THE MANAGEMENT OF THE CONTRACTED FIRST WEB SPACE

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The function of the thumb is usually assessed at between 40 and 60% of the total function of the hand. The usefulness of the hand as a whole depends on variations of the pinch grip and the power grip. The thumb forms one limb of the pinch grip, and of the radial component of the power grip, as in holding a screwdriver—the ulnar component of the power grip is used as in holding a golf club.

The position of the metacarpal determines the position of the thumb tip for the pinch grip; when the metacarpal is fully abducted and extended it determines the 'span' of the hand, and so the grasp for the power grip. Hence the need for a fully mobile thumb metacarpal with an adequate first web space to allow free movement of the thumb. In both the pinch grip and the power grip the metacarpal of the thumb swings across the palm as a gate which is hinged at the carpo-metacarpal joint.

FUNCTIONAL ANATOMY OF THE FIRST WEB SPACE

Anatomy of the Skin and Subcutaneous Tissues

As shown in Fig. 1, the distal free margin of the normal skin fold runs in a gentle curve from a point just distal to the metacarpo-phalangeal joint of the thumb to a point opposite the metacarpo-phalangeal joint of the index finger. The distal edge of this fold is a supple margin formed by the fusion of the dorsal and palmar skin.

The dorsal skin is relatively lax and separated from the muscles of the first web space by loose connective tissue in which run the dorsal digital nerves to the index finger, the origin of the cephalic vein, and the terminal branches of the radial artery. These are the princeps pollicis artery, and the radialis indicis artery, with the terminal portion of the radial artery diving between the 2 heads of origin of the first dorsal interosseus muscle to enter the palm and form the radial component of the deep palmar arch. These arteries of the first web space commonly run a variable course. Should it prove necessary to divide one of these during operation, both ends should be ligated.

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The palmar skin is thick 'gripping skin' which is attached to the palmar fascia by vertical fibrous bands running through the palmar fat. There is a skin crease running obliquely across the web skin of the thenar eminence where the skin folds when the thumb is brought across the palm. The neurovascular bundles to the adjacent sides of the index finger and the thumb emerge from under the palmar fascia and run along the adductor pollicis muscle into the index finger and thumb.

Anatomy of the Muscles

The first dorsal interosseus muscle runs obliquely across the first web space from the base of the first metacarpal to the radial wing tendon of the extensor expansion of the index finger. The muscle belly is covered by a substantial fascial envelope. The action of this muscle is important in stabilizing the index finger for counter-pressure to the thumb in the pinch grip. It is always supplied by the deep branch of the ulnar nerve.

The adductor pollicis muscle arises by 2 heads which are separated from the palmar surface of the first dorsal interosseus muscle by loose areolar tissue.

The fan-shaped transverse head arises from the distal two-thirds of the palmar surface of the shaft of the third metacarpal. It is inserted by a common tendon from the oblique head to form the ulnar wing tendon of the extensor expansion of the thumb.

The oblique head arises from the bases of the second and third metacarpals and the surrounding bones and ligaments of the carpus.

The nerve supply to both heads is from the deep branch of the ulnar nerve. The oblique head at least may occasionally be supplied by the median nerve.[1]

The action of this muscle is to adduct the thumb and to stabilize the metacarpo-phalangeal joint of the thumb by pulling on the wing tendon. Hence its importance in both the pinch and the power grip. This action is opposed by long and short abductor muscles; and by the long and short extensor pollicis muscles.

First palmar interosseus muscle (also called the deep head of flexor pollicis brevis) arises from the proximal half of the palmar surface of the first metacarpal and is inserted with the

adductor pollicis tendon. It is supplied by the deep branch of the ulnar nerve.

MECHANISM OF CONTRACTURE OF THE FIRST WEB SPACE

As is shown in Fig. 1, the normal thumb in the fully abducted position forms an angle with the index finger of 90°. In the normal adult the 'span' measures 6 - 7 in. from the tip of the thumb to the tip of the index finger. Any reduction of this means there is some degree of contracture of the first web space.

The skin itself may be contracted as is seen in scarring following burns. For relief of this contracture all scar tissue must be excised, the secondary soft tissue contractures must be corrected, and the resulting skin defect must be covered by healthy pliable skin, using local flaps by preference. If no local flaps are available, free skin grafts, either full-thickness or thick split-skin may be used, but the grafts will always contract to some degree. Rarely, a flap from a distance may be required.

The muscles of the first web space may be primarily or secondarily involved in the contracture:

(a) *Prolonged incorrect splintage*, with the thumb in the adducted position, is probably the commonest cause of a contracted first web space. The muscle fibres of the adductor pollicis and the first dorsal interosseus become shortened and more especially there appears to be a thickening and contracture of the fascia over the first dorsal interosseus muscle.

(b) *Infection of the first web space* may cause contracture due to scar formation.

(c) *In an ulnar nerve palsy* the muscles of the first web space are paralysed, the muscle fibres shorten and are partially replaced by fibrous tissue.

(d) *With a radial nerve palsy* causing paralysis of the abductor pollicis longus muscle and the extensor pollicis longus and brevis muscles, the adductor pollicis muscle becomes unopposed. If the 'span' of the first web space is not maintained by splints, the fibres of the adductor pollicis muscle become shortened and there is fibrous tissue laid down to cause a permanent contracture.

(e) *With a median nerve palsy* and paralysis of the opponens muscle, the long muscles supplied by the radial nerve are in themselves capable of securing full abduction and extension of the thumb.

The joint capsule of the saddle-shaped carpo-metacarpal joint of the thumb often becomes secondarily contracted. If this has occurred, a capsulotomy of this joint may be required to secure full release of the thumb metacarpal.

TREATMENT

Prophylaxis of Contracture of the First Web Space

The hand may require splinting for lesions of the hand itself, e.g. in the case of trauma or burns; or it may be splinted for lesions of the forearm, e.g. in the case of fractures of the forearm bones or for nerve paralysis.

If the thumb requires immobilization—as with a fracture of the scaphoid bone, or if the muscles acting upon the thumb are paralysed—the position of the thumb in the splintage should always be in the fully abducted position and with the metacarpal of the thumb in the position of full opposition.

If the thumb is to be left free, and it has normal motor function, the splintage must be cut away from the thenar eminence to allow the thumb to perform a full range of movement.

Treatment of Contracture of the First Web Space

If the contracture is caused by scar tissue, this scar must be excised and the skin defect covered by healthy pliable skin. This skin may be supplied by a local flap of skin from the dorsum of the hand, if this is available. More commonly a free skin graft is required. All free skin grafts will contract, and so tend to cause a relapse of the condition, but this may be minimized by using a thick graft, either a full-thickness (Wolffe) graft, or a thick split-thickness graft (Dermatome). Occasionally, it may be necessary to fill the skin defect with a pedicle flap (usually from the abdomen).

Paul Brand, writing in 1959[2] on the problem of the contracted first web space in patients suffering from leprosy, makes two important observations:

1. That the skin incisions, made on the Z-plasty principle, should have unequal flaps.
2. That where the contracture had been present for some time, even with normal structures within the web space, that release of the skin alone usually did not provide adequate release of the contracture. The fascia and muscles of the first web space must always be explored for thickened bands that bind down the first metacarpal.

This paper sets out the various stages for the operation of release of a contracted first web space as advocated by Paul Brand, but with some modifications. All the stages may not be necessary to correct the deformity. In fact with a thumb of normal length, it may be undesirable to deepen the first web space too much, since this leaves a very ugly hand without necessarily improving function.

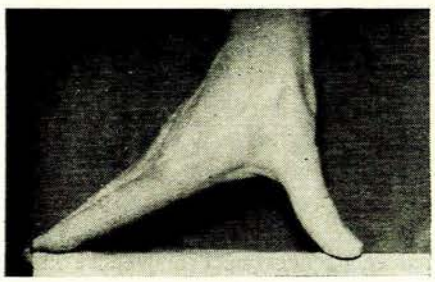

Fig. 1. Span of normal first web space.

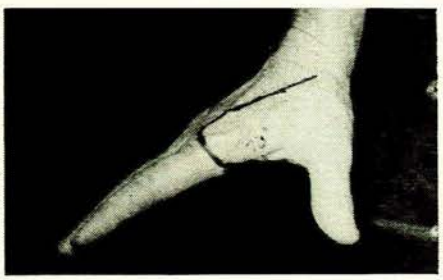

Fig. 2. Dorsal skin incision for Z-plasty first web space.

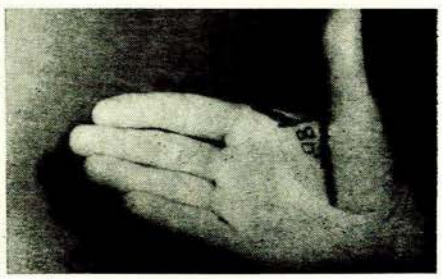

Fig. 3. Palmar skin incision for Z-plasty first web space.

Case 3, with a short thumb, demonstrates that this operation carried to its limit will provide adequate phalangization of the first metacarpal.

THE OPERATION FOR RELEASE OF THE FIRST WEB SPACE

Skin Incisions

Under a bloodless field the skin incisions are made on the Z-plasty principle, using unequal flaps as shown in Figs. 2 and 3. When the wound is closed the large dorsal flap is brought through into the palm. This leaves a skin defect over the dorsum of the index metacarpal which is covered by a thick split-thickness graft.

The Deeper Structures

The dissection is carried out from the dorsum through to the palm. The first dorsal interosseus muscle is usually shortened with a contracted first web space. Often incision of the fascia covering this muscle alone will provide adequate release. If this does not occur as expected, then the origin of this muscle is stripped off the periosteum of the base of the first metacarpal.

The transverse head of the adductor pollicis muscle usually requires some degree of release. The degree to which this muscle is released will determine the ultimate depth of the new first web space. This muscle is released either by dividing the muscle fibres in the centre of the web space at right-angles to the line of the fibres, or by stripping the origin of the muscle from the third metacarpal. If the oblique head of the adductor pollicis muscle is normal, one may strip the distal two-thirds of the transverse head without causing material weakening of the power of adduction of the thumb.

The palmar fascia is divided in the line of the palmar skin incision as far proximally as is necessary to secure release of the first metacarpal. Care is obviously taken not to divide the motor branch of the median nerve to the thenar muscles, or the neurovascular bundles to the index finger or the thumb. The carpo-metacarpal joint of the thumb may be held by secondary contracture of the capsule. This is released if necessary by a capsulotomy.

CASE HISTORIES

The following clinical cases show some of the deformities that can be improved by this operation.

Case 1

The patient was a right-handed White male of 58 years, who had cut himself across the right wrist in a suicide attempt 3 years before. He had had a primary repair of all the flexor digitorum profundus tendons, the flexor pollicis longus tendon, and the median and ulnar nerves. As shown in Figs. 4 and 5, his present position was that all his long flexor tendons were pulling adequately, he had protective sensation over the whole of his hand, the opponens pollicis muscle had a fair function, but no re-enervation of the other small muscles of the hand had occurred, leaving him with a fixed claw hand with an adducted first web space.

At the first operation he had an arthroplasty of the fixed metacarpo-phalangeal joints of the index, middle, ring and small fingers performed; and in addition, the operation for release of his adducted first web space as described above.

Fig. 4

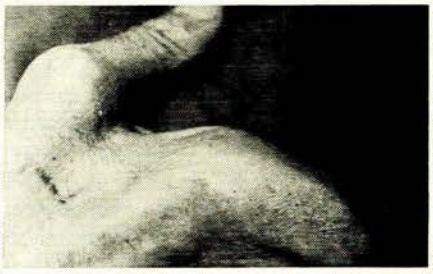

Fig. 5

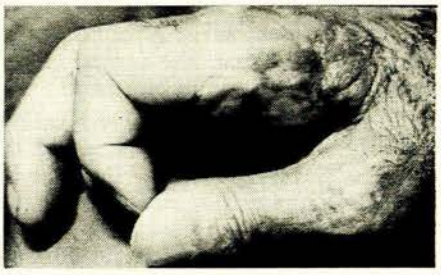

Fig. 6

Fig. 4. Case 1. Shows the thumb in adducted position before operation, at rest, with fixed hyperextension deformity of all metacarpo-phalangeal joints of the fingers. *Fig. 5. Case 1.* Maximum assisted abduction of thumb, showing contracted first web space, before operation. *Fig. 6. Case 1.* Shows thumb and index finger in pinch position after operation.

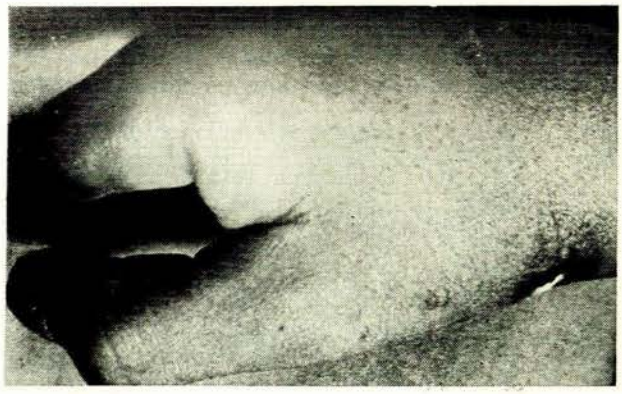

Fig. 7. Case 2. Thumb and index finger in maximum pinch position before operation.

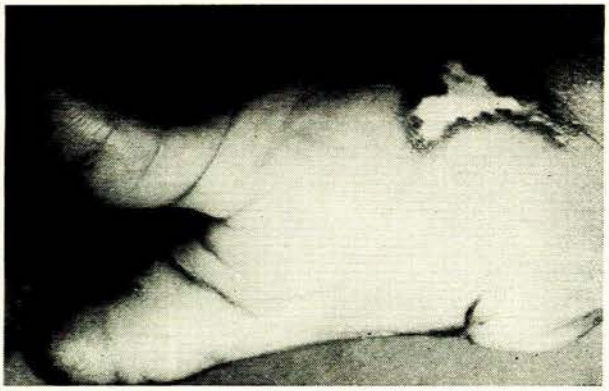

Fig. 8. Case 2. Tight scar pulling index finger into ulnar deviation before operation.

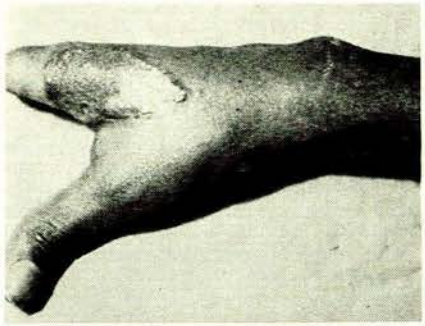

Fig. 9

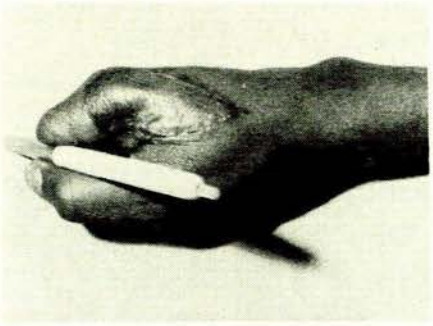

Fig. 10

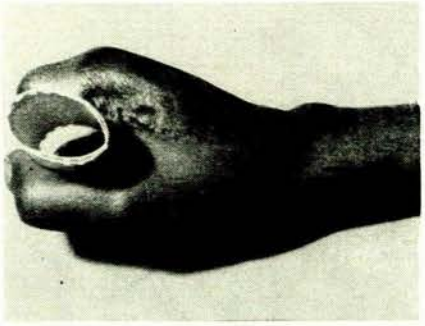

Fig. 11

Fig. 9. Case 2. Postoperative view showing deepening of first web space with skin graft on the dorsum of the index finger. *Fig. 10. Case 2.* Postoperative view showing restoration of pinch grip. *Fig. 11. Case 2.* Postoperative view showing position of power grip.

Fig. 12. Case 3. Postoperative view showing flap repair of metacarpal head, and how large dorsal skin flap has been brought through into the palm.

Fig. 13. Case 3. Postoperative view showing phalangization of first metacarpal.

He has had his pinch mechanism restored with a reasonably adequate span for power grip (Fig. 6). He has been offered a tendon transfer operation to replace the missing intrinsic muscle action of the hand.

Case 2

The patient was a right-handed Bantu male aged 28 years, who fell under a train and sustained an ulnar hemi-amputation of the right hand; taking the index finger through the distal two-thirds of the middle phalanx and the head of the middle finger metacarpal (Figs. 7, 8). The scar on the ulnar border of the hand had contracted and pulled the shortened index finger away from the thumb, so that pinch grip was impossible. The thumb and the first web space were normal.

At one operation the scar along the ulnar border of the index finger and palm remnant was released by 3 Z-plasty incisions. A rotation osteotomy was performed upon the shaft of the second metacarpal so that the pulp of the index finger was rotated in order to be able to pinch against the thumb tip. The first web space was deepened by the operation described above. The improved function of the hand in his ability to carry out the pinch grip and the power grip are shown in Figs. 9 - 11.

Case 3

A right-handed Bantu male of 34 years had his left thumb neatly amputated through the metacarpo-phalangeal joint. As a primary procedure the cartilage was removed from the end of the metacarpal and the bare bone was covered by an abdominal flap.

As a second-stage operation, his first web space was deepened as described above to phalangize the metacarpal. The span of the hand and the position of the dorsal skin flap as it comes through the palm is shown in Fig. 12 and a photograph of the dorsum shows how well the metacarpal can be abducted (Fig. 13), and also shows the large split-skin graft that has been placed over the index metacarpal.

SUMMARY

The diagnosis and aetiology of a contracted first web space is discussed.

The functional anatomy of the first web space is described.

The prevention and treatment of a contracted first web space is described. The Paul Brand operation for release of this contracture is detailed.

Three clinical cases are presented, the first being a case with a contracture of the first web space, while the second two cases are shown as examples of how this operation can be used to improve the function of the hand where parts are missing but the first web space itself is normal.

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