FIRST WEB CONTRACTURES- AN OVERVIEW

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Importance of first webspace contractures can be illustrated by this powerful quote ***"Complete thumb amputation is the only condition more disabling than a severe first web contracture"***[1]. Widening of the first webspace and thumb opposition are the features of human evolution and provides the great versatility to the thumb for various functional activities that a man is able to perform. It is this thumb opposition and abduction which takes a hit in first web contractures.

Anatomy

Normal webspace is a complex, multi-layered anatomic region spanned by first and second metacarpals. It is triangular in shape with its vertex located at the base of the first and second metacarpals. It harbours the bellies of the adductor pollicis and first dorsal interosseous muscles with their investing fascia (*Fig 1*).

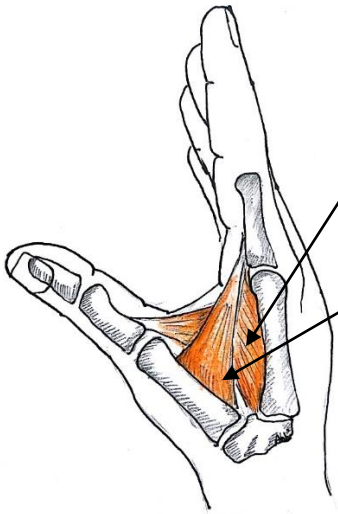

Fig 1- Muscles of First Webspace.

SALIENT CHARACTERISTICS

Predominant characteristics of first webspace are suppleness and strength which are highlighted during grasping and pinching. In span grasping, (*Fig. 2*) the web has to be supple to allow maximal opening of the thumb for grabbing large objects. Once the object is held, (*Fig. 3*) power is needed to keep it in the hand; the muscles of the web are responsible for 80 percent of pinch strength. [2]

Fig. 2 Span grasp in which thumb should be maximum abducted and to bring it in another plane → which requires a 'supple' web.

Fig. 3 Key pinch → requires web muscles to be strong.

Development of web contractures is an ongoing process and the amount of time elapsed since the injury increases the severity and hence worsens the prognosis of the web release surgery. Initially the web contracture is elastic but soon becomes irreversibly fixed. Another specific characteristic of first webspace contractures is the ***"phenomenon of progressive involvement of formerly healthy layers"*** i.e, problem may start in one structure (e.g., deficient skin) but in time it becomes widespread and the other structures also become contracted in progressive manner (i.e., affects muscle, fascia, ligaments)[3-5]. Hence during the web release the surgeon will have to divide structures that were former healthy and uninvolved in primary pathology.

Progression of 1st web contracture –

Three periods of evolution in first web contracture have been described, that are independent of its severity: elastic, reversible, and fixed. In elastic first web contracture which lasts for initial 4-6 weeks full correction can be expected by passive abduction of the thumb and active exercises for strengthening of the abductor muscles. Reversible contractures respond to splinting while fixed contractures will require surgical intervention.[6]

Another characteristic of first webspace is that because of its triangular shape, small limitations of aperture at its base have a major effect on the extremes of the triangle (the thumb and index pulps) [6]. As we move away from the axis of abduction the contracture effect of the tissues in first web space increases because of longer lever arm (*Fig.4*).

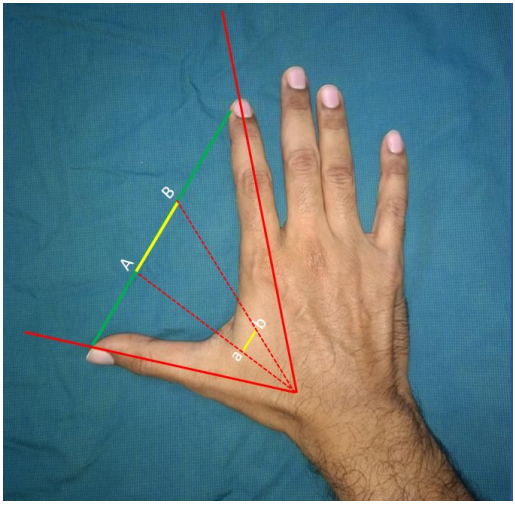

Fig. 4- Limitation at the vertex of the triangular web space (a-b) causes major effect at extremities i.e. between thumb and index towards the base (A-B).

Aetiology

Most common aetiologies of web contractures are trauma, burns, Dupuytren's disease, congenital shortening of muscles of the first web space and paralysis of the median innervated thenar muscles. Francisco del Piñal, has described five types of post traumatic contractures which include idiopathic, retracting band, major skin loss, deep scar, and ischemic[6].

1) **Idiopathic** - It is common to find first web space contractures despite no apparent primary pathology to the webspace. This can be attributed to swelling of the hand and hand positions following immobilization.

   A. Swelling - As the hand swells, the previously flattened skin will expand until the hand is nearly balloon- shaped. In this process, the first metacarpal moves toward the second metacarpal to allow the skin envelope to deform as a sphere. (*Fig.5*)

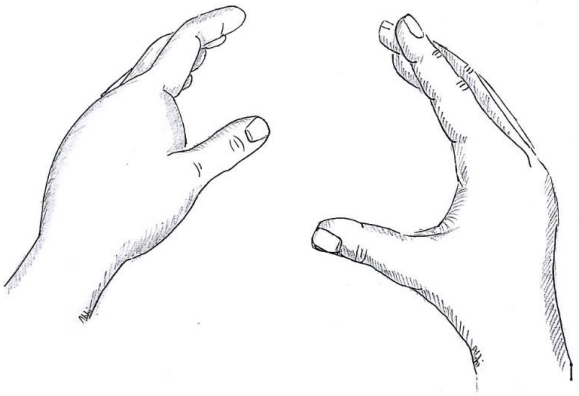

Fig.5- Swelling of hand causes adduction of the first metacarpal towards second to accommodate the swelling under the skin on radial side thus limiting the first webspace span.

B. Hand position - While the wrist is in flexion, the extensor pollicis longus muscle will passively drag the thumb into extension and, most importantly, into adduction-supination. In a position where elbow is flexed in a sling with the hand up against the trunk the thumb is cranial and will spontaneously fall against the index finger by its own weight, thus closing the first web (*Fig. 6*).

When the hand is held elevated against trunk, thumb falls against index finger due to gravity and thus predisposes to development of first web contractures

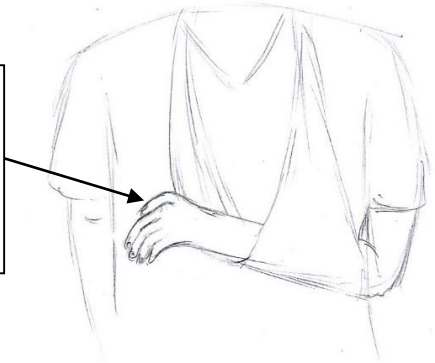

Fig. 6- Figure showing how the position of hand leads to first web contracture formation.

2) **<u>Linear scarring</u>** -Any linear wound that crosses a flexion crease will heal by forming a retracting band and web space is no exception (*Fig-7*).

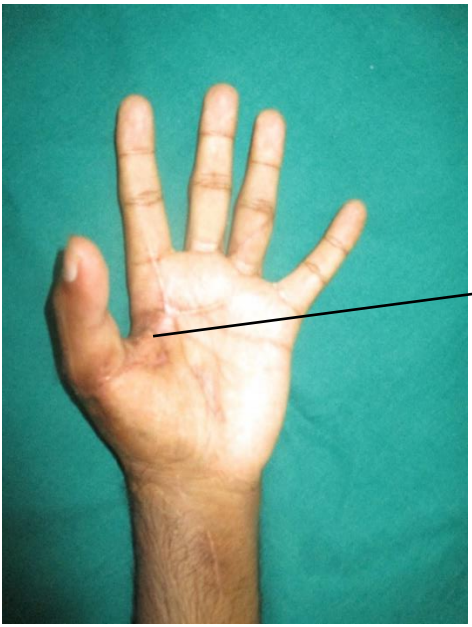

Fig-7 Linear contracture of the first web space decreasing the first webspace angle.

3) Major skin defect over the dorsum of hand will slowly drag the first metacarpal toward the second as it heals, since over the dorsum of the hand, the only mobile part is the first metacarpal at the CMC joint.

4) Major penetrating trauma to the first web is generally accompanied by partial muscle destruction and/or fractures, sometimes with concomitant bone loss. The haemorrhagic fluid, edema, and contused-necrotic muscle fill up the web space, and slowly resolve by forming a cicatricial-retracting magma in the depths of the web. After this type of trauma, neighbouring structures not directly damaged by the injuring agent will be filled with edematous fluid (e.g., the

carpometacarpal ligaments, muscle fascia), and as stated, this will resolve with fibrosis and stiffness in a shortened position.

5) **Ischaemic** - One of the inconspicuous causes of development of first web contractures is ischaemia to the muscles following compartment syndrome particularly on the radial aspect of the hand. Failure to release swollen muscles confined in closed osseofascial compartments invariably causes muscle death, fibrosis and subsequently contracture.

Prevention

Prevention is mainly aimed at the above-mentioned pathogenesis.

- **Swelling**- Limb elevation for trauma cases is most important to prevent swelling.
  Careful tissue handling would go a long way in preventing post-operative swelling and thus avoiding contractures.

- **Hand position-** While positioning the hand, care must be taken to keep thumb in full palmar abduction in line with the radial border of index finger (*Fig.8*).

Fig. 8 1st web spreader keeping thumb in maximum palmar abduction such that it should in line of radial border of index finger.

- **Linear scarring** across the web can be avoided by use of Z-plasties while larger defects should be covered early using supple tissues.

- **Deep crush injuries/ scars-** Immediate radical debridement of all devitalized tissues to diminish the potential cicatricial mass and to minimize the risk of infection should be done in cases of deep injuries to first web space like a *"First web burst injuries"*. This should be followed by bony stabilisation to prevent contracture in the form of transmetacarpal K-wires or thermoplastic splints and primary coverage with a nonretracting flap.

- **Ischaemia**- Early recognition and release of compartment syndrome particularly those involving the radial side can be done by giving one incision in the thenar area and one in line with the second

metacarpal so as to prevent development of contractures.[7,8] The contracture of these ischemic muscles can be prevented by prophylactically putting a wire across the first and second metacarpal to maintain the web space.

Evaluation

Need for measuring 1st web angle is for documentation of preoperative, postoperative and follow up. Such that we can document and intervene early as it was prone for high chances of recurrence.

There were multiple ways of measuring 1st web angle.

1. Clinical measurement by goniometer (Fritschi)
2. Radiological measurement between 1st and 2nd metacarpal axis with radiograph taken in maximum palmar abduction.
3. Stent mould angle described by S. Bhattacharya
4. Triangular Wooden block method by Shrinivasan.

There is no universally accepted way of measurement of 1st web angle. The most widely used method is by use of goniometer with the thumb in maximum palmar abduction. With patient in sitting position and hand rested on a table, the fixed arm of goniometer should be kept in line with axis of 2nd ray, centre of the goniometer corresponding to first CMC joint and the mobile arm of goniometer is used to measure the web angle along the thumb while keeping thumb in full palmar abduction (*Fig. 9*). Normal webspace angle if

the first and second metacarpals are used as reference (clinical or radiological) has been found to be 40 – 60 degrees. If the angle is measured using the thumb and the index finger as reference or by using stent mould and wooden blocks it will come around 70-90 degrees. The laxity in the thumb joints is the reason for this difference in the values.

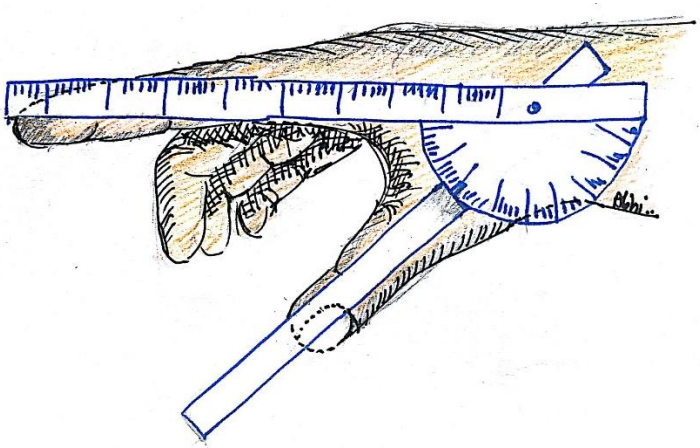

Fig. 9- With thumb in full palmar abduction, fixed arm of goniometer along the axis of 2nd metacarpal, centre at first carpometacarpal joint and the mobile arm along the 1st metacarpal axis will give the webspace angle.

Treatment considerations

1) **Timing of Release**

   In initial 4-6 weeks, the contractures are said to be elastic and are amenable to conservative management in form of passive abduction stretching and active abduction exercises. From 4-6 weeks to 3 months, the contractures are inelastic and respond to splinting to

some extent. Beyond 3 months surgical intervention is almost always required.

2) **Depth of release**- Depth of release depends on the structures involved. Generally, after skin is divided, the webspace is stretched in a controlled manner and fascial bands which are holding the webspace are divided. If needed the muscles can be elevated from the site of origin (i.e, Adductor pollicis from 3rd metacarpal and 1st dorsal interossei from 1st metacarpal). One has to be very careful about the princeps pollicis artery while performing release as the artery will be traversing the first webspace at its apex near to the base of first metacarpal.

3) **Coverage Options-** Assessment of contracture with respect to whether it is a linear band or biplanar contracture should be done, as a single band is more amenable to Z plasty while other would most probably need a flap coverage. A plethora of options are available when it comes to coverage of first webspace defects. Skin Grafts although simple and helpful in coverage of large areas, are seldom used for web contractures resurfacing because of their inherent tendency for contraction but are routinely combined with local flaps. Local flaps have the advantage of having a close match to native web space tissue but are limited by the fact

that they may be in short supply, especially in burn or trauma situations.

Four flap Z plasties (*Fig. 10*) with a gain of 100% and five flap Z plasty (jumping man) (*Fig. 11*) with an incorporated V-Y advancement flap which gives a gain of 125% are time tested options in management of linear band contractures.

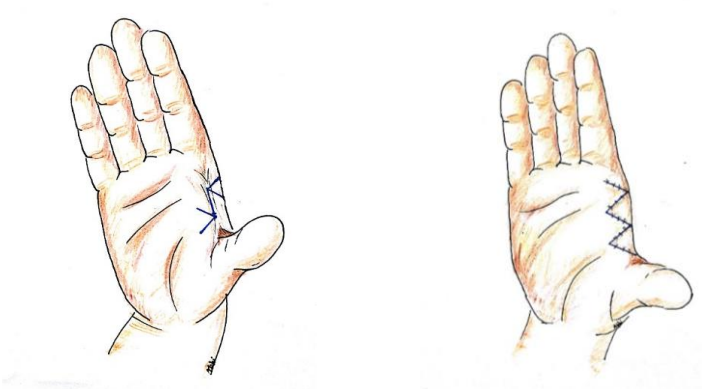

Fig. 10- Four flap Z plasty.

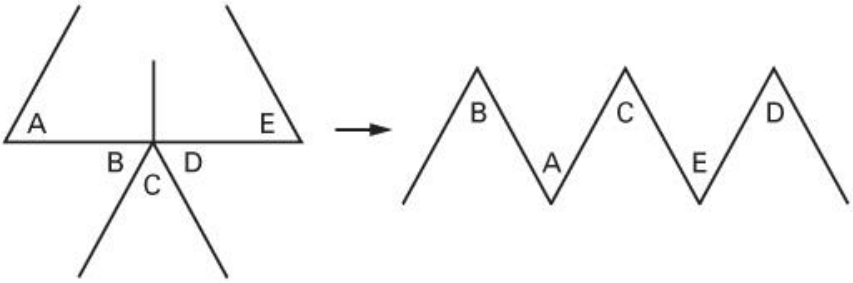

Fig. 11 Five flap Z plasty.

Posterior Interosseous Artery (PIA) flap is fasciocutaneous flap based on PIA, although quoted to have variable vascular anatomy it has the advantage of being away from zone of injury and providing supple tissue for coverage after release (*Fig.12*). Other flaps which can be used for first web contractures include the free lateral arm flap, groin flap (either distant pedicle flap or free flap) and reverse radial forearm flap. As the 1st web contracture is most commonly associated with other complex trauma, where local pedicle flaps usage is limited, groin flap is most commonly used to cover defect after its release.

Fig. 12- Case of severe first web contracture following post traumatic sequelae treated with PIA flap coverage.

Role of Splints and External fixation devices:

Splints have an important role, both in attempting to reverse minor contracture and in maintaining the gain achieved by surgical release of the shortened first web. Such splints may be external or internal, static or dynamic, temporary or permanent[9,10]. Temporary external splints of a static nature are generally applied following definitive treatment of a potential or established contracture. These are usually constructed at the time of surgery from plaster of Paris and may later be replaced by thermoplast (*Fig – 8*). External splints are often difficult to apply accurately in the injured hand and more reliable maintenance of first webspace can be achieved by temporary internal splintage using K wires. Transmetacarpal K wires are the only option when the web space has not been opened. Internal dynamic splints or spring pins (wire bent to make a configuration) can only be used when the web has been opened. They are inserted into holes drilled in one cortex either side of the metacarpals and are usually placed in the plane between the adductor pollicis and the first dorsal interosseous (*Fig 13*).

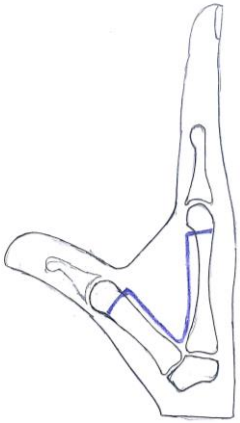

Fig 13 - Internal dynamic splints or curved splints being used to maintain the first webspace in a mutilated hand.

To summarize, severe first web contracture is a highly disabling condition owing to the loss of opposition and abduction of the thumb. It can be prevented by paying attention to minor details like oedema prevention, splinting the thumb in palmar abduction, avoiding linear scars and early coverage of dorsal defects. Z plasty, groin flap and PIA are few of the many reconstructive options for coverage of well-established first web contractures after an adequate release.

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