# Thumb Hypoplasia: Genesia, Pollicization

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**Abstract**

Congenital malformation of the thumb is one of the most important problems in congenital disease. The hypoplastic thumb is characterized by a variable degree of bony and soft tissue inadequacy. It may occur alone or as part of a multiple congenital anomaly syndrome. Depending on degree of hypoplasia, the nonsurgical or surgical treatment differs. Every treatment, usually, starts very early in the childhood to improve brain plasticity.

In case of surgical management, the primary goal is to improve or restore pincer grip. In general when the hypoplastic thumb lacks basilar joint stability or is absent, the hand is best treated by politicization of the index finger. When hypoplasia is less severe, surgical strategy includes first web deepening, MP ligamentoplasty, opponensplasty, and tendon transfer.

**Keywords**

Congenital hand deformities · Thumb hypoplasia · Pollicization · First web deepening · Opponensplasty · Tendon transfer

Congenital malformation of the thumb is one of the most important problems in congenital disease. The thumb has unique characteristics despite of long fingers. The CMC joint, the intrinsic and extrinsic muscles, the vascularization, and innervation make it the most important finger in the hand with the capability of opposition that differentiates human from the other species.

The hypoplastic thumb is characterized by a variable degree of bony and soft tissue inadequacy. There are several definitions of hypoplastic thumb: A thumb is considered to be underdeveloped if deficiency of any one or all structures is present [1]. Congenital hypoplastic thumb is defined as a short, underdeveloped thumb with deficient or absent intrinsic muscles with or without deficient extrinsic musculoskeletal structures [2]. The thumb is considered hypoplastic when its tip does not reach the midway point of the proximal phalanx of the index finger.

Depending on degree of hypoplasia, the nonsurgical or surgical treatment differs. In general, when the hypoplastic thumb lacks basilar joint stability or is absent, the hand is best treated by politicization of the index finger. When hypopla-

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sia is less severe, the thumb should be retained and reconstructed.

Treatments, usually, starts very early in the childhood. The pollicization is performed at about 1 year of age. This is preferred because by 6 months the infant begins to move the thumb voluntarily, by 9 months the thumb gains its independence and mobility from the palm whereas by 1 year of age, it becomes a crucial portion of hand function [3]. Than younger surgery takes advantage of brain plasticity and ease of incorporation into daily activities.

## 14.1 Epidemiology

The exact incidence of thumb hypoplasia is difficult to determine because of the large number of upper limb malformations, which contain some type of thumb deficiency. Kozin reported that the rate of birth anomalies is about 1% to 2%; of these about 10% occur in the upper extremity [4]. Entin [5] reported a 16% incidence of thumb hypoplasia among Canadian patients whereas Flatt [6] published an 11.2% incidence of thumb abnormalities and a 3.6% incidence of thumb hypoplasia or aplasia.

## 14.2 Associated Conditions

Thumb hypoplasia can occur isolated or in the context of other diseases. The presence of associated congenital anomalies and syndromes should be investigated with the aid of a geneticist.

More common association include:

- Holt Horam syndrome.
- VACTERL associations: vertebral abnormalities, anal atresia, cardiac abnormalities, tracheo esophageal fistula and/or esophageal atresia, renal agenesis and dysplasia, and limb defects.
- TAR SYNDROME (thrombocytopenia-absent radius): does not result in thumb hypoplasia but instead leads to a flat broad thumb.
- Fanconi anemia.
- CHARGE syndrome (coloboma of the eye, heart defects, atresia of the nasal choanae, retardation of growth and/or development, genital and/or urinary abnormalities, and ear abnormalities and deafness).

## 14.3 Classification

Muller described the first classification of thumb hypoplasia in 1937, subsequent modification done by Blauth, Buck-Gramcko and Manske has improved the classification.

Nowadays, the accepted classification is the modified Blauth classification that is categorized into five general types or grades.

This classification is used not only to describe the degree of hypoplasia but also to predict physical findings and guide treatment.

A type I hypoplastic thumb is stable with good overall function but slightly smaller than a typical thumb. Both intrinsic and extrinsic muscles are present.

In type II and type III, there is a narrowing of the thumb index web space, aplasia/hypoplasia of thenar muscles, and instability of the thumb metacarpophalangeal (MCP) joint. In type II, thumbs have intrinsic muscle aplasia/hypoplasia whereas type III thumbs have intrinsic and extrinsic muscle aplasia/hypoplasia.

Manske et al. [7] sub-classified type III thumbs into A or B based on the condition of the carpometacarpal (CMC) joint. The distinction is that the type IIIA thumb has a stable CMC joint. Type IIIB has severely underdeveloped CMC joint unstable.

Type IV deficiency is a floating thumb, in which a rudimentary digit is connected to the hand by only skin and a neurovascular bundle. Type V deficiency is a complete absence of the thumb (Fig. 14.1).

## 14.4 Indications

In severe grade of hypoplasia, from type IV to type V, the indication is the pollicization of the index finger.

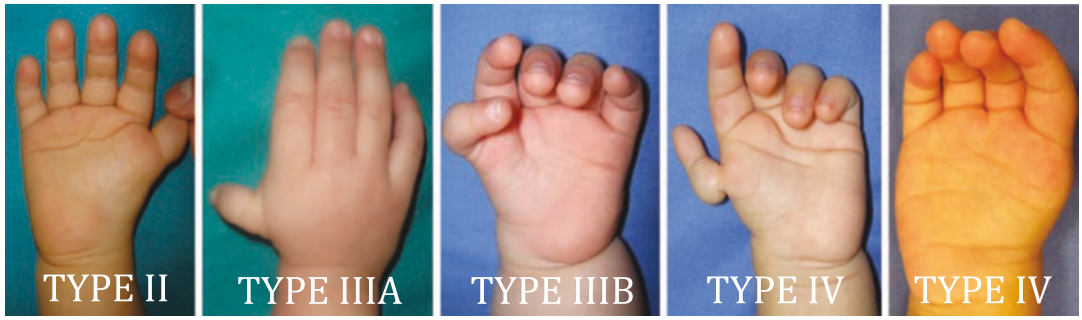


**Fig. 14.1** Grades of thumb hypoplasia from grade II onwards

Although in the last years there are some controversial for the indication in Blauth IIIB, index finger pollicization remains the ideal reconstruction also in this grade of hypoplasia.

Pollicization is also indicated in other congenital diseases as mirror hand, macrodactyly, multifingered hand and some traumatic cases.

The patient has to be healthy and able to tolerate general anesthesia. Must be investigated for any associated syndrome and disease. The surgery is not appropriate for children with several central nervous system deficiencies.

Must be discussed with parents the expected functional results: a stiff index finger will make a stiff neo thumb [8].

## 14.5 Techniques

The current technique of pollicization represents a consolidation of contributions from surgeons over the last 100 years [9–11].

The procedure was first described by Littler in 1952, modified by Buck-Gramcko in 1971 and then many surgeons refined the technique to improve appearance and function.

In the literature, the most discussed items include skin incision, positioning and fixation of the metacarpal head, rebalancing of intrinsic muscles and extensor tendons.

There isn't a perfect technique but every surgeon prefers the one in his hands is better.

The goals are to provide ample access to the index for pollicization, to reconstruct the first web space, recreate a functional new thumb with a good opponent position.

The pollicization requires a stepwise approach. Some of the critical points are:

1. Adequate design of the skin incision to allow easy index finger transposition and creation of an adequate thumb-index web space. This allows avoiding scar in the web space and preventing a contracture.
2. Preservation and reinsertion of intrinsic muscles in order to ensure thumb adduction and abduction,
3. Epiphysiodesis of the grow plate of metacarpal to prevent excessive growth of the base of the pollicized index finger,
4. extension of the MCP joint to avoid future thumb hyperextension,
5. fixation of the new thumb in opposition [12].

Our personal technique based on Buck-Gramcko technique modified by Foucher [13].

In this procedure, there' s a modification of the skin incision, rebalancing of extensor tendons, and bone fixation (Fig. 14.2).

The surgery starts with the children placed in a supine position under general anesthesia. A brachial plexus axillar block is performed to avoid pain during operation and in the early postoperatory period. A pediatric tourniquet is placed on the upper arm. Preoperative antibiotic prophylaxis is administered routinely.

The limb is gently exsanguinated to allow better visualization of the digital vessels.

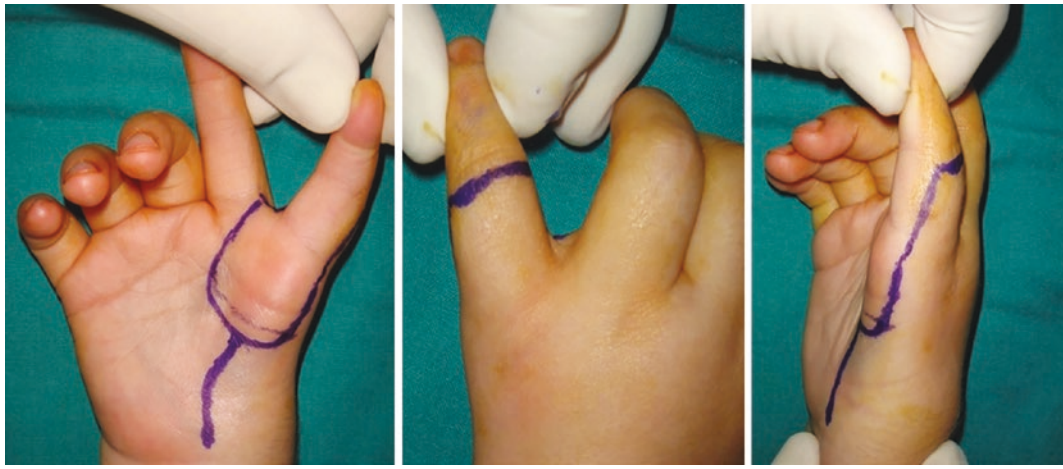

**Fig. 14.2** Buck-Gramcko technique modified by Foucher: skin incision

In children with a type IV or IIIB thumb hypoplasia, the incision wraps around the base of nonfunctional thumb. The extra digit is then removed with bone, tendon, nail, and neurovascular bundle are cauterized. In case of presence of hypoplastic thenar muscle, this is detached and preserve to restore thenar eminence.

The palmar skin is incised first and the flap is raised distally. Neurovascular bundles are identified and isolated from common digital vessels and nerves to the index-long web space and radial side of index finger. Additional dissection could be necessary in case of arterial variations. The distal arterial bifurcation is identified and its contribution to the long finger is ligated. Proximal microdissection is necessary to further separate the proper digital nerves to easier translation of the finger. To prevent inadvertent vessel injury could be helpful the use of surgical loop.

The first annular pulley of the index finger is identified and incised to allow mobilization of index finger and prevent buckling of the flexor tendons after the digit is shortened. The intermetacarpal ligament is identified and divided.

The dorsal incision extends transversely across the PIP joint. The dorsal flap is sharply elevated with the conservation of as many dorsal veins as possible. The veins are then followed proximally to allow good exposure of extensor tendons until MCP joint. The index extensor tendons are isolated and cut at the MCPJ. Then are splitted proximally until PIP joint into two bundle. This procedure creates new tendons for the reinsertion of intrinsic muscle.

The pollicization proceeds with the identification, isolation, and mobilization of the first dorsal and palmar interossei muscles. They are released distally with a portion of aponeurosis in preparation for suture fixation and reinsertion. Beware to isolate carefully the tendons from collateral ligaments to avoid damage of the metacarpophalangeal joint.

Once all of the soft tissues are adequately dissected and prepared, the entire metacarpal bone is exposed.

Removing of the diaphysis metacarpal bone shortens the index finger. With the soft tissues retracted, two osteotomies through metaphyseal portion are performed in a perpendicular direction. The distal cut is directly through the physis using a fine blade. In this step, it is important to preserve the periosteal because it gives stability to the new CMC joint. Then it is performed the epiphysiodesis through physeal ablation to prevent unwanted growth of the new thumb.

The base and the head of the metacarpal bone are fixed into hyperextension position with a mini or micro mitek anchor. This position is made to rectify the discrepancy between index metacarpophalangeal joint that hyperextend and normal thumb carpometacarpal joint that does not hyperextend.

Many authors prefer to give the right position and fix the new joint with a Kirschner wire. Usually, we prefer to avoid that to allow early rehabilitation program. The correct position is reached by suturing the intrinsic muscle, tendons, and skin. Just in older children, the fixation with k wire could give more stability at the joint.

Next step is the reinsertion of intrinsic muscles and extensor tendons. The palmar and dorsal interossei muscles are sutured at the ulnar and radial bands, respectively. In this way, the palmar interossei muscles become the new adductor pollicis and the dorsal one the new abductor of the thumb. The proximal portion of extensor tendon is reattached to the central part of extensor complex to be new extensor pollicis longus.

This rebalancing gives a stable and good position to the thumb: about 45 degrees of abduction and 135 degrees of pronation.

Once the index finger has been secured in the new position is important to ensure hemostasis control to avoid bleeding and hematoma formation.

The final closure of the skin is performed with rotation of the volar part of the flap to cover the first web space. This allows avoiding scar in the first web space and giving more stability to the thumb. Any redundant skin is excised (Fig. 14.3).

The procedure is completed. The tourniquet is deflated. Any persistent bleeding, ischemia or venous congestion must be investigated before making the dressing. The upper extremity is immobilized with a well-padded long arm cast with the thumb in an opposition.

The child is admitted overnight and the arm is elevated to promote venous drainage. Ten days later, the cast and the dressing are removed under sedation and replaced with removable split. From now start the rehabilitation program.

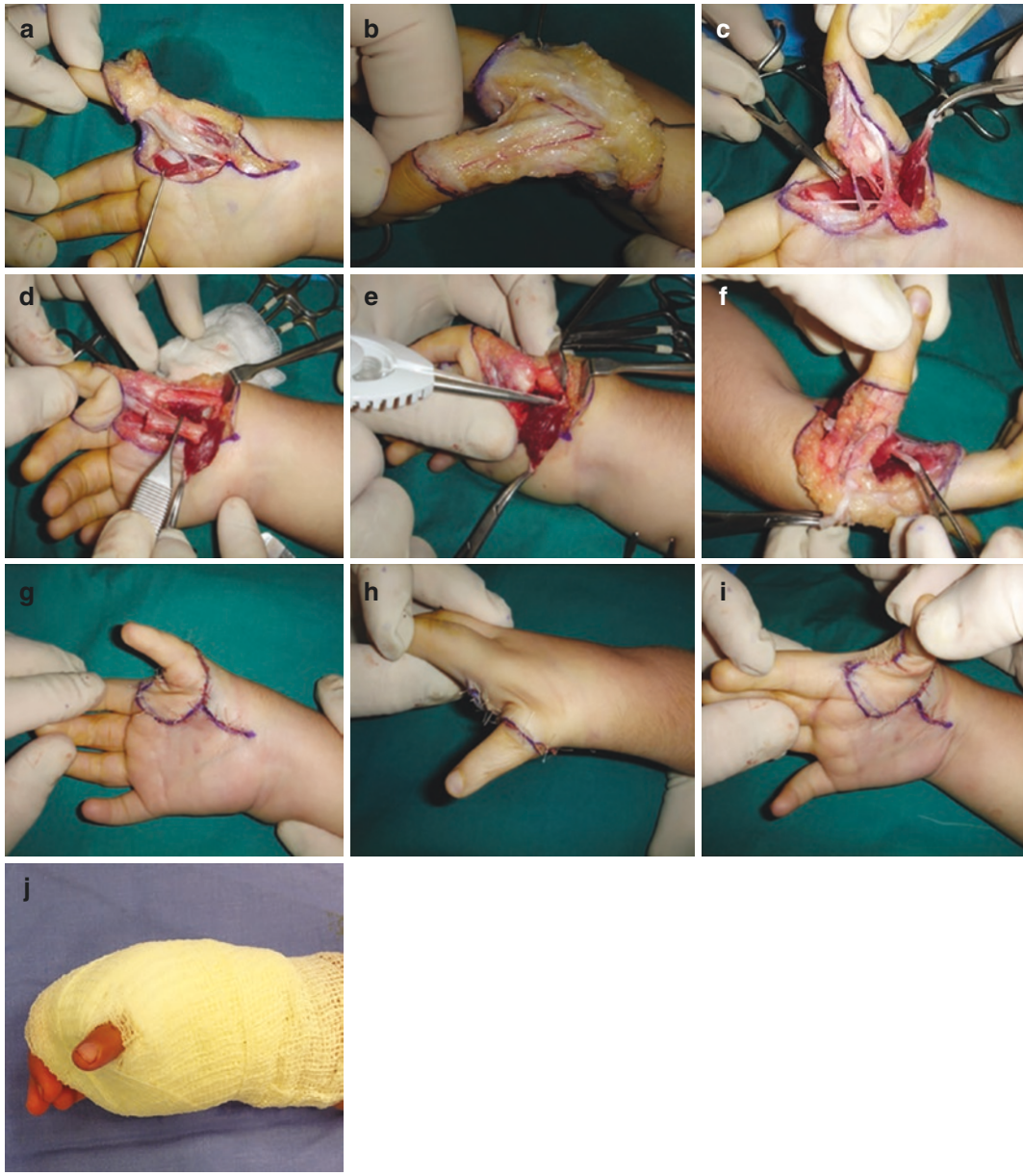


**Fig. 14.3** Pollicization technique: (**a**) isolation of the index finger, including the neurovascular bundles, tendons, and soft tissue attachments. (**b**) Isolation of dorsal veins and extensor tendons. (**c**) Detached interossei muscles and reserved for later reconstruction. (**d**) Isolated metacarpal bone (**e**). Fixation with anchor base and head of metacarpal bone. (**f**) Reinsertion interossei muscles. (**g**–**i**) Final skin suture. (**j**) Dressing and cast

## 14.6 Complications and Outcomes

The common complications are wound dehiscence and maceration, necrosis of distal part of the flap. Infection and hematomas are rare. Vascular compromise can occur but is extremely rare and can happen if the dissection will not respect the neurovascular bundle.

Long-term complications are: keloid or hypertrophic scar, insufficient first web space, excess of length caused for ablation's failure growth

**Fig. 14.4** Pollicization results

plate, hyperextension of MCP joint, malrotation of the thumb, stiffness or instability, lack of opposition.

Sometimes this result needs a second surgery as revision of first web space, tenolysis, epiphysiodesis and osteotomy of metacarpal, rotational osteotomy, and opposition transfer [14].

The results following pollicization are dependent on the status of index finger and its surrounding musculature. Pollicization of index finger provides a better result in isolated thumb hypoplasia compared with patients with a hypoplastic or absent radius [15].

A mobile index finger transferred to the thumb position provides stability for grasp and mobility for fine pinch. A stiff index finger, however, provides a stable thumb for gross grasp but will not be nimble enough to participate in pinch [16].

Pollicization is one of the most beautiful procedures in congenital disease but is a relatively uncommon procedure that requires considerable repetition to gain adequate experience. The surgeon must be expert to reach the best result and avoid dramatic complications (Fig. 14.4).

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