?

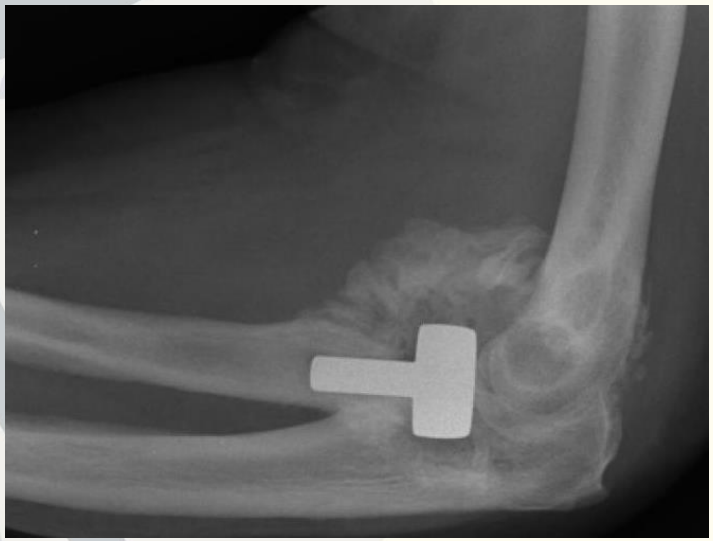
- LAPS in stable position
- Immediate protected ROM
- External fixation
  - Dynamic vs static

Outcome Radial Head Arthroplasty



- Most literature reports favorable results
- Grewal JBJS 2006
  - 26 primary metallic replacements for comminuted radial head fx
  - Smooth stem
  - MEPS score 83
- Best results with
  - Early intervention
  - Repair of associated ligamentous injuries in primary setting
- Radiocapitellar wear problematic

Complications of Radial Head Arthroplasty

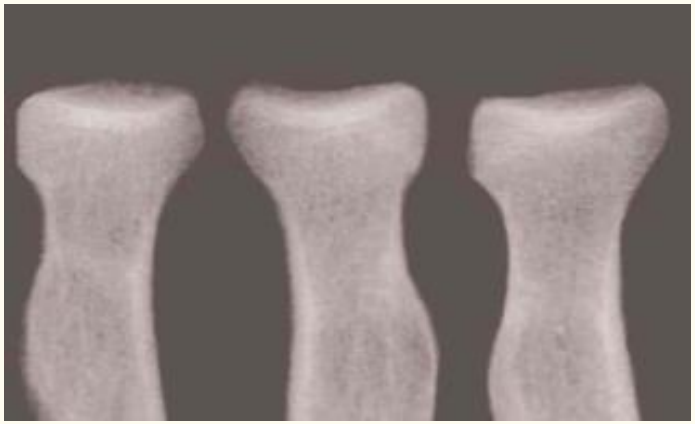


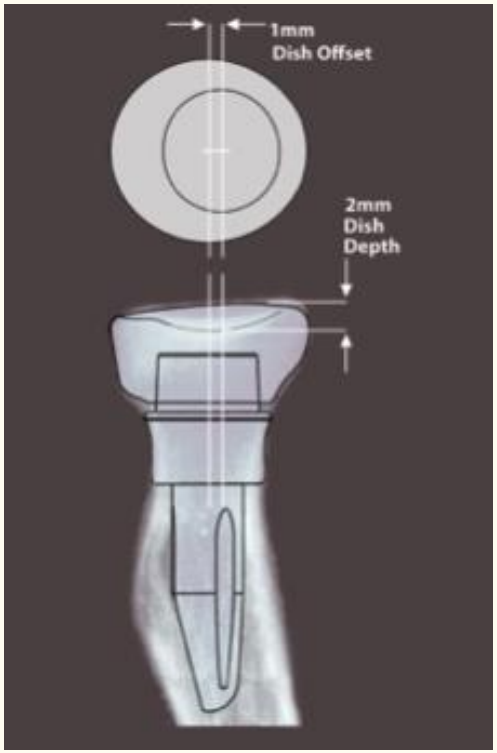
- Instability
  - elbow, forearm, wrist
- Heterotopic ossification
- Stiffness
- Nerve injury
- Stem loosening / hardware failure
- Overloaded radiocapitellar joint
  - Hardware impingement
  - Post-traumatic arthritis

Fixation versus replacement of radial head in terrible triad: is there a difference in elbow stability and prognosis?

- Walters CORR 2014
- Retrospective review
  - 39 patients with terrible triad injuries
  - 18-53 month f/u (mean 24)
  - 30 RHA, 9 ORIF
- Both groups similar final rom and elbow scores
- RHA:
  - better immediate stability
  - 1/3 had radiographic signs of arthrosis.
- ORIF group: no evidence of OA

Pain / OA





- Failure of implant?
- Alternative materials
  - pyrocarbon
- Anatomic vs circular design

Pyrocarbon Implants

- Density and modulus similar to cortical bone
  - Softer than metal
    - Off-load force?
  - Very strong
    - Wont fragment like silicone
- Abdulla Orthopaedics 2014
  - Retrospective review of 21 cases
  - MEPS 86 “acceptable outcomes”

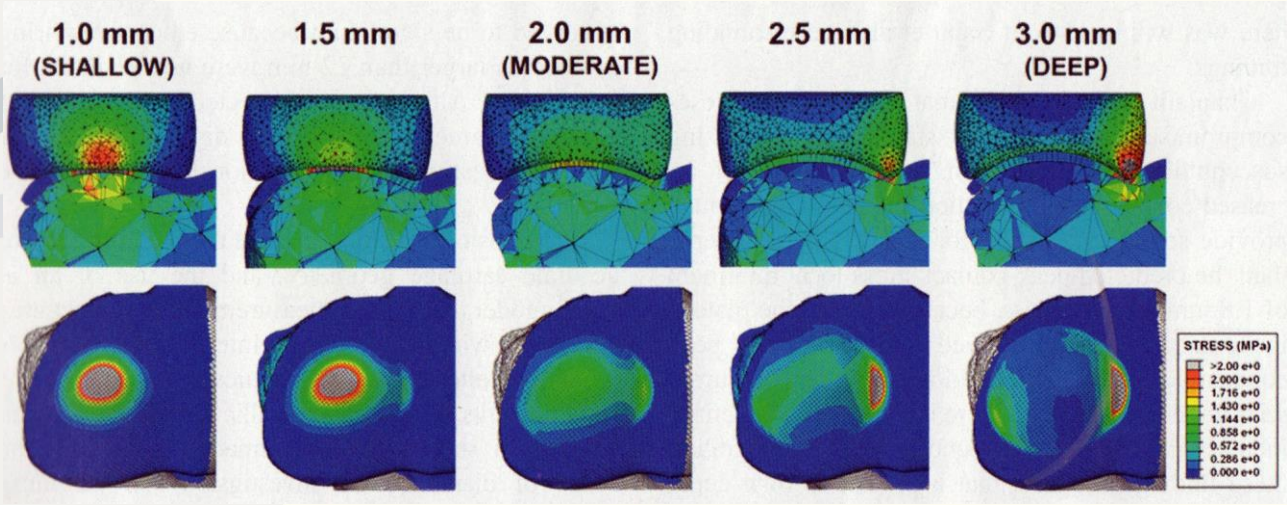
Implications of Radial Head Hemiarthroplasty Dish Depth on Radiocapitellar Contact Mechanics

S. Elizabeth Irish, G. Daniel G. Langohr, MASc, Ryan Willing, PhD, Graham J. King, MD, MSc, James A. Johnson, PhD

- Evaluated radial head implant dish depth on radiocapitellar joint contact mechanics
- 13 fresh frozen cadavers
- Dish depths of 1.0, 1.5, 2.0,2.5 and 3.0 mm
- 4 different flexion angles (0, 45, 90, 135)
- 100 N load

Implications of Radial Head Hemiarthroplasty Dish Depth on Radiocapitellar Contact Mechanics

S. Elizabeth Irish, G. Daniel G. Langohr, MASc, Ryan Willing, PhD, Graham J. King, MD, MSc, James A. Johnson, PhD



- All implants demonstrated decreased contact area and increased radiocapitellar JRF relative to the native joint.
- Peak forces were noted at 1.8mmm (central loading) and 3.2 mm by extrapolation (edge loading)
- Optimal dish depth: 2.0 mm
- King J Arthroplasty 2001 avg. native RH depth of 2.4 mm

The Effect of Prosthetic Radial Head Geometry on the Distribution and Magnitude of Radiocapitellar Joint Contact Pressures

Daniel R. Bachman, MD, Sutee Thaveepunsan, MD, Sangeun Park, MD, James S. Fitzsimmons, BSc, Kai-Nan An, PhD, Shawn W. O'Driscoll, PhD, MD

TABLE 1. Native Radial Head and Modular Prosthesis Design Characteristics*

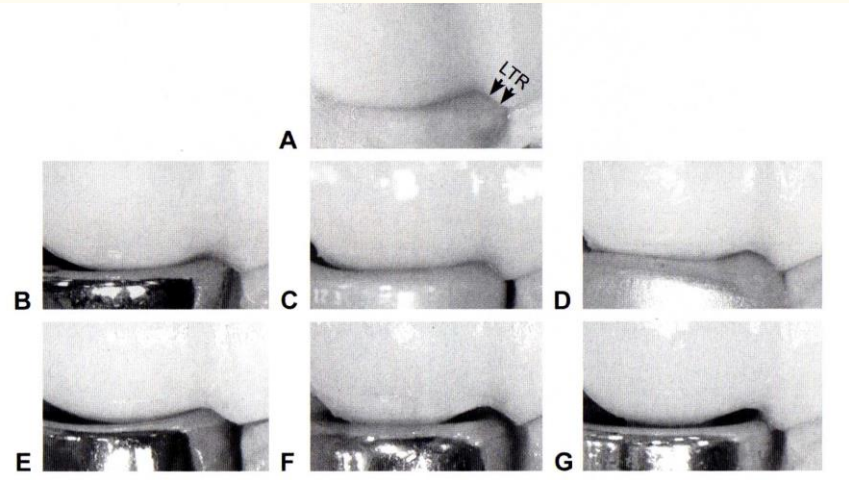
	Articulating Dish Depth (mm)	Radius of Curvature	Lateral Offset	Stem Fixation	Monopolar vs Bipolar Head/Neck
Intact	Varies	Variable	Yes	N/A	N/A
ARH	2.3	Variable	Yes	Grit-blasted	Monopolar
ARH prototype 1	2.6	Variable	Yes	Grit-blasted	Monopolar
ARH prototype 2	2.3	Variable	Yes	Press-fit trial	Monopolar
Evolve	2.0	Single	No	Undersized, unfixed (smooth)	Monopolar
rHead	1.0	Single	No	Grit-blasted	Monopolar
RHS	1.0	Single	No	Grit-blasted	± 10° Bipolar

*Prototypes 1 and 2 have anatomical geometry; Evolve, rHead, and RHS are circular designs.

- JHS 2015
- Compared radiocapitellar contact forces in non-anatomical (circular) prosthesis vs anatomical design
- 10 cadavers
- 3 circular vs 2 modified anatomical implants

The Effect of Prosthetic Radial Head Geometry on the Distribution and Magnitude of Radiocapitellar Joint Contact Pressures

Daniel R. Bachman, MD, Sutee Thaveepunsan, MD, Sangeun Park, MD, James S. Fitzsimmons, BSc, Kai-Nan An, PhD, Shawn W. O'Driscoll, PhD, MD



- All had increased forces vs native RH
- Variable contact pattern from central to edge load
- Best (D) with anatomical medial sulcus and closest to native radial head

Xiang Cochrane Data base 2013

- Meta-analysis1946-2012
  - including 3 clinical trials
- Compared with ORIF to RHA
- Low quality evidence in favor of RHA over ORIF
  - better elbow function
  - need for good quality evidence

Thank You!