

Tendon Transfers for Low Median Nerve Paralysis

Part I

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Abstract : This presentation will discuss the procedures used by the author as developed over a 46 year period in performing reconstructive transfers for hand deformities produced by low median nerve lesion from any cause. The restoration of opposition, using one of two methods employing a fixed pulley and dual insertion, will be presented.

PRINCIPLES

Irreparable damage to the low median nerve, such as seen in poliomyelitis, leprosy, traumatic lesions, or neurological diseases such as Charcot-Marie-Tooth disease require the replacement of the paralyzed opponens, abductor brevis, and flexor pollicis brevis muscles. The function of all three muscles can be replaced functionally by reproducing the mechanical pull of the abductor brevis muscle, which, according to Duchenne, was the most important muscle of the thenar muscles. By using the techniques to be described a satisfactory restoration will result in most cases.

INCISIONS

- Ring finger. The incision on the ring finger for the exposure of the flexor digitorum superficialis can be midlateral incision on the ulnar side of the finger, or a transverse one on the palmar side of the proximal phalanx. In either incision, care must be taken to avoid damage to the digital vessels and nerves of the finger. The detachment of the superficialis is done about one centimeter proximal to the bony insertion on the middle phalanx, and just distal to the A2 pulley. The two slips of insertion are cut, and the two slips are separated to the chiasm of Camper, and the vincula is cut. One slip of the tendon is held in a hemostat for easier identification proximally by traction.

Thumb. The incision is a reverse shallow "C" incision for a left thumb, and a shallow "C" incision for a right thumb. The

incision starts just proximal to the interphalangeal joint of the thumb on the dorsal surface, and continues into the midlateral line on the radial side, and ends about one centimeter proximal to the metacarpophalangeal joint. Care is taken to expose and identify the branches of the radial nerve to the thumb and retract them dorsally. The extensor pollicis longus over the metacarpophalangeal joint, the tendon of insertion of the abductor pollicis brevis, and the extensor pollicis longus distally to the interphalangeal joint are exposed. In addition, the tendon of insertion of the adductor pollicis is exposed on the ulnar side of the metacarpophalangeal joint.

Wrist. If a fixed pulley is to be made from one half of the flexor carpi ulnaris as a loop (Riordan), the incision is a transverse one in the flexion crease of the wrist from the middle of the wrist to over the flexor carpi ulnaris.

If the fixed pulley using the volar carpal ligament (Snow) is to be used a curving incision in the thenar crease is made. In both incision care is taken to identify and protect the sensory branches of the medial palmar branch, and the small ulnar sensory branches near the pisiform.

Tendon pathway. The transferred superficialis tendon must pass over the thenar eminence in the midline of the mass of the abductor pollicis brevis muscle. This passageway is made using a Johansen tendon tunneller. The tunneller is started over the tendon of the abductor pollicis brevis, passed subcutaneously over the paralyzed thenar muscles, and brought to pass the base of the thenar crease one centimeter distal to the wrist flexion crease. If the slip of the flexor carpi ulnaris is to be the loop pulley (Riordan), the tunneller is made to exit in the wrist flexion crease incision. If the fixed pulley is to be the volar carpal ligament (Snow), the tunneller is brought out through the curved incision in the base of the thenar crease.

Withdrawal of the superficialis tendon. The superficialis tendon of the ring finger is withdrawn by exposing the tendon sheaths of the superficialis either through the incision in the

wrist flexion crease, or in the incision in the thenar crease, or distal to the volar carpal ligament. The superficialis tendon is exposed in either place taking care to try and preserve the synovial covering of the tendon. It is separated from the superficialis of the little finger, and using a round instrument passed under the tendon, it is lifted and withdrawn as the hemostat on the tendon slip distally is released. Tugging on the hemostat before its release helps to identify the correct tendon.

Passing the tendon over the thenar eminence. The tendon tunneller which had previously been passed over the thenar eminence is then opened (in which ever area the pulley is to be in) and the distal ends of the superficialis are each grasped with tunneller and it is withdrawn to deliver the superficialis into the incision at the metacarpophalangeal joint level. A hemostat is placed in each slip of the tendon, and by cutting or splitting the two slips of the tendon are separated to the level of the tendon of the abductor pollicis brevis. This allows the two slips to be brought in diverging paths from this point on.

Fixing the superficialis tendon to prevent wander at the metacarpophalangeal joint. In some hands, as in poliomyelitis, the tissues are extremely mobile and the transfer tends to wander in to flexion, or into extension. To try and prevent this, two parallel cuts five millimeters apart are made partially through the tendon of the abductor pollicis brevis. The intervening tendon between these two cuts is elevated by splitting the tendon horizontally, creating a small tendon tunnel. One slip of the superficialis tendon is passed through this small tunnel. This slip of the tendon (usually the most palmar one) is then grasped with a small hemostat and is passed through a small longitudinal slit made in the center of the extensor pollicis longus about five millimeters proximal to the interphalangeal joint. This tendon slip is then passed proximally back over itself and held over the small tendon tunnel created in the abductor pollicis brevis.

Establishing the correct tension of the transfer. Following the above step, a hemostat is placed on the other slip of the superficialis tendon. This hemostat is then moved distally in line with the transferred tendon. With the wrist in neutral position, and the thumb held in full opposition, and the distal phalanx of the thumb held in extension, traction is placed on the hemostat of the second slip, in the line of the transferred tendon. Its most distal movement is marked, and the tendon is allowed to retract without any tension being placed on the hemostat. The rebound of the normal muscle will cause the tendon to retract. The maximum retraction point is marked. The difference between the maximum retraction point and the maximum stretch point is the approximate range of motion of the muscle tendon unit being transferred. The halfway point of the total distance of travel is selected as the tension that the tendon is to be placed under. The palmar slip of the tendon which has been held at the level of the tunnel in the abductor pollicis brevis is then sutured to the tunnel while this same tension of being maintained. The same slip of tendon is then sutured to the extensor pollicis longus where it was passed

through the tendon. The free end of the tendon is then trimmed off to remove the traumatized area, and is sutured under itself, thus burying the free end of the tendon. The longitudinal slit made in the extensor pollicis longus is sutured closed anchoring the tendon slip passed through the extensor, so this will not tear the extensor pollicis longus tendon longitudinally.

To see if the tension of the transfer is correct the following test can be performed before the final suturing of the transfer is done. If the wrist is flexed to 45 degrees, the tension of the transferred tendon is released and the thumb should be able to be fully extended and ADDUCTED. If the wrist is then extended 45 degrees, the tension on the transferred tendon should fully extend the distal joint of the thumb, fully abduct the thumb, and rotate it into opposition. If the tension is correct this will bring the tip of the thumb into contact with the manually flexed index and long finger thus creating a "three jawed chuck" type of pinch. If the tension is correct and the thumb passively does this with the wrist motion, then the suturing of the second slip can be done. The second slip of the split superficialis tendon is then passed dorsally over the first metacarpal and extensor mechanism proximal to the metacarpophalangeal joint, and is passed through a small hole made in the tendon of insertion of the abductor pollicis. The tension on this slip is slightly less than the tension of the first slip.

WOUND CLOSURE

The closure can be in any method preferred by the surgeon. I usually prefer to use an intracuticular continuous wire suture, which leaves minimal scarring, but interrupted or continuous suturing can be used.

IMMOBILIZATION

A compression type of bandage is used with either plaster or plastic splints to immobilize the extremity. I preferred to immobilize the wrist is 25 to 30 degrees of flexion, the thumb in complete opposition with the distal joint extended, and the proximal finger joints held in 60 to 70 degrees of flexion, and immobilized out to the end of the middle phalanx. The ring finger is then taped to the long finger with tapes on the middle phalanx and the distal phalanx. This is to discourage the patient from trying to independently flex the ring finger and putting the transfer to the thumb under strain. Splinting is this position is maintained for three weeks. At the end of three weeks the splint is removed, the sutures removed, and the wrist brought to neutral position. The thumb is kept in full opposition, and the distal joint allowed some gentle motion. The proximal phalanges of the four fingers are prevented from extending more than thirty degrees, but are allowed to flex without meeting any resistance. The middle and distal phalanges are allowed full motion, but no resistance to motion is allowed. Padded plaster or plastic splints are used to maintain this position for two more weeks. The patient is encouraged to try

and touch the tip of the thumb to the tips of the index and long fingers lightly. No pinching against resistance is allowed.

At five weeks the dorsal splint can be removed and the thumb taped into opposition, but allowing wrist motion, finger motion, and partial thumb motion against a hard object or against resistance is not allowed until eight weeks has elapsed. This eight weeks is needed for full mature healing of tendon to be able to stand against resistance and not stretch or pull a part.

SUMMARY

Two methods of restoring opposition of the thumb have been presented. Both methods use the dual insertion on the

thumb, one slip into the tendon of the extensor pollicis longus, and one into the tendon of the adductor pollicis. Two fixed pulleys for changing direction of pull of the transferred tendon are described, one the modified flexor carpi ulnaris loop pulley fixed to the pisiform, and the other using the transverse carpal ligament as the fixed pulley. The incisions and tunnelling techniques have been described and the necessary post operative immobilization have been presented. These methods reflect the 46 years experience of the author in performing tendon transfers for deformities produced by traumatic nerve lesions, paralysis resulting from poliomyelitis or leprosy, or the rare congenital absence of thenar muscles or intrinsic muscle absence.