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Tendon Transfers for the Hypoplastic Thumb

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Article Synopsis

Thumb hypoplasia is a component of radial longitudinal deficiency. The severity of hypoplasia can range from a slightly smaller thumb to a complete absence. Types II and IIIA hypoplastic thumbs are candidates for reconstruction to improve function, stability, and strength. There are two commonly used tendon transfers that can augment thumb opposition strength, the Huber abductor digiti minimi muscle transfer and flexor digitorum superficialis (FDS) opposition transfer. Both transfers utilize ulnar sided structures to augment the thenar musculature. The Huber opposition transfer increases thenar bulk, but does not provide additional tissue for metacarpophalangeal (MP) stability. In contrast, the FDS opposition transfer utilizes the flexor of the middle or ring finger to augment the thenar musculature without increasing bulk, but does have additional tendon to allow for reconstruction of the thumb MP joint.

Keywords

hypoplastic thumb; radial longitudinal deficiency; Huber; flexor digitorum superficialis; opposition transfer

Background

Thumb hypoplasia is a manifestation of radial longitudinal dysplasia (RLD), incomplete development of the radial or preaxial side of the upper extremity. Thumb hypoplasia describes underdevelopment of the thumb and its related structures. When treating individuals with thumb hypoplasia, the surgeon should always be aware of the potentially life-threatening associated conditions and syndromes. These include Fanconi's anemia, Holt-Oram syndrome, VACTERL association, and Thrombocytopenia Absent Radius (TAR) syndrome. We recommend screening for all individuals with thumb hypoplasia for these conditions by either referring the patient for a genetics consultation or obtaining a complete blood count, renal ultrasound, cardiac evaluation, spine radiographs, and consideration of chromosomal breakage test for Fanconi's anemia. Once the screening has been complete, attention can be placed to the hand for evaluation of thumb function.

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Thumb hypoplasia was originally classified by Blauth (1) and subsequently modified by Buck-Gramko and Manske et al (2,3) (Table 1). The classification system is dependent on the degree of hypoplasia, ranging from a slightly smaller thumb to a completely absent thumb. The modification proposed by Manske et al divides grade III based on the stability of the thumb CMC joint (3). The modified classification provides surgeons guidance with regards to treatment of these underdeveloped thumbs. While some surgeons may choose to reconstruct all forms of hypoplastic thumbs, most Western surgeons utilize the classification and reconstruct thumbs type II and IIIA, and choose pollicization for grades IIIB, IV, and V thumbs.

When considering reconstruction for types II and IIIA, there are 3 specific components to be considered:

- 1) There is hypoplasia of the thumb muscles, intrinsic only in type II and extrinsic with intrinsic muscles in type 3.
- 2) There is instability of the thumb MP joint. The MP joint instability must be addressed in order to provide stability for use and function of the thumb specifically with regards to pinch and grasp. This can be isolated to laxity of the ulnar collateral ligament or can be a global instability.
- 3) The first webspace may be narrowed, requiring widening with a Z-plasty or dorsal transposition flap. This can be challenging to recognize in small hands and as a guide, in a normal hand the distance between the thumb and index metacarpal head should be the same as that of the index to small metacarpal head.

There are two commonly utilized tendon transfers to augment thumb function and strength in opposition, the Huber opposition transfer (4-13) and the flexor digitorum superficialis (FDS) opposition transfer (11-16). Both techniques are effective in improving thumb function and each has specific advantages.

The Huber opposition transfer involves transfer of the abductor digiti minimi (ADM) muscle from the ulnar border of the hand to the thumb. This muscle is a reliable transfer candidate; it is always present in radial longitudinal deficiency and there is little (if any) notable deficit once transferred. The ADM is rotated across the palm and augments thumb opposition and increases bulk in the thenar region, improving cosmesis of the hand. Also the transfer does not require the use of a pulley, which the FDS transfer necessitates. Unfortunately the muscle is short and has a very small tendon insertion. As a result, this muscle cannot be used to help stabilize the thumb MP joint. Additional steps, such as imbrication of the ulnar collateral ligament and capsule of the MP joint, must be performed to create stability of this joint. This is important because the pull of the Huber transfer on the APB insertion adds a further deforming force to the UCL and can worsen UCL instability if this is not addressed. Lastly, we do not use the Huber in older children because we have been limited in the length of the transfer, though the necessary length has not been quantified at this time.

The FDS opposition transfer is the alternative to the Huber to improve hypoplastic thumb strength and function. This technique utilizes a flexor tendon from one of the ulnar digits, typically the ring finger or long finger, as a transfer to augment thumb strength. As with the

ADM, the FDS is present in the ring finger and can be reliably harvested. There has been no documentation of decreased strength in the hand with this transfer. The FDS passes across the palm to the thumb. This technique does not augment the thenar eminence cosmetically, but the tendon length is beneficial because it allows for simultaneous reconstruction of the collateral ligament of the thumb MP joint.

Surgical techniques

Huber opposition transfer

a curvilinear incision is made along the ulnar border of the hand, at or slightly volar to the glabrous, non-glabrous border. This incision extends from the pisiform ending just proximal to the MP flexion crease of the small finger (Figure 1). The palmar skin is elevated exposing the underlying musculature. The ADM muscle is identified and isolated. There are 2 tendinous insertions, which are isolated and detached distally. The ADM is then mobilized proximally to its origin on the pisiform. Care is taken to protect the neurovascular bundle that is entering the muscle deep and radial, near the pisiform origin. A blunt Kelly clamp is used to create a generous subcutaneous tunnel from the level of the pisiform to the radial border of the thumb MP joint. A longitudinal incision is made over the radial aspect of the thumb MP joint to accept the transfer. The ADM is folded, like a turning the page of a book, across the palm and is then passed through this large subcutaneous tunnel to the thumb (Figure 2). If length as needed, the origin of the ADM can be detached from the ulnar border of the pisiform allowing further length to reach across the palm. The ulnar incision is irrigated and closed. The tendon of the ADM is then sutured to residual Abductor Pollicis Brevis tendon, the joint capsule and radial collateral ligament of the thumb MP joint. If there is instability to the thumb MP joint ulnarly a counterincision is made and the joint capsule imbricated or ligament reconstruction is performed.

FDS opposition transfer

A longitudinal (or transverse) incision is made in just proximal to the MP flexion crease of the ring finger, approximately 1.5 cm in length (Figure 3). The A1 pulley is opened and the FDS tendon is identified. It is drawn out of the incision and transected as distally as possible. It is not necessary to incision further in the digit for additional length because the tendon length obtained from an incision at the level of the A1 pulley is adequate for the transfer. A second incision is made proximal to the wrist flexion crease and slightly ulnar to the palmaris longus tendon, approximately 2 cm in length. The FDS tendon to the ring finger is identified in the volar wrist wound. Often times it is necessary to free the tendon from surrounding adhesions in the distal wound to allow it to be drawn out in the proximal wound. The distal incision is then closed. The FDS must now be taken across the palm to the thumb MP joint (Figure 4). There are multiple options for creation of a pulley to provide an effective line of pull for the FDS tendon (17) and no one pulley has been found to be superior. More distally placed pulleys will result in greater flexion and adduction force of the transfer, while more proximal pulleys result in greater palmar abduction of the transfer. We recommend using the flexor carpi ulnaris (FCU) tendon as a pulley. A small portion of the FCU tendon is cut, folded, and sutured in place as a tendon loop, to act as a pulley. Another option is to simply pass the FDS tendon through the FCU tendon with a stay stitch

placed proximally to avoid proximal migration of the incision in the FCU. An alternative is to utilize the transverse carpal ligament as a pulley. A strip of tissue can be used from the ligament to create a pulley.

After the chosen pulley is created, a blunt Kelly retractor is passed across the palm making a wide tunnel through which the FDS tendon is passed. The proximal incisions are closed. An accepting incision is made on the radial border of the thumb MP joint and the FDS tendon is delivered. A hole is created transversely through the neck of the metacarpal. This can be with drill or a manual punch tool. The FDS tendon is passed to the ulnar side of the thumb MP joint. The tendon is secured to the palmarly abducted metacarpal. The thumb ulnar collateral ligament is reconstructed by suturing to the periosteum at the base of the proximal phalanx (or attaching with a suture anchor). If there is instability of the radial collateral ligament of the thumb MP joint, the FDS tendon can be split longitudinally, with half passed into the metacarpal to reconstruct the ulnar collateral ligament and the remaining half used on the radial side to reconstruct the radial collateral ligament.

General technical considerations

As with all tendon transfer procedures, we recommend closing the incisions as one proceeds through the case. This prevents the need to close multiple incisions after the transfer has been sutured, risking of loosening. When considering the appropriate tightness of the transfer, we recommend tensioning of the thumb out of the plane of the fingers and into palmar abduction with the wrist in a neutral position. Care is taken not to strangulate the pedicle of the ADM muscle belly with a narrow tunnel. We have found that there is risk of vascular compromise with over tightening the ADM transfer and the transferred muscle can exert compression at the carpal tunnel.²⁰ Lastly, some surgeons may choose to place a 0.045 or 0.035 Kirschner wire to hold the thumb opposed to decrease stress and tension on the transferred during the time of healing.

Our postoperative protocol for both of these transfers includes a long-arm cast for the younger children, up to approximately age 7, and short arm cast for older children. We recommend immobilization for 5 weeks while the transfers heal. After 5 weeks the cast and pins are removed and a splint is made by the therapist and gentle motion is started. This removable orthoplast, thumb spica forearm based splint is utilized for the next 4 weeks at all times except for monitored range of motion exercises. At approximately 9-10 weeks we transition out of the brace during the day for normal activities and continue wearing the brace at night for one additional month. At this point gentle strengthening is started.

Outcomes

Currently there is minimal literature concerning the outcomes of opposition transfers for the hypoplastic thumb. At this time, there are no reports of the outcomes of the Huber opposition transfer. Two studies have reported outcomes of the FDS opposition transfer for types II and IIIA hypoplastic thumbs (18,19). De Kraker et al assessed 27 thumbs, 21 that had undergone tendon transfer and 6 that were treated non-operatively. They found that the FDS transfer significantly improved strength in those that had undergone surgery and that strength (grip and pinch) was 50% and 35% of normal in type II and IIIA respectively (18).

Vuillermin et al reported on 40 thumbs at minimum 2 years follow-up and found grip and pinch strength was approximately 50% of normal and that overall perceived function and happiness was high. There was no difference between the different pulleys utilized and 36 of the thumbs underwent UCL reconstruction (19). Both studies reported increased stability of the thumb MP joints after reconstruction.

Quantitative assessment of outcomes is difficult to perform secondary to the varying levels of hypoplasia and severity of involvement. Additionally, as with most congenital hand procedures, the progressing age of the child makes both subjective and objective outcome assessments difficult to compare. However, there are numerous studies reporting specific surgical techniques for opposition reconstruction, our preference for reconstruction is described here.

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Key Points

1. Types 2 and 3A hypoplastic thumbs can be augmented by the Huber and FDS opposition transfers.
2. The Huber opposition transfer involves transfer of the ADM muscle from the ulnar side of the hand, improving opposition strength and thenar bulk.
3. The FDS opposition transfer utilizes the FDS of the ring finger to transfer to the thumb MP joint to improve opposition strength and can also be used to stabilize an unstable thumb MPJ.

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Journal HCL	Vol : No. 32: 03	Fig # HCL-32-03-fig01.eps
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Figure 1.
The incisions for the Huber opposition transfer. A curvilinear incision is made along the ulnar boarder of the hand and a second incision is placed over the radial boarder of the thumb MP joint.

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Figure 2.
The ADM muscle is transferred across the palm to the thumb MP joint, passed subcutaneously.

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Figure 3.
The incisions for the FDS opposition transfer. One incision is made at the base of the ring finger for harvest of the FDS tendon. A second incision is made proximal to the wrist flexion crease to bring out the FDS tendon and placed through the FCU tendon. A third incision is made over the radial boarder of the thumb MP joint.

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Figure 4.
The FDS tendon is transferred across the palm to the thumb MP joint, passed subcutaneously.

Table 1

Thumb hypoplasia classification of Blauth as modified by Manske.

Hypoplastic Thumb Classification	
Type 1	Slightly small thumb
Type 2	Small thumb with Narrow first web space Unstable MCP joint Deficient thenar musculature
Type 3a	Type II with Extrinsic tendon abnormalities Metacarpal hypoplasia Stable CMC joint
Type 3b	Type II with Extrinsic tendon abnormalities Absent metacarpal base/ CMC instability
Type 4	Floating thumb
Type 5	Absent thumb