Thumb volar plate reconstruction utilizing extensor pollicis brevis autograft: evaluation of a new technique

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Abstract

Background Sagittal plane instability of the thumb metacarpophalangeal joint is a difficult problem with numerous surgical techniques described. The purpose of the study is to demonstrate a technique in which a distally based extensor pollicis brevis tendon autograft is utilized to reconstruct the deficient volar plate.

Methods This is a retrospective case series of four patients who were followed a minimum of 2 years after this procedure. Patient demographics, return to work status, and objective outcomes are reported.

Results This technique compared favorably to those previously described, in terms of technical ease, functional results, and patient satisfaction. Each patient returned to his previous activity level and was maintained on active duty in his current military occupational specialty. None required a permanent profile to limit the physical demands of his job.

Conclusions Preliminary data suggests this technique is anatomically sound, technically less demanding, and requires minimal surgical dissection compared to previously described procedures.

Keywords Thumb · Volar plate · Extensor pollicis brevis

Introduction

Chronic sagittal plane laxity of the thumb metacarpophalangeal (MCP) joint occurs most commonly in the context of generalized ligamentous laxity and is rarely problematic. However, it may be symptomatic if it is secondary to systemic conditions such as collagen vascular disease, congenital or acquired paralytic disorders, collapse deformity secondary to basal joint arthritis, or direct trauma. Post-traumatic hyperextension of the thumb MCP joint may be the consequence of an unrecognized or otherwise untreated tear of the volar plate or a dislocation of the joint. Patients with instability caused by generalized ligamentous laxity are able to volitionally maintain the joint in flexion during pinch and grip, whereas those with post-traumatic laxity cannot. The resultant collapse of the joint into hyperextension may be painful and result in weakness in pinch and grasping activities [8].

Moberg recognized the MCP joint volar plate to be of equal importance to the collateral ligaments in maintaining joint stability [7]. It was in conjunction with Stener that he described the anatomic basis for traumatic thumb MCP hyperextension [10]. The proximal volar plate attachments failed in tension before the accessory ligaments or surrounding musculature, which would otherwise provide dynamic stabilization of the joint. They also noted frequent failure of immobilization, therefore advocating early surgical repair.

Although multiple surgical techniques are available for thumb volar plate reconstruction, there have been few studies documenting their efficacy. A technique using the extensor pollicis brevis (EPB) tendon as an autograft has been previously described [4]. While their results appear acceptable, it requires extensive surgical dissection and may entrap the thumb flexor tendon. The technique introduced in this study avoids binding the flexor tendon, requires less surgical dissection, and may result in greater functional recovery in a high

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demand patient population. The purpose of the study is to demonstrate a new surgical technique to treat thumb MCP joint instability that is technically simpler and potentially more efficacious than those previously described.

Materials and Methods

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Surgical Technique

A curvilinear incision is centered over the MCP joint, on the radial or ulnar aspect, as indicated by preoperative assessment of the respective collateral ligaments. The soft tissues are carefully dissected, ensuring preservation of the radial sensory nerve branches. The EPB tendon is identified and isolated. If there is no concomitant collateral ligament disruption, we prefer approaching the MCP joint from the radial aspect (Fig. 1a). The abductor aponeurosis is incised longitudinally and retracted volarly. In the case of associated ulnar collateral ligament dysfunction, the joint is approached ulnarly through the adductor aponeurosis. A second longitudinal incision is placed just proximal to the first dorsal wrist compartment (Fig. 1b). The EPB tendon is isolated and incised at the myotendinous junction (Fig. 2). It is then pulled distally into the operative field maintaining its insertion at the base of the proximal phalanx just radial to the adjacent extensor pollicis

Fig. 1 Skin incisions (a) distal over radial aspect of thumb MP joint and (b) proximal over EPB myotendinous junction

Fig. 2 Isolating the EPB tendon graft

longus (EPL) tendon (Fig. 3). The free tendon end is sewn with a 3.0 FiberWire suture in a locked Kessler's fashion to provide secure fixation for future intraosseous tendon passage. Though unusual, variation in the anatomy of distal EPB insertion may require utilizing this tendon as a free graft.

A window in the flexor tendon sheath at the MCP joint is incised and protected for subsequent repair. A 2.7-mm drill is used to create transosseous tunnels at the base of the proximal phalanx, just adjacent to the EPB insertion, in a dorsal to palmar direction. A second tunnel is drilled at the distal metacarpal neck, just proximal to the articular surface, in a dorsal to volar direction. Tunnel placement may be guided by intraoperative fluoroscopy (Fig. 4). Utilizing a flexible tendon passer, the EPB tendon is then passed through the distal drill hole from dorsal to volar (Fig. 5), proximally along the interval between the volar plate and flexor pollicis longus tendon, and then volar to dorsal through the proximal drill hole in the metacarpal (Figs. 6 and 7).

The tendon is tensioned with the MCP joint flexed to 20° and repaired to its insertion point dorsally (Fig. 8). In the instance of radial or ulnar collateral ligament insufficiency, the tendon graft can be used to augment its repair or reconstruction. Alternatively, the tendon can be secured with an intraosseous suture anchor or biotenodesis screw. The MCP joint may be stabilized in flexion with a 0.045-in Kirschner wire though we have not found this to be necessary.

The flexor tendon sheath is then repaired. This is followed by repair of the abductor aponeurosis (or adductor aponeurosis in the instance of associated ulnar collateral ligament injury). A postoperative thumb spica splint is worn for 2 weeks

Fig. 3 Harvesting the distally based EPB tendon graft

Fig. 4 Drilling bone tunnels to pass tendon graft

at which time the sutures are removed. The hand is then immobilized for an additional 4 weeks in a thumb spica cast with the thumb interphalangeal joint free. Active motion of the interphalangeal joint is encouraged to prevent adhesion of the EPL tendon.

A graduated range of motion protocol is initiated at postoperative week 6. A hand-based thumb spica splint protects the reconstruction when not performing rehabilitative exercises. Thenar intrinsic muscle isometrics and progressive grip strengthening is initiated at postoperative week 6 to 8. Thumb pinching activities are initiated at postoperative week 10 to 12.

Clinical Follow-Up

Medical records were reviewed for pre- and postoperative disability of the arm, shoulder, and hand (DASH) survey and range of motion. Postoperative lateral pinch and grip strength obtained at final follow-up were compared to the opposite nonoperative hand.

Results

Four active duty military males, mean age 29 years (range, 20 to 38 years), underwent reconstruction of the thumb MCP joint volar plate after traumatic injuries. Time from injury to surgery averaged 2.6 years (range, 1 to 5 years). Each was followed postoperatively for at least 2 years, mean 41 months (range, 24 to 74 months) (Table 1).

Fig. 5 Passing tendon graft through distal bone tunnel

Fig. 6 Passing tendon graft through proximal bone tunnel

Patients in this series demonstrated marked improvement of their MCP joint hyperextension as well as improvement of their lateral pinch and grip strength. The DASH for all available were also improved (Table 2). Upon release from surgical and occupational therapy follow-up, each patient was performing all duties required of his military occupational specialty (MOS). None required a profile for activity limitation.

Discussion

There are multiple surgical procedures to correct hyperextension of the MCP joint. The earliest reported techniques addressed MCP instability secondary to intrinsic palsy [12] or due to spasticity [3]. We sought to develop a procedure durable enough to withstand the demands of a physically active population yet allow return of a full range of motion. The use of autologous local tendon graft with existing bony fixation is appealing. Additionally, there is no requirement for complicated instrumentation or the use of implants. Use of the EPB tendon, which may otherwise provide an additional

Fig. 7 Illustration depicting passage of tendon autograft

Fig. 8 Tensioning and securing tendon graft with MP joint flexed 20°

deforming force, serves this function well. Care must be taken to note the potential for variation in the anatomy of distal EPB insertion. In a series of cadaveric dissections, Lyons et al. [6] noted a direct insertion of EPB tendon to the base of the proximal phalanx in 61 %, a slip to the distal phalanx with no proximal attachment in 26 %, an indistinct insertion blended into the dorsal MCP joint capsule in 10 %, and an insertion to both the proximal and distal phalanx in the remaining 3 %.

There are several procedures employing a capsulodesis technique. Eaton and Floyd [1] utilized 3–0 nonabsorbable suture placed in the radial aspect of the volar plate proximally. Subperiosteal suture was advanced proximally and dorsally onto the distal metacarpal and tied. Schuurman and Bos [9] proposed a similar procedure with sutures passed on both the radial and ulnar borders of the volar plate and secured interosseously to the dorsal metacarpal neck. Each of these case series reported good to excellent results with little to no residual hyperextension. One criticism of Eaton and Floyd's procedure is that only the lateral aspect of the volar plate was sutured, resulting in a less durable repair with accompanying loss of thumb flexion. Schuurman and Bos's technique, by their own admission, is more difficult and requires significant surgical dissection.

Eiken [2] advised against volar capsuloplasty due to a perceived difficulty in performing the procedure, as well as their observation of gradual failure. He employed a palmaris tendon graft in which the distal aspect remained attached to the palmar fascia. The proximal tendon was advanced subcutaneously and secured through a drill hole in the volar aspect of the proximal phalanx to serve as a checkrein to hyperextension with the thumb in abduction. He reported improved function but did not provide objective outcome measures. Tonkin [11] described a sesamoid arthrodesis in which the radial sesamoid, along with

Table 1 Patient demographics

Patient	Age	Sex	Dominant hand	Time since injury	MOS
#1	28	M	Yes	1.5 years	Infantryman
#2	20	M	No	3 years	Infantryman
#3	30	M	No	1 year	Corpsman
#4	38	M	No	5 years	Logistics officer

Table 2 Objective outcome measures

Patient	Dash pre vs. post-op	MCP hyperextension (°) pre vs. post-op	Lateral pinch (kg) post-op vs. contralateral	Hand grip (kg) post-op vs. contralateral
#1	Not available	70 vs 0	13.6 vs 13.6	56.8 vs 53.6
#2	27 vs 16	40 vs 0	13.6 vs 12.7	60.9 vs 53.6
#3	93 vs 18	45 vs 10	9.5 vs 10.4	50 vs 51.8
#4	73 vs 1	90 vs 0	6.8 vs 8.2	45.4 vs 56.4

the palmar plate, was advanced proximally onto the volar aspect of the metacarpal neck. Thirty-three of 37 patients had good to excellent results; however, only one of their patients had the instability secondary to trauma. Posner et al. [8] reported a series of six patients who underwent distal advancement of the thenar intrinsic muscles onto the proximal phalanx, thereby providing dynamic stabilization of the MCP joint. All of these patients returned to their previous levels of activities, though only two of six regained full extension of the MCP joint.

Kessler [4] published a technique using a distally based EPB autograft weaved in a figure-of-eight fashion around the volar aspect of the thumb MCP joint with one leg interosseously anchored through the distal thumb metacarpal. This series of 11 patients demonstrated good results with 7 being completely free of symptoms. Of note, this technique is technically demanding requiring three separate incisions. Additionally, one limb of the tendon weave is passed volar to the flexor pollicis longus tendon potentially binding its excursion. Lim et al. [5] criticized Kessler's technique, noting the occurrence of EPL subluxation ulnarly as well as the development of MCP joint extensor lag. They used a split EPB tendon graft to preserve its MCP joint extensor function. The graft was routed in a crisscross fashion dorsal to the flexor pollicis longus (FPL) tendon. While pinch strength was preserved, they did note potential drawbacks of adhesions causing flexion contractures in two of six patients in their series. They also postulated that the bulk of a crisscross graft might also prevent full flexion. We did not note the presence of extensor lag or loss of flexion in our series in which a full EPB graft is used which also passes dorsal to the FPL tendon.

A technique of volar plate reconstruction, which does not rely solely on plication of previously attenuated soft tissue, or adversely affect the mechanics of adjacent important myotendinous structures is appealing. In our series, all four patients returned to unrestricted active military duty. Each regained full and stable range of motion with no recurrence of painful MCP joint hyperextension. Lateral pinch and grip strength was comparable to the uninvolved opposite hand. Our procedure using distally based EPB tendon autograft for reconstruction of the thumb volar plate is efficacious,

relatively simple, biomechanically sound, and well-tolerated by patients.

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Conflict of Interest Kenneth F. Taylor declares that he has no conflict of interest.

Jeffrey A. Levy declares that he has no conflict of interest.

Statement of Human and Animal Rights This study involved human subjects. The study was approved by an institutional review board.

Statement of Informed Consent Written informed consent was obtained from all patients prior to being included in this study.

References

1. Eaton RG, Floyd WE. Thumb metacarpophalangeal capsulodesis: an adjunct procedure to basal joint arthroplasty for collapse deformity of the first ray. *J Hand Surg [Am]*. 1988;13:461–5.
2. Eiken O. Palmaris longus tenodesis for hyperextension of the thumb metacarpophalangeal joint. *Scand J Plast Reconstr Surg*. 1981;15:149–52.
3. Filler BC, Stark HH, Boyes JH. Capsulodesis of the metacarpophalangeal joint of the thumb in children with cerebral palsy. *J Bone Joint Surg Am*. 1976;58:667–70.
4. Kessler I. A simplified technique to correct hyperextension deformity of the metacarpophalangeal joint of the thumb. *J Bone Joint Surg Am*. 1979;61:903–5.
5. Lim GJ, Yam A, Tay SC, et al. A split-EPB tendon sling for chronic post-traumatic palmar instability of the thumb metacarpophalangeal joint. *J Hand Surg Eur*. 2009;34:358–62.
6. Lyons RP, Kozin SH, Failla JM. The anatomy of the radial side of the thumb: static restraints in preventing subluxation and rotation after injury. *Am J Orthop*. 1998;27:759–63.
7. Moberg E, Stener B. Injury to the ligament of the thumb and fingers. *Acta Chir Scand*. 1953;106:166–86.
8. Posner MA, Langa V, Ambrose L. Intrinsic muscle advancement to treat chronic palmar instability of the metacarpophalangeal joint of the thumb. *J Hand Surg [Am]*. 1988;13:110–5.
9. Schuurman AH, Bos KE. Treatment of volar instability of the metacarpophalangeal joint of the thumb by volar capsulodesis. *J Hand Surg (Br)*. 1993;18:346–9.
10. Stener B. Hyperextension injuries to the metacarpophalangeal joint of the thumb—rupture of ligaments, fracture of sesamoid bones, rupture of flexor pollicis brevis. An anatomical and clinical study. *Acta Chir Scand*. 1963;125:275–93.
11. Tonkin MA, Beard AJ, Kemp SJ, et al. Sesamoid arthrodesis for hyperextension of the thumb metacarpophalangeal joint. *J Hand Surg [Am]*. 1995;20:334–8.
12. Zancolli EA. Claw-hand caused by paralysis of the intrinsic muscles: a simple surgical procedure for its correction. *J Bone Joint Surg Am*. 1957;39:1076–80.