1 Adult Elbow Trauma
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2 Periarticular Elbow Fractures
   • Radial head
   • Coronoid
   • Olecranon
   • Distal humerus

3 Recent Advances
   • Elbow anatomy – surgical approaches
   • Elbow biomechanics – radial head preservation, replacement
   • Biomaterials – titanium radial head implants, congruent plates, headless screws, suture anchors

4 Radial Head Fractures

5 Epidemiology
   • 2–5% of all fractures
   • 33% of elbow fractures
   • 85%, 20–60 years of age
   • Mean age 30–40 years
   • Females : males = 2:1

6 Mechanism of Injury
   • FOOSH
     – Axial load
     – Pronated forearm
     – Fx anterolateral RH
   • Direct blow

7 Biomechanics – Radial Head
   • If collateral ligaments intact, RH not necessary for stability
   • In MCL deficient elbow, RH is an important secondary stabilizer

8 Physical Exam
   • Tenderness, crepitus
Elbow effusion
Limited elbow motion
Elbow instability
Ecchymosis from other injuries

9 Imaging
Plain radiographs
- AP, lateral, RH views
- Stress views elbow, forearm
- PA, lateral both wrists
CT scan in selected cases

10 Mason Classification
11 Mayo Classification

12 Radial Head Fracture: A Potentially Complex Injury
Davidson et al., CORR, 297: 224–30, 1993
Prospective study 50 consecutive RHFx
Valgus stress radiographs, clinical stress tests
Minimally or nondisplaced fx were all stable
Comminuted or displaced fx were unstable

13 Valgus Gravity Stress Test
Medial Collateral Ligament

14 Axial Stress Test
IOM, TFCC (Mehlhoff)

15 Hotchkiss Classification
Management-Based System

16 ORIF of Radial Head Fractures
Ring et al., JBJS, 84A: 1811–5, 2002
Retrospective review 56 ORIF pts, 1990–97
4/15 comminuted Mason Type 2 unsatisfactory
13/14 Mason Type 3 (>3 frags) unsatisfactory
Reserve ORIF for fx with 3 or less fragments

17 Treatment – Hotchkiss Type 1
- Sling for comfort
- Early active ROM
- Aspirate hemarthrosis prn
- Expect mild flexion contracture
- Arthrofibrosis is possible

18. Treatment – Hotchkiss Type 2
   - Indications
     - Displaced > 2 mm
     - Involves > 30% articular surface
     - Mechanical block to motion
   - Intraoperative decision-making
     - ORIF
     - Excision head w/replacement
     - Soft tissue repair
   - Operative goals
     - Stable internal fixation
     - Early active ROM

19. Radial Head Fx ORIF – Basic Principles
   - Kocher approach
   - Preserve LUCL
   - Assess fx comminution
   - Assess soft tissue injury
   - ORIF, bone graft

20. Hotchkiss “Safe Zone”
    - 100 degree arc nonarticular radial head

21. Radial Head Fx ORIF
    - Kocher Approach
    - Preserve LUCL
    - Reduction, Provisional Fixation
    - Implant Selection
    - Stable Fixation, Good Motion
22 Treatment – Hotchkiss Type 3
   • Indications
     – Comminuted radial head fx
     – Not repairable
     – Associated soft tissue injury
   • Implant selection
     – Silastic vs. metal
     – Monoblock vs. modular
     – Appropriate size
   • Operative goals
     – Identify & address all pathology
     – Secure ligamentous repair
     – Early active ROM

23 Modular Metallic Implants

24 Radial Head Replacement
   – Lateral vs. Posterior Approach
   – Head Resection
   – Instrumentation & Implants
   – Check ROM, Closure

25 Coronoid Fractures

26 When you see a coronoid fracture...think elbow fracture-dislocation
27 Coronoid Anatomy – Key Points
   - Anterior elbow capsule attaches 4–6 mm distal to tip of coronoid
   - Coronoid process & radial head resist posterior ulnohumeral subluxation
   - Anterior bundle of MCL attaches at sublime tubercle of anteromedial coronoid facet
   - 50% loss of coronoid height gives rise to ulnohumeral instability

28 Regan & Morrey Classification
29 O’Driscoll Classification

30 Coronoid Fracture Patterns
   Doornberg & Ring, JHS, 31A: 45–52, 2006
   - Retrospective analysis 67 elbow fx–dislocations
   - Massachusetts General, Dr. Ring, 1997–2004
   - Coronoid fracture type correlates w/specific elbow injury patterns
   - Fracture type guides optimal treatment

31 Coronoid Fracture Patterns
   - Terrible Triad (PLRI)
   - Anteromedial Facet Fracture (PMRI)
   - Trans–olecranon Fracture–dislocation

32 Evaluation
   - History of elbow dislocation, self-reduced
   - Examine for tenderness, bruising collateral ligaments, common flexor & extensor origins
   - Plain AP & lateral elbow radiographs
   - CT (2D, 3D) scan to assess fracture anatomy
   - EUA, stress radiographs to assess stability
33 Small Coronoid Tip Fractures
- Shear fx from elbow dislocation
- Not an elbow capsular avulsion
- If elbow concentric and stable, treat as simple elbow dislocation
- Early protected elbow ROM

34 Terrible Triad Injury
- Coronoid fracture (type I) w/radial head fracture after elbow dislocation
- Anterior elbow capsular avulsion
- LCL avulsion from humerus
- Elbow PLRI pattern
- Address w/lateral Kocher approach

35 Terrible Triad – Kocher Approach
Order of repair is medial to lateral

36 Terrible Triad – Operative Finding
Bare spot on lateral epicondyle (avulsed LCL)

37 Terrible Triad – Illustrative Cases

38 Anteromedial Facet Fracture
- O’Driscoll type II fracture
- MCL at sublime tubercle
- Varus mechanism of injury
- Associated with PMRI
- Medial approach to fracture
- Fix w/screws or buttress plate

39 Medial Approach & Fixation Technique
Depend on Fragment Size

40 Anteromedial Facet Fracture – Illustrative Cases

41 Coronoid Base Fracture
- O’Driscoll type III fracture
- Through the coronoid base or body
- Often trans-olecranon fx-dislocation
- Less soft tissue disruption
- Posterior or posteromedial approach

42 **Coronoid Base Fracture – Illustrative Case**

43 **Olecranon Fractures**

44 **Olecranon Anatomy**
- Subcutaneous location, vulnerable to trauma
- Triceps inserts on olecranon (extends elbow)
- Linear area of absent cartilage in sigmoid notch is key landmark
- Proximal–distal dimension of notch must be preserved in reconstruction

45 **Mayo Classification (Morrey)**

46 **Treatment – Olecranon Fractures (Type I)**
- Plaster immobilization 1–3 weeks
- Early protected elbow range of motion
- No active flexion > 90 degrees until 4 weeks
- Older patients, earlier motion

47 **Treatment – Olecranon Fractures (Type II)**
- Posterior approach to fracture
- ORIF tension band technique
- Posterior splint immobilization
- Early gentle AROM in 3–7 days
- Remove K–wires > 8 weeks

48 **Tension Band Technique**

49 **Preserve Sigmoid Notch Anatomy**

50 **Olecranon Fractures (Type II) – Illustrative Cases**

51 **Treatment – Olecranon Fractures (Type III)**
- Posterior approach
- Rigid neutralization fixation
- Contoured plate & screws
- Short period immobilization
Early protected elbow ROM

52 Comminuted Olecranon Fractures: Comparison of Plating Methods
- 15 male cadaver elbows, olecranon fx (type III)
- ORIF w/Synthes standard 3.5 mm DCPs
- Tested to failure via cantilever bending
- Posterior plate & intramedullary screw fixation was biomechanically strongest

53 Olecranon Fractures (Type III) – Illustrative Case

54 Salvage Situations
- Open, unstable fractures
  - external fixator
- Comminuted fx (< 30%)
  - excision prox fragment, triceps advancement
- Pre-existing disease (RA)
  - semi-constrained TER

55 Pre-existing RA – Illustrative Case

56 Distal Humerus Fractures

57 DHFx – Basics
- Incidence – Rare, 2% all fx
- Anatomy – Complex bone & soft tissue
- Fx Patterns – Many & varied
- Treatment – Operative
- Surgeon Experience – Limited

58 Mechanisms of Injury
- FOOSH or direct trauma
- Axial loading into coronoid may split trochlea
- Elbow subluxation may shear articular surface

59 Milch Classification

60 Riseborough & Radin Classification
Mayo Classification
Davies–Stanley Classification
Operative Treatment Is Usually Required
Surgical Approach
  • Extensile posterior approach (most)
    – lateral decubitus, arm support
    – supine with arm over bolster
  • Extensile lateral approach (some)
    – capitellar fractures
    – lateral column fractures
Triceps Management
  • Retraction – Mobilize medial & lateral for Type I Fx
  • Split – For fractures w/proximal extension
  • Reflection – For TER
  • Olecranon osteotomy – For Type 2 and 3 Fx
Olecranon Osteotomy Technique
Treatment Goals
  • Anatomic reduction
  • Rigid internal fixation
    – precontoured plates
    – headless screws
  • Limited immobilization
  • Early active elbow ROM
Comparison of Double-Plate Fixation Methods for Complex Distal Humerus Fractures
Self et al., JSES, 4: 11–16, 1995
  • Biomechanical cadaver study
  • Three reconstruction configurations
  • Cyclic loading specimens to failure
  • Posterolateral plates > distal screws failed
  • Dual parallel plates bolted together is most rigid
Intercondylar Fractures – Keystone Arch Concept
Interdigitating screws act as arch keystone

Fracture Reconstruction – Sequential Steps
- Provisional assembly articular surface
- Plate placement & provisional reduction
- Articular fixation w/screws through plates
- Supracondylar compression & fixation
- Final screw fixation

Preserve Trochlear Anatomy

Intercondylar Fracture – Illustrative Cases

Dubberley Classification

Articular Fracture – Illustrative Cases

Take Home Messages
- Standard of acceptable surgical treatment has been set higher now than ever before
- Rigid internal fixation with latest techniques allows for early active elbow motion
- For comminuted radial head fractures, modular metallic implants are preferred
- For coronoid fractures, think elbow fracture-dislocation and address instability
- Prefer stiff congruent joint to an incongruent elbow joint with good range of motion

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