The Stiff Elbow

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ANATOMY OF ELBOW JOINT

The elbow joint includes two articulations:

(l) The humero-ulnar, between the trochlea of the humerus and the trochlear notch of the ulna and,

(2) The humero-radia, between the capitulum of the humerus and the facet on the head of the radius. It is hence a compound synovial joint. Its complexity is increased further by its continuity with the superior radio - ulnar joint and the complete articular complex is called the cubital articulation. **(1)**

a) The articular surfaces: are the trochlea and capitulum of the humerus, on one side, and the trochlear notch of the ulna and the head of the radius, on the other. The trochlea is not a part of a simple pully, because its medial flange is much more extensive than the lateral flange and projects downwards to a lower level so that the line of the joint, which is roughly 2 cm below the line joining the two epicondyles passes downwards and medially. In addition, the trochlea is widest posteriorly and, in this position, its lateral edge is a sharp rim .The trochlear notch is by no means perfectly congruent with the trochlea. In full extension the medial part of its upper (olecranon) half is not in contact with the trochlea, and a corresponding strip on the lateral side loses contact on flexion.

The capitulum and the head of the radius are reciprocally curved, but the best contact is obtained when the semiflexed radius in the midprone position. The rim of the head, which is more prominent medially, fits into the groove between the capitulum and the troclea. The humero-ulnar and humero-radial articulation together form a largely uniaxial joint, The ligaments of which are the articular capsule, and ulnar and radial collateral ligaments**. (1)**

b) The articular capsule:

The anterior part of the fibrous capsule is abroad and thin layer. It is attached above, to the front of the medial epicondyle and to the front of the humerus immediately above the coronoid and radial fossae below, to the anterior surface of the coronoid process of the ulna and to the annular ligament being continuous at the sides with the ulnar and radial collateral ligaments.

The posterior part of the fibrous capsule is thin. Above, it is attached to the humerus immediately behind the capitulum and close to the lateral margin of the trochlea, to all but the lower part of the rim of the olecranon fossa, and the back of the medial epicondyle some distance from the trochlea.

Inferomedially, it is fixed to the upper and lateral margins of the olceranon, and laterally it is continuous with the capsule of the superior radio - ulnar joint deep to the annular ligament. **(2)**

d) The Ligaments:

1: The ulnar collateral ligament:

It is a thick triangular band consisting of two parts, an anterior and a posterior, united by a thinner intermediate portion. The anterior part is attached above by its apex to the front of the medial epicondyle of the humerus and below by its broad base to a tubercle on the upper part of the medial margin of the coronoid process. The posterior part, also of triangular form is attached above to the lower and back part of the medial epicondyle and below to the medial margin of the olecranon, between these two bands a few intermediate fibers descend from the medial epicondyle to an oblique band which stretch between the olceranon and coronoid processes**. (3)**

2: The radial collateral ligament:

It is attached above to the lower part of the lateral epicondyle of the humerus, and below to the annular ligament, some of its posterior fibers pass over it to the upper end of the supinator crest of the ulna. **(4)**

The radio- ulnar joints:

The radius and the ulna are connected at their upper and lower extremities by synovial joints, the proximal and distal radio – ulnar joins. In addition, the shafts of the bones are connected by an interosseous membrane and a ligament, which together are commonly regarded as a non- synovial middle radio - ulnar joint**. (1)**

A) The proximal radio-ulnar joint:

The articulation forms a uni-axial pivot joint between the circumference of the head of the radius and the osseofibrous ring formed by the radial notch of the ulna and the annular ligament. The annular ligament is a strong band that encircles the head of the radius and retains it in contact with the radial notch of the ulna. It forms about four fifths of the osseofibrous ring. In front it is attached to the anterior margin of the radial notch. Posteriorly it broadens and may divide into several bands to attach to a rough ridge on the ulna at or just behind the posterior margin of the radial notch. The upper border of the ligament blends with the fibrous capsule of the elbow joint except posteriorly where the fibrous capsule passes as a separate entity deep to the ligament to be attached around the posterior and inferior margins of the radial notch. From the lower border, a few fibers pass over the reflection of the synovial membrane to be loosely attached to the neck of the radius. **(5)**

A thin fibrous layer, often termed the "quadrate ligament", covers the synovial membrane, which closes the distal aspect of the joint between the radius and ulna. **(6)**

B) The middle radio ulnar joint:

The shaft of the radius and ulna are connected by the oblique cord and the interosseous membrane.

The oblique cord is a small inconstant flattened band or cord formed in the fascia overlying the deep surface of supinator extending from the lateral side of the tuberosity of the ulna to the radius a little below the radial tuberosity. Its fibers run at right angle to those of the interosseous membrane. **(7)**

The interosseous membrane of the forearm is a broad and thin sheet. the fibers of which passes distally and medially from the interosseous border of the radius to that of the ulna, the lower part of the membrane is attached to the posterior of the two lines into which the interosseous border of the radius divides**. (2)**

C) The distal radio ulnar joint:

This is pivot joint between the convex lower end (head) of the ulna and the concave ulnar notch of the lower end of the radius, the surfaces are enclosed in an articular capsule and are also held together by an articular disc.

The articular disc is triangular in shape binds the lower ends of the ulna and radius together. Its periphery is thicker than its center. It is attached by a broad apex to a depression between the styloid process and the inferior surface of the head of the ulna, and by its base which is thin to the prominent edge which separates the ulnar notch from the carpal articular surface of the radius. Its margins are united to the ligaments of the wrist joint. Its upper and lower surfaces are both smooth and concave. The upper surface articulates with the head of the ulna, whilst the lower forms a part of the radio-carpal joint and articulates with the medial part of the lunate bone. When the hand is adducted, it articulates with the triquetral bone. **(2)**

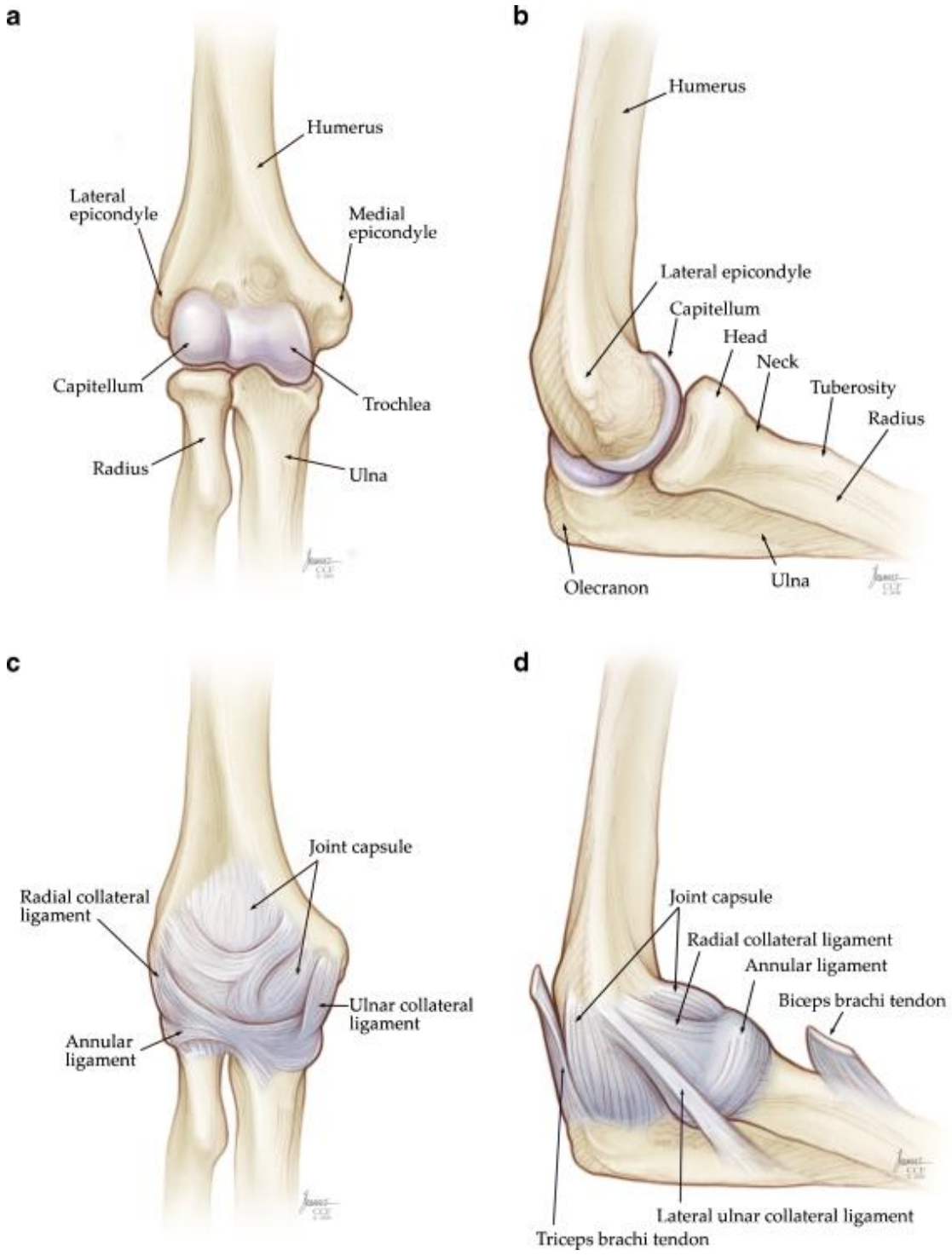

Fig.1: Anterior (a) and lateral (b) views of elbow bony anatomy. Anterior (c) and lateral (d) views of elbow ligamentous anatomy. **(From Hand (N Y).2009 dec: 4(4):368-379, published online on pubmed 2009 apr 7.doi).**

c) The synovial membrane:

Extends from the margin of the articular surface of the humerus, lines the coronoid, radial and olecranon fossae on that bone and covers the flattened medial surface of the trochlea, It is reflected over the deep surface of the fibrous capsule and lines the deep surface of the lower part of the annular ligament. Projecting into the joint between the radius and ulna from behind, there is a crecentric fold of synovial membrane, partly dividing the joint into humero-radial and humero-ulnar parts. This fold is irregularly triangular and contains a variable quantity of extra synovial fat. **(2)**

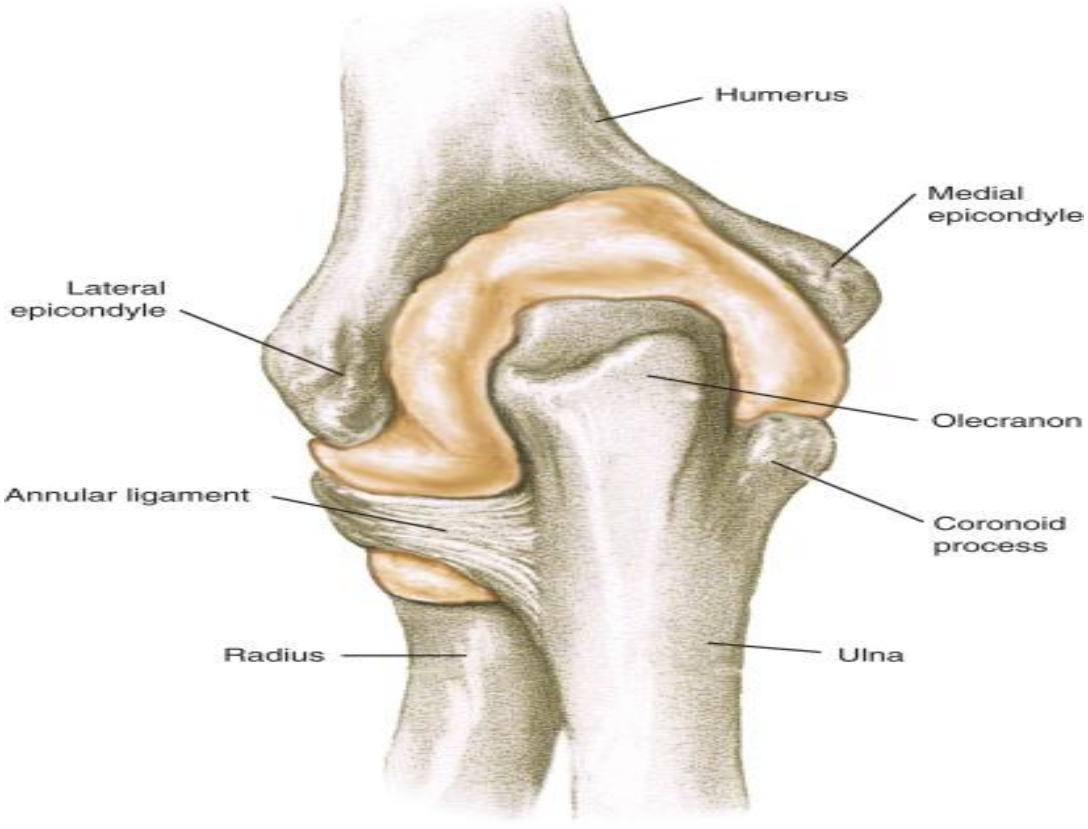

Fig. 2: Distribution of the synovial membrane from the posterior aspect. **(From Beethman,WP: Physical Examination of the Joints, 1965)**

BIOMECHANICS OF THE ELBOW

Normal use of the hand depends largely on a well functioning elbow joint. Mobility and stability of the elbow joint are necessary for daily recreational and professional activities. Loss of elbow function, possibly more than for any other joint, can jeopardize an individual's independent daily existence. A more through appreciation of biomechanics is important to all aspects of an effective clinical practice and has dramatically improved the reliability of joint replacement. Knowledge of the instant centre of rotation has allowed development of "distraction arthroplasty" and effective ligament reconstructive procedures**. (37)**

The axes:

A-Axis of elbow joint flexion- extension:

This axis passes through the center of the arcs formed by the trochlear sulcus and the capitellum. It is internally rotated 3-8 degrees relative to the plane of the epicondyles as seen from below. Flexion and extension of the elbow occur about this single axis and are of a sliding type except at the extremes (5-10) degrees of flexion and extension when the axis moves and the sliding motion changes to rolling motion. **(33)**

B-Axis of pronation- supination:

It is the line which joins the center of the radial head and the base of the styloid process of the ulna. This axis is fixed in relation to the ulna, but the axis of the forearm itself is not fixed in relation to the ulna through out the range of pronation- supination. **(2)**

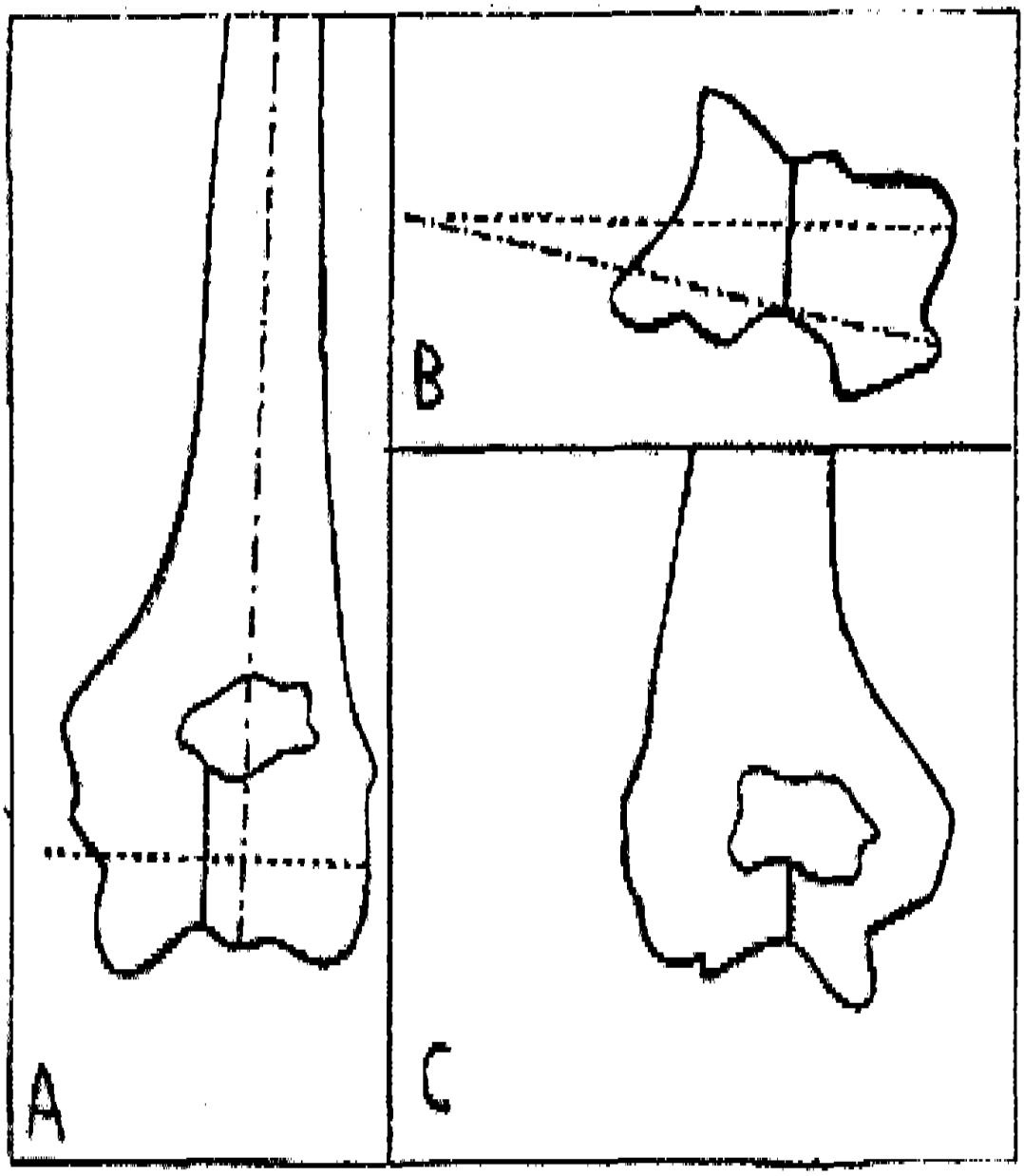

Fig.3 : Left humerus from the front (A), from below (B), from behind (C). As the ulna flexes about the humerus, the path it follows is directed by the deep sulcus in the trochlea (solid lines in A, B, C). The plane defined by this sulcus is not parallel to the long axis of the humerus (long-dashed line in A). Nor is it perpendicular to the plane of the epicondyles (long-dashed lines in B). The axis of rotation of elbow flexion (short dashed lines in A, B) is not coincident with the line through the epicondyles (long-dashed line in B)- The axis of rotation for elbow flexion (short-dashed line in B) is internally rotated 3 -8 degrees relative to the line through the epicondyles (long-dashed line in B). **(From London, J.T.: Kinematics of the elbow, J. bone joint surg, 63 A: 529,1981).**

C- Axis of the forearm:

It runs from the midpoint between the epicondyles of the humerus down to the midpoint between the styloid processes of the radius and ulna. In pronation, the axis of the forearm crosses the ulna obliquely and lies parallel with the axis of pronation-supination. It runs in line with the shaft of the humerus**. (2)**

D- Axes of ulna and radius:

Axes of ulna and radius are imaginary rod inserted inside the medulla between the central points of the upper and lower ends. Axis of the humerus can be considered in the same manner**. (6)**

E- Carrying angle:

The carrying angle, which is defined as the angle formed by the long axis of the humerus and the long axis of the ulna is measured in the frontal plane with the elbow joint in the extended position. It averages 10 to 15 degrees in men and is about 5 degrees greater in women. **(2)**

Factors share in carrying angle formation are:

(1) Obliquity of the distal end of the medial edge of the trochlea which lies 6 mm distal to the lateral edge. **(1)**

(2) The shaft of the ulna is angled some what laterally from the line of the trochlear notch to form the carrying angle. **(2)**

KINEMATIC ASPECTS OF ELBOW JOINT

1- Types of elbow movement:

Elbow joint movements are of a sliding type except at the extremes 5-10 degrees of flexion and extension, when the axis moves and the sliding motion changes to a rolling motion. To explain this change in axis position and type of motion of elbow, London (1981) found that the instant centers of rotation for ulno-humeral motion were tightly clustered about the center of the arc formed by the trochlear sulcus, except that the instant centers for the last 5-10 degrees of flexion was displaced toward the cornoid fossa and the instant center for the last 5 -10 degrees of extension was displaced toward the olecranon fossa . similarly, The instant centers, of rotation for the radio-humeral were tightly clustered about the center of arc formed by the capitellum except that the instant the center for the last 5-10 degrees of flexion was displaced toward the radial fossa and the instant center for the last 5-10 degrees of extension was displaced toward the posterior of the capitulum. For each successive displacement of the radius and ulna about the humerus, the instant center of rotation of the radio-humeral joint and the instant center of rotation of the ulno-humeral joint (excluding the centers for extreme flexion and extension) could be super-imposed on one another.

This coincidence of the instant centers of these two joints established that elbow flexion is unipolar. The flexion occurs about an axis of rotation that passes through the centers of the arcs described by the trochlear sulcus and by the capitulum. **(33)**

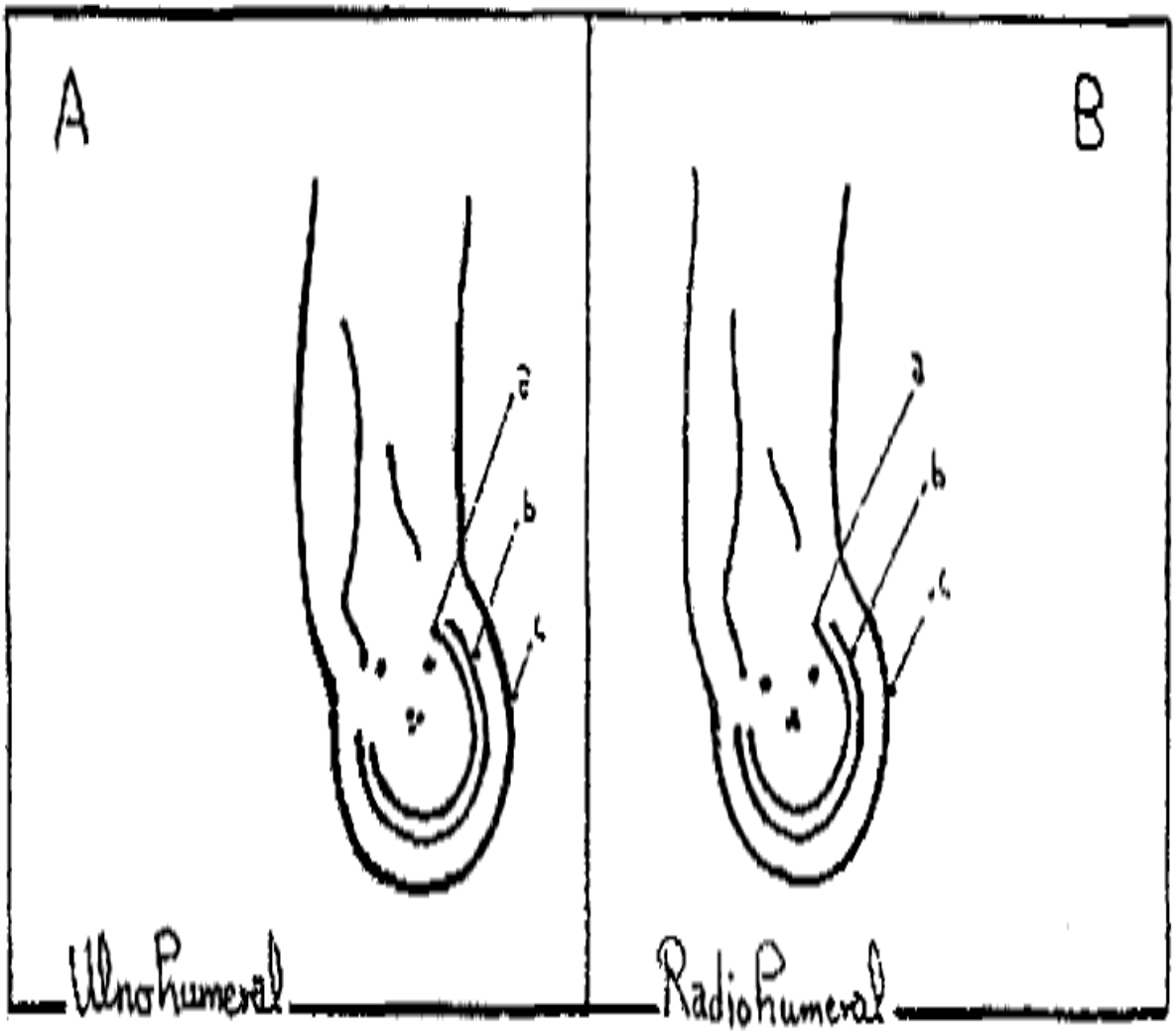

Fig. 4:
A= arc of the bottom of the trochlear sulcus.
b = arc of the periphery of the capitulum.
c = arc of the medial facet of the trochlea.
(From London JT: Kinematics of the elbow, J.bone joint surg. 63 A : 529, 1981).

(Arc of the bottom of the trochlear sulcus, arc of the periphery of the capitulum, and arc of the medial facet of the trochlea) the velocity vectors of the elbow for both ulno-humeral and radio-humeral motion will be tangent to the articular surface, indicating that motion at the joint surface is of a sliding type. **(33)**

2- Range of movements of the elbow joint:

The position of reference of the elbow joint is defined as the position achieved when the axes of the arm and forearm are in a straight line. Extension is movement of the forearm posterioly. Since the position of reference corresponds to complete extension, the range of extension of the elbow joint is zero by definition, except in subjects e.g. women and children, in whom great laxity of the ligaments allows hyperextension of 5- l0 degrees. By contrast, relative extension is always possible from any position of flexion. Flexion is movement of the forearm anteriorly with approximation of the forearm to the anterior aspect of the arm. Active flexion has a range of 145degrees. Passive flexion has a range of 160 degrees. ***(8)***

With development of the electrogoniometer the useful arc of elbow flexion is found 100 degrees (from 30 to 130 degrees) which seems adequate to perform most of the adequate daily activities e.g. reading a newspaper, typing, putting glass to mouth, cutting with a knife. **(9)**

3- Relation of anatomy to the elbow joint movement:

1- The distal end of the humerus resembles a fork which holds between its prongs the axis of the articular surfaces. Immediately above the articular surfaces two concavities present; anteriorly , the coronoid