ARTHROPLASTY OF THE ELBOW JOINT

Essay Submitted for Fulfilment of Master
Degree in Orthopaedic Surgery

By

ABDEL AZIZ MOHAMED ABDEL AZIZ

Under Supervision Of

Prof. Dr. NABIL HASHEM
Professor of Orthopaedic Surgery
Faculty of Medicine
Ain Shams University

Dr. MOHAMED REDA ABDEL WAHAB
Assisstant Professor of Orthopaedic Surgery
Faculty of Medicine
Ain Shams University

AIN SHAMS UNIVERSITY
1994

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

بسم الله الرحمن الرحيم

Acknowledgment

I would like to thank Professor **Dr. Nabil Hashem** whose support, supervision, and continuous gidance throughout this work can not be denied. I thank God for working under his supervision.

I also appreciate the great efforts, valuable comments and scientific supports of **Dr. Mohamed Reda Abdel Wahab.**

Contents

Introduction and Historical Aspect

Introduction and Historical Aspect

Restoring function to unstable, stiff or dislocated joints continues to be one of the most interguing and difficult problems in reconstructive surgery of the extrimities. Articular pathology due to trauma, disabling arthritis or infection is as old as mankind.

According to Coonard, the history of elbow arthroplasty can be divided into four time periods. The first period, from 1885 to 1947, included the development of resection and anatomic arthroplasties, with and without interpostion. The second period, 1947 through 1970, was one in which partial and total hinge arthroplasties of a constrained metal to metal were developed. The third period 1970 to 1975, included the development of polymethyl-methacrylate fixation techniques. During the fourth period, from 1975 to the present evolution of semiconstrained metal and ployethylene hinges; snapfitting prostheses, and unconstrained metal to polyethylene resurfacing arthroplasties occured. (*Sisk and Wright, 1991*).

The first recored logical efforts at treating such disease by simple resection of the affected soft tissue and adjacent diseased bone were carried out on the elbow by *Ambroise Pare* in the sixteenth century in the hope of avoiding amputation of a limb for incurable joint infection; this desperation type of surgery was the birth of all future articular reconstructive surgery and of the specialty of orthropaedic surgery in the eighteenth century.

Further development of arthroplasty, or reconstruction of joints, was a logical sequence of the resection arthroplasty procedur.

Ollier,1885 in his continuing study of resection arthroplasty as a method of mobilising fused joints, first attemped to interpose a buffer between the recreated articular surfaces in order to prevent bony healing; adipose tissue was first used, but it was soon discarded because it was found to be quickly resorb. Prior to 1900 other surgeons in America, England and Europe inserted such materials as wood, thin sheets of gold, silver, zinc and magnesium, some inserted synthetics e.g. celluloid, rubber sheets, collodion and heterogenous materials such as pig's bladder. *John B. Murphy, 1910* of Chicago made a major contribution when he noted that fascia was an excellent interpositional membrane for arthroplasty as much as it did not easly resorb. The use of fascia for joint reconstruction became popular because it has eleminated the unpredictable effects of heteroplastic or irritating synthetic inclusions in living tissue. (*Manuel, et al., 1990*).

Orthopeadic surgeons of the early twentieth century further refined resection arthroplasty techniques and extended their application in the treatment of most arthritic joints of the upper and lower extremities. In 1925 *Smith-Petersen* of Boston interposed synthetic materials, glass, viscaloid and bakelite in arthroplasties of the hip. After the introduction of implantable metals for fracture surgery by *Venable and Stuck in 1938.*, Smith-Petersen experimented with a nonferrous alloy vitallium, and it became a landmark in the use of interpositional materials for arthroplasty (*Petersen, et al.,1971*).

Great advances have been made in the treatment of the arthritic upper extremity, mostly the hand. The success of total joint replacement concept in which the function of a joint is completly substituted by a mechanical model has certain attractive possibilities from the engineering stand point, a problem remains, however, with total dependency on insubstantial synthetic materials and the interface, or boundary, between the artificial material and the human tissue. There must always be this boundary separation and, as a result, any implanted device is only successful as it is biomechanically and biologically tolerated by human host tissue.

Since 1975, Prosthetic design has been charactarized by two types, as the constrained type is not used any more due to high rate of looseining,. One is the semiconstrained metal-to-polyethylene hinge in which there is some laxity from medial to lateral and rotational motion. These designs include Mayo, Tri-Axial, Pritchard-Walker, Coonard, and G.S.B.III prostheses. The second type of implant is totally unconstrained desing, or one in which a snap-fit is provided for the humeral and ulnar components. These include the Ewald, Capitellocondylar, Kudo, Wadworth, and other designs. There are now more than 20 different elbow prosthetic designs. (*Sisk and Wright., 1991*).

Biomechanics of The Elbow joint

Biomechanics of the Elbow Joint

The Function of the elbow-forearm complex must be interpreted from a biomechanical as well as an anatomical viewpoint although morphology places constraints on mechanical performance, mechanical laws have also influenced the evolution of human anatomy. Therefore, an elementary understanding of mechanical principles in relation to functional anatomy and appreciation of elegant interrelations of form and function are necessary before undertaking repair and reconstruction of the elbow.

Kinematic Aspects of Elbow-Forearme Function :-

Capability for motion of a joint is often expressed in terms of degrees of freedom, a ball and socket joints has three degrees of freedom with rotation possible in three orthogonal (mutually perpendicular) plains, around three orthogonal axes. The elbow is a compound joint with degrees of freedom.(fig.1.)The ulnohumeral part of the articulation consists of a hinge which premits one degree of freedom. i.e. angular displacement of the forearm (link) about a transverse axis with an orientation that oscillated slightly in flexion and extension. The radio-humeral articulation participates in this action. The second degree of freedom at the elbow is added by the unusual compound arrangement afforded by the radio-humeral and radio-ulnar joints. This articulations permits rotation of the forearm (pronation-supination) around a second longitudinal axis which is approximately perpendicular to the elbow axis and movable in the

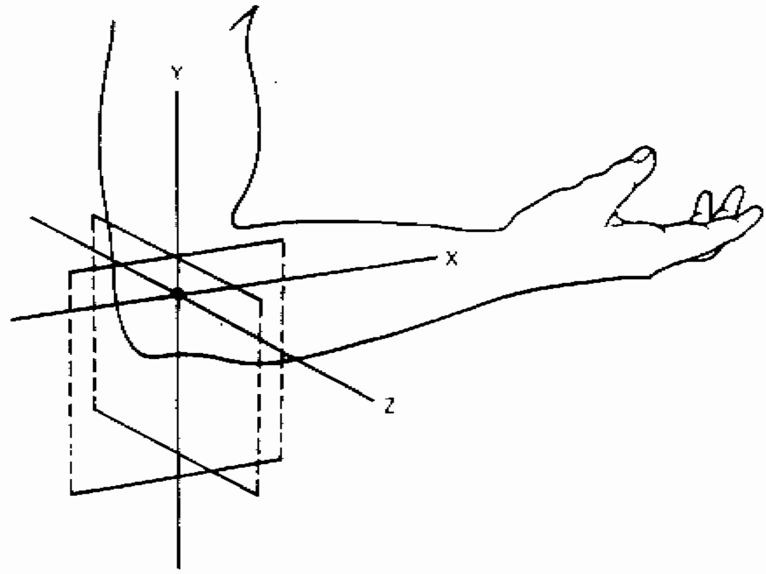

Figure (1)

Degree of freedom of joint motion defines for rotation around three axes x y z. *(Wadsworth ,1982).*

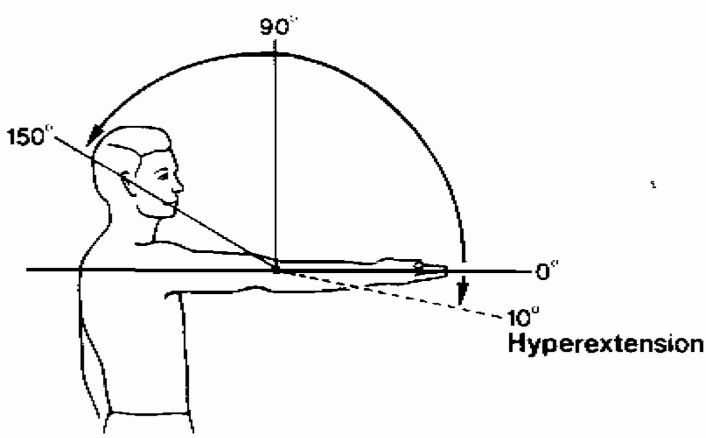

Figure (2)

Flexion range of motion. *(Wadsworth., 1982).*

plain of flexion-extension. In view of these combined mechanisms of motion about transverse and longitudianl axes, the elbow has been designated as a trochogingmus joint. (*Steindler, 1955*).

Range of Motion:-

The normal range of flexion-extension is from 0 to 146 degrees.(fig.2) Most activities of daily living may be accomplished with a functional arc of 100 degrees from 30 to 130 degrees. The average normal range of pronation-supination is from 71 degrees of pronation to 81 degrees of supination. Most activities of daily living may be accomplished in 100 degrees of forearm rotation from 50 degrees of pronation to 50 degrees of supination. Thus it appears that the elbow may not be represented by a uniaxial hinge throughout the flexion extension range. The changing center of rotation and the sliding movement at extremes of joint movement may be related to the high incidence of loosening seen with constrained hing-type total elbow replacement. (*Ries, et al., 1988*).

The arc of forearm rotation is limited to approximately 150 degrees, but wrist action permits 180 degrees of pronation and supination of the hand.(fig.3.) Forearm rotation is restricted at its extreme by the associated ligaments,tendons, and muscles, but not specifically by the interosseous membrane. This structure acts to prevent proximal displacement of the radius on the ulna, as might occur in pulling. The interosseus membrane is under maximum tension with the forearm in mid position, the point at which the diaphyses of the radius and ulna are separated farthest, this position of

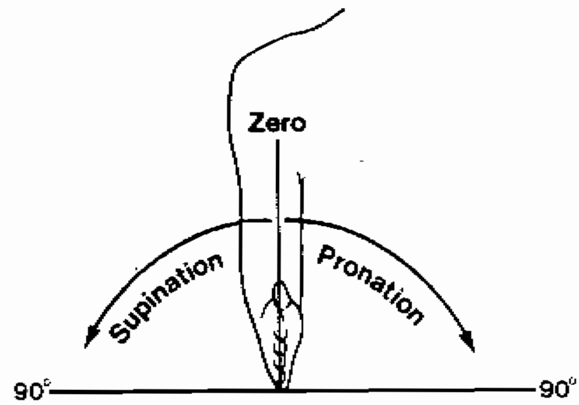

Figure (3)

Forearm rotation.

N.B. The wrist joint action permits 180 degrees of pronation and supination of the hand. *(Wadsworth, 1982).*

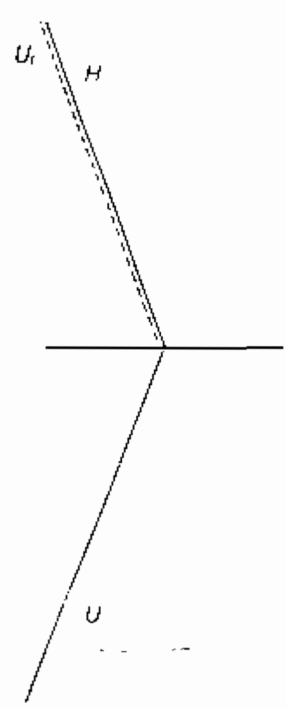

Figure (4)

The elbow axis normally bisects the cubital angle which disappears in flexion U_1. *(Ries, et al., 1988).*

immobilization, offers the best chance to avoid synostosis in complicated fractures. (*Wadsworth,1982*).

Axis of Motion:-

The elbow axis of flexion-extension motion is determined by the transverse axis of the distal humerus which is slightly oblique to the longitudinal axis of the bone, in particular because of the increased depth of the medial lip, this of the trochlea as compared with the lateral lip, this accounts for the carrying (cubital) angle. The normal angle lies within the range of 0 and 20 degrees of valgus with a tendency toward the higher side of range in women. Despite this deviation in extension which is more apparent in supination, it is essential to recognise that the angle disappears in flexion as the forearm and humerus become closely aligned with the hand lying in front of the shoulder.(fig.4.) (*Steindler, 1955*).

In fact *Morrey and Chao, (1976)* indicate that the long axis of forearm changes linearly from valgus to slight varus during flexion, independent of forearm position in pronation-supination. Also that the ulna, and hence the entire forearm, rotates about its long anatomical axis during flexion-extension, irrespective of the degree of pronation-supination. Internal rotation of 5 degrees occurs during early flexion, and external rotation of 5 degrees during terminal flexion. A point approximating the instant centres of rotation for flexion-extension lies on a line passing through the center of trochlea and in the plane of the anterior surface of the distal humerus. These observations may have clinical significance in explaning loosening of