Functional Anatomy of the Hand

IONE SELLARS

OPSOMMING

Sekere aspekte van die funksionele anatomie van die hand word beskryf. Daar word spesiale klem op individuele gewrigte, veral die karpometacarpale gewrig van die duim gelê. Spiere wat verantwoordelik is vir gewrigsbewegings, word getabuleer en bewegings van die hand as geheel word kortliks bespreek.

SUMMARY

Aspects of the functional anatomy of the hand are described with special emphasis on the individual joints, especially the carpometacarpal joint of the thumb. Muscles responsible for joint movements are tabulated and movements of the hand as a whole are briefly discussed.

STRUCTURE

The skeleton of the hand consists of nineteen long bones of varying size (Fig. 1). These are connected together, and to the bones of the wrist (carpus) by uniaxial, biaxial and multi-axial joints. Movements of these joints are controlled by both intrinsic and extrinsic muscles of the hand.

The blood supply to the hand comes from the deep and superficial palmar arterial arches which are the terminal branches of the radial and ulnar arteries. From these arches branches pass into the substance of the hand and fingers, each artery being accompanied by veins. Nerves that supply the hand and the muscles that control it, are the three major branches of the brachial plexus, the radial nerve (C5678T1), the median nerve (C678T1) and the ulnar nerve (C78T1).

Use of the hand depends upon synchronized muscle and joint action. Knowledge of the structure and movement of each joint and the muscles responsible for the actions that occur, is important in the understanding of the function of the hand. The joints and the movements that take place are described in some detail and the muscles responsible are considered.

JOINTS

1. Interphalangeal

There are **nine interphalangeal joints.** These are uniaxial synovial hinge joints each with a synovial lined capsule, palmar and collateral ligaments. Active movement is confined to flexion and extension.

IONE SELLARS, M.Sc. (Med.), M.C.S.P., Dip. TP.
Senior Lecturer, Dept of Anatomy, University of Cape Town. (Deceased)

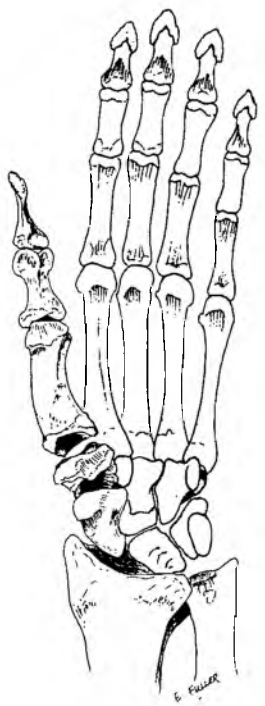

Fig. 1. The skeleton of the hand.

2. Metacarpophalangeal

The **metacarpophalangeal joints** are biaxial. Each joint capsule is supported collaterally by obliquely placed ligaments, and ventrally by a palmar plate of dense thick fibrocartilage.[1] These palmar plates or ligaments are grooved for the long flexor tendons, and interconnected by the deep transverse metacarpal ligaments. These transverse structures hold the metacarpal heads of the fingers together preventing their distraction

during hand movements. Dorsally each extensor digitorum expansion is separated from the appropriate joint capsule by a bursa. Movement of the metacarpophalangeal joints of the fingers includes flexion, extension, abduction and adduction. Rotation is demonstrated especially as an accessory movement during strong gripping actions. The metacarpophalangeal joint of the thumb allows less movement than is seen in the fingers except for rotation which can be considerable.[1]

3. Carpometacarpal

The **carpometacarpal joints of the fingers** connect the metacarpal bones with the carpus. The joints together with the intermetacarpal joints often share a common synovial cavity with the intercarpal joints. They are supported by palmar, dorsal and interosseus ligaments. Movement that occurs here is secondary to actions of the fingers and thumb. Slight gliding between adjacent articular surfaces takes place especially during grasping actions as the hand moulds to the shape of the object being held. The amount of movement which occurs does vary, the metacarpal of the little finger being the most mobile.

The carpometacarpal joint of the thumb is the most important joint of the hand. Without it, opposition of the thumb to the fingers is lost; the power, precision and dexterity which is so often taken for granted would be greatly reduced. The carpometacarpal joint of the thumb is described as a synovial multiaxial joint. It has a synovial lined fibrous capsule, distinct from those of the fingers.

The articular surfaces are the concavoconvex distal surface of trapezium and the similarly shaped base of the first metacarpal bone (Figs 1 & 2). At rest the bones are so placed that the palmar surface of the thumb faces medially across the plane of the fingers (Fig. 1). This position directs thumb movements which are thus at right angles to similar movements of the fingers (Fig. 3).

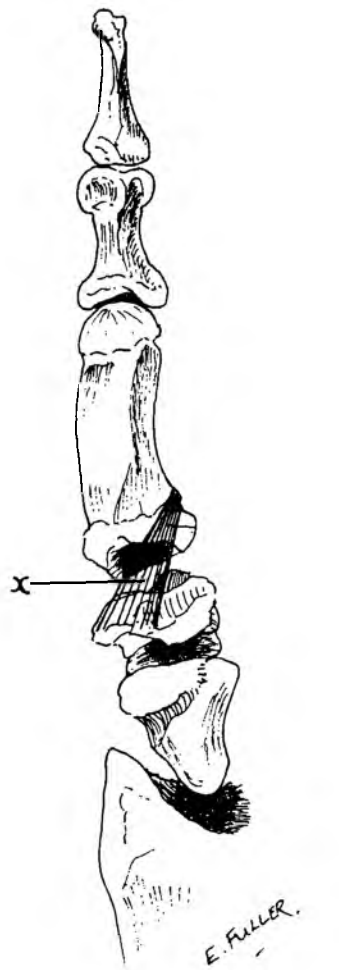

Fig. 2. The bones of the thumb and the position of its palmar carpometacarpal ligament (x).

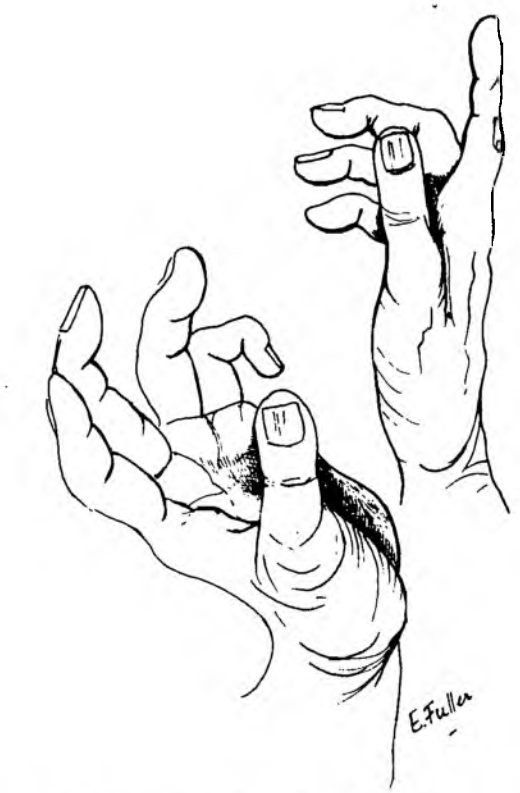

Fig. 3. Positions of the thumb in relation to the fingers.

Three **ligaments** support this joint; they are lateral, dorsal and palmar. The lateral ligament supports the radial side of the joint, connecting trapezium and the base of the metacarpal. The palmar and dorsal ligaments are oblique, stretching from the respective surfaces of the trapezium (Fig. 2). They are directed distally and medially to attach to the ulnar side of the metacarpal bone on each surface[2] anchoring this bone medially.

This medial restriction of the first metacarpal allows the lateral side of the bone to swing across the palm in medial rotation of the thumb, which, when combined with flexion, causes opposition.

FUNCTION

The **muscles** responsible for isolated movement at individual joints are listed in Tables I and II. However, it is rare that specific movement in the hand is so distinctly isolated. These muscles are constantly contracting and relaxing, changing the position and shape of the hand to suit its situation and desired function. When the hand is poised to grip, muscles contract to spread the fingers (extension and abduction) while synergistic muscle action at the wrist fixes the radiocarpal joint in extension. The succession of movements which then occurs is as follows: flexion of the fingers begins at the metacarpophalangeal joints with contraction of the intrinsic muscles (lumbricals and interossei) which move the fingers through an arc of about 90°.[3]

Table I.

FINGERS

	Distal interphalangeal joints		*Proximal interphalangeal joints*	
	Flexion	*Extension*	*Flexion*	*Extension*
Flexor digitorum Profundus	*		(*)	
Flexor digitorum Superficialis			*	
Interossei		*		*
Lumbricals		*		*
Long Extensors				(*)
( ) assisted by				

METACARPOPHALANGEAL JOINTS

	Flexion	*Extension*	*Abduction*	*Adduction*
Lumbricals	*			
Long flexors	(*)			
Long extensors		*		
Dorsal interossei	*		*	
Palmar interossei	*			*

Table 2.

THUMB

	Interphalangeal Joint		*Metacarpophalangeal Joint*	
	Flexion	*Extension*	*Flexion*	*Extension*
Flexor pollicis longus	*		*	
Flexor pollicis brevis			*	
Extensor pollicis longus		*		*
Extensor pollicis brevis				*

CARPOMETACARPAL JOINT

	Flexion	*Opposition*	*Extension*	*Abduction*	*Adduction*
Flexor pollicis brevis	*	*			
Opponens pollicis		*			
Abductor pollicis brevis				*	
Abductor pollicis longus			*	*	
Adductor pollicis					*
Extensor pollicis longus			*		
Extensor pollicis brevis			*		

Subsequently the long flexors (flexor digitorum superficialis and profundus) contract, causing flexion at the interphalangeal joints which close the hand. Full finger flexion occurs with adduction to complete the tightly closed fist. During this action each finger tip appears to converge towards the scaphoid bone.[4]

The thumb can be opposed to each finger in turn or to all the fingers together. To form a clenched fist (power grip) the thumb is first extended and is then flexed and medially rotated. In the 'precision grip' the distal phalanx of the thumb can be placed against any finger tip by contraction of flexor pollicis longus. A more powerful grip is obtained by the added contraction of the adductor pollicis muscle.

When the fingers and thumb firmly hold an object the metacarpals are rotated at the metacarpophalangeal joints by intrinsic muscle action. This rotation allows the fingers to mould to the shape of the object being held.

The hand is one of the most active parts of the body. It is capable of amazing strength and control. Yet it is also the instrument of dexterity and compassion, as seen in the hands of an artist or a musician, or even in the hands of those who care for the sick.

References

1. Warwick & Williams eds. *Gray's Anatomy*. 35th ed. London: Longmans, 1973.
2. Haines RW. The mechanism of rotation at the first carpometacarpal joint. *J Anat* 1944; **78:** 44-46.
3. Kilgore E and Graham W. *The Hand: surgical and non-surgical management*. Philadelphia; Lea & Febiger, 1977: 400.
4. Tubiana R. *The Hand*. Philadelphia: Saunders & Co., 1981: 22.