Citations Classics Shoulder & Elbow

Medial Elbow Instability

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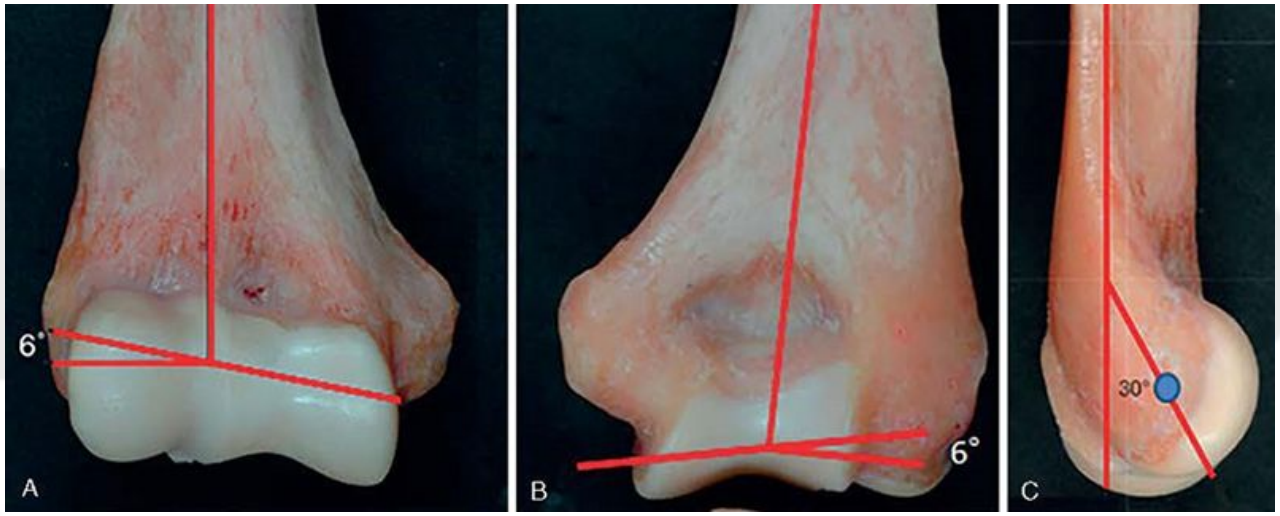
Anatomy

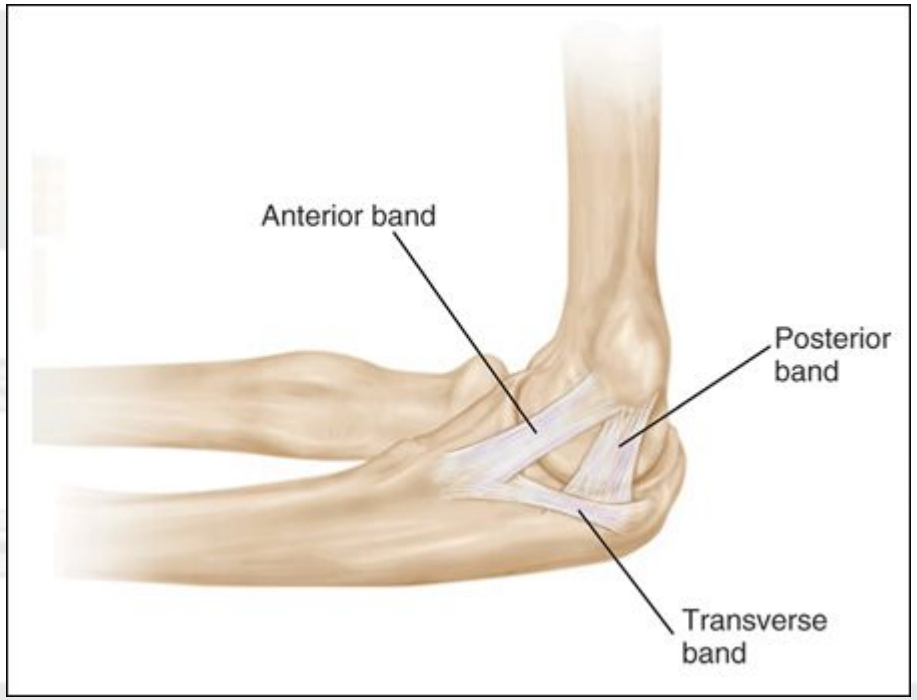
- Distal humerus has an average valgus angle of 4 to 8 degrees giving the elbow its natural “valgus carrying angle”

- Valgus stability is attributable to several dynamic and static stabilizers
  - Bony Congruence (Radial Head)
  - Flexor-Pronator Mass
  - Medial Ulnar Collateral Ligament Complex

- The Medial (Ulnar) Collateral Elbow Complex
  - Anterior band attaches to the sublime tubercle (Anteromedial process of coronoid) and is the primary stabilizer of the joint in valgus



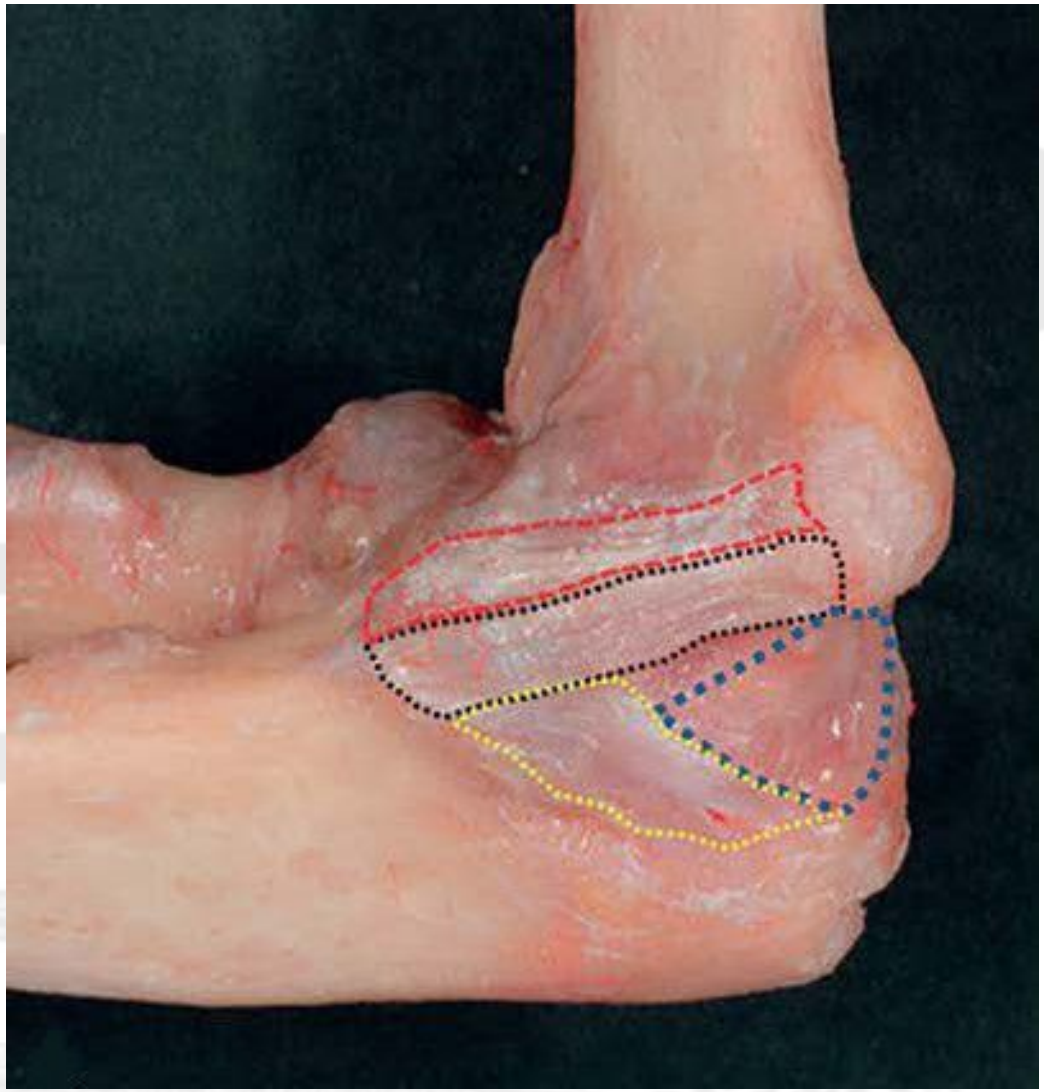
Morrey ME: Anatomy, biomechanics, physical examination, and imaging of the elbow



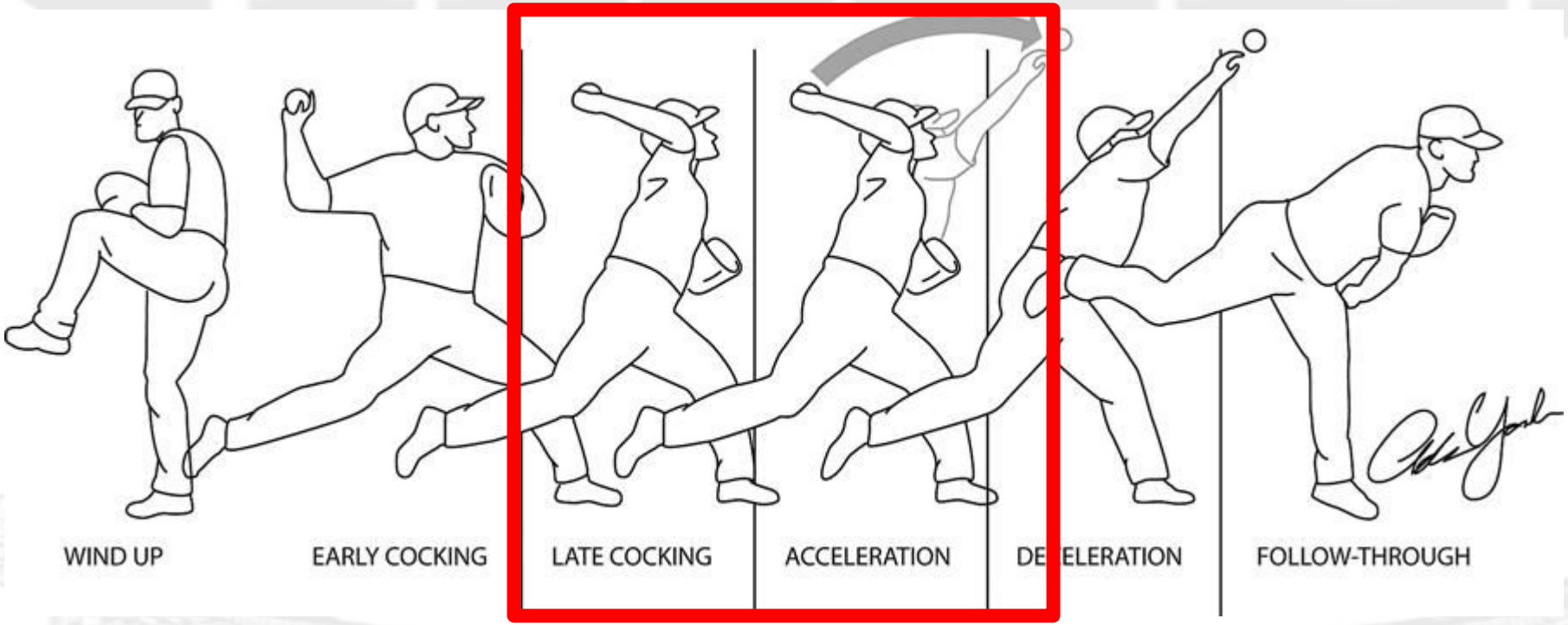
Gramstad G: Anatomy of the shoulder, arm, and elbow

Anatomy

- Anterior Band of the MUCL
  - Anterior Bundle
    - Tight in Extension
  - Central Bundle
    - Isometric
  - Posterior Bundle
    - Tight in Flexion

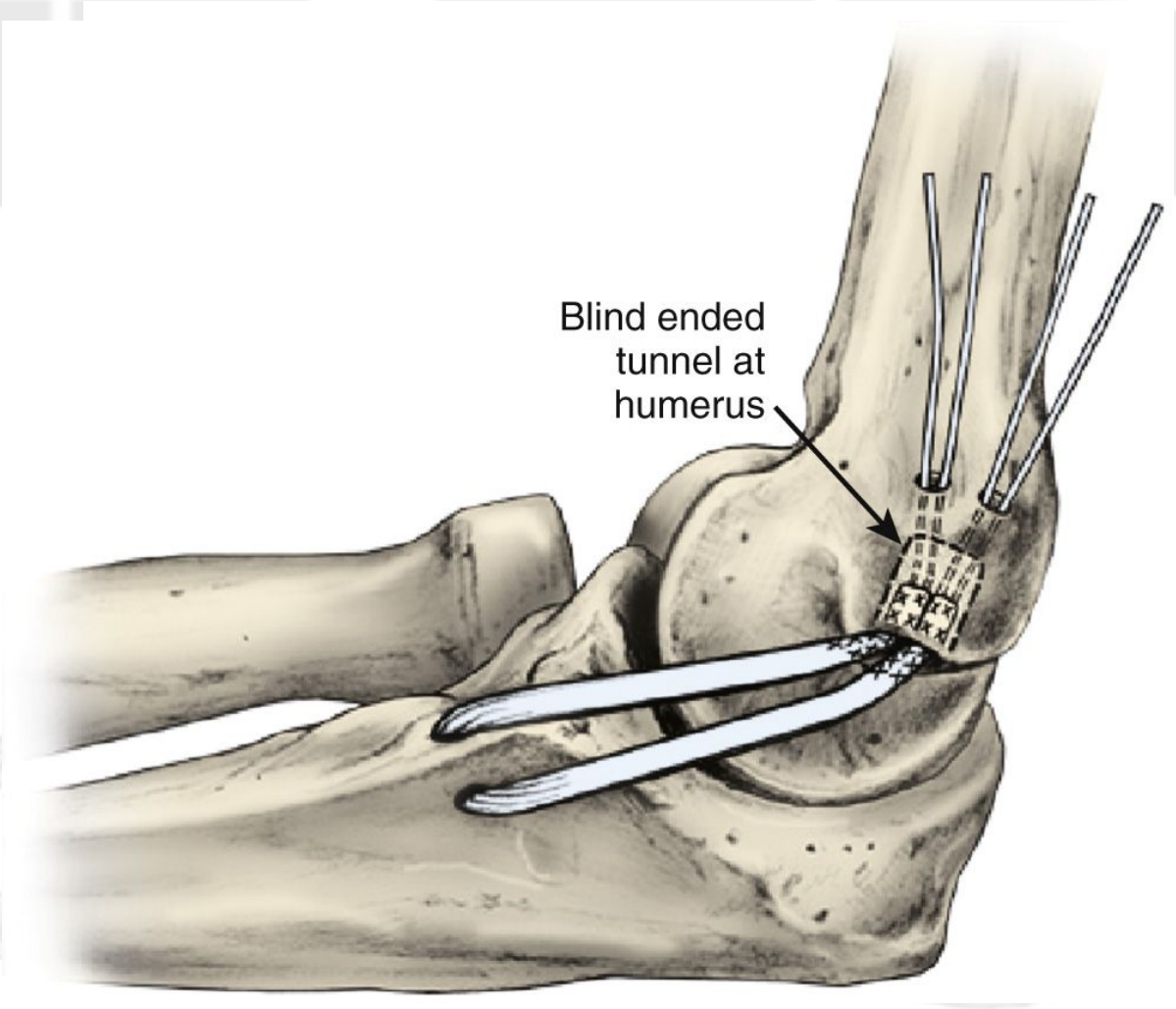


Throwing Elbow



Throwing Elbow

Ahmed CS: Elbow injuries and the throwing athlete



Safran M, Ahmed CS, ElAttrache NS: Ulnar collateral ligament of the elbow

Valgus Stability of the Elbow

A Definition of Primary and Secondary Constraints

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Background

- Understanding the stabilizing structures of the elbow joint, particularly their role in resisting valgus stress had been a previous poorly investigated topic.
- Previous investigations have primarily focused on calculating force-displacement curves, but these approaches have limitations in replicating real-life scenarios.
  - The clinical question of what is the contribution of the radial head and the MCL to the normal kinematics and constraints of the elbow during activity had yet to be answered
- **Study aim:** address previous limitations by examining the contributions of the medial collateral ligament (MCL) complex and the radial head to elbow stability during active motion and muscle activity

Study Design

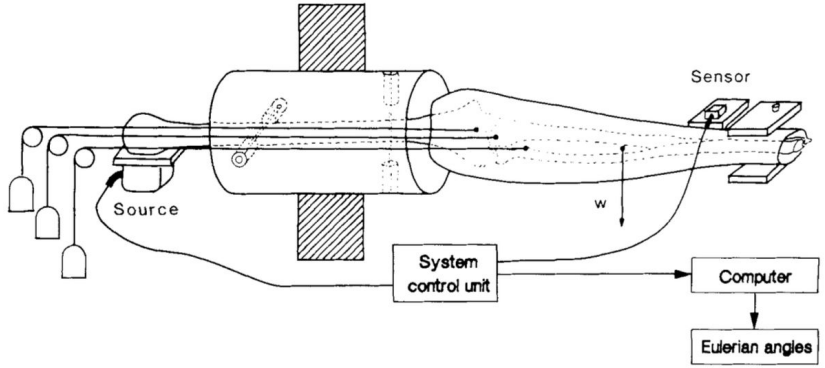
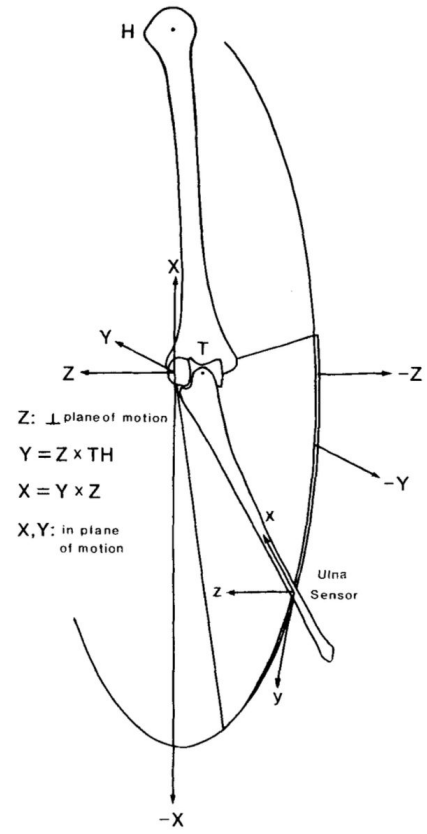


FIG. 1. Experimental arrangement demonstrating the gravity valgus position. The simulated muscle force has been applied. The signal is processed and sent to the computer, which calculates the eulerian angles that describe flexion, axial rotation, and varus and valgus changes.

- Six fresh anatomic specimens were used in the primary study.
  - two left and four right
- Simulated motion and joint compressive force were applied to mimic muscle activity.
  - 1-kg load to biceps and 2-kg load to triceps was applied to represent muscle load and contrast against no load
  - Valgus stress was applied to elbow via the effect of gravity on the arm
  - The elbow was tested from full extension to 140 degrees of flexion
    - This protocol was verified in pretesting that used two separate specimens
  - Six additional specimens were used for detailed info
    - 3 were examined with absent MCL complexes and an intact radial head
    - 3 were examined without a radial head but an intact MCL complex
- 3D motion of the ulnohumeral joint was described about three axes: flex-ext, abd-add, and axial ulnar rotation.
  - Rotation about the axes was expressed as the eulerian angles



Results

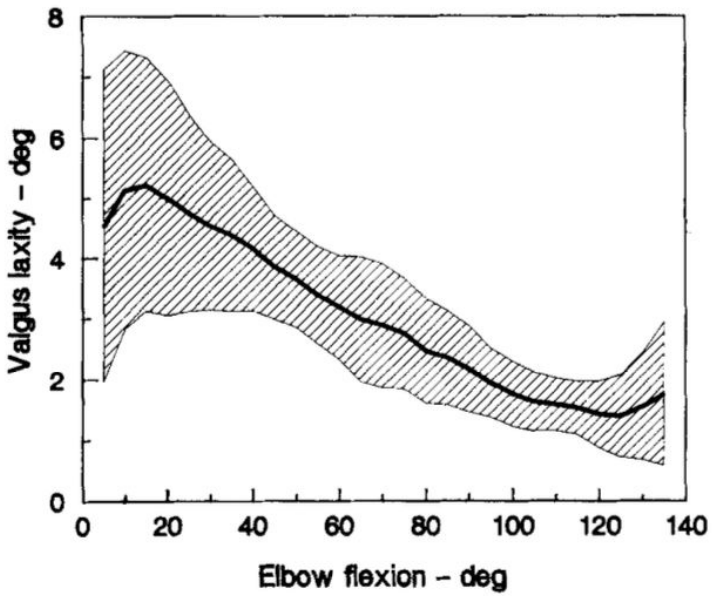


FIG. 3. Mean (solid line) and standard deviation (shaded area) of valgus laxity pattern from neutral during flexion of the normal elbow under valgus stress. The greatest amplitude and specimen variation (3°–7°) is observed at 10°–20° of flexion.

- Peak mean of *5* degrees normal valgus laxity, which typically occurs between 10" and 20" of elbow flexion.

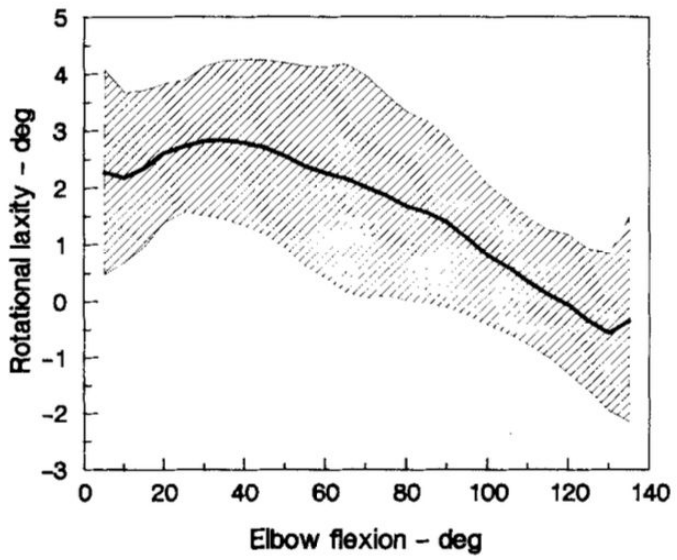


FIG. 4. Mean (solid line) and standard deviation (shaded area) of the axial rotational laxity of the ulna during elbow flexion for all specimens under valgus stress (internal rotation is positive). Up to approximately 3° of internal axial rotational laxity is observed during flexion at approximately 30° with valgus load.

- In the valgus gravity-stressed position, internal rotation of the ulna during flexion averaged 2.8 degrees and was of greatest magnitude between 20 and 40 degrees of flexion

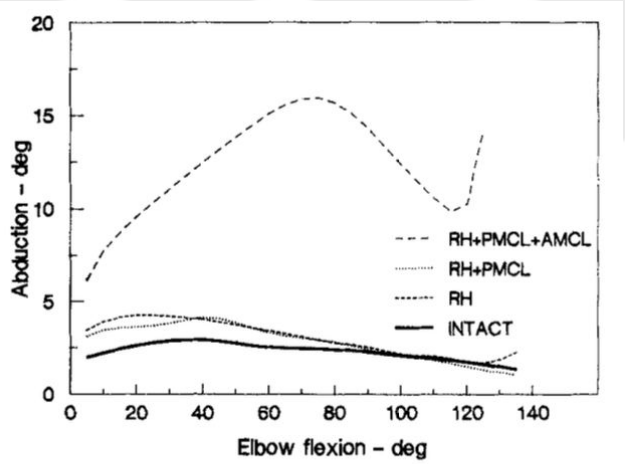


FIG. 5. Release of the radial head demonstrates no alteration in the normal abduction displacement pattern. Note that little additional change is observed after release of the posterior bundle of the MCL, but a section of the anterior portion, which constitutes complete release of the valgus stabilizers, causes marked displacement and subluxation at 120° of flexion. RH, radial head; AMCL and PMCL, anterior and posterior medial collateral ligament.

- Radial head removal: little change in ABD & IR with elbow flexion
  - removal of posterior MCL bundle had little change
- Radial head and MCL removal: gross instability

Results cont.

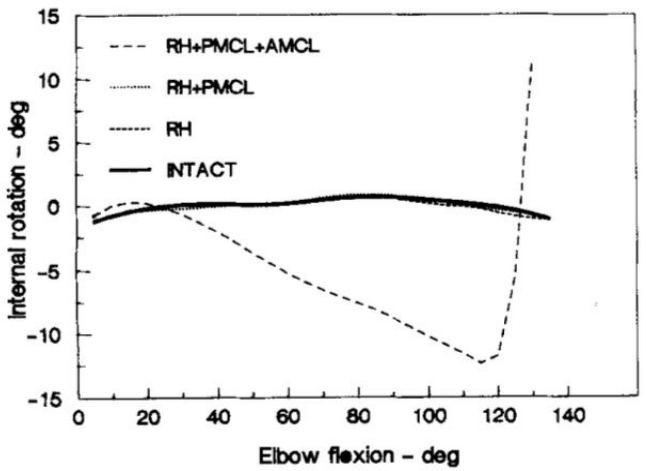


FIG. 6. Removal of the radial head shows no alteration in the normal axial rotational displacement pattern. Subsequent removal of the MCL causes marked internal rotational laxity and subluxation at approximately 120° of flexion. RH, radial head; AMCL and PMCL, anterior and posterior medial collateral ligament.

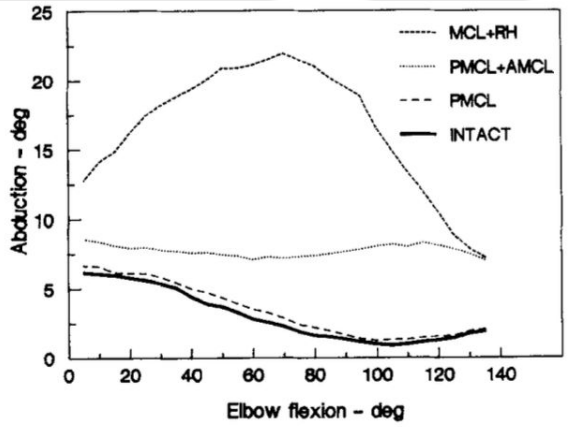


FIG. 7. Release of the MCL shows minimal abduction displacement when the posterior bundle is first removed and moderate displacement when the anterior bundle is then sectioned. However, when the radial head is removed, all constraints are absent and marked displacement occurs, similar to that observed for the specimen in Figure 4. RH, radial head; AMCL and PMCL, anterior and posterior medial collateral ligament.

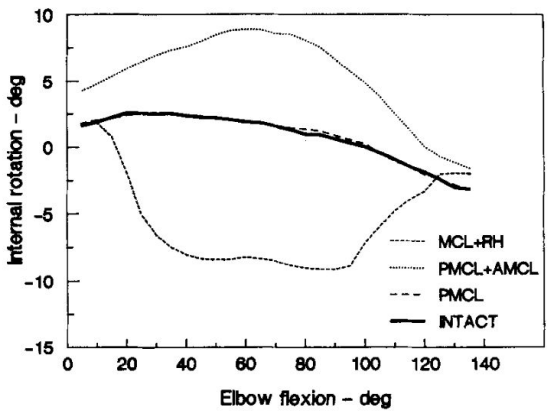


FIG. 8. Internal axial rotation of the ulna after release of the MCL of approximately 9° at 60°–80° flexion. With removal of the radial head even greater internal rotation occurs, and gross instability is reflected by an external rotation of the ulna at 30°–100° flexion. RH, radial head, AMCL and PMCL, anterior and posterior medial collateral ligament.

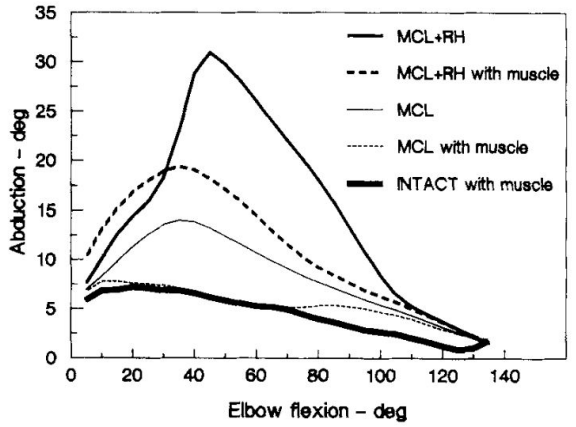


FIG. 9. Valgus instability pattern as represented by the abduction displacement for a joint in which the MCL is released before the radial head. The effect of the simulated muscle force application is to restore some degree of stability that is roughly comparable to the state prior to the last constraint release but that does not return to normal.

- Removal of head: no change in rotation
- Removal of head & PMCL bundle: no change
- Removal of head & MCL: IR laxity at 120 degrees of flexion

- Release of PMCL: minimal change
- Release of PMCL & AMCL: Approx 5 degree increase in ABD
- Release of MCL & head: gross displacement

- Release of MCL: IR of 9 degrees from 60-80 degrees of flexion
- Release of MCL & head: IR instability of 8 degrees & ER of ulna of 8 degrees from 30-100 degrees of flexion

- Release of MCL w/ muscle load: restored stability to baseline
- Release of MCL & head w/ muscle load: 5-15 degrees of valgus instability from 10 to 120 degrees of flexion

Conclusions

- The study found that the radial head is a secondary constraint and does not significantly contribute to elbow valgus or axial rotation stability when the MCL complex is intact.
  - However, when the AMCL is absent, moderate laxity occurs, even with the radial head present.
- Study also showed simulated muscle activity reduces valgus laxity caused by MCL release but does not fully restore stability.
- The findings suggest that the radial head may not need to be replaced with a prosthesis in cases where the MCL & DRUJ is intact to restore stability.
  - However, in situations where there is MCL disruption, the radial head plays a significant role in resisting instability, justifying its preservation or internal fixation rather than resection.
  - Understanding the roles of these structures can inform operative management, particularly in cases of radial head fractures and MCL disruption.

Reconstruction of the Ulnar Collateral Ligament in Athletes*

BY FRANK W. JOBE, M.D.†, HERBERT STARK, M.D.†, AND STEPHEN J. LOMBARDO, M.D.†, LOS ANGELES, CALIFORNIA

From the Department of Orthopaedic Surgery, University of Southern California School of Medicine, Los Angeles, and the Kerlan-Jobe Orthopaedic Clinic, Inglewood

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Sample

- 16 athletes between 1974-1986
  - 100% male, 20-31 years of age
  - 12 Pro Pitches (5 MLB, 7 MiLB), 1 NCAA Pitcher, 1 Outfielder (Pro), 2 Javelin
  - 8 Acute event of rupture reported
  - 9 h/o Steroid Injection
  - 5 h/o prior surgery (1 MuCL repair, others debridement or LB removal)

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Procedure

- Full reflection of the flexor-pronator mass from medial epicondyle with obligatory ulnar nerve transposition
- Palmaris (12), Plantaris (3), Achilles (2) autograft
- 2 converging bone tunnels on medial epicondyle and single bone tunnel on ulna so that tendon is in Figure-of-8
- Repair of the flexor origin

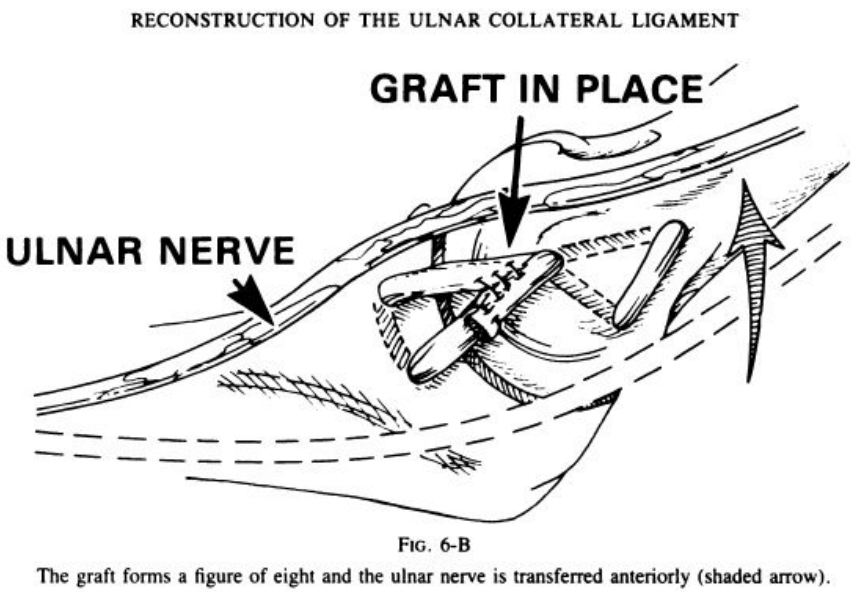


FIG. 6-B

The graft forms a figure of eight and the ulnar nerve is transferred anteriorly (shaded arrow).

Results

DATA ON ELEVEN PATIENTS WHO RETURNED TO PARTICIPATION IN SPORTS

Case	Sports Activity	Duration of Symptoms (*Mos.*)	History of Sudden Tear	Type of Previous Treatment	Age at Op. (*Yrs.*)	Date of Op.	Time until Full Activity (*Mos.*)	Postop. Status	Length of Follow-up (*Mos.*)
1	Baseball	48	Yes	1 op., steroids	31	9/74	18	Competing	117
2	Javelin	2	Yes	1 op., steroids	28	4/76	12	Competing	89
3	Baseball	96	Yes	2 ops., steroids	29	4/78	19	Competed for 1 yr., retired	74
4	Baseball	Several yrs.	No	—	24	6/78	17	Competed for 4 yrs., retired	72
6	Baseball	18	No	Steroids	27	4/80	11	Competed for 2 yrs., retired	50
9	Baseball	36	No	Steroids	24	10/81	17	Competing	32
11	Baseball	5	No	—	20	3/82	12	Competing	27
13	Baseball	2	Yes	—	20	7/82	12	Competing	24
14	Baseball	4	Yes	Steroids	30	7/82	18	Competing	24
15	Baseball	36	Yes	1 op.	24	9/82	17	Competing	24
16	Baseball	10	Yes	Steroids	21	10/82	18	Competing	24

J Bone Joint Surg Am. 1992 Jan;74(1):67-83.

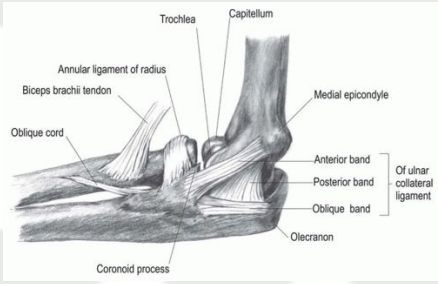
Medial instability of the elbow in throwing athletes. Treatment by repair or reconstruction of the ulnar collateral ligament

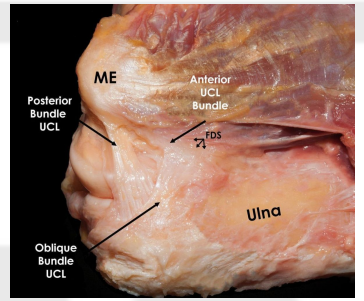
J E Conway [1], F W Jobe, R E Glousman, M Pink

Affiliations + expand

PMID: 1734015

Background





- Primary constraint resisting valgus stress is the anter. oblique band of the ulnar collateral ligament (UCL).
- Throwing activities lead to enormous valgus stress on the elbow, during late cocking and early acceleration phases.
- Repetitive microtrauma from overloading causes inflammation and microscopic tears in the ligament. Leading to weakness and occasionally rupture leading to instability.
- At the time, repair or reconstruction were two operative ways to manage tears of the UCL complex.
- Authors of the paper usually performed a reconstruction approach, although they note direct repair of acutely torn ligaments can be appropriate in some patients.
- Purpose: Assess the results of repair and reconstruction of the UCL in throwing athletes and identify factors that affect the results and outcomes.

Study Design

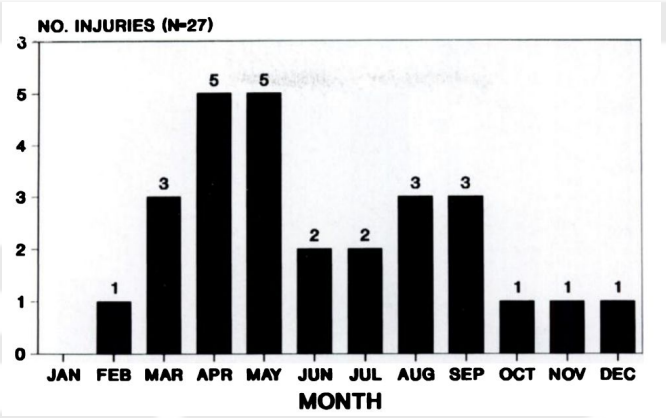
- September 1974 - December 1987
- 71 pts w/ valgus instability (confirmed torn or incomplete UCL during op.)
  - 67 baseball players, 3 javelin throwers and one tennis player
- 68 (96%) of the 71 were f/up, broken into two groups,
  - Direct repair (n = 14)
  - Reconstruction with autologous graft tendon (n = 56)
  - 2 pts in recon group had poor results after previous repair, included in both groups.
- Study was particular to high level throwing athlete w/ chronic use.
- Followed for an avg. of 6.3 yrs. (2-15).
- Followed up with H&P (valgus stress testing), radiographic imaging w/ valgus stress on elbow.
- Pts all had similar non op treatment prior to surgery which included rest, oral NSAIDs, supervised stretching and strengthening program and PT modalities.
- Both groups had the same postoperative care routines.

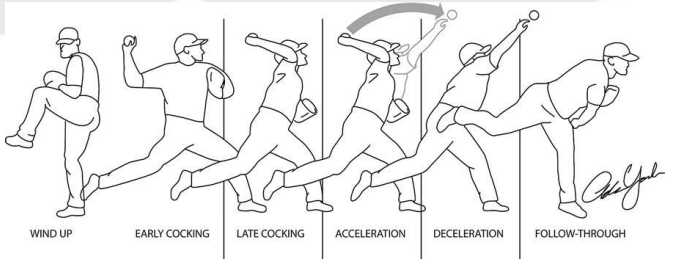
Population

- **Repair group (n =14)**
  - All male w/ mean age 26 (19-38), all baseball players
  - No previous operation, 10 reported injury during single throw
  - Mean time from injury to op. was 7.6 mths (0.5 to 30)
  - Valgus stress test - 8/14 demonstrated instability
  - All but 2 had pain on palpation of the UCL
  - All 14 had direct repair of ant. bundle of UCL w/o augmentation
    - 2 w/ transposition of ulnar nerve, 2 w/ osteophyte debridement, 3 w/ calcifications
- **Reconstruction group (n = 56)**
  - 55 male,1 woman - 52 in baseball, 3 were javelin throwers, 1 professional tennis
  - Mean age at time of reconstruction was of 24 (15-24) for those in MLB 27 (19-44)
  - 9 pts (16%) had previous operation including;
    - transposition of ulnar nerve (4), repair of UCL (2) arthroscopic removal of loose body (1), diagnostic arthroscopy (5) debridement of osteophytes (4).
  - 34 pts. (61%) the injury happened on single throw, 22 did no remember such event
  - Mean time between injury and op. was 12 mths (0.5 to 64).
  - Valgus stress test (+) - 33/56 elbows
  - All but 2 had pain on palpation of the UCL
  - Graft selection
    - Palmaris longus tendon graft - 15 pts ipsilateral 30 pts contralateral.
    - Plantaris tendon 7 pts, 1 extensor tendon of 4th toe
  - All pts but one had an anterior submuscular transposition of the ulnar nerve

Results

- Seasonal occurrence
  - 31 (48%) of 64 baseball players injury occurred during spring training or first 2 mths. of season.
- Relationship of pain and phase of throwing
  - Occurred most in accl. phase (85%) followed by follow through (25%)
- Op. findings
  - Ligament avulsed dist. in 7, prox. in 2, midsubstance tear in 61.
  - 27 w/ calcification in ligament, 11 large osteophyte
  - 10/18 w/o instability had calcification, once removed demonstrated instability
- Postop. physical exam findings
  - 41 pts examined post op., 8 w/ repair 34 w/ recon.
    - Extension to 0 deg. not possible in 4 w/ repair, 17 w/ recon.
    - Loss of extension of 5 deg or more, 2 w/ repair, 9 w/ recon.
    - Loss of extension >10 deg, 6 pts w/ recon.
      - 4 of 6 pts who had flexion deformity of 10-25 degrees had excellent functional results.
- Postop. radiograph findings.
  - Pts. who returned preinjury level of sport, stress radiographs demonstrated mean opening of 3 mm in repair grp. 2 mm in recon.





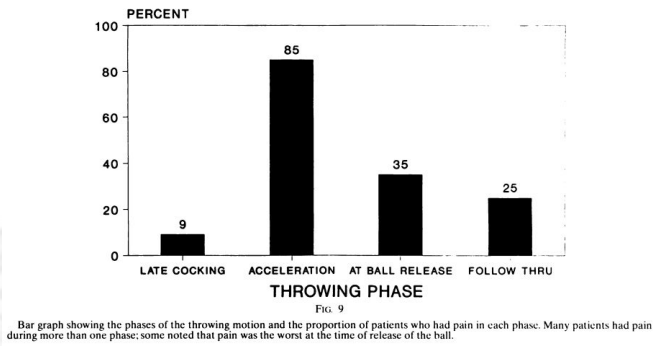


FIG. 9

Bar graph showing the phases of the throwing motion and the proportion of patients who had pain in each phase. Many patients had pain during more than one phase; some noted that pain was the worst at the time of release of the ball.

Results cont.

- Results-Rating scale
  - “Excellent”, “good”, “fair”, “poor” on basis of return to comp.
- Previous op treatment (all repair)
  - Decreased chance of returning to previous level of sports participation (p = 0.04). (Fig. 10)
- Type of procedure
  - “Excellent” or “Good” in 10 of the repair vs 45 (80%) in the reconstruction group
  - Return to previous level - 7 of the 14 (50%) who had repair vs. 38 of 56 (68%) who had reconstruction. (Fig. 11)
  - Major league level to previous level (Fig. 12)
    - 13/20 (65%) w/ reconstruction
    - 2/7 (29%) w/ repair
- Post Op Ulnar neuropathy
  - 15 develop neuropathy
    - Transient in 6, 1 unable to return to sport
    - 9 others had additional operation; 4 able to return to sport

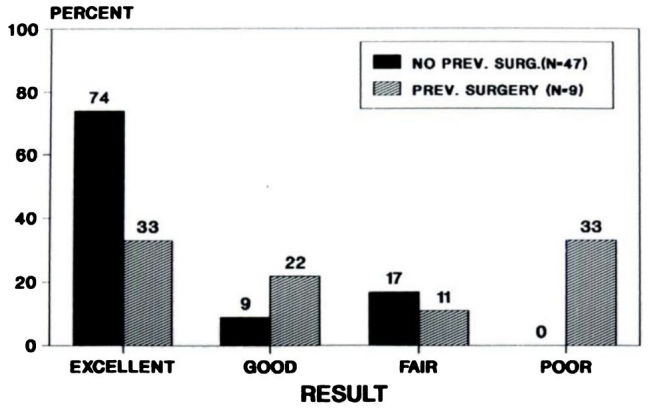


FIG. 10

Bar graph of the results (in percentages) of reconstruction when no previous operation had been done (forty-seven patients) compared with the results after reconstruction in patients who had had a previous operation (nine patients).

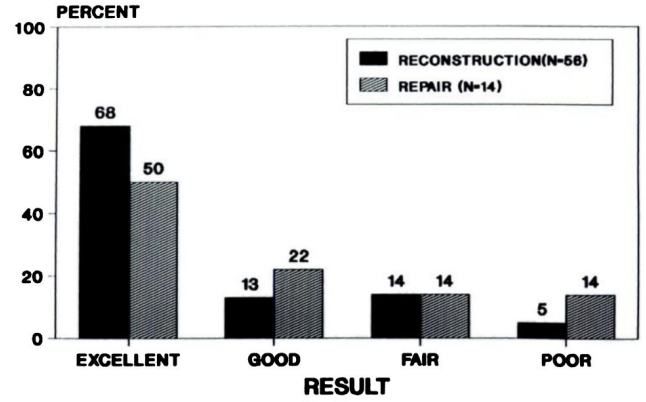


FIG. 11

Bar graph of the results (in percentages) after direct repair of the ulnar collateral ligament (fourteen patients) compared with the results after reconstruction (fifty-six patients).

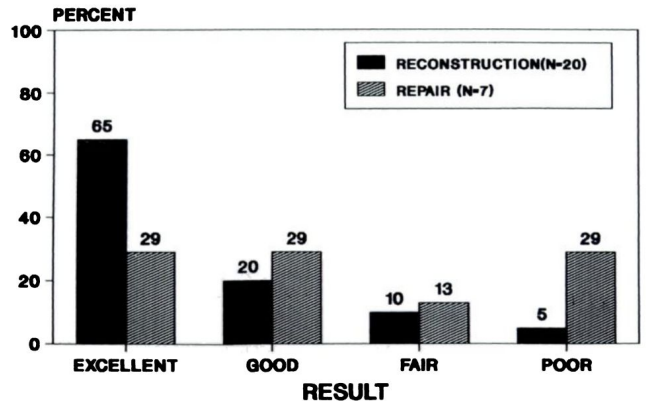


FIG. 12

Bar graph comparing the results (in percentages) in major-league baseball players. Seven players had direct repair and twenty had reconstruction.

Conclusions

- When to consider repair?
  - Acute injury, no ulnar-nerve symptoms, operation soon after injury, UCL normal except for complete separation from bone at origin or insertion.
- What to use for reconstruction?
  - Results obtained w/ different grafts were similar, authors prefer ipsilateral palmaris longus tendon (permitting availability)
- With reconstruction of the anterior band of the UCL, most athletes are able to return to previous level of sport participation.
- Chance of return to competitive level of sports is reduced when prior operations preceding reconstruction are taken.

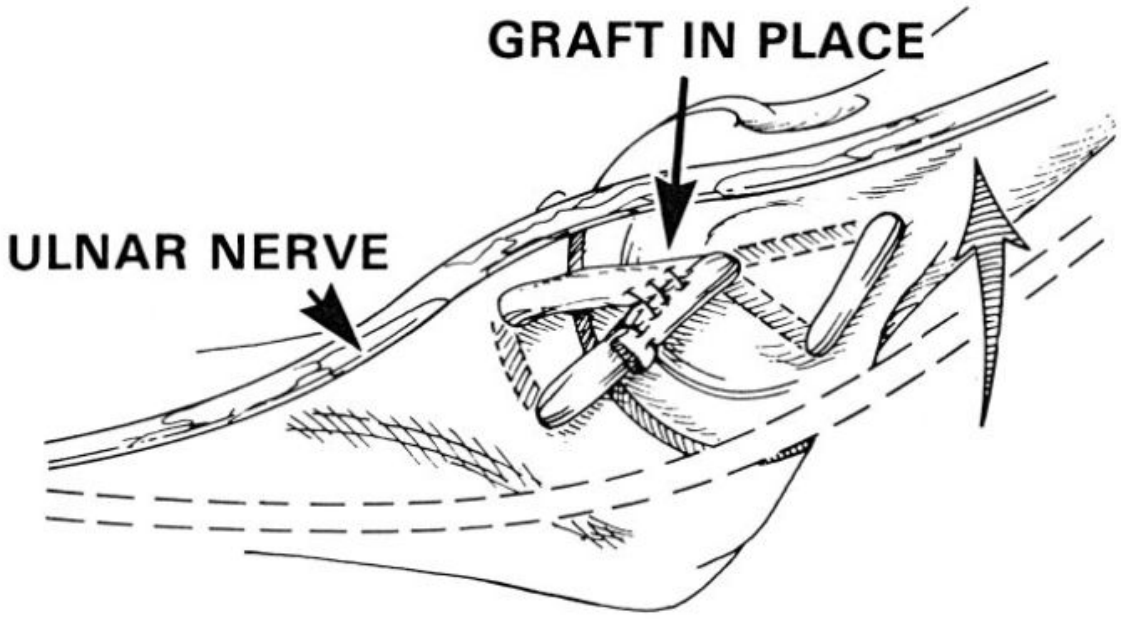
> Am J Sports Med. 2002 Jul-Aug;30(4):541-8. doi: 10.1177/03635465020300041401.

Medial collateral ligament reconstruction of the elbow using the docking technique

Joel T Rohrbough [1], David W Altchek, Jon Hyman, Riley J Williams 3rd, Jonathan D Botts

Background

- Medial ulnar collateral ligament common injury in overhead athletes and is the primary restraint to valgus stress during throwing
- Typically treated with free tendon graft reconstruction in humeral and ulnar bone tunnels as described by Frank Jobe
- Issues with this techniques: strength of the suture fixation of the free tendon graft, adequate tensioning of the graft at the time of final fixation, and the potential for complications resulting from the detachment of the flexor origin, three large drill holes in the medial epicondyle, routine transposition of ulnar nerve, concurrent intra-articular pathology
- Issues lead to the “docking technique”



Docking Technique Goals

1. to perform a tendon graft reconstruction of the MUCL through a muscle-splitting “safe-zone” approach
2. to avoid obligatory transposition of the ulnar nerve
3. to routinely arthroscopically assess and treat intra-articular pathologic conditions, particularly in the posteromedial compartment of the elbow joint
4. to place the tendon graft in bone tunnels
5. to reduce the number of humeral drill holes from three to a single hole (reducing the invasiveness and possible complication of an epicondylar fracture)
6. to simplify graft tensioning and improve fixation methods

Study Design

- Single surgeon retrospective review of records from October 1995 - February 1999
- 36 athletes with symptomatic MUCL insufficiency confirmed by MRI and intra-operatively
- Average age: 23 (range 15-57)
- Average follow-up 3.3 years
- 33 baseball, 1 lacrosse, 1 tennis, 1 golf
- Average time to fixation from symptom onset: 24.5 months
- Palmaris longus autograft used in 34/36 cases

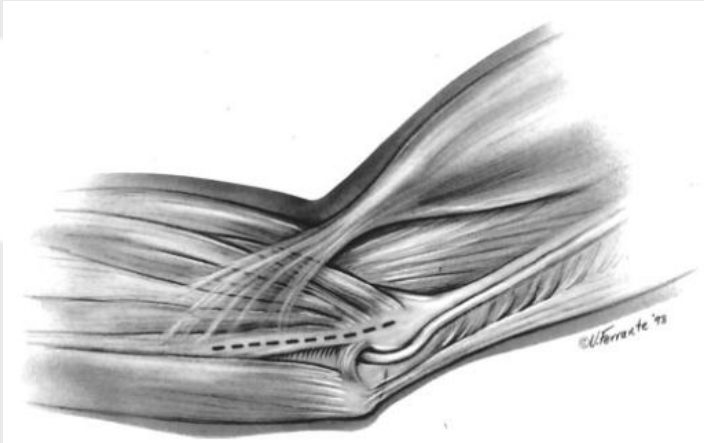


Figure 4. Muscle-splitting incision through the flexor carpi ulnaris muscle. (Reprinted with permission of Hospital for Special Surgery, New York, New York.)

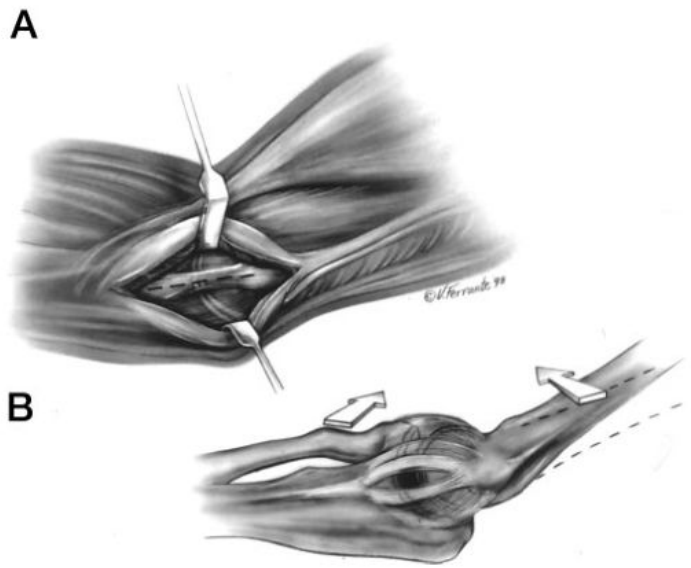


Figure 5. A, submuscular exposure of the MCL. B, assessment of joint laxity after a longitudinal incision of the native ligament. Note the opening (in black) between the medial ulnohumeral articulation with valgus stress. (Reprinted with permission of Hospital for Special Surgery, New York, New York.)

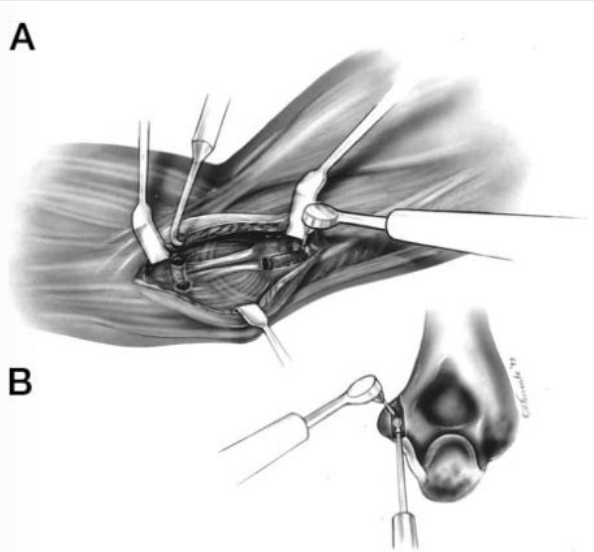


Figure 6. A, creation of the ulnar tunnel using a curved curette to connect the ulnar holes. B, creation of the single humeral tunnel and the exit punctures for the two suture bundles using the dental bur. (Reprinted with permission of Hospital for Special Surgery, New York, New York.)

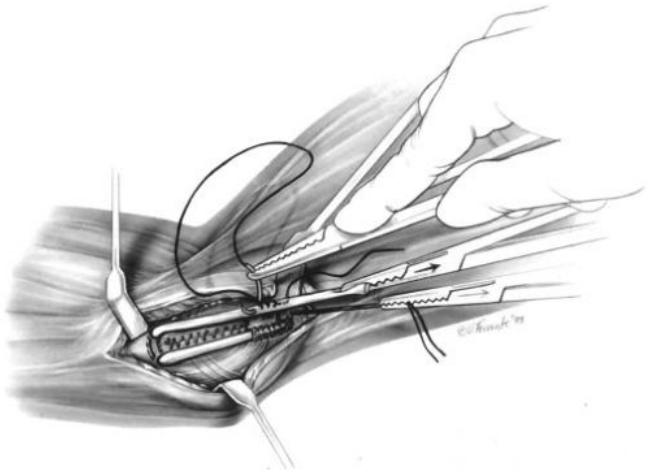


Figure 7. The posterior limb of the graft was docked in the humeral tunnel. The elbow was reduced with varus stress, and, after final tensioning of the graft, a Krackow stitch using No. 1 Ethibond was placed in the anterior limb of the graft. (Reprinted with permission of Hospital for Special Surgery, New York, New York.)

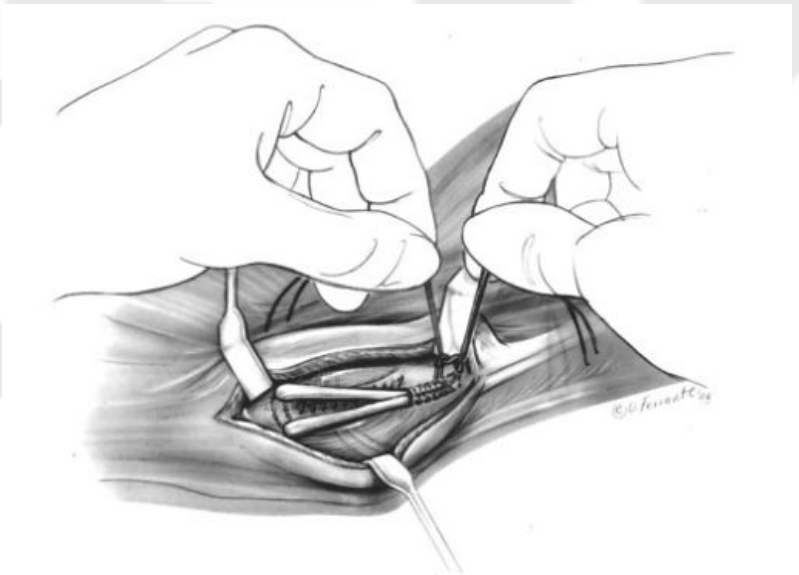


Figure 8. The anterior limb was passed into the humeral tunnel, and the sutures from both limbs were tied over the bone bridge to secure the graft. (Reprinted with permission of Hospital for Special Surgery, New York, New York.)

Results

- 45% of patients had osteophyte removal
- 2 patients underwent ulnar nerve transposition due to preop diagnosis of ulnar nerve instability or compression
- 33/36 (92%) returned to or exceeded their previous level of competition for at least 1 year
- All 22 professional or collegiate athletes returned to or exceeded their previous competition level
- 2 post-op complications: wound hematoma and mild paresthesia in ulnar nerve distribution; both resolved within 3 weeks
- 3 patients had poor results: new diagnosis of reflex sympathetic dystrophy; fracture of ulnar tunnel during batting practice, unable to achieve sufficient power while throwing

Conclusions

- The docking technique allows for simplified graft tensioning and improved graft fixation
- Athletes of all skill levels can expect a high rate of return to their previous level of play
- Previous success rates can be matched and even improved using the docking technique modifications.

The American Journal of Sports Medicine

Outcome of Ulnar Collateral Ligament Reconstruction of the Elbow in 1281 Athletes

Results in 743 Athletes With Minimum 2-Year Follow-up

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Investigation performed at the American Sports Medicine Institute, Birmingham, Alabama

Background

- **Anterior bundle of UCL** - primary restraint to valgus stress at elbow during 20-120 flexion
- Injuries occur most often in overhead athletes, acute elbow dislocation and leds to valgus instability
- Dr. Frank Jobe pioneered UCL reconstruction received first by baseball pitcher “Tommy John” in 1974

Study Design

- Single-surgeon retrospective review of patients who received UCL reconstruction between 1988-2006 with min 2-yr follow-up
- Elbow arthroscopy performed to confirm valgus instability
  - Anterolateral viewing portal with valgus stress applied at 70 flexion. Positive if >2mm medial joint space narrowing
- Graft used for reconstruction: Palmaris longus tendon (73%), gracilis tendon (23%), and toe extensor tendon (3%)
- Ulnar nerve transposed with flexor muscle fascial sling in subcut tract
- Outcomes - return to play, competition level, complications, revisions

Population

- 1281 patients with UCL recon/repair between 1988-2006
  - *98% males, 98% dominant side*
  - *Age: mean 21.5 yrs old (14-59 years)*
  - *Sport: 95% from baseball – of which 89% pitchers*
  - *Level: 32% professional, 48% collegiate*
- 743/942 (79%) eligible patients with 2yr min follow-up
- Pain (96%) during cocking and acceleration phase of throwing
- Surgery performed avg 7.1 mo after symptoms began
  - *Failure to progress with rehab for 3mo led to consideration of surgery*
- 34% also received excision of PM olecranon osteophyte

Results

- **83%** (617/743) patients returned to prior competition level or higher
- **4.4mo** (range, 2.8-12mo), avg time from surgery to throwing
- **11.6mo** (range, 3-72mo), avg time to full competition
- No differences in outcomes between graft choices or with additional olecranon osteophyte excision
- **16%** postop ulnar nerve neurapraxia - mostly sensory paresthesias in ring/small finger that resolved in 6 wks
- **4%** graft site complication, superficial wound infx resolved w antibiotics

Conclusions

- **UCL reconstruction for valgus instability in athletes allows 83% return to prior level of competition regardless of sport and skill level**
- **20% minor complication rate can be expected, mostly temporary ulnar nerve sensory neurapraxia**

- Limitations
  - Inability to contact 21% of eligible patients for 2yr follow-up
  - No physical exam and radiographic follow-up data
  - No elbow outcomes scores available

Citations Classics Shoulder & Elbow

Elbow Instability

Samuel Fuller, MD PGY1
Alexander MacFarlane, MD PGY5
Teja Polisetty, MS4
Matthew Corsi, MS3
Jalen Warren, MS3

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