بسم الله الرحمن الرحيم

قالوا سبحانك
لا علم لنا إلا ما علمتنا
إنك أنت العليم الحكيم

صدق الله العظيم

البقرة 32

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Dedication

I dedicate this work to ***my parents***

and ***my brother Islam***

for their help and assistance.

AIM OF THE STUDY

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Aim of this study is to focus on the reconstruction of thumb and different procedures of management of thumb reconstruction after traumatic injury.

INTRODUCTION

FUNCTIONAL ANATOMY OF THE THUMB

Bones of the thumb:

The thumb ray consists of four bones: Trapezium, first metacarpal bone, proximal phalanx and distal phalanx. [8]

1- Trapezium:

One of the carpal bones which articulates with the adjacent trapezoid and these together by concave facets fit the distal convexity of the scaphoid. A distal articular surface, saddle-shaped, is for the thumb metacarpal and this is a separate synovial joint.[8] It has a ridge that fits the concavity of first metacarpal base which extends in a palmar and lateral direction at an angle of 60° with the plane of second and third metacarpals. The two layers of flexor retinaculum and the tendon of flexor carpi radialis are attached to its margins. The thenar muscles (oppenones pollicis, flexor pollicis brevis and abductor pollicis brevis) are attached to it and obscure the tubercle on its palmar surface. The radial artery is related to the dorsal surface. The lateral surface gives attachment of radial collateral ligament and capsular ligament of the thumb carpometacarpal joint. Abduction, and adduction occur in the plane of the ridge and its axis passes through the metacarpal base while the axis of flexion and extension passes through the trapezium[2]. Fig. (1)

2- First metacarpal bone:

It is the shortest and most mobile. It does not lie in the same plane as the others but occupies a more anterior position. It is also rotated medially through a right angle so that its extensor surface is directed laterally and not backward [(1)]. Its long axis diverges distolaterally from its neighbour. The shaft is flattened, dorsally broad and transversely convex. The palmar surface is longitudinally concave and divided by a ridge into a larger lateral and smaller medial part. The opponens pollicis and the first dorsal interosseus muscles are attached to the shaft. The base is concavo convex and articulates with the trapezium. The abductor pollicis longus and first palmar interosseus muscles attached to the base. The head is less convex than the other metacarpals and is transversely broad. Sesamoid bones glide on its palmar aspect [(2)]. Fig.(1)

3- Phalanges:

They are only two phalanges, termed the proximal and distal "however, a study of comparative anatomy shows that the first metacarpal behaves like a proximal phalanx, and parts of trapezium are the true metacarpal for the thumb" [(9)]. Each has a head, shaft, and proximal base. The shaft tapers distally its dorsal surface transversely convex. The palmar surface is transversely flat but gently concave anteriorly in its long axis. The bases of the proximal phalanges carry concave, oval facets adapted to the metacarpal heads.

Their own heads are smoothly grooved like pulleys and encroach more on to the palmar surfaces. Articular ligaments and numerous muscles are attached to the phalanges. The tendon of extensor pollicis brevis, the oblique head of adductor pollicis "dorsally", and the oblique and the transverse heads of adductor pollicis sometimes conjoined with the first palmar interosseous "medially" which are attached to the base of the proximal pollicial phalanx [(2)]. The tendon of flexor pollicis longus is inserted into the base of distal phalanx while the tendon of flexor pollicis brevis is inserted into the base of proximal phalanx. Fig. (1)

4- The sesamoid bones:

They are a pair of small, oval sesamoid bones buried in each side of the palmar ligament of the metacarpophalangeal joint of the thumb where the tendons of the adductor pollicis and flexor pollicis brevis fuse with the ligament. Each bone articulates with the corresponding surface of the head of the metacarpal and the tendon of flexor pollicis longus lies in the groove between them [(10)].They diminsh friction, alter the direction of pull of muscles and prevent compression devascularization of the tendons of small muscles[(1)].

In some congenital malformations, there are three true phalanges which are of no greater use and appear to interfere with the other fingers during pulp-to-pulp opposition. This is because they impair the degree of flexion at the distal interphalangeal joint of the finger to which it is being opposed. The more complex structure of a thumb with three phalanges would not appear desirable considering the minimal advantages that it would afford [(9)].

Conversely, a thumb which is too short, such one sees after amputation of the phalanges, is less efficient, not only because of insufficient length to reach the other fingers and inability to obtain

sufficient separation from the palm, but also because of a deficiency in the overall flexion range of the column[9].

Ossification of the bones of the thumb:

● *Trapezium:*

The ossification centre appears around 4 years in girls, and 5 years in boys and it soon develops a long axis which is directed towards the second metacarpal joint [11].

● *The first metacarpal bone:*

The ossification centre appears between prenatal weeks 8 and 10 which occurs shortly after that of terminal phalanx. The first metacarpal bone ossifies like a proximal phalanx by ossification from a single centre that forms the shaft and the distal articular surfac, while the base of the bone at its proximal extremity forms a separate centre of ossification [11].

So, in embryology, the trapezium equal to a metacarpal. After this comes the first metacarpal which is only a modified proximal phalanx and finally it ends with the two phalanges, the first and the second [1].

● *The phalanges:*

The first centre of ossification appears in the distal phalanx as early as prenatal weeks 7-9. The ossification of a distal phalanx starts at the tip and progresses proximally, while the ossification centre of proximal phalanx appears very shortly after that of the first metacarpal in prenatal weeks 9-11[11].

● *The sesamoid bones:*

They are the last bones in the hand to commence ossification. The ossification centres appear between 11 and 15 years in girls, and 13-18 years in boys [11].

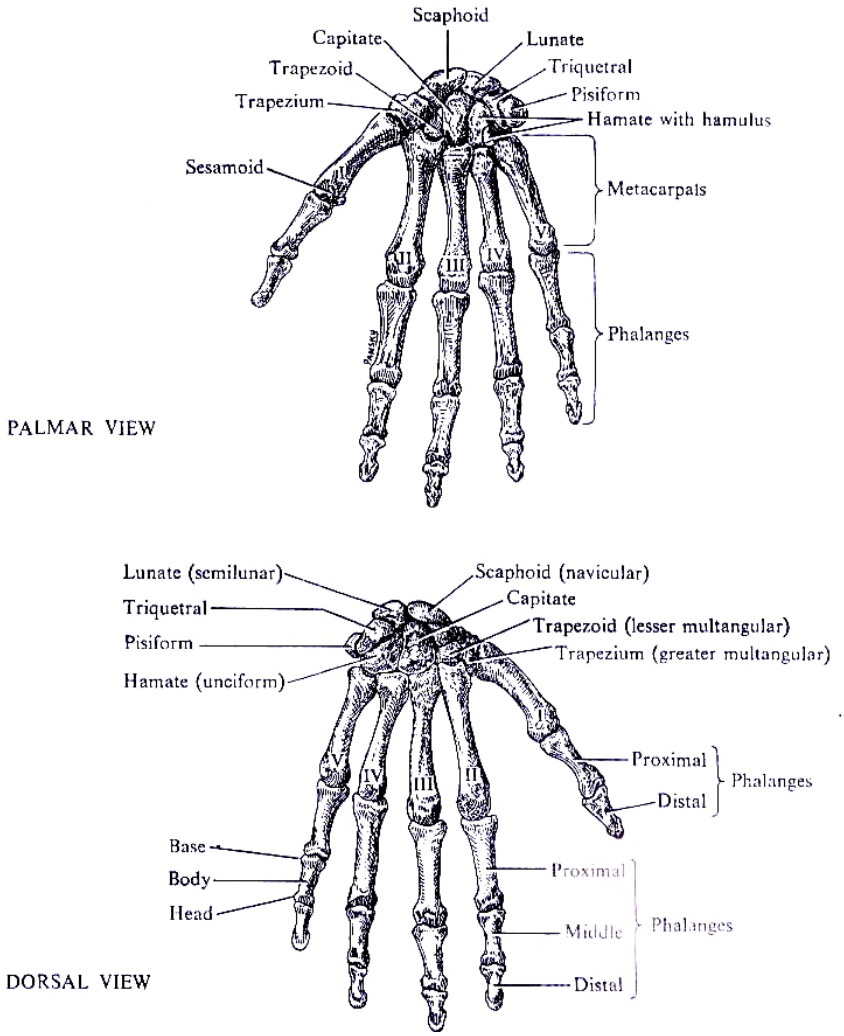

Fig. (1): The wrist and hand bone. [12]

The joints of the thumb:

There are three major articulations: carpometacarpal, metacarpophalangeal and interphalangeal joints which are quite different from each other in structure and function. Their ranges of motion vary among individuals and between the hands of the same individual, more than any other joint in the body [13].

The thumb axis is based at the carpometacarpal joint and is pronated and flexed approximately 80 degree with respect to the other metacarpals in the hand. This positioning allows for circumduction which permits opposition [2].

Stability is achieved not only through the shape of the articular surfaces but also by other supportive aids including the collateral ligaments and joint capsule. Movement and dynamic stabilization are provided by nine active musculo-tendinous units, including the first dorsal interosseus. These give the thumb strength equal to that of all the other digits combined and have earned it the name pollex-the strong [14].

1- The carpometacarpal joint of the thumb:

It is the most important joint of the thumb and it is largely resposible for the characteristic dexterity of human prehension. It is a saddle joint between the first metacarpal base and trapezium. Three other adjacent articulations are functionally related to this joint, which include the joint between the trapezium and the scaphoid, the trapezium and the trapazoid, and the base of first metacarpal and the radial side of the base of the second metacarpal. As aset, the four synovial articulations are referred to as the basal joint complex [15].The characteristic feature of a saddle joint is that each articular

surface is concave in one dimension and convex in the other.The longitudinal diameter of the articular surface is generally concavewhile the transverse diameter of the articular is generally convex. [16] Both joint surfaces are oval saddle like depressoins so, the joint is called a double saddle joint. [9] ***Ligaments***: The joint is connected by lateral, anterior, posterior ligaments, and a fibrous capsule. These ligements have three functions: to control the extent and direction of joint motion, to help maintain norml alignment of the joint and to help control and dissipate forces produced by activated muscles.[15] ***Synovial membrane:*** It lines the joint capsule and is separate from it. ***Vascular supply:*** The joint receives its blood supply from the radial artery and its first dorsal metacarpal branch. ***Innervation:*** The joint is innervated by articular twigs from the posterior interosseus nerve .[2] ***Movements:*** Motions that occur at this joint include flexion, extension, adduction, abduction, and opposition which includes varying amounts of flexion, internal rotation, and palmar adduction. [13]Fig. (2)

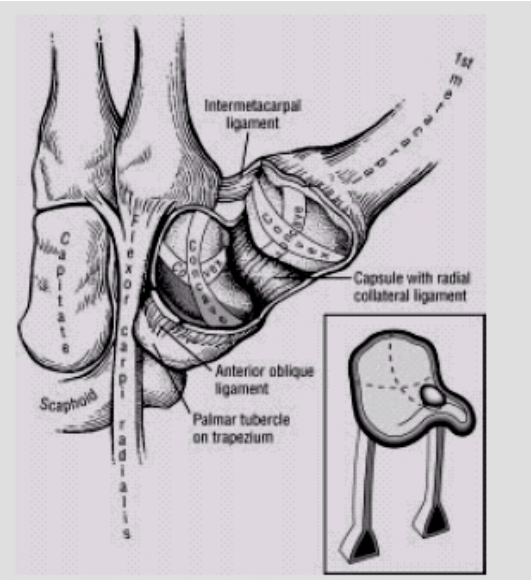

Fig. (2): the carpometacarpal joint of the right thumb is opened to expose the shape of saddle joint [16].

The position of maximum congruity of opposing joint surfaces is termed close-packed position of the joint. The position of least congruity is termed open-packed position. So, the close-packed position of the carpometacarpal joint is full opposition and open-packed (resting) position of the carpometacarpal joint is midway between abduction-adduction and flexion-extension [17].

2- The metacarpophalangeal joint of the thumb:

This is the second joint, both in importance and in its anatomical position from the bone of the thumb.[18] The joint is usually considered ellipsoid between the first metacarpal head and the proximal phalanx. It is not regularly convex but partially divided on their palmar aspects and thus almost bicondylar. ***Ligaments:*** It has palmar, two collateral ligaments and a fibrous capsule. The medial and lateral collateral ligaments are taut in flexion and relaxed in extension. This quality makes adduction-abduction movement at the metacarpophalangeal joint nearly impossible if the joint is flexed.[9] ***Synovial membrane:*** It lines the joint capsule. ***Vascular supply:*** The joint receives its blood supply from dorsal, palmar metacarpal arteries and the arteria princeps pollicis. ***Innervation:*** The joint is innervated by twigs from the posterior interosseus nerve.[2] ***Movements:*** Approximately 75 to 80 degrees of flexion is available at this joint. The extension movements as well as the abduction and adduction motions are negligible. [14]

In practice, the metacarpophalangeal joint moves in different ways depending on how the thenar muscles contract:

- Pure flexion: achieved by equal symmetrical contraction of the muscles acting through medial and lateral sesamoids.
- Flexion together with some ulnar deviation and supination of the proximal phalanx.
- Flexion together with some radial deviation and pronation of proximal phalanx [18].

The intrinsic muscles are particularly important in controlling the motions of the metacarpophalangeal and carpometacarpal joints of the thumb during various hand movements such as grip and pinch. The abductor pollicis brevis intrinsic muscle helps to maintain radial stability. The adductor pollicis intrinsic muscle helps to maintain ulnar stability. These intrinsic muscles act together with the flexor pollicis longus, the powerful extrinsic muscle that flexes the interphalangeal and the metacarpophalangeal joints to produce tip pinch[19].

Close-packed position of the metacarpophalangeal joint of thumb is full flexion. Open-packed (resting) position of the metacarpophalangeal joint of thumb is slight flexion [10].

3- The interphalangeal joint of the thumb:

This is the least important of the three joints of the thumb. It is uniaxial hinge joint between the proximal phalanx and the distal phalanx. ***Ligaments:*** The joint has a palmar ligament, two collateral ligaments, and a fibrous capsule. ***Synovial membrane:*** It lines the joint capsule. ***Vascular supply:*** It is supplied by branches from the palmar digital arteries. ***Innervation:*** It is innervated by the palmar digital branch of the median nerve. ***Movements:*** Flexion and extension, flexion is