SURGICAL TECHNIQUE

Ulnar Thumb Pulp Reconstruction Using the Anterograde Homodigital Neurovascular Island Flap

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The thumb ulnar pulp is a critical component of key pinch and precision manipulation. Injuries to this area should be reconstructed with robust, sensate tissue that restores bulk and contour. The existing reconstructive options, however, have substantial risks and drawbacks. We describe an anterograde homodigital neurovascular island flap that provides both sensate and durable coverage of the ulnar thumb pulp. The flap uses innervated glabrous tissue, limits donor site morbidity to the thumb and first web space, and does not require microvascular anastomoses or nerve coaptation. The flap has been previously described for nonthumb fingertip injuries, but it has not been applied to the thumb. We discuss several important technical modifications that are essential to raising and insetting this flap in the thumb, review potential pitfalls, and highlight key steps to ensuring judicious intraoperative decision making and success. *(J Hand Surg Am. 2017;■(■):1.e1-e7. Copyright © 2017 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Thumb, ulnar pulp, tip, reconstruction, island flap.

Online Exclusive

THE THUMB ACCOUNTS FOR roughly 40% of normal hand function. The ulnar pulp, in particular, is critically important in precision manipulation and key pinch. Accordingly, defects of this region require a reconstructive technique that utilizes highly sensate tissue of adequate bulk and contour. Several reconstructive options exist, each with its own set of advantages and disadvantages.[1] First dorsal metacarpal artery (FDMA) flap is a common choice, but it relies on thin skin from the dorsum of the index finger to replace the thick glabrous skin of the pulp. Furthermore, return of sensation is often incomplete, which has led to modifications that rely on nerve coaptation to improve 2-point discrimination.[2,3] Finally, there is a risk of referred sensation to the index finger. A free toe pulp flap is an excellent alternative, but this requires extended operative time, microsurgical expertise, an inpatient stay, and a donor site outside of the upper extremity. A "simpler" cross-finger flap involves a period of immobilization and may lead to stiffness. Flaps such as the reversed-flow homodigital pedicled flaps are dependent on available arc of rotation and require nerve coaptation to achieve sensibility.[1,4] Exceptional results have been reported with semiocclusive dressings, but these can be extremely tedious for the patient.[1]

Herein, we describe our technique for reconstruction of the ulnar thumb pulp using an anterograde homodigital neurovascular island (AHNI) flap. This flap provides sensate glabrous tissue, restores adequate contour, and does not rely on microvascular anastomoses or nerve coaptations. The surgery is performed on an outpatient basis. Conceptually, the

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Received for publication May 30, 2017; accepted in revised form October 14, 2017.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

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0363-5023/17/■ ■-0001$36.00/0
https://doi.org/10.1016/j.jhsa.2017.10.013

flap is similar to the anterograde homodigital island flap for nonthumb fingertip injuries, as originally described by Segmuller (1976)[5] and more recently refined by Katz (2013).[6] Because the thumb differs anatomically from other digits, the thumb-based AHNI flap carries a unique set of considerations regarding flap design, dissection, and potential pitfalls. To our knowledge, limited mention of this flap exists in literature. Lim et al (2008)[7] described a spiral homodigital island flap for reconstruction of 32 fingertip defects, 7 in the thumb. The "spiral" design is not intuitive and there is limited discussion with respect to how the design is adjusted based on defect location (thumb vs nonthumb; ulnar tip vs central defect). Han et al (2013)[8] described the use of a dorsoulnar homodigital island flap for thumb tip amputations; this flap is based on dorsal blood supply, includes periosteum, does not include the ulnar digital nerve, and covers bone-nail composite grafts, a slightly different clinical scenario.

INDICATIONS AND CONTRAINDICATIONS

A successful thumb reconstruction will restore sensibility, maintain length, and replace missing pulp with durable tissue that is suitable for gripping and pinch. In general, small thumb tip defects (< 1 cm^2) may be allowed to heal by secondary intention with good results. Defects greater than 1 cm^2 with substantial loss of underlying soft tissue require skin grafts or flap coverage. Flaps are typically reserved for cases involving exposed bone, joint, or tendon. Even when periosteum or paratenon is intact, simple skin grafting may fail to provide sensation and contour, whereas healing by secondary intention requires a long and cumbersome period of dressing changes.

The AHNI flap described herein provides sensate and durable coverage of the ulnar pulp, a key functional region of the hand with an otherwise limited number of reconstructive options. Many of the local or regional flaps for thumb coverage are ill-suited for ulnar-sided tip defects. The traditional Moberg advancement flap, for example, is meant for total tip defects or amputations because it is based on both neurovascular pedicles. Reversed-flow homodigital pedicled flaps are utilized more for radial or dorsal thumb tip defects, involve delicate dissection, and require nerve coaptation if sensibility is desired.[1,4] In a way, defects of the ulnar thumb tip are a "special challenge," as recently highlighted by Germann et al. 2017.[1] In these cases, the FDMA flap serves as the primary reconstructive "workhorse."[1] The AHNI flap can be a useful alternative to the FDMA flap, with several distinct potential advantages. Relying on thumb tissue adjacent to the defect, the AHNI flap avoids (1) index finger donor site morbidity, (2) risk of referred sensation to the dorsum of the index finger, and (3) nonglabrous skin coverage. In our experience so far, patients were also able to regain an average of 6 mm 2-point discrimination within 3 months after surgery (see case illustrations later). This compares favorably with the 10.8-mm average 2-point discrimination reported for the FDMA flap that does not utilize nerve coaptation.[9] If raised on the contralateral radial digital artery, the AHNI flap can be considered for radial thumb tip defects as well.

The AHNI flap is contraindicated in cases in which the neurovascular pedicle is compromised. This includes cases in which the injury extends proximally to affect the pedicle or there is a history of prior injury to the area. A hand-held Doppler can be helpful when there is uncertainty about the degree of injury and patency of vessels. Systemic conditions such as small vessel vasculitis or peripheral vascular disease also prohibit the use of this flap. Smoking is not a contraindication for AHNI flap, similar to the experience by Katz (2013) for the non−thumb-based flap.[6]

SURGICAL ANATOMY

The vascular anatomy of the thumb is considerably different from that of other digits. Understanding this anatomy is key to properly executing flap dissection, anticipating potential roadblocks, and making appropriate adjustments. The princeps pollicis artery (PPA) serves as the dominant blood supply to the thumb.[10] It originates from the radial artery on the dorsal hand and travels along the thumb metacarpal in a dorsopalmar direction, eventually exiting between the adductor pollicis and the first dorsal interosseous muscles in the first web space (Fig. 1). There, it gives rise to both the ulnar and the radial digital arteries on the palmar side, while also contributing to the dorsal ulnar artery.[10] The palmar ulnar digital artery (PUDA) is the pedicle for the ulnar-based AHNI flap. In addition to receiving contribution from the PPA, the PUDA receives contribution from the first palmar metacarpal artery (1MCA), which itself originates from the superficial palmar arch.[10] Anastomoses exist between the 2 palmar thumb arteries and between the palmar and the dorsal circulation systems.[10] This complex network of vessels should be kept in mind when raising the AHNI flap in order to avoid injuring the main pedicle. Having only 2 phalanges, the thumb is