Extensor Indicus Proprius Opponensplasty*

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ABSTRACT: Opponensplasty using the extensor indicis proprius routed subcu-
taneously around the ulnar side of the forearm and across the palm to the extensor
tenons longus tendons in the region of the thumb metacarpophalangeal joint re-
stored excellent thumb function in fifty-seven of sixty-five forearms: nineteen with
low and thirteen with high median-nerve injuries and seventeen with high and four-
ten with low combined median and ulnar nerve injuries, and two brachial plexus
injuries. The main indications for this procedure are a high median-nerve injury and
any combined median and ulnar-nerve injury.

The loss of ability to oppose the thumb to the fingers is the most significant
motor loss associated with injury to the median nerve, either above or below the
elbow. Multiple types of operative procedures have been devised in order to restore
opposition to the thumb in cases of thenar paralysis. The earliest operative pro-
cedures for restoration of thumb function attempted to restore short flexor action to
the completely intrinsic-minus thumb 3, 8, 10, 11, 13, 16, 18, 21. Sterling Bunnell 1, in a
review article in 1938, stated that a fixed pulley in the area of the pisiform, a sub-
cutaneous route across the palm, and an attachment to the base of the proximal
phalanx on its dorsal ulnar aspect were requisites for restoration of opposition to the
thumb by tendon transfer. Using these precepts, he was able to achieve true opposi-
tion rather than short flexor action. That is, the thumb was brought away from the
fingers and at the same time pronated so as to oppose the fingers pulp to pulp.

Bunnell 1, 2 in addition recommended flexor motors, either wrist or flexor super-
facialis, because the extensor motors were too weak and had an excessively long
course. With an isolated low median-nerve injury, these precepts have stood the
test of time. The ring finger superficialis, when transferred around a fixed pulley in
the area of the pisiform, passed subcutaneously across the palm and into the dorsal
ulnar aspect of the proximal phalanx, is unquestionably the most frequently used
opponensplasty. Certain patients, however, without available finger flexors or wrist
motors were difficult problems. Phalen and Miller and Henderson used wrist ex-
tensors or brachioradialis prolonged with a tendon graft in order to obtain opposi-
tion of the thumb when available flexors could not be used. Cook 20 and later
Schneider have used the extensor digiti minimi to obtain opposition of the thumb
in patients in whom the more standard procedure could not be done for various rea-
sons.

Materials and Methods

In all but two cases in our patient group, the thenar paralysis resulted from

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Figs. 1-A through 1-D: This is a diagrammatic representation of the steps involved in performing an extensor indicis proprius opponensplasty.

Fig. 1-A: The tendon is removed from the extensor hood of the index finger. The hood is carefully repaired in order to avoid subluxation of the remaining extensor tendon.

Fig. 1-B: A large incision on the coraco-ulnar aspect of the forearm allows wide fascial excision and complete transposition of the muscle superficial to the extensor carpi ulnaris and into a subcutaneous position.

Fig. 1-C: The tendon of the extensor indicis proprius is brought out in the area of the pisiform and then passed again subcutaneously across the palm to the thumb.

Fig. 1-D: The method of attachment to the thumb utilizing the abductor pollicis brevis tendon, the metacarpophalangeal joint capsule and the extensor pollicis longus tendon over the proximal phalanx.

high-velocity penetrating injury to the median nerve. In addition to the nerve injury, frequently above the elbow, other nerves and other tissues within the limb were also injured. With this multiplicity of tissue trauma, a satisfactory opponensplasty may
be very difficult to obtain. In the high median or high median and ulnar-nerve injury, only radially-innervated extensor muscles are available for transfer. This is our experience with sixty-five extensor indicis proprius opponensplasties performed at Fitzsimons General Hospital over the past four years.

Of the sixty-five patients, sixty-three were men and incurred their injury to the upper extremity secondary to a penetrating wound, either fragment or bullet. In this group there were nineteen patients with low median-nerve injury and thirteen with high median-nerve loss. The term high median-nerve injury refers to damage proximal to the extrinsic flexor motors and the term low denotes injury distal to these motor branches. There were seventeen patients with high median and ulnar nerve loss, fourteen with low median and ulnar nerve loss, and two with injury to the brachial plexus. There were two women in this series. Both incurred their injuries secondary to lacerations from a knife. One had a high median and ulnar-nerve injury and the other a low median-nerve injury.

Of the combat-incurred injuries, fifteen were associated with major arterial damage, thirteen with major long-bone fracture, and all with varying degrees of muscle-tendon loss in the arm and forearm. Seven of the patients had significant direct injury to the hand.

**Technique**

The precepts of Mayer and Steindler 6,19 must be strictly adhered to and full passive range of abduction and pronation of the thumb must be possible prior to the opposition transfer. This was certainly our most significant problem in our patient group with multiple tissue injuries and in certain long-standing cases. A web-space release and even an osteotomy of the first metacarpal may be necessary at the time of opponensplasty.

The technique of extensor indicis proprius opponensplasty is as follows. The extensor indicis tendon is identified over the metacarpophalangeal joint of the index finger and a small portion of the tendon and extensor hood mechanism is removed by sharp dissection. The hood is then meticulously repaired with interrupted non-absorbable sutures. It is frequently necessary to make a small incision over the mid-dorsum of the hand to free the common extensor from the indicis. A curvilinear incision is then made over the dorsal ulnar aspect of the distal part of the forearm and the deep fascia of the forearm excised widely. The extensor indicis proprius tendon and muscle belly are then delivered into this more proximal wound and the muscle freed bluntly from the surrounding soft tissues and retracted proximally. A small incision is then made in the area of the pisiform and the tendon passed subcutaneously around the ulnar border of the forearm.

It is most important at this time to develop subcutaneously a large enough tunnel so that the entire muscle bulk of the extensor indicis proprius lies against the subcutaneous border of the ulna. After the tendon is brought out through the small incision in the area of the pisiform, a subcutaneous tunnel is made across the palm of the hand to the area of the metacarpophalangeal joint of the thumb and the tendon is passed into this incision. At this point, after all incisions have been made, we release the tourniquet and obtain strict hemostasis. All of the incisions can then be closed with the exception of the one in the area of the metacarpophalangeal joint of the thumb.

The method of distal attachment varies somewhat and should be tailored individually. In the combined median and ulnar-nerve injury, in which there is complete lack of intrinsic-muscle activity in the thumb, we feel that the insertion should include attachment to the abductor pollicis brevis tendon, the joint capsule, and ex-
Fig. 2-A

Figs. 2-A and 2-B: This patient incurred segmental loss of median and ulnar nerves, flexor tendons to all fingers and volar skin secondary to explosive injury. Closure was obtained with pedicle flap skin. Additional surgery included nerve and tendon grafts. With intact extrinsics to the thumb, these photographs represent thumb motion possible.

Fig. 2-B

Fig. 2-C

Full passive motion of the thumb must be possible prior to any opponensplasty.

tensor pollicis longus over the proximal phalanx. This is the method described by Riordan. Attachment in this fashion increases the tension on the extensor pollicis longus so that full passive flexion of the interphalangeal joint is not possible. By increasing the tension on the extensor pollicis longus in the totally intrinsic-minus thumb, we force the flexor pollicis longus to become a flexor of the metacarpophalangeal joint as well as the interphalangeal joint. The full excursion of the flexor pollicis longus cannot be utilized because of the dorsal tenodesis, and so the re-
extensor indicis proprius opponensplasty

...remainder of the excursion is then used up at the metacarpophalangeal joint. With this we obtain short flexor as well as long flexor action by this one tendon.

On the other hand, the nerve injury does not involve the ulnar-innervated muscles, and there is no significant direct injury to these muscles, attachment to the abductor pollicis brevis tendon gives satisfactory rotation of the thumb. The tension of either method of attachment is adjusted while flexing the wrist 30 degrees and holding the thumb in maximum opposition. The transferred extensor indicis proprius tendon now passes volar to the axis of the wrist joint and is no longer an extensor of either the wrist or finger. The attachment is with non-absorbable sutures and a bulky hand dressing is used for several days followed by a thumb spica which maintains the wrist in flexion and the thumb in full opposition for approximately four weeks.

In all but ten of the patients the operation was performed by the resident staff.

Analysis of Results

These opponensplasties were evaluated according to the criteria outlined by Jacobs and Thompson. An excellent result was 75 per cent function compared with the opposite or normal thumb or those with less than 20 degrees difference between the plane of the opposed thumbnail and the plane of the palm with good power. In a...
The tendon of the extensor indicis proprius is passed subcutaneously across the palm and attached by the method of Riordan to the thumb. The radial nerve innervation to the thumb must be protected during the attachment.

At the conclusion of the operation, the thumb assumes an excellent position with good abduction and pronation.

fair result the patient had good rotation of the thumb and poor power or vice versa. The result was rated a failure if there was slight or no rotation with poor power.

An excellent result was obtained in fifty-seven of the sixty-five patients. Four results were considered fair and four were considered complete failures. One of the failures occurred in a patient with marked tissue loss about the thumb, including an interphalangeal joint amputation. The procedure included web space release but because of local tissue injury in the hand, we were really unable to gain satisfactory passive motion of the thumb. In two patients with combined median and ulnar-nerve injuries, the tendon was placed too far distally in the palm, with resultant short flexor action only but no true opposition. In both patients the tendon was rerouted in another operative procedure and an excellent result was obtained. In one patient with an isolated median-nerve injury, the distal suture line failed with loss of function. Subsequent opponensplasty gave an excellent result. Thus, three of the patients with results rated failure, obtained excellent results after additional surgery.

**Complications**

There were no infections. Extensor lag of the index finger was a major problem in only one patient in the series. In this patient, the extensor hood seemed to subluxate radially and this necessitated hood repair with subsequent loss of lag. If the pulley on the ulnar border of the hand is not placed in the area of the pisiform but
far distally, short flexor action only will result, and as mentioned previously, this occurred in two of our patients and required reoperation for correction. The complication of flexion contracture of the proximal interphalangeal joint of the donor finger or swan-neck deformity of the same digit was not encountered in this group of patients. A complication rate approaching 8 per cent was reported by Jacobs and Thompson. In addition, there was no removal of flexor power on the volar side of the hand.

**Discussion**

The procedure as outlined is certainly not new with the authors. We have subsequently discovered that Santiago Chouhy-Aguirre of Buenos Aires described this opposition transfer in 1956. He continued to use it in his patient population and has had no late complications with its use. We tried this transfer of necessity because of our inability to use the more conventional opponensplasty in our patients. Even at the present time we feel that in our hands this is just as functional an opposition transfer as the more standard ones and we now preferentially employ this transfer. The transfer may be performed either early or late in the management of peripheral nerve injury without reducing flexor strength, without complications of the donor finger, and with satisfactory over-all return of opposition of the thumb.

We feel that early restoration of opposition to the thumb in median-nerve injury and in those limbs with multiple tissue trauma adds immeasurably to the overall early rehabilitative effort. The patient may be free of external supports to the palsied thumb and this opposition transfer will prevent the development of contractures which are difficult to control in the more proximal nerve injuries. The transferred motor that is used does not create any significant deficit and there is adequate strength to position the thumb. The extensor indicis proprius muscle itself is phasic in character with short abductor function of the thumb, so little retraining is necessary to utilize the transfer satisfactorily. The main disadvantage of the transfer seems to be that the excursion of the extensor indicis proprius is somewhat less than we would like, and for this reason full extension of the thumb is not usually seen postoperatively.

**Conclusions**

We feel that the extensor indicis proprius opponensplasty should be in the armamentarium of all those treating upper extremity peripheral nerve injuries. The main usefulness of the procedure at the present time seems to be in the high median nerve injury and in the combined median and ulnar nerve injury, either high or low. The extensor indicis proprius has satisfactory amplitude, strength, and does not require a tendon graft to obtain satisfactory opposition of the thumb.

**References**