Elbow Instability

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I. General Considerations:

1. Elbow instability is a complex and evolving topic. Understanding the functional anatomy is fundamental to evaluation and treatment of elbow instability.
2. Anatomic concerns can be divided into four broad categories:
   a. osseous anatomy
   b. capsuloligamentous anatomy
   c. muscular anatomy
   d. neurovascular anatomy
3. Pathophysiology relates to whether a disruption of normal anatomy is acute or chronic and simple (ligamentous or bony only) or complex (multiple factors)

II. Osteology:

1. Distal Humerus
   a. two articular surfaces
      - spool-shaped trochlea
      - the medial aspect of the trochlea is large in comparison to the lateral side
      - the trochlear sulcus lies slightly medial to the central axis of the humerus and is thus supported by a relatively smaller medial humeral column
      - hemispherical capitellum
2. Proximal Ulna
   a. unique shape and articular surface
      - longitudinal guiding ridge of greater sigmoid notch which articulates with the apex of the trochlear groove
3. Radial Head
   a. Radial head consists of a concave dish which articulates with the capitellum. The radial head is not a circular structure but rather elliptical in shape.
   b. The elliptical shape of the radial head is seen in combination with the offset of the head from the neck of the radius. Because of this, simple radial head designs seen with either metallic or sylastic implants, do not recreate normal radial capitellar, kinematics. This leads to either early prosthetic loosening or capitellar arthrosis or both.

III. Capsulo Ligamentous Tissues

1. Capsule
   a. Joint capsule is normally very thin both anteriorly and posteriorly.
   b. Although quite thin and almost translucent, there is a regular orientation of fibrous bands within the capsule which can lead to significant strength resisting joint subluxation.
   c. These fibrous bands unfortunately are quite prone to becoming thickened and scarred and thought to be the major pathophysiologic mechanism for elbow contractures.
   d. The joint capsule attaches at an average of 6 mm distal to the coronoid tip.
2. Medial Collateral Ligament (General)
   a. Medial collateral ligament has three components
      1. anterior bundle
      2. posterior bundle
      3. transverse portion
   b. The anterior bundle is the strongest portion and it inserts on the anterior subline tubercle of coronoid.
   c. It inserts an average of 18 mm posterior to the tip of the coronoid and is therefore involved in only type 3 coronoid fractures. The origin of the anterior band of the medial collateral ligament is at the axis of rotation along the medial epicondyle.
   d. It has a broad origin encompassing 67% of the medial epicondyle. The mean width of the ligament at the medial epicondyle is 5-6 mm as compared to 4-5 mm at is insertion. The average length of the complex is 27 mm.
3. Lateral Collateral Ligament
   a. Works as integrated complex consisting of
      1. Radial collateral ligament
      2. Anular ligament
      3. Lateral ulnar collateral ligament

IV. Muscles

1. The contribution of dynamic influence on elbow instability is an evolving topic.
2. Dynamic stability may in part, be by muscles primarily by compressing the joint and increasing the bony stability afforded by this highly congruous articulation.
3. Additional stability may be imparted to the muscles by a bulk effect. This is particularly relevant to the brachialis muscle which is a broad cross-sectional area and anterior insertion on the proximal ulna but a poor mechanical advantage for flexion. This suggests a role as an anterior buttress in addition to a dynamic role.
4. Elbow extension is almost exclusively by the triceps muscle. The triceps like the brachialis has an insertion close to the axis of joint motion and thus may have both a bulk effect and a dynamic effect for elbow stability.
5. The anconeus is a relatively small muscle draped along the posterior lateral aspect of the elbow with an origin near the center of rotation and insertion based along the ulna for 10 cm. The function has remained unclear but its location suggest

maybe an important dynamic constraint to varus and posterior lateral rotatory stability.

6. Functional anatomy of the flexor pronator group in relation to the MCL
   a. The flexor carpi ulnaris is the predominate muscular tendons unit overlying the MCL. It is the only muscle overlying the MCL at greater degrees of elbow flexion.
   b. In more extension, the posterior aspect of the flexor digitorum superficialis muscle is the only other significant overlying muscle.
   c. The anatomic relationship of these two muscles would suggest they are most responsible in augmenting the stability of the MCL.
7. **Force transmission**
   a. Forced transmission is difficult to analyze but has been calculated with different methods to be potentially significant across the elbow.
   b. Peak force is at approximately 30° of flexion, it has been as high as 4x body weight or 3,200 newtons. Strenuous weight lifting has been shown to produce resulting forces of approximately 3x body weight at 30° of flexion.
   Push up exercises in contrast place about 45% body weight across the joint.
   Relative distribution and joint compression forces:
   57% of the joint compression forces seen through the capitellar joint
   43% through ulnar humeral joint
8. Valgus stress
   a. Stress on the medial collateral ligament has been estimated to exceed double body weight and to exceed triple weight at the radial humeral joint.
   b. Because the strength of a MCL complex has been afforded the only 420 newtons in elderly specimens, this suggest that muscle forces are important in protecting ligamente structures (780 newtons = equaling body weight).
9. Varus stress
   a. This is the predominate stress for ADL's
   b. Lateral Elbow Instability
      1) Seen as a spectrum of injury starting from lateral side
         -stage 0: reduced
         -stage 1: posterolat subluxation radial head and ulna
         -stage 2: perched
         -stage 3A: dislocated with AMCL intact
         -stage 3B: dislocated with AMCL torn
      2) Essential lesion is disruption of the ulnar band of the lateral collateral ligament
      3) Exam shows
         -Pivot shift
         -Laxity to valgus stress in supination
         -Stable to valgus in pronation
      4) surgical repair
         -Extended kocher incision
         -Palm longus graft

VI. Stabilizing Structures

1. Articular Surfaces
   The bony contribution to elbow stability has not been fully characterized but is uniformly considered to be important. It is important to note that after simple dislocations in which complete disruption is seen at the medial collateral ligament and a capsule that significant stability can be maintained for ADLs through dynamic stability alone when the articular surfaces are intact.
2. Ulna
   Ulna olecranon can contribute a significant amount of varus valgus stability especially in full extension where up to 65% of the stability can be imparted by bony concerns alone.
3. Proximal Radius
   Relative contribution of radial head is controversial, but it may be as high as 30% even with an intact MCL. When the MCL is torn, 75% of the resistance of valgus stress is seen through the radial head.
4. Distal Humerus
   This has not been fully quantified but the congruent nature of the distal humeral articulation with the ulna and radius is considered to impart significant stability to the elbow.

VII. Modern Perspective

1. Modern understanding of elbow stability would suggest two major groupings.
   a. Primary restraints include the anterior bundle medial collateral ligament, the lateral ulnar collateral ligament, and the articular anatomy.
   b. Secondary restraints would include dynamic stability, the capsule, and the radial head.
2. Among the primary constraints, the lateral collateral ligament may be the most important here.
   - The lateral collateral ligament is farther away from the varus valgus axis and thus dysfunctional of this complex will allow greater joint excursions.
   - Additionally, the lateral collateral ligament resists varus forces which are predominant during activities of daily living.
   - Traumatic elbow instability appears to generally result from a supination or external rotation mechanism of the elbow.
3. Forearm rotation
   - Pronation to protect lateral
   - Supination to protect medial

VIII. Treatment

1. Medial Instability
   a. MCL Reconstruction with tendon graft
   b. MCL Repair- suture through bone holes
2. Lateral Instability
   a. LUCL Reconstruction - with tendon graft

b. LUCL Repair - suture through bone tunnels

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