Double lateral band transfer for treatment of traumatic hyperextension instability of the proximal interphalangeal joint: a report of two cases

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Abstract Post-traumatic hyperextension instability of the proximal interphalangeal joint may lead to pain, difficulty with initiating finger flexion, and a swan-neck deformity. Most techniques to correct a traumatic hyperextension deformity of the proximal interphalangeal joint require a window in the flexor retinaculum, retraction of the flexor tendons, and manipulation of the joint capsule with a conceivable potential for joint stiffness, tendon adhesions, and tendon bowstringing. We describe an extra-articular lateral band transfer technique that utilizes strips of both lateral

bands and preserves the functional integrity of the flexor tendon sheath.

Keywords Proximal interphalangeal joint · Volar plate · Sprain · Joint instability · Lateral band transfer

Introduction

Traumatic hyperextension instability of the proximal interphalangeal (PIP) joint results from disruption of the volar capsuloligamentous complex and may lead to pain, difficulty with initiating finger flexion, and a swan-neck deformity [4, 5, 11, 15]. In cases of persistent hyperextension deformity of the PIP joint, with reasonably well-preserved articular cartilage and joint architecture, direct repair of the volar plate is generally considered [4, 15, 16, 19–21, 27]. However, primary repair may not be possible due to retraction and attenuation of the capsuloligamentous complex [4, 6].

Other joint-preserving procedures to address traumatic hyperextension instability of the PIP joint include tenodesis using one or both slips of the flexor digitorum superficialis (FDS) tendon [6, 12, 15, 19, 20, 26], fascial or tendon graft bridging of the joint [1], and collateral ligament advancement [3, 11]. The aforementioned operations necessitate a window in the flexor tendon sheath for exposure of the joint capsule, and manipulation of the flexor tendons, with a conceivable potential for joint stiffness, tendon adhesions, and tendon bowstringing.

The extra-articular transfer of a single lateral band proximal and volar to the axis of rotation of the PIP joint has been reported in a limited number of traumatic cases of hyperextension instability [2, 8, 25]. The redirected lateral band replicates the course of the oblique retinacular ligament, serving as a check-rein to overextension of the PIP

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joint. Although the functional integrity of the flexor tendon sheath is preserved, there is uncertainty regarding the durability of PIP joint hyperextension correction with a single lateral band transfer [7].

We modified the lateral band transfer concept, redirecting strips of both lateral bands proximal and volar to the axis of PIP joint rotation. Our premise was that a double, rather than a single, lateral band transfer would provide for a more durable and balanced biological construct over time. We propose the surgical technique of double lateral band transfer and report the clinical outcome in two cases at a minimum follow-up of 2 years. The study was approved by the Institutional Review Board of the participating university, and informed consent was obtained from both patients at follow-up evaluation.

Surgical Approach

Figure 1 demonstrates the surgical technique. Under regional or general anesthesia and tourniquet control, a longitudinal incision is made over the PIP joint. The extensor apparatus is exposed, and 2-mm wide, distally-based slips of both lateral bands are fashioned, necessitating incisions through Cleland's ligaments and the transverse retinacular ligaments. While protecting the neurovascular bundles, small parallel vertical slits approximately 5 mm apart are made in both sides of the flexor tendon sheath, proximal and palmar to the axis of rotation of the PIP joint. The free ends of the lateral bands are drawn proximally through the retinacular slits, reflected distally, and tensioned with the PIP joint flexed 5° to 10° . The reflected ends of the lateral bands are then secured to lateral

Fig. 1 Surgical technique: **a** Two-millimeter wide, distally based slips of both lateral bands are fashioned; **b** parallel transverse slits approximately 5 mm apart are made in both sides of the flexor tendon sheath, proximal and palmar to the axis of rotation of the PIP joint; **c** the free

ends of the lateral bands are drawn proximally through the retinacular slits and reflected distally; **d** the lateral bands are tensioned with the PIP joint flexed 5° – 10° , and the reflected ends of the lateral bands are sutured to lateral band tissue; **e** photograph of a transferred lateral band

band tissue using 4–0 monofilament sutures. The joint flexion angle is adjusted, if necessary, by further incising or suturing the distal attachment of each lateral band slip to the extensor apparatus. The skin incision is closed, and the finger is immobilized in a dorsal extension block splint with the PIP joint in slight flexion.

Case Report

Patient 1

A 21-year-old, right-hand-dominant college student presented with chronic hyperextension instability of his left ring finger PIP joint. He recalled injuring the digit while playing soccer more than 10 years earlier. He experienced recurrent episodes of instability despite finger splinting and buddy taping. On examination, the PIP joint actively hyperextended 15° and passively hyperextended 25° (Fig. 2). The joint was stable to radially and ulnarly applied stresses. There was normal active motion of the distal interphalangeal (DIP) joint, full composite finger flexion, and independent function of the flexor digitorum profundus and FDS tendons. His contralateral ring finger PIP joint did not actively or passively extend beyond neutral. Radiographs of the injured finger revealed a concentric reduction of the PIP joint and no degenerative arthritic changes.

The patient elected to proceed with surgery, and a double lateral band transfer procedure was completed. At his first

postoperative visit 5 days later, a dorsal extension block finger splint was fabricated, restricting the PIP joint from extending beyond 10° from full extension, and active finger motion exercises were initiated. After 6 weeks, static extension splint treatment was initiated to treat a 20° flexible PIP joint flexion deformity. Finger splinting was discontinued, and unrestricted activities were permitted at 3 months.

At the latest examination 27 months postoperatively, the patient reported no pain in his left ring finger or recurrent episodes of PIP joint hyperextension instability. The Disabilities of the Arm, Shoulder and Hand (DASH) score was 0, supporting an excellent result [9]. There was mild swelling localized to the PIP joint, but without point tenderness or perceptible instability. Active and passive extension of the PIP joint measured 0° (Fig. 2). The DIP joint actively hyperextended 5°; this was equivalent to pre-operative DIP joint motion and motion of the contralateral ring finger DIP joint. Normal power of extension across both interphalangeal joints in the left ring finger and full composite ring finger flexion were demonstrated. Grip strength measurements using a dynamometer (Sammons Preston, Inc., Bolingbrook, IL) averaged 80 lbs in both hands, and sensibility testing was normal. New radiographs were not completed.

Patient 2

A 32-year-old, right-hand-dominant software developer presented with chronic instability of the PIP joint of his left small finger, which he had injured in a softball game 1 year

Fig. 2 Patient 1: **a** Preoperative active ring finger extension and flexion and passive PIP joint extension; **b** 27 months after surgery, active ring finger extension and flexion and passive PIP joint extension

earlier. Application of a figure-of-eight ring splint for a period of several months was ineffective in correcting the PIP joint hyperextension deformity. He reported recurrent episodes of PIP joint instability with activities necessitating lifting and carrying. On examination, the left small finger PIP joint actively hyperextended 10° and passively hyperextended 50° (Fig. 3). Minimal asymptomatic laxity of the joint was noted with applied radial and ulnar stresses. There was normal active motion of the DIP joint, full composite finger flexion, and independent function of the flexor digitorum profundus and FDS tendons. His contralateral small finger PIP joint actively extended to neutral and passively hyperextended 10° . Radiographs of the traumatized digit revealed an old injury to the radial margin of the proximal phalanx neck, but without PIP joint deformity or degenerative changes.

The patient elected to proceed with surgery, and a double lateral band transfer procedure was completed. A 15° passively correctable extensor lag of the DIP joint developed postoperatively and was effectively treated by night-time extension splinting for a period of 4 months. The prescribed splinting and rehabilitation measures were otherwise identical to patient 1.

At the latest examination 24 months postoperatively, the patient reported an occasional stiff sensation in the left small finger, but no pain or recurrent episodes of PIP joint hyperextension instability. The DASH score was 1, supporting an excellent result [9]. The PIP joint exhibited a passively correctable 30° extensor lag, whereas the DIP joint actively

extended to neutral. Passive extension of the PIP joint was not possible beyond neutral (Fig. 3). Normal power of extension across both interphalangeal joints and full composite finger flexion were demonstrated. Grip strength measurements using a dynamometer averaged 110 lbs in both hands, and sensibility testing was normal. New radiographs of the operative finger showed no change in comparison to preoperative radiographs.

Discussion

Traumatic hyperextension instability of the finger PIP joint is managed in the acute or subacute setting with protective dorsal extension block splinting of the PIP joint [17]. Bowers proposed that hyperextension deformity is more likely to occur in the absence of bone injury due to the poor vascularity of the distal volar plate [4]. If extension block splinting, or later use of a PIP joint figure-of-eight ring splint and/or buddy taping, does not prevent recurrent PIP joint hyperextension deformity, the patient may experience difficulty initiating finger flexion and painful snapping as the lateral bands slide over the condyles of the proximal phalanx [17]. A swan-neck deformity of the finger can develop, and the PIP joint surfaces may degenerate over time, complicating treatment.

Articular-based procedures to address traumatic, refractory hyperextension instability of the PIP joint include direct repair of the volar plate [4, 15, 16, 19–21, 27], superficialis

Fig. 3 Patient 2: **a** Preoperative active small finger extension and flexion and passive PIP joint extension; **b** 24 months after surgery, active small finger extension and flexion and passive PIP joint extension

tenodesis [6, 12, 15, 19, 20, 26], fascial or tendon graft bridging of the joint [1], and collateral ligament advancement [3, 11]. The joint must be supple and the articulating surfaces in reasonably good condition for a soft-tissue rebalancing operation; otherwise, PIP joint arthroplasty or fusion may be indicated. Direct repair of the volar plate is generally preferred [6, 16, 27], whereas tenodesis using one or both slips of the FDS tendon is considered when the volar plate is found to be retracted or attenuated [6]. Fascial and tendon graft bridging of the PIP joint and collateral ligament advancement are procedures largely of historical interest.

Stability of the PIP joint is restored with either direct volar plate repair or FDS tenodesis; however, flexion contractures of the PIP joint have been reported with both techniques [6, 16]. In addition, sacrificing one or both slips of the FDS tendon may lead to decreased finger flexion and diminished hand strength. Each procedure will necessitate a window in the flexor retinaculum, retraction of the flexor tendons, and manipulation the PIP joint capsule with a conceivable potential for scar, tendon adhesions, and tendon bowstringing. To our knowledge, there are no published studies that have specifically assessed the competency of the flexor tendon sheath and/or excursion of the flexor tendons following volar plate repair or FDS tenodesis.

Littler [13, 14] was the first to report an extra-articular technique to correct PIP joint hyperextension. He sectioned the ulnar lateral band at the musculotendinous junction in a rheumatoid patient with swan-neck deformities, leaving the distal insertion intact, and attached the free end to the flexor tendon sheath volar to the axis of rotation of the PIP joint on the ipsilateral side of the finger. The function of the oblique retinacular ligament was replicated: active extension of the PIP joint leads to passive tenodesis of the DIP joint into extension. Zancolli [28] adapted the lateral band transfer concept in the treatment of PIP joint hyperextension instability in association with cerebral palsy by mobilizing one lateral band, without disrupting the proximal or distal attachments, and stabilizing the band in a sling created by approximating a slip of the FDS tendon to the volar plate.

There have been several reports of single lateral band transfers to treat PIP joint hyperextension and swan-neck finger deformities in association with rheumatoid arthritis and cerebral palsy [7, 13, 14, 18, 22, 24, 25, 28]. Further variations in technique include use of the radial lateral band, attachment of the lateral band to the bony proximal phalanx, use of a bone anchor [10], rerouting the lateral band across the volar aspect of the PIP joint to the contralateral side of the digit, and use of a free tendon graft (the so-called spiral oblique retinacular ligament reconstruction) [23]. The results have been generally favorable in the short term, but recurrent finger deformities with longer follow up have been reported [7]. Progressive pannus formation in rheumatoid arthritis will lead to attenuation of soft tissues and joint

deformity with a potential for relapsing instability [18]. Failures in cerebral palsy have been postulated to result from suboptimal surgical technique, muscle imbalance, and postoperative rehabilitation measures [7].

There are relatively few reports of single lateral band transfer for treatment of traumatic PIP joint hyperextension instability [2, 8, 24]. Foucher et al. [8] reported 16 patients with a traumatic PIP joint hyperextension deformity who were seen at a minimum of 6 months after unilateral lateral band transfer. There were no cases of recurrent PIP joint hyperextension instability; however, eight patients exhibited a PIP joint flexion contracture of greater than 20°. Tonkin et al. [24] reported 1 patient with a 15° hyperextension deformity of the PIP joint who exhibited a 10° flexion of the joint 10 weeks following unilateral lateral band transfer. Ahmed and Goldie [8] described one case of single lateral band transfer to treat concomitant hyperextension and lateral instability of the PIP joint. The joint was effectively stabilized and normal interphalangeal joint motion was recorded after 5 years.

We modified the lateral band transfer concept by re-routing slips of both lateral bands proximal and volar to the PIP joint axis of rotation and securing the tendon slips to the flexor retinaculum through small transverse slits. The gross integrity of the sheath was preserved. Given the absence of preoperative DIP joint deformity in our two patients, sections of each lateral band dorsally were retained in an effort to uphold normal tension across the terminal extensor tendon. Our premise was that a double, rather than a single, lateral band tenodesis would provide for a more durable and balanced restraint to PIP joint hyperextension over time.

A flexible PIP joint flexion deformity developed postoperatively in both of our cases, and a passively correctable extensor lag of the DIP joint developed in patient 2. At the final evaluation, a functional 30° passively correctable PIP joint flexion deformity persisted in patient 2. There was no recurrence of PIP joint hyperextension instability in either case. We suspect that the temporary DIP joint extensor lag in patient 2 resulted from diminution of excursion of the distal extensor apparatus, possibly related to scar tissue, whereas the persistent PIP joint extensor lag was the sequela of an overly tensioned transfer. A stiff extension deformity of the DIP joint from taught lateral band slips was not observed.

We propose a dual-slip lateral band transfer procedure as a viable option for treating chronic, post-traumatic hyperextension instability of the PIP joint when the articulating surfaces and joint architecture are reasonably well-preserved. An extensor lag of the PIP joint may develop; however, the gross integrity of the flexor tendon sheath is preserved, and the flexor tendons and PIP joint capsuloligamentous complex are left undisturbed. Recognized limitations of our study include the case report format, the lack of preoperative DASH scores, and the absence of a direct

comparison to other surgical procedures. Clinical and biomechanical studies are necessary to further assess the efficacy of this approach.

Disclosure The authors declare that they have no conflict of interest.

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