Abductor Digiti Quinti Opponensplasty*

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ABSTRACT: Fifteen neurovascular pedicle transfers of the abductor digitii quinti to the base of the proximal phalanx of the thumb were performed: seven for laceration of the median nerve, seven for neurological disease, and one for congenital absence of the thenar muscles. Fourteen of the transfers were viable, and twelve gave excellent results. The three failures all had inadequate release of contractures of the thumb. This transfer offers the following advantages over other opponensplasties: (1) an intrinsic muscle with correct amplitude and direction of pull replaces intrinsic muscles; (2) the tension of the muscle transfer is automatically correct; and (3) the appearance of the hand after this procedure is superior to that after other types of opponensplasty.

An opposable thumb is necessary for powerful grasp and delicate fine pinch. The problems involved in the restoration of adequate opposition with available motor units are evident from the large number of surgical techniques described in the literature. Bunnell was the first to clarify the requirements for a successful opponensplasty: the tendon must pull subcutaneously in the direction of the pisiform bone and should insert on the dorso-ulnar aspect of the base of the proximal phalanx of the thumb. He preferred to use an available flexor superficialis with a pulley constructed at the insertion of the flexor carpi ulnaris. Since that time almost every available tendon around the wrist or hand has been used, and most of the procedures require the construction of a pulley or use of an intervening tendon graft.

The prerequisites for a successful opponensplasty as noted by Goldner and Irwin include the following: a strong flexor pollicis longus, extensor pollicis longus, and abductor pollicis longus; no limitation of thumb motion either by bone or joint lesions or by soft-tissue contractures; and adequate strength and coordination in the fingers.

In 1963, Littler and Cooley redescribed transfer of the abductor digitii quinti, preserving its neurovascular bundle to restore thumb opposition in the absence of other motors. Historically, credit for devising this procedure should go to Huber and Nicolaysen, who independently reported on its use in 1921. In Littler and Cooley's original report on four cases, they concluded that the transfer of the abductor digitii quinti was as effective as the more conventional transfers but technically more difficult. Discussing the advantages of this transfer, the authors noted that an intrinsic muscle replaces intrinsic muscles of similar amplitude without an intervening pulley or tendon graft; the thanar muscles and abductor digitii quinti are synergistic, and little or no re-education is required; the transferred abductor digitii quinti reproduces closely the action of the abductor pollicis brevis; and the correct muscle tension is always obtained by the transfer. The transfer has been mentioned infrequently in the literature since Littler and Cooley's report. This paper presents our results in fifteen hands.

Technique

Using a tourniquet for hemostasis, three skin incisions are made (Fig. 1). The first is on the ulnar border of the hypothenar eminence and extends from the flexion crease of the proximal joint of the little finger to the flexion crease of the wrist; the second is parallel to the thenar crease in the palm and extends from the base of the thumb web to the proximal flexion crease of the wrist; and the third is a semicircular incision over the radial aspect of the proximal joint of the thumb.

The abductor digitii quinti is visualized by undermining the skin that overlies the hypothenar eminence. Its tendinous insertion is detached from the base of the proximal phalanx of the little finger and ulnar border of the aponeurosis of the extensor digitii quinti proprius, and the muscle is mobilized proximally as far as its origins on the pisiform bone and the tendon of the flexor carpi ulnaris, preserving its proximally placed neurovascular bundle. The mobilized muscle is then rotated (supinated) on its origin and passed through a subcutaneous tunnel made across the palm from the ulnar incision to the mid-palmar incision and thence to the incision on the radial border of the thumb. This tunnel, which passes along the superficial surface of the palmar fascia, must be of ample size so that it does not constrict the transfer. To be sure that its size is adequate, the surgeon should be able to pass his long finger through the tunnel from the ulnar aspect of the hand to the thumb prior to passage of the transfer.

The transfer is attached to the tendon of the abductor pollicis brevis by passing the flat tendon of the abductor digitii quinti through a slit in the abductor pollicis brevis tendon and transfixing it with a single 3-0 nylon suture. Because the abductor digitii quinti has no extra length, the problem of appropriate tension is avoided. The thumb is brought into a position of opposition and abduction in order to attach the transfer.

All skin incisions are sutured, and the extremity is immobilized in a volar splint and suitable pressure dressing, with the thumb in a position of opposition and the
wrist dorsiflexed approximately 30 degrees. This position is maintained for three weeks. Then all skin sutures are removed and the patient is encouraged to start active motion. No postoperative physical therapy was either used or required to achieve maximum function in this series.

**Materials and Methods**

From 1962 to 1975 fifteen abductor digiti quinti opponensplasties were performed on thirteen patients: seven for laceration of the median nerve, seven for neurological disease resulting in thenar atrophy, and one for congenital absence of the thenar muscles. All patients who were seen by one of us (H. A. W., on his private and referral hand service) during the period covered by this study and who required restoration of opposition had this transfer. There were ten male and three female patients. Twelve of the hands were dominant and three, non-dominant. The average age of the thirteen patients at the time of surgical repair was 29.6 years (range, ten to forty-seven years). The average follow-up was 34.4 months (range, two to 149 months). The indication for an abductor digiti quinti opponensplasty was sufficient loss of thenar muscles, for whatever reason, to make it impossible for the patient to perform usual and necessary daily activities. The prerequisites for a successful opponensplasty, as previously noted by Goldner and Irwin, should be met before the transfer is attempted.

Evaluation of the result was based on six criteria: (1) the patient's opinion of the result; (2) the performance of daily activities; (3) the appearance of the hand; (4) the type of pinch provided; (5) the range of active motion of the thumb; and (6) the strength of opposition. The patient's opinion was elicited in a personal interview during which he was asked to rate the result as excellent, good, fair, or poor. This was an uncoached, subjective response.

Next, the performance of daily activities was evaluated on the basis of such heavy and fine functions as use of a hammer and screwdriver, opening doors and jars, writing, painting, sewing, buttoning clothes, picking up pins and coins, and rolling pills or pins. Performance was rated excellent when thumb function was normal and equal to the opposite thumb; good when there was acceptable function with specific minor limitations, such as inability to use a screwdriver or pick up pins; fair when the patient had
major difficulties with pinch and grasp, such as the inability to open doors and jars and difficulty with writing; and poor when pinch and grasp were absent.

The appearance of the hand was considered excellent when the thenar eminence looked normal; good when only slight atrophy was present; fair when there was noticeable atrophy; and poor when there was complete atrophy.

The ability of the patient to perform specific types of pinch — nail-to-nail, pulp-to-pulp, key-pinch, and pill-rolling fine pinch — was observed and recorded as possible or not possible. Ability to perform all four types of pinch was considered excellent; three types, good; two types, fair; and one or none, poor. The strength of the pinch was measured and recorded separately.

The range of active motion was evaluated by two measurements. First, the angle between the first and second metacarpals was measured in full abduction and expressed as a percentage of the angle made by the opposite thumb. Second, the pronatory angle, the angle that the nail makes with the palm, was measured. Schneider classified the pronatory angle as excellent when it was parallel (zero degrees); good when less than 30 degrees; fair when less than 50 degrees; and poor when greater than 50 degrees.

The strength of pinch was measured during pulp-to-pulp pinch between the thumb and index finger, using a pinch meter, and was compared with that in the opposite hand. The rating of strength was excellent when it was 100 per cent; good when 75 per cent; fair when 50 per cent; and poor when 25 per cent or less. Although there was loss of abduction of the little finger after transfer, there were no deleterious effects on the function of either the little finger or the hand, or on the over-all grasp of the hand.

The over-all result was expressed as an average of the six individual categories.

Results

Using the evaluation procedures already described, the ratings of the fifteen hands following abductor digiti quinti opponensplasty were excellent in twelve hands; fair in two, and poor in one. There were no deleterious effects on the little finger except for loss of abduction, and it did not appear to affect grasp or the over-all function of the hand. In the seven patients with lacerations of the median nerve, the nerve was repaired in either the primary or a secondary procedure. Protective sensation was regained in the median distribution in all of these hands but no appreciable function of the thenar muscles was found at follow-up.

One of the excellent results is illustrated by the following case report.

A forty-five-year-old football coach had a laceration of the volar aspect of the distal part of the dominant right forearm. Initially, the wound was thought to be superficial and wound closure was the only primary treatment. It later became apparent that the median nerve was lacerated. Eight months later he had complete thenar atrophy, no pulp-to-pulp, nail-to-nail, or pill-rolling pinch, no opposition, and hyposthesia in the distribution of the median nerve. The flexor superficialis and flexor pro-

fundus were intact to all fingers, as were the flexor pollicis longus, extensor pollicis longus, and abductor pollicis longus. Full range of motion of the thumb had been maintained through passive exercises. A neuroma was removed, the median nerve was repaired, and an abductor digiti quinti opponensplasty was performed at the same time. Sixteen months after repair of the median nerve and transfer of the abductor digiti quinti, there was protective sensation in the median distribution but no evidence of thenar muscle function. The ratings in the six result categories at that time were as follows: (1) the patient's rating of the result was excellent; (2) the performance of all activities, including throwing a football, was excellent; (3) the appearance of the hand was good; (4) all types of pinch could be performed, resulting in an excellent rating; (5) the range of active motion of the thumb was normal, giving an excellent result; and (6) the strength of pulp-to-pulp pinch was the same in both hands (9.1 kilograms), an excellent result. Averaging the six categories, the over-all result was excellent.

The poor result was in a fourteen-year-old girl who had congenital absence of the intrinsic muscles of the thumb. Initially, the thumb had the appearance of a finger. It was adducted against the palm and had essentially no opposition. The thumb metacarpophalangeal joint was subluxated and the carpometacarpal joint was unstable. The remainder of the hand and forearm was normal, sensation was intact on the thumb and all fingers, and the extrinsic muscles of the thumb were intact and functional.

Five months prior to opponensplasty, the patient had a z-plasty of the first web space, fusion of the thumb metacarpophalangeal joint, and stabilization of the carpometacarpal joint by capsular reefing. Because the patient required restoration of opposition and was thought to meet the prerequisites of Goldner and Irwin, an abductor digiti quinti opponensplasty was performed. However, the thumb in fact lacked adequate stability and mobility at the time of surgery and the transferred muscle was placed under excessive tension, probably resulting in the impairment of the blood supply and subsequent fibrosis of the muscle. Four months after the opponensplasty the thumb was adducted into the palm. The fibrotic muscle was excised, and the carpometacarpal joint was restabilized. At follow-up examination thirty months after the opponensplasty, however, the thumb was again adducted into the palm.

The two patients with fair results both had flat hands and adduction contractures of the thumb. One of them had extensive injuries involving the soft tissues of the forearm, and loss of bone from the radius and humerus caused by the explosion of a grinding stone. Among the problems were loss of the median and superficial radial nerves, flexion contractures that required a flexion slide, and nonunion of the humerus which was treated by internal fixation. Prior to opponensplasty, there was no active opposition, only 20 degrees of wrist motion, 20 degrees of interphalangeal motion, 30 degrees of metacarpophalangeal motion in the thumb, and free flexion-extension of the carpometacarpal joint. The thumb was adducted against the palm and there was a contracture of the first web space. A z-plasty of the web space was performed at the same time as the abductor digiti quinti transfer. At follow-up twenty-nine months later, a viable con-
tracting transfer was palpable but it did not oppose the thumb due to recurrence of the contracture of the first web space.

The second patient with a fair result had had a power-saw injury to the forearm which severed the median nerve, the flexor pollicis longus, all of the superficialis muscles, and the profundus to the index finger. The superficialis tendons were excised, the median nerve was repaired, and the middle and distal joints of the index finger were fused. After these procedures, an adduction deformity of the thumb developed, which was treated by a Z-plasty of the first web space and opponensplasty. Subsequently, the transfer could be felt to contract but the thumb could not be opposed beyond the plane of the long finger. When the transfer was explored, the abductor digitii quinti was viable, but the anastomosis had failed. After reanastomosis a full range of motion was never regained, and the thumb could not be opposed past the plane of the index finger despite the viable transfer. The loss of motion was the significant factor responsible for the fair result in this patient.

Discussion

There are many successful ways to provide opposition for the thumb. Transfer of the abductor digitii quinti has certain advantages, particularly in the hand with few available motor units for transfer. The abductor digitii quinti transfer replaces the lost intrinsic muscles with another intrinsic muscle whose amplitude of contraction and direction of pull are correct without the need for an intervening pulley or tendon graft. Exact muscle tension is automatically obtained by the transfer, making it considerably less difficult to establish correct length-tension relationships with this procedure than with others. Jacobs and Thompson noted that failures after opponensplasty are seldom the result of the particular method employed but more often are the result of insufficient tension on the motor. Another advantage is that after an abductor digitii quinti transfer the thenar eminence has a more normal appearance than after other procedures.

Bunnell, Goldner and Irwin, and Jacobs and Thompson clearly delineated the prerequisites for a successful opponensplasty. We believe that if these prerequisites are met, an abductor digitii quinti opponensplasty is indicated as the procedure of choice. Possible contraindications to this procedure would include damage to the abductor digitii quinti muscle, damage to the ulnar nerve, neuropathy of the ulnar nerve, and damage to the palm preventing subcutaneous passage of the transfer. In each of our failures an acceptable preoperative range of thumb motion was not obtained and the transfer could not overcome the fixed deformity. While not necessarily the only contributing factor in each of the three failures, the adduction deformity of the thumb was a serious hindrance to a satisfactory result.

Conclusions

1. Opponensplasties must not be performed in the presence of a fixed deformity.
2. The abductor digitii quinti transfer offers certain advantages because exact muscle tension is obtained automatically by the muscle transfer, there is no intervening pulley or tendon graft, an intrinsic muscle replaces the missing intrinsic muscles, and the appearance of the hand is improved by the transfer.
3. Of the fifteen opponensplasties performed, twelve gave satisfactory results and fourteen of the neurovascular transplants remained viable.

References