Index Finger Pollicization

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The thumb is a specialized organ with unique functions that cannot be replicated by any other digit. The most powerful technique for construction of a missing thumb is index finger pollicization. In this article, we outline our technique for index finger pollicization. Over a 30-year period, certain technical refinements have improved the function and appearance of these transposed digits. *(J Hand Surg 2011;36A:333–339. Copyright © 2011 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Pollicization, thumb, hypoplasia, congenital.

THE THUMB CONTRIBUTES over 50% of hand function. Its skeletal and soft tissue structure reflects a highly specialized evolutionary advancement devoted entirely to manipulation. Many of these structures are unique and not reproducible. The saddle-shaped carpometacarpal joint allows mobility in all directions. The instrinsic muscles provide a short moment-arm about the carpometacarpal and metacarpophalangeal (MCP) joints, thus affording fine manipulation and powerful pinch. The asymmetric condyles of the proximal phalanx allow the distal phalanx to pronate as the interphalangeal joint flexes, thus allowing more surface contact area for tip-to-tip prehension. The broad distal phalanx and the highly innervated pulp are also specific to the normal thumb.

Although these specialized components of the thumb cannot be reproduced, a close replica can be fashioned using the index finger. Technical maneuvers have evolved over the past 30 years to improve appearance and function. These refinements include placement of the incisions, positioning and fixation of the metacarpal head, rebalancing of the extrinsic and intrinsic muscles, and use of an adipofascial flap to improve the appearance of the thenar eminence in certain hypoplastic thumbs.

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INDICATIONS

In congenital absence or hypoplasia, the unequivocal indications for index finger pollicization include hypoplastic thumb German (Blauth) types IIIB, IV, and V.[1,2] In type IIIB thumb hypoplasia, the carpometacarpal joint is unstable. Although some surgeons, including the senior author, have noted success with vascularized metatarsophalangeal joint transfers for this condition, index finger pollicization remains the ideal reconstruction. In traumatic cases, index finger pollicization can also be indicated when the entire ray or most of the metacarpal is missing. The alternatives of toe transfer versus index finger pollicization should be carefully considered, especially in an adult whose cortical adaptation to the new thumb may not be as robust or flexible as that of a child.

CONTRAINDICATONS

The patient has to be healthy and able to tolerate general anesthesia. The surgery is not appropriate for children with severe central nervous system deficiencies. The presence of associated congenital anomalies and syndromes should be investigated, perhaps with the aid of a geneticist. More common associations include Holt-Oram syndrome; vertebral anomalies, anal atresia, cardiovascular anomalies, tracheoesophageal fistula, and renal and limb anomalies association; and Fanconi anemia. The importance of testing for Fanconi anemia cannot be overemphasized. Although the incidence of this condition is low, the potentially devastating consequences can be thwarted with a simple blood test. In syndromic conditions or as part of radial longitudinal deficiency, the index finger is often abnormal. Although this alone is not a contraindication for pollicization, the expected functional outcome should be

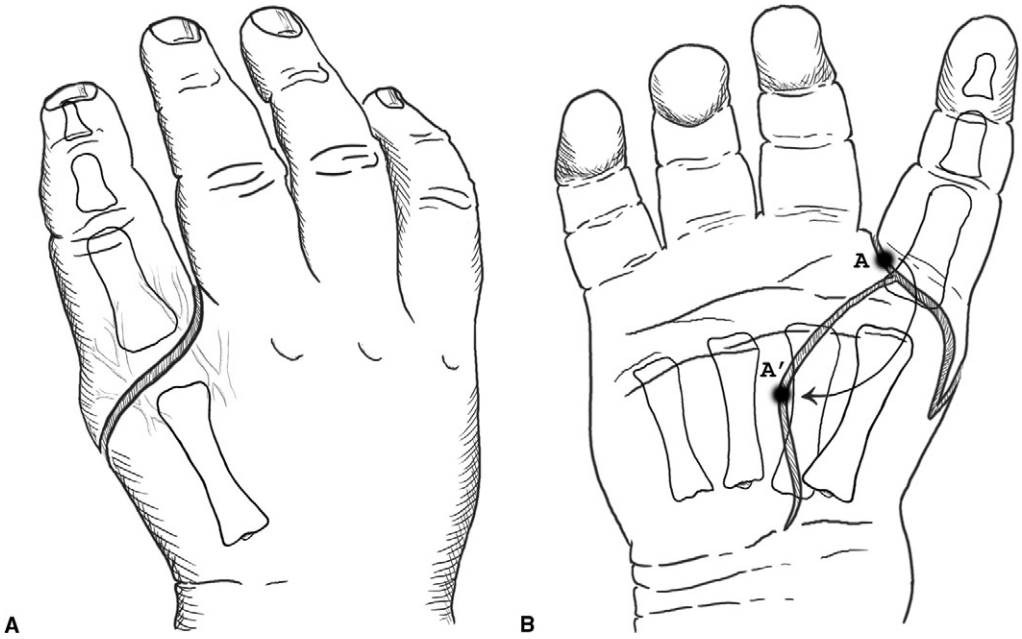

FIGURE 1: Incisions. A racquet-shaped incision is planned at the base of the index finger extending into the first web space. **A** The dorsal view. **B** The palmar view. A thenar flexion crease incision is planned in the palm. Point A at the base of the index finger will move to point A′ at the thenar flexion crease incision.

stressed to the parents of the child preoperatively. A stiff index finger will make a stiff neo-thumb.[3,4]

TECHNIQUES

Incisions

In congenital cases, adequate skin is usually present. The incisions are planned with a racquet-shaped incision at the base of the index finger and a palmar incision in the proposed new thenar flexion crease (Fig. 1).[5,6] The palmar incision is made across the base of the index finger 1 to 2 mm proximal to the digitopalmar flexion crease. Dissection of the flap proceeds ulnarly to the long finger metacarpal level and is kept above the palmar fascia to avoid neurovascular injury. The radial dissection extends to the base of the index metacarpal to provide adequate placement of the metacarpal head. The dorsal incision extends transversely across the index finger MCP joint. Once the dermis is incised, upward traction on the skin will enable scissor dissection between the 2 layers of fat. Two large dorsal veins are usually located on either side of the MCP joint between these layers of fat. The veins are followed proximally for about 3 cm. Hemostasis must be meticulous to avoid blood staining of the tissues.

In type IIIB and IV hypoplastic thumbs, the incision wraps around the base of the nonfunctional thumb. The extra digit is then stripped of its skin, bone, tendon, and nail and is isolated as a vascularized adipofascial flap for augmentation of the thenar eminence in these deficient hands.[7]

Soft tissue dissection

Dissection through the palmar fascia reveals the common vessels and nerves to the index–long web space (Fig. 2). The distal arterial bifurcation is identified and its contribution to the long finger is ligated. Neural loops around either side of the vessel are identified and gently teased proximally. The A1 pulley is identified in the palmar digital midline and divided. The transverse metacarpal ligament within the web space is identified and divided.

Next, insertion of the intrinsic muscles to the index finger is identified, divided, and mobilized (Fig. 3). A few millimeters of distal aponeurosis are retained for subsequent suture fixation and reinsertion of these muscles. The first dorsal interosseous muscle varies in size and bulk, and in a normal index finger often has 2 parts. Along with the volar interosseous muscle and the lumbrical muscle, there can be up to 4 intrinsic muscles that require reattachment.

Skeletal manipulation

Once all of the soft tissues are adequately mobilized, the index metacarpal is exposed. Subperiosteal dissection is performed from the base of the metacarpal to the epiphysis within the metacarpal head. With the soft tissues retracted, 2 metacarpal osteotomies are performed: a transverse cut through the physis and a dorsal oblique cut through the base. The excised metacarpal is saved on the back table and its length is used to estimate the length of extensor shortening.

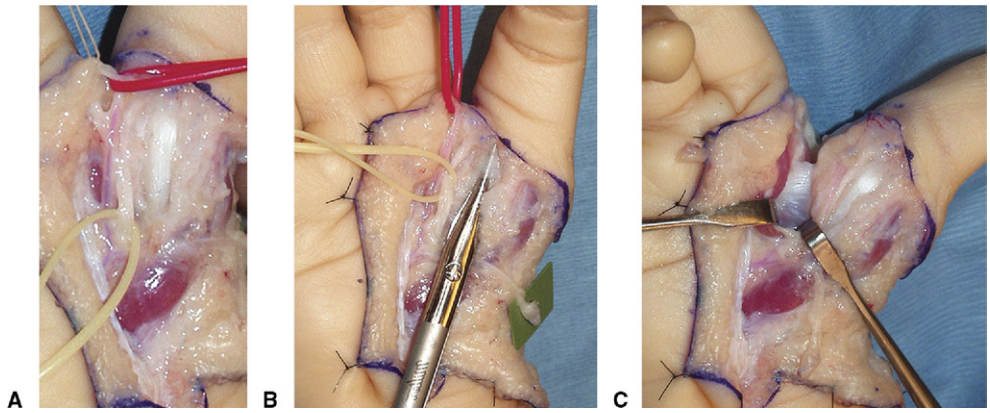

FIGURE 2: Palmar dissection. The palmar flap is elevated and the underlying neurovascular and tendinous structures are identified deep to the palmar fascia. **A** The arterial contribution to the long finger is ligated (absorbable suture). **B** The A1 pulley is divided. **C** The transmetacarpal ligament is identified and incised.

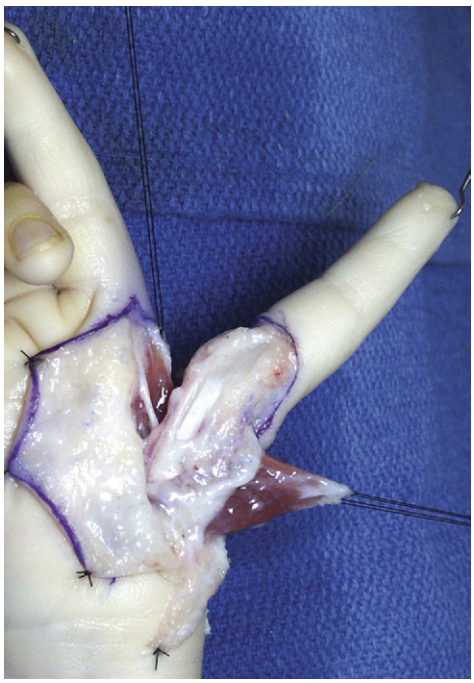

FIGURE 3: Intrinsic muscle dissection. The intrinsic muscles are dissected with a small distal periosteal sleeve to allow for easier reinsertion. Nylon sutures hold these muscles out until they are ready for reinsertion. Typically, 2 dorsal interosseous muscles are found. The more ulnar, volar interosseous muscle is small and makes a weak adductor.

The metacarpal head is then recessed and rotated in 90° to 100° of pronation and fixed with one or 2 nonabsorbable sutures anterior to the oblique osteotomy of the index finger metacarpal base to recreate the normal metacarpal arch (Figs. 4, 5). The soft cartilaginous texture of these pediatric bones allows easy placement of the mattress sutures. It is critical to remove the growth plate and to hyperextend the MCP joint.[1] The recessed and rotated neo-thumb lies with the metacarpal head pronated 100°, flexed 35°, and abducted 25° in a radial position. The skeletal shortening and recession is often the most critical step in this procedure because it will determine the position and length of the new thumb ray.

Skin draping and assessment

Once the new position has been secured, the precise location of a dorsal longitudinal incision over the index finger is determined. The thumb is held in full palmar abduction and the soft tissues are draped over it (Fig. 6). A longitudinal incision, usually dorsal but sometimes more radial, extends out to the proximal interphalangeal extension crease of the index finger (now MCP extension crease of the new thumb). This incision allows for creation of an aesthetic web space as the ulnar skin of the dorsal index finger is transposed to the web space, thereby giving it a gentle curve rather than a deep trough between the MCP joints. Furthermore, this cut-back incision provides excellent exposure of the extensor apparatus and makes rebalancing of the tendons and muscles much easier.

Extrinsic tendon rebalancing

The extensor tendons always require shortening. The extrinsic flexor tendons, however, are usually left unaltered; they will shorten and adjust to proper tension with time and growth. The potential exception is in stiff index fingers (eg, in radial longitudinal deficiency), which can benefit from flexor tendon shortening.

Distally, the lateral bands are separated from the central portion of the extensor; proximally, the extensor indicis proprius is separated from the

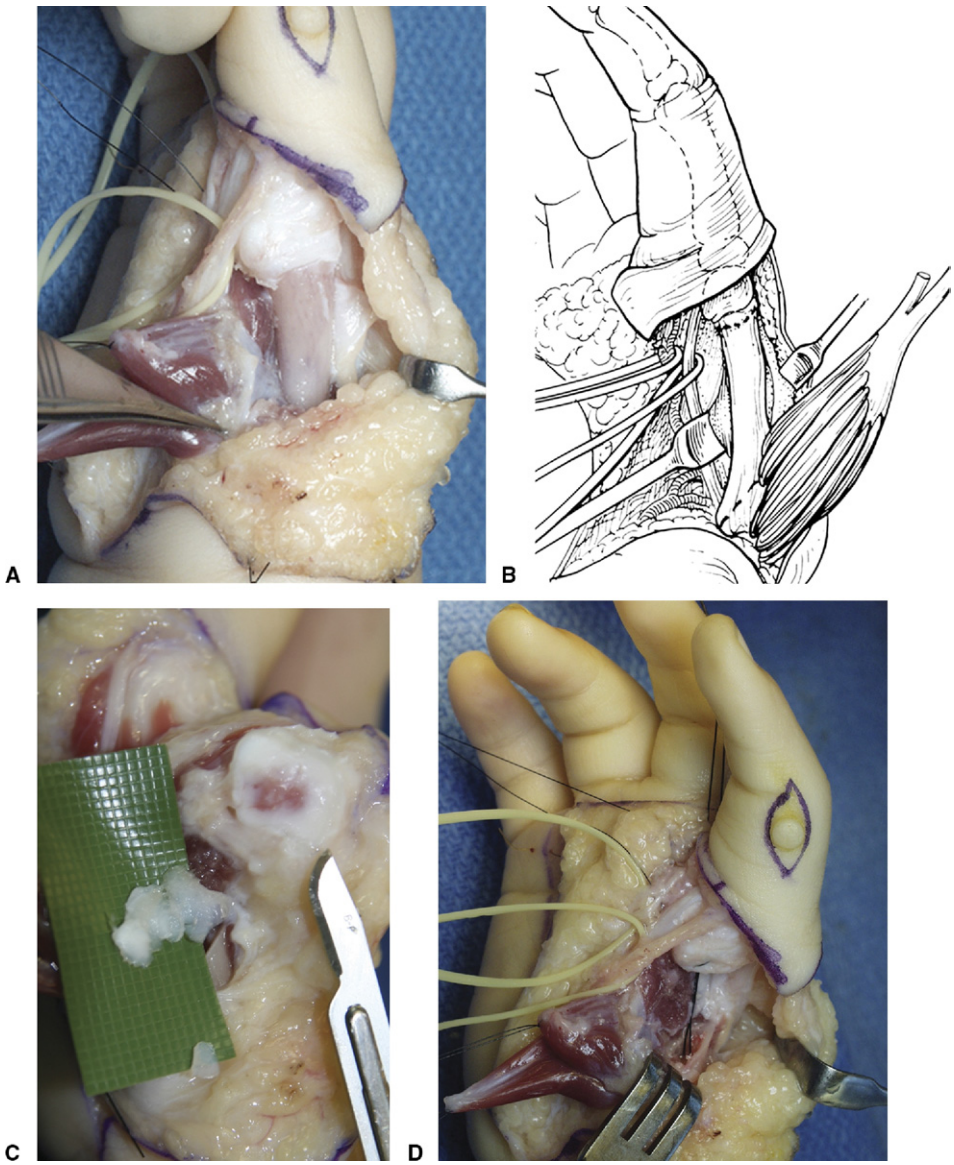

FIGURE 4: Metacarpal osteotomy and recession. **A** The index metacarpal is exposed in the subperiosteal plane. **B** A transverse distal osteotomy at the growth plate and a palmar oblique osteotomy at the metacarpal base are performed. **C** Adequate care must be taken to make sure the entire growth plate is removed; a blade is an appropriate tool for this maneuver. **D** A nonabsorbable suture is used to recess the metacarpal head into the proximal oblique osteotomy. The metacarpal head must be placed in hyperextension.

more radial and dorsal extensor digitorum communis tendon (Fig. 7). Both are transversely incised and shortened. The degree of shortening correlates with the length of the metacarpal bone removed. The common extensor is then advanced to the base of the thumb metacarpal; insertion of this tendon on the ulnar side of the thumb metacarpal (formerly the index finger proximal phalanx) provides, in addition to extension, a few degrees of pronation to the new thumb ray. The extensor indicis proprius is then shortened and reattached to the central portion of the extensor mechanism to become the extensor pollicis longus. End-to-end, simple overlap, or interweave suture techniques work equally well.

Intrinsic muscle rebalancing

The first volar interosseous muscle becomes the adductor pollicis. The ulnar lateral band is weaved through this muscle (Fig. 7). The muscle is small and has poor mechanical advantages as an adductor. The first dorsal interosseous is attached to the radial side of the proximal phalanx. If 2 muscles are present, which is often the case in normal index fingers, the more external part is interwoven into the radial lateral band and the inner portion is attached directly to the bone.

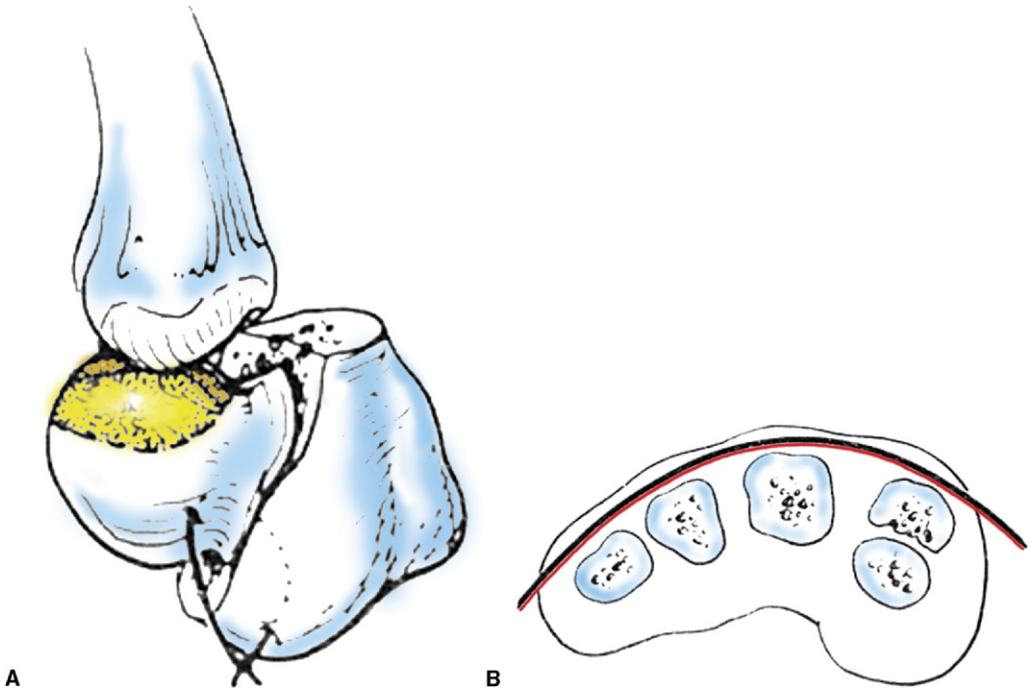

FIGURE 5: Placement of the metacarpal head. **A** The metacarpal head is placed anteriorly and in hyperextension. Placement in hyperextension avoids future problems with thumb hyperextension. **B** Placement anteriorly replicates the normal metacarpal arch.

Skin closure

With the final closure, one can effect minor positional changes to get the thumb into optimal position. The skin closure also provides additional stability to the construct. The skin closure is performed with absorbable 6-0 chromic sutures. The most proximal portion of the radial flap is first inset into the base of the thenar eminence. If an adipofascial flap has been harvested, it

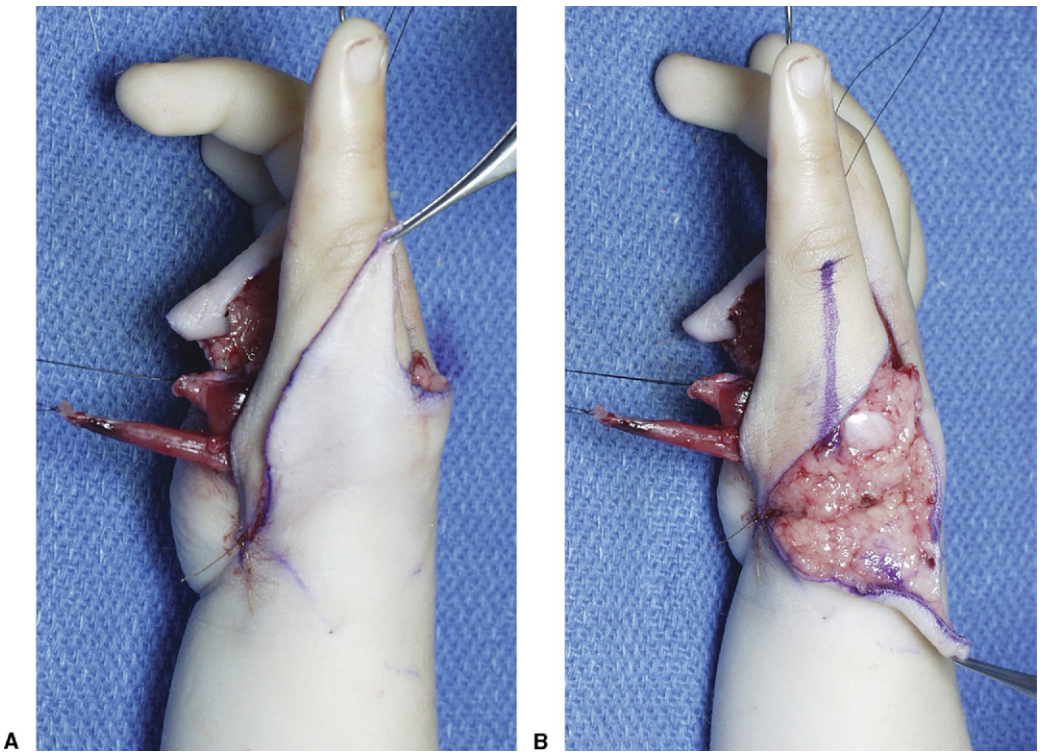

FIGURE 6: Skin redraping. **A** The palmar skin (flap radial to thenar flexion crease incision) is draped over the new thumb to determine a good position for the dorsal incision. **B** The dorsal incision is planned out. The skin ulnar to this incision will be transposed into the web space.

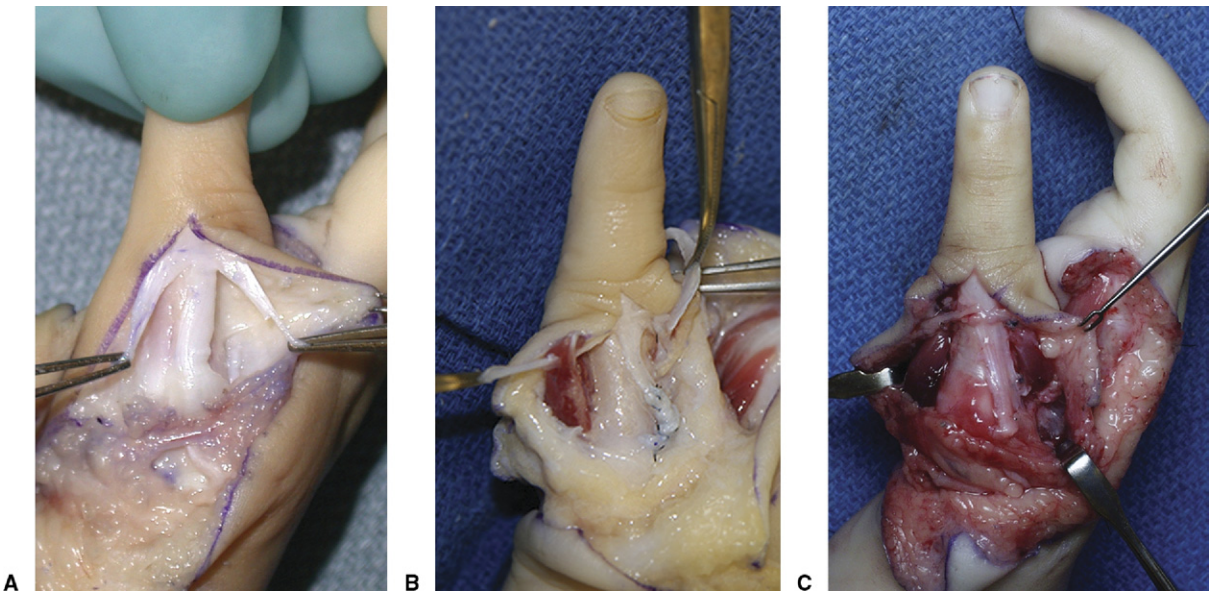

FIGURE 7: Extrinsic and intrinsic rebalancing. **A** The extensor tendons and lateral bands are exposed. The extrinsic tendons are reinserted as outlined in the text. **B** The lateral bands are interwoven into the intrinsic muscles. **C** Final appearance after reinsertion of the extrinsic tendons and intrinsic muscles.

is placed under this flap to augment the thenar eminence. The distal portion of the first web space at the base of the long finger is closed next. The dorsal ulnar tissue from the new thumb is advanced into the web space to create a gentle curve between the long finger MCP joint and the new thumb MCP joint. The dorsal skin flap from the hand is then advanced over the thumb and first web space. Skin trimming is then performed as necessary and the final closure is completed (Fig. 8).

Dressings

The incisions are covered with a sterile dressing and the entire upper extremity is immobilized with a well-padded long arm cast extending well beyond the elbow. The thumb tip may be kept exposed.

REHABILITATION AND POSTOPERATIVE CARE

Three weeks later, the cast is removed and a thumb spica splint is made for wear at night. An active range of motion program is started without any restraints. The patient is observed closely in the first year. Development of postoperative adhesions are rare in children but should be addressed aggressively with hand therapy. The long and ring fingers can be buddy-taped to encourage use of the new thumb. A relatively common finding is weak palmar abduction, which should be addressed a few years later with an opposition transfer—either the flexor digitorum superficialis from the ring finger or the abductor digiti minimi.

CLINICAL CASE

Figure 8 shows a clinical case of a patient with type V thumb hypoplasia immediately before and after pollicization. Figure 9 shows the long-term result.

PEARLS AND PITFALLS

From a technical perspective, the key to success is adequate mobilization, exposure, and retraction. In a child, the important structures are small and there is not much room, especially for visualization of the metacarpal head as it is recessed. This maneuver determines the final position of the thumb and is arguably the most important part of the surgery. Multiple, well-placed retractors and adequate positioning and lighting are critical to success.

The new thumb will never be a normal thumb because the necessary skeletal foundation is absent, the intrinsic muscles are weaker, and the nail width, pulp volume, and phalangeal lengths are not normal. The primary determinant of outcome is the preoperative state of the index finger: normal index fingers make better pollicized digits than stiff ones.

COMPLICATIONS

Vascular compromise after index to thumb transposition can occur but is rarely seen. Careful dissection of the arterial and venous structures avoids this catastrophic outcome.

Infection and hematomas are rare. Wound dehiscence and maceration is more common and results

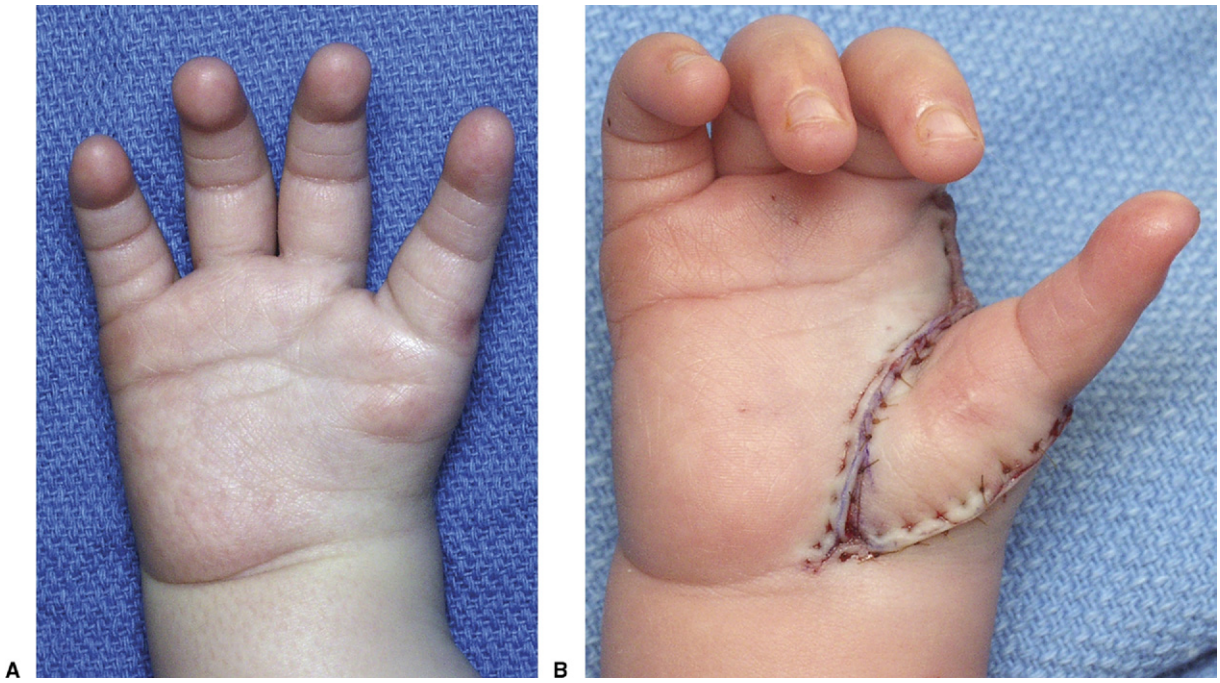

FIGURE 8: A, B Images of a 2-year-old child before and after index finger pollicization. Note a small scar on the radial side of the index finger where a soft tissue nubbin was removed in the newborn nursery.

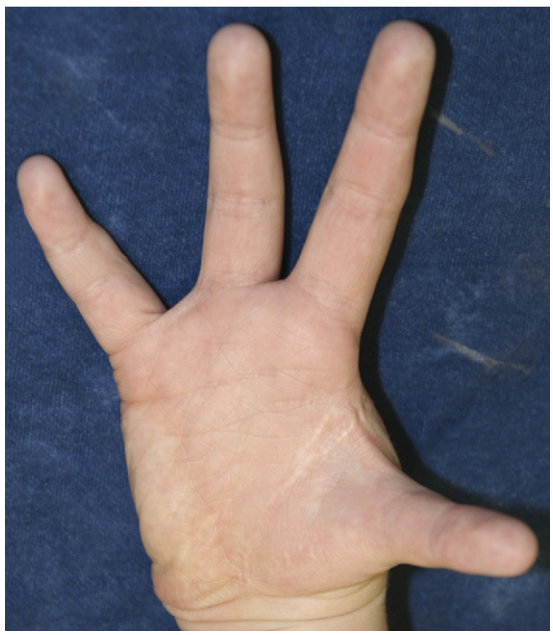

FIGURE 9: Five-year postoperative view of patient shown in Figure 8.

typically from inadequate immobilization. Skin flap necrosis is usually the result of a high-tension closure (from inadequate immobilization), poorly planned flaps, or flaps that are too thin. Failure to ablate the growth plate will enable the new thumb to grow and become too long. Hyperextension of the new thumb will occur when the index metacarpal head is not seated in hyperextension.

Experience is the essential ingredient in this demanding procedure. Improvement in outcomes and refinement of the technique can only be gained by understanding surgical cause and effect with careful critical appraisal of one's results.

REFERENCES

1. Buck-Gramcko D. Pollicization of the index finger. Method and results in aplasia and hypoplasia of the thumb. J Bone Joint Surg 1971;53A:1605–1617.
2. Upton J. Hypoplastic and absent thumb. In: Mathes S, Hentz VR, eds. Plastic surgery. 2nd ed. Vol. VIII. Philadelphia: Saunders Elsevier, 2006:343–350.
3. Manske PR, Rotman MB, Daily LA. Long-term functional results after pollicization for the congenitally deficient thumb. J Hand Surg 1992;17A:1064–1072.
4. Manske PR, McCaroll HR Jr. Index finger pollicization for a congenitally absent or nonfunctioning thumb. J Hand Surg 1985;10A:606–613.
5. Littler JW. The neurovascular pedicle method of digital transposition for reconstruction of the thumb. Plast Reconstr Surg 1953;12:303–319.
6. Upton J. Pollicization for the aplastic thumb. In: Marsh JL, ed. Current therapy in plastic and reconstructive surgery. Toronto: BC Decker, 1989:232–236.
7. Upton J, Sharma S, Taghinia AH. Vascularized adipofascial flap for thenar augmentation in pollicization. Plast Reconstr Surg 2008;122:1089–1094.