Distal interphalangeal joint to proximal interphalangeal joint homodigital island transfer

Article in Operative Techniques in Plastic and Reconstructive Surgery · February 1997
DOI: 10.1016/S1071-0949(97)80013-3

4 authors, including:

Roger Khouri
Miami Breast Center
103 PUBLICATIONS 3,161 CITATIONS

Alejandro Badia
Badia Hand to Shoulder Center, Miami, FL USA
47 PUBLICATIONS 608 CITATIONS

Jorge Orbay
Miami Hand & Upper Extremity Institute, Miami,…
35 PUBLICATIONS 1,482 CITATIONS
DISTAL INTERPHALANGEAL JOINT TO PROXIMAL INTERPHALANGEAL JOINT HOMODIGITAL ISLAND TRANSFER

ROGER K. KHOURI, MD, YOUNG-JIN SHIN, MD, ALEJANDRO BADIA, MD, AND JORGE L. ORBAY, MD

Reconstruction of the damaged proximal interphalangeal (PIP) joint is a challenge in the young active patient. Arthrodesis is disabling and implant arthroplasty is not satisfactory. Microvascular transfer of the second toe PIP joint is technically demanding, requires sacrifice of the toe, and achieves only 40° of average arc of motion in most reported series. The distal interphalangeal (DIP) joint of the same digit is conveniently located for potential transfer and its loss is well tolerated. We hereby describe our technique of homodigital DIP to PIP joint island flap transfer. With this procedure, the traumatized digit serves as its own donor and no other digit or toe is compromised. It exchanges the DIP joint, which contributes only 15% to the digital flexion arc for the PIP joint whose functional contribution is 85%. In addition, it provides the opportunity to shorten the stiff finger, making it less prone to interfere with hand activities. It is currently our preferred procedure, and because of its excellent result, has superseded the microvascular toe joint transfer.

The proximal interphalangeal (PIP) joint is the most important joint of the finger. Saving the PIP joints is a primary consideration in the overall treatment and rehabilitation of hand injuries. From full extension to complete flexion, Littler found that the finger describes an equiangular spiral (Fig 1). While the majority of the overall flexion arc is provided by the metacarpophalangeal joint (MP), the portion attributed to the PIP joint is most important functionally because it is responsible for the completion and the strength of the grasp.

Arthrodesis is disabling and should be kept as the procedure of last resort. Resurfacing arthroplasty with perichondrial autografts is applicable only when the subchondral bony architecture is intact, and in most hands, the procedure has yielded unpredictable results. Prosthetic implants and spacers, despite many improvements, are still limited in terms of stability, durability, and range of motion. Most of all, they are contraindicated in the young active patient. Nonvascularized joint transfers, and vascularized toe joint transfer.

Foucher et al described in 1990 a homodigital island transfer of the distal interphalangeal (DIP) joint to replace a damaged PIP joint. The patient recovered 65° of active motion at the PIP joint at 6 months follow-up. Foucher et al subsequently published his series of seven homodigital DIP to PIP joint transfers who recovered an average of 52° of active motion. Inspired by his procedure, we have slightly modified the technique and have since performed a number of PIP joint reconstructions. It is currently our preferred method of reconstruction of the PIP joint in the young active patient.

INDICATIONS AND PATIENT SELECTION

The procedure should be reserved for the well motivated young healthy patient whose professional or avocational activities places significant mechanical demands on the hand. This is a delicate and complex operation to be performed only for the well informed patient who requests and requires good motion of his PIP joint.

Anatomically, the patient should have two intact digital arteries, an intact flexor tendon mechanism, and be able to show satisfactory range of active motion at the DIP joint. The results of vascularized PIP joint reconstruction have been uniformly disappointing in the multiple-operated digit and whenever there is simultaneous need to reconstruct the flexor tendon apparatus. In cases of fixed contractures with soft tissue deficiency, simultaneous flap coverage should be performed.
Fig 1. The natural biological spiral found in snails, shells, and flowers is also inscribed by the motion of the phalanges from full flexion to full extension. Littler noted that the extremity of the finger describes a curve of progressively diminishing radius that allows the closing finger to wrap around objects of decreasing diameters. The MP joint contributes to 77% of the total flexion arc, the PIP joint provides 20%, whereas the contribution of the DIP joint is only 3%. The contribution of the PIP joint is therefore 6.7 times more important than that of the DIP joint. (Reprinted with permission.)

VASCULAR ANATOMY

The two digital arteries communicate in the transverse plane via a series of vascular arcades most of which are located just proximal to the joints (MP, PIP, and DIP). The main blood supply to the DIP joint arises from the last palmar arches communicating the two digital arteries before they converge at the digital pulp. The main blood supply to the DIP is through the proximal DIP transverse arch. This branch comes off the digital arteries just proximal to the flare of the condyles and has a retrotendinous course. It gives off the vincular branches to the tendons and proceeds under the volar plate to perfuse the joint (Fig 2). Additional perfusion to the joint is provided by the distal DIP transverse arch and by multiple direct smaller branches to the joint through the collateral ligaments.

SURGICAL TECHNIQUE

The procedure is performed under tourniquet without exsanguination to visualize the fine vascular structures. Through a midaxial incision, the palmar vascular bundle on the noncritical side of the finger is exposed and dissected with a generous cuff of fibrofatty tissue to preserve the venae comitants. While separating the nerve from the bundle, extreme care should be given not to disturb these venae comitants. From the distal third of the middle phalanx up to the mid distal phalanx, all soft-tissue connections between the vascular bundle and the DIP joint should be preserved. The flexor tendon sheath is then exposed and divided in the mid-palmar axis. The flexor tendon is delivered from the sheath and retracted exposing the volar plate that should be left undisturbed to preserve the main blood supply to the DIP.

To facilitate the exposure of the DIP joint, a transverse dorsal skin incision can be made at the level of the joint. The dorsal skin is dissected off the extensor tendons. A distal osteotomy is made with a sharp osteotome just distal to the terminal slip insertion of the extensor tendon, taking care not to destroy the germinal matrix of the nail. The extensor tendon is divided proximal to the DIP and the proximal osteotomy is made at a level just proximal to the

DIP TO PIP HOMODIGITAL ISLAND JOINT TRANSFER
Fig 3. Design of the skeletal reconstruction. The DIP joint (shaded area) is transferred en-bloc with its volar plate and the terminal tendon. The vertical lines denote the level of the osteotomies. The profundus tendon is left attached to the distal segment of the distal phalanx. The dotted areas represent the amount of PIP resection. Note that the central slip of the extensor is left attached to a dorsal lip of middle phalanx.

Fig 4. Completed skeletal reconstruction. The bones of the DIP joint are of smaller caliber and are inserted as tongues in the grooves left by the PIP resection. The distal middle phalanx is fused to the distal phalanx with minimal flexion. In contrast to Doctor Foucher’s original procedure, no tendon repairs are performed.

Communicating transverse branch of the digital artery (Fig 3). The origin of this branch off the digital artery is usually identified but should not be skeletonized. Following this second osteotomy, the soft-tissue attachments on the opposite side of the finger are divided with the bipolar and the joint is delivered as an island flap connected only by the dissected vascular bundle.

Fig 5. Through a mid-axial incision, the DIP island flap is isolated on the ulnar digital vessels and reflected over the palm of the hand. Note the generous cuff of tissue harvested with the digital artery to preserve venous drainage. ThePIP joint is dislocated exposing the damaged articular surface to be resected. Both flexor tendons are left intact and are visible below the edge of the palmar skin.

The damaged PIP joint is then resected taking care not to damage the flexor tendon apparatus. The resection should be conservative especially on the middle phalanx. The finger ends up being shortened by the amount of PIP resection. The DIP island flap is then inset at the PIP defect. The bony segments of the DIP are smaller in diameter and are inserted as pegs into the recipient phalangeal troughs (Fig 4). The transfer is fixed in full extension with two criss-crossing K-wires proximally and distally. The DIP arthrodesis is similarly fixed with two K-wires. A split-thickness hypothenar graft is harvested to cover the folded

Fig 6. Radiographs immediately following the transfer (anteroposterior view). Note the criss-crossing pins kept extra-articular.

Fig 7. Radiographs immediately following the transfer (lateral view). Note the criss-crossing pins kept extra-articular.
up vascular pedicle and prevent closure under tension of the mid-axial incision. The fixation wires are kept for 6 weeks after which gradual exercises are instituted to restore range of motion.

CLINICAL CASES

Case 1

A 33-year-old male professional boxer fractured his middle finger PIP joint and was managed with open reduction and internal fixation. One year later he developed traumatic arthritis with severe limitation of motion that prevented him from donning his boxing gloves. The active range of motion of the PIP joint was 20°, whereas his DIP joint had 90° of active motion. The DIP joint was dissected as an island flap perfused by the ulnar digital artery (Fig 5) and fixed into the proximal and middle phalangeal troughs with criss-crossing K-wires. The K-wires did not violate the transferred joint space (Figs 6 and 7). At 9 months the recovered active range of motion at the PIP joint level was 90° (100° to −10°) (Figs 8 and 9).

Case 2

A 34-year-old male computer programmer presented with a stiff left ring finger PIP joint secondary to multiple softball and football injuries. The range of motion of the PIP joint was 15° (0° to 15°) (Fig 10). His DIP joint was transferred to the PIP position as a homodigital island flap. The fixation wires were removed 6 weeks after the transfer. At 3 months, the recovered active range of motion at the PIP joint level was 90° (100° to −10°) (Figs 11 and 12).
CONCLUSION

The technique for PIP joint reconstruction by means of a homodigital DIP joint island flap achieves excellent functional results. The traumatized digit serves as its own donor and no other digit or toe is compromised. It exchanges the DIP joint, which contributes only 15% to digital flexion arc for the PIP joint whose functional contribution is 85%. In addition, it provides the opportunity to shorten the stiff finger making it less prone to interfere with hand activities. It is currently our preferred procedure, and because of its better result, has superseded the microvascular toe joint transfer.

REFERENCES


