

## Review Article

# Tendon transfer for median nerve palsy

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### ABSTRACT

The article describes the approach practiced by the author from 1995. Mainly Hansen's patients and lower forearm injuries formed the bulk of these. In Opponen's transfer ECU was used only when others were not available as the wrist developed a tendency to radial deviation even when FCU was acting. PL with palmar aponeurosis as extension was used again in limited cases. The main stay was FDS and EIP. The Guyan's canal and lower end of ulna were the common pulleys. APB and EPL two slip inserts yielded good results. The approach describes the procedure under three distinct headings of choosing motor, Pulley and insert. Varying combinations of these can be used as per requirement.

### KEY WORDS

Opponensplasty; opponens palsy; low median paralysis; tendon transfer for median nerve paralysis

### INTRODUCTION

Median nerve lesions can be low or high depending on the site of injury. In low lesions, the extrinsic muscles supplied by median are spared. Abduction, opposition and pronation are lost resulting in loss of pinch. If the FPB is paralysed or weak, the MP joint goes into extension and the interphalangeal (IP) joint goes into flexion [Figure 1].

I consider opposition as near circumduction of the thumb. Opposition movement starts first from EPL and EPB acting, to gently take the thumb away from the palm, followed in sequence by APL, APB, OPB, FPB and finally adductor pollicis acting to give force against the object.

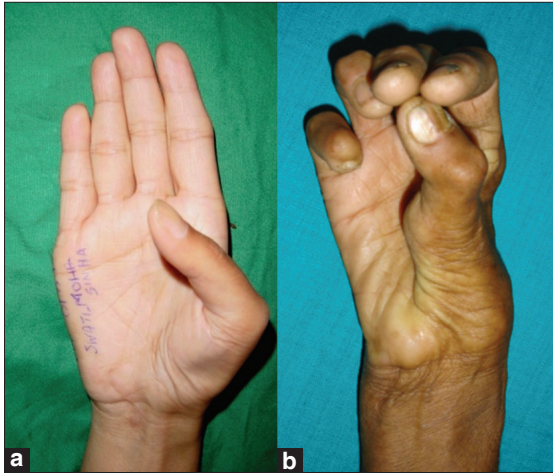
This full circle of movement is altered in all the nerve palsies. In radial the dorsal part of the circle, in median the main central part of the arc and in ulnar the final inner part of the circle are compromised.

In high lesions the FDS, FDP to index, middle and FPL are involved. In leprosy, it is common to see low median palsy.

### EVALUATION OF THUMB

Examine the thumb carefully by noting its resting position, state of all the muscles moving the thumb and its three joints: the carpometacarpal (CMC) joint at the base, the metacarpophalangeal (MCP) joint in the middle and the IP joint at the distal part. Check the CMC joint for subluxation or contracture in the extended and externally rotated position. Check the MCP joint for arthritis and instability in flexion. Check the IP joint for contracture. Further, verify that the thumb web is adequate and not contracted. When you suspect any joint problem like subluxation or arthritis, radiographs must be taken to confirm the suspicion. When joint problems are present,

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**Figure 1:** (a) Abd.Pollicis wasted and MCP is flexed by FPB. (b) FPB is also wasted, MCP is extended and IP flexed

or, when there is contracture of the thumb web or the IP joint flexion contracture of more than 20°, then transfer cannot be done before correcting them.

### Checking the CMC joint

1. Hold the metacarpal of the thumb with your hand and push and pull the thumb along its long axis. When the joint is normal, it does not move up and down during the manoeuvre, but when the joint is subluxated it does.
2. Take hold of the thumb by its metacarpal, lift it off and across the palm as much as possible. If the terminal phalanx of the thumb can now face the base of the little or the ring finger, it indicates that there is no contracture of this joint in external rotation.

### Checking the MCP joint

1. If there is swelling of this joint, or, if on passively moving the joint you feel crepitus or elicit abnormal or excessive movement in any direction, it suggests arthritis of the joint. Radiographic examination is indicated.
2. Ask the patient to hold the thumb stiff whilst you push it back at the terminal phalanx. When there is instability, this joint buckles into a hyperextended position (the so-called “Z” deformity) during this manoeuvre. In many hands, the Z deformity (MCP joint extension) is present to a varying extent even whilst the thumb is at rest {indicating instability of the MCP joint in flexion} and becomes even more pronounced when you do this test.

### Checking the IP joint

#### For contracture

Take hold of the proximal phalanx of the thumb with

one hand and the distal phalanx with the other hand and passively extend the distal phalanx as much as possible. The extent of extension at this joint varies in different ethnic groups, it being quite high amongst Asians. When the joint cannot be fully extended, measure the extent of flexion contracture with a goniometer and record the contracture angle. If there is flexion contracture of more than 30° refer the patient to a specialist centre.

#### For the state of the extensor

Do this test only when there is no flexion contracture. Steady the thumb by holding it by the metacarpal and the proximal phalanx, and ask the patient to lift the thumb. When the extensor pollicis longus muscle is weak or if its tendon is damaged over the IP joint -and if there is no flexion contracture, the terminal phalanx cannot be lifted fully into the straight or the hyper extended position. Measure the extent of “extension lag” and record it as an “assisted extension angle” or as an “extension lag” by so many degrees.

## ASSESSMENT OF THUMB WEB

Let the patient place the hand on the table, resting on its ulnar border and palm facing one side, and hold the hand steady. You take hold of the thumb by its metacarpal head, not by the proximal or distal phalanx, and move it passively off the plane of the palm and across it (i.e., abduct and make the thumb oppose) as much as possible, stretching the thumb web in the process. Measure the angle between the shafts of the metacarpal bones of the thumb and the index. The measurement gives the “passive abduction” or “thumb web” angle. When this angle is less than 40°, it indicates thumb web contracture. Such patients should be referred to a specialist centre. Corrective surgery without correction of thumb web contracture is sure to fail.

## RESTING POSITIONS OF THE THUMB

Normally, the thumb lies in a plane in front of the palm, its metacarpal diverging away from the palm by 15–20° and the phalanges pointing forward (the MCP joint is flexed by about 20–25° and the IP joint is straight). When all the intrinsic muscles of the thumb are paralysed as in combined paralysis of ulnar and median nerves, the thumb falls back and is more or less on the same plane as the palm, its metacarpal diverges more than normal, the MCP joint is more flexed than normal and the IP joint is flexed by 50° or more.

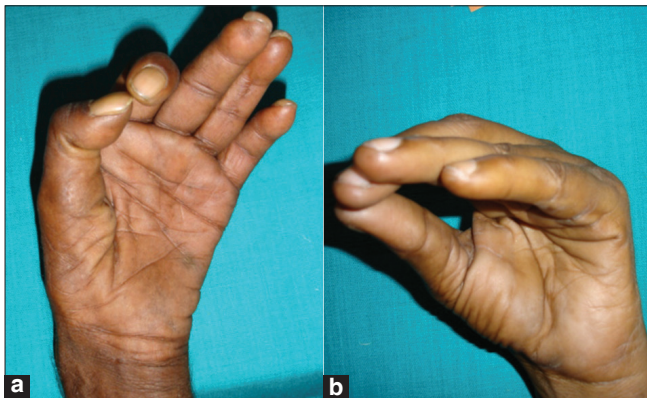
Thus the thumb lies hyper extended at its basal joint and flexed at the middle and distal joints, like the claw finger. This is the “paralytic claw thumb’ deformity present when all the intrinsic muscles are paralysed. When there is only ulnar nerve paralysis and when the flexor pollicis brevis muscle is completely paralysed the thumb shows a characteristic resting posture in which, the CMC joint position is normal, but the MCP joint is straight so that the proximal phalanx now lies in the same line as the metacarpal, or it is hyper extended and the IP joint is flexed by 15–30°.

## CORRECTIVE SURGERY FOR PARALYTIC CLAW THUMB

As mentioned above, the thumb is unable to abduct (lift itself off the palm) because of the paralysis of abductor pollicis brevis and rotate inwards whilst in abduction to face the fingers [oppose] because of the paralysis of opponens pollicis. If flexor pollicis is also paralysed then this also has to be restored otherwise when the thumb comes into contact with the opposing fingers against resistance it will collapse into supination and opposition will be lost (the Crank Handle effect) [Figure 2].

In low median palsy, the muscles involved are abductor pollicis, opponens pollicis and flexor pollicis if supplied by median.

Abduction, opposition and pronation are lost resulting in loss of pinch. If the FPB is paralysed or weak the MP joint goes into extension and the IP joint goes into flexion. Abduction and opposition are to be restored, FPB is required to oppose against forces like ulnar fingers or objects and the thumb must pronate.



**Figure 2:** (a) When FPB is not acting “Crank Handle effect”. Note the index finger on attempted opposition. Collapses the thumb into supination. (b) Normal FPB resulting in good opposition with pronation

For convenience of understanding, we can divide these into three variables.

- The motor.
- The pulley (this changes the direction of the line of pull).
- The insert.

All the muscles supplied by ulnar and radial nerves and median supplied extrinsics are available for transfer in low median palsy.

The motors which are commonly used are

1. FDS of the ring finger.<sup>[1]</sup>
2. ECU extended on a graft.<sup>[2]</sup>
3. Ext. Indicis Proprius.<sup>[3]</sup>
4. Palmaris Longus<sup>[4]</sup> extended with palmar aponeurosis.
5. Abductor Digiti Minimi.<sup>[5]</sup>

The most commonly used motor is FDS of the ring finger. This has adequate length and hence does not require any extension, powerful and easy to perform. However if the patient has hyper mobile finger then, the loss of PIP flexor may result in Swan Neck deformity, which is a difficult deformity to correct. We must also remember that a good percentage of Indian patients have hyper mobile fingers.

ECU is a phasic transfer and will yield good result. Electrical activities are noticed in ECU during normal opposition movement. However if there is an associated high ulnar lesion where in the FCU is paralysed and if we remove ECU also then the wrist may go for radial deviation due to unopposed action of FCR, ECRL and ECRB.

EIP is an easy transfer to perform but since the tendon is thinner and power is less it is better to use it when the flexor brevis function is present and thumb extensor is also not weak. It is ideal wherein we need to replace only abduction rotation. The donor site hood must be meticulously repaired.

I do not prefer Palmaris, as it may be useful as a graft or for some other transfer if necessary. This also needs an extension. Abductor Digiti Minimi gives good aesthetic result, but it may not be available when there is associated ulnar palsy too. Half FPL, Split EPB to ECU are some of the other uncommon transfers which are used in selective cases.

## PULLEY CREATION

Once we have chosen the motor then we have to route it to thumb from the direction of pisiform bone. This necessarily means we need a pulley, which will change the direction of pull and maintain it in that position.

Various pulleys are used for this purpose. The common ones are:

1. Sub-cutaneous pulley around pisiform.<sup>[6]</sup>
2. Guyon's canal.<sup>[7]</sup>
3. Half FCU turned as loop.<sup>[8]</sup>
4. Through the distal part of flexor retinaculum.<sup>[9]</sup>
5. Around Lower end of ulna.<sup>[10]</sup>

Sub-cutaneous tunnel if not taken deep may slowly migrate and loosen the tension over the years. If ulnar nerve is not involved it may be risky to tunnel through Guyon's canal for fear of injury, otherwise it is an excellent pulley. Gliding may not be good in flexor retinacular window. If we are using ECU or EIP then the lower end of ulna is ideal, as it has to curve around it from the extensor side to reach the thumb. One-half of the distal 2–3 cm of FCU can be cut attached distally to pisiform and can be turned to be sutured onto itself as a loop or to nearby ECU and this will serve as a good pulley. I will either use FCU or deep sub-cutaneous pulley.

## CHOOSING THE PULLEY

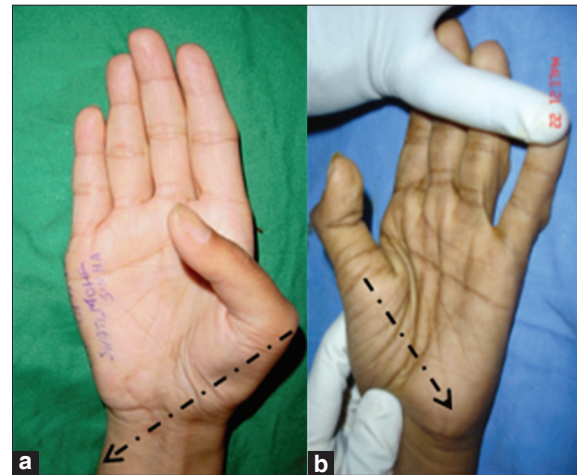
We choose the pulley depending on the line of pull required and it is dictated by the presence or absence of the FPB function. If FPB is acting and only APB is paralysed then the line of pull is logically to be in line with the axis of APB. But if both FPB and APB are not acting, then the direction of pull must be in line with the vector between these two muscles [Figure 3]. Therefore, I choose a proximal pulley like ulna, Half of FCU, mouth of FCR tunnel for the former and a distal or palmar side pulley like Guyon's canal, around pisiform for the later.

## INSERT (DISTAL ATTACHMENT)

Having selected the motor and the pulley now we have to decide on the distal attachment.

The common attachments are:

1. To Abd.Poll.Brevis<sup>[11]</sup> (LITTLER).
2. To Abd.Poll.Brevis continued distally onto dorsal hood and EPL<sup>[12]</sup> (RIORDAN).



**Figure 3:** (a) FPB present and axis of pull should be along mid-axis of APB. (b) Both FPB and APB are paralysed—axis of pull should be between APB and FPB

3. One slip to Abd.Poll.Brevis continued onto EPL and the second to Add.Poll.Brevis<sup>[7,13]</sup> (BRAND).
4. One slip to MP joint capsule and Add.Pollicis and the other to EPL (Common Insert).
5. I normally divide it into two slips and attach one to Abd.Poll.Brevis and the second to the MP joint capsule and EPL taking the slip volar to the axis of the MP joint.

Basic steps as algorithm is

- Choose a motor.
- Route it from the ulnar direction so as to abduct (minimum).
- Select a pulley as described.
- Optionally one slip must travel volar to the MCP joint of thumb for acting like FPB.
- Inserted distally on extensor side of IP to keep IP straight.

## STEPS OF A TYPICAL FDS TRANSFER

Under axillary block the transfer can be done. An incision is made on the radial side of the ring finger proximal PIP region in the neutral line and deepened. Flexor sheath is exposed and incised. The radial slip of FDS is held with a haemostat and divided close to its insertion. When we pull at this slip, the ulnar slip will emerge out and it can also be divided after holding with a haemostat. Next the two slips must be separated until the decussation so that it does not get caught by the FDP, when pulled out into forearm. An incision is made proximal to wrist and medial to the FCU, the FDS can be easily identified by pulling at



the distal end held by haemostat and delivered into the forearm wound. Sometimes when we pull at the tendon, we will notice that the little finger is moving and the tendon cannot be delivered. In such a situation, separate any connections between the two tendons in the forearm. If still we are unable to deliver then we must open the palm and look for any connections between FDS of the ring and little fingers and divide them.

Next an incision is made just distal to the pisiform bone in the palm and the incision deepened to expose small globules of fat suggestive of Guyon's canal. By inserting a tendon tunneller deep through the canal, the FDS slips are pulled through the canal distally.

Next three incisions are made in the thumb. The first one is made in the radial side of the thenar area in the middle of first metacarpal along one of the creases, the second longitudinal incision on the ulnar side of dorsum of the thumb in the region of the MP joint of the thumb for 2 cm, and the third incision is made over the dorsum of proximal phalanx just proximal to the IP joint.

The two slips are tunneled to the thenar wound. Here they are separated for about 5–6 cm. The proximal slip is passed to the ulnar side and the distal one passed to the dorsal incision keeping the MP joint in 60° of flexion and passing the tendon volar to the axis of the MP joint. Now the hand is positioned with the wrist in a neutral position, the thumb in 80° of abduction and rotation, the MP joint in 30° of flexion and the IP joint in a straight position. The proximal slip is passed around the Add. Pollicis and pulled and fixed maintaining the position. Suturing is also done to the MP joint capsule. Tension is given by pulling the tendon for about 1 cm after taking the slackness off. The second slip is sutured to the EPL without tension. After the suturing, the position must remain as it is after leaving the hold on to the thumb. Skin is closed and POP is given keeping the thumb in an abducted, opposed position with MP flexed at 30°, IP straight and wrist in minimal flexion.

## HIGH PALSY

Additionally, we need power to FDP of index and middle fingers and FPL. If the power in little and ring fingers are good and the patient does not require more precision we can tag the radial two finger tendons to the ulnar

fingers. If needed, we can transfer ECRL to FDP and Brachio radialis to FPL.

## POST-OPERATIVE MANAGEMENT

The splint is maintained for 3 weeks and then discarded. Sutures also can be removed during this time if we use fine monofilament material.

Gradual active mobilization is given in the first 2 weeks after discarding the splint keeping the MP joint in 30° flexion and encouraging movements within this. In the third week purposeful movement like holding pen, etc. can be given and during the fourth week he can use the hand for eating. However, heavy manual work should not be done for another 2 months.

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