Extensor Pollicis Brevis Spiral Tenodesis for Combined Metacarpophalangeal Instability and Trapeziometacarpal Arthritis

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Abstract

Background: In more advanced stages of trapeziometacarpal arthritis, the thumb metacarpal may develop an adduction contracture, leading to secondary hyperextension instability of the metacarpophalangeal joint. Following trapeziometacarpal arthroplasty, uncorrected substantial metacarpophalangeal hyperextension may contribute to ongoing Z-collapse deformity, weakness of pinch and grip, and patient perception of diminished function. **Methods:** We prospectively analyzed a consecutive case series of 55 trapeziometacarpal arthroplasty patients (mean age, 60 years; 7 males) who received simultaneous extensor pollicis brevis spiral tenodesis for thumb metacarpophalangeal hyperextension of at least 50°. Preoperative/postoperative (mean, 24 weeks) objective measurements and Disabilities of the Arm, Shoulder and Hand (DASH) scores were compared using paired *t* tests with *P* < .05. **Results:** Mean preoperative/postoperative measurements were as follows: metacarpophalangeal hyperextension, 62.0°/–1.7°; metacarpophalangeal flexion, 52.1°/50.1°; interphalangeal arc of motion, 66.4°/65.5°; key pinch, 3.6/5.4 kg; grip strength, 14.1/20.1 kg; DASH score, 56.6/8.4. Differences were statistically significant for metacarpophalangeal hyperextension, key pinch, grip strength, and DASH score. Differences were not significant for metacarpophalangeal flexion or interphalangeal arc of motion. No patient demonstrated paresthesias or hypersensitivity of the digital nerves. All patients achieved stability at the metacarpophalangeal joint. One Kirschner wire was removed earlier than planned after migration and penetration through the skin. **Conclusions:** Performed in conjunction with trapeziometacarpal arthroplasty, spiral tenodesis effectively stabilizes the metacarpophalangeal joint without compromising metacarpophalangeal flexion, interphalangeal motion, or the digital nerves. Postoperatively, patients demonstrate significant improvements in key pinch, grip strength, and DASH scores.

Keywords: metacarpophalangeal, instability, thumb, arthritis, tenodesis

Introduction

As osteoarthritis progressively worsens at the trapeziometacarpal (TMC) joint, many patients will develop an adduction contracture of the thumb metacarpal. The continued need to grasp medium to larger sized objects then leverages the metacarpophalangeal (MP) joint into progressive degrees of hyperextension instability. Eventually, the entire thumb axis develops what has been termed a *Z-collapse deformity* corresponding to a decline in objective pinch and grip strength and subjective perception of diminished function. When TMC arthroplasty is performed to address the primary problem, the question has remained whether anything should be done at the MP joint to enhance pinch, grip, and subjective patient satisfaction with outcome.^{4,6} The most common procedures performed in conjunction with TMC arthroplasty have been MP fusion, MP volar capsulodesis, and sesamoid fusion.^{1–10} Fusion eliminates all MP motion and may reduce interphalangeal motion.^{4,10} Local

capsulodesis techniques using a volar incision can produce excessive local scar tissue around the digital nerves (paresthesias and hypersensitivity) and the flexor pollicis longus (reduced MP and interphalangeal motion) as well as an initial rigid end point that ultimately fails over time.^{2–8}

Spiral tenodesis using the extensor pollicis brevis (EPB) constitutes a different approach to the prevention of MP hyperextension instability. No wound is created over the path of the digital nerves that are neither seen nor touched by an instrument in the course of the procedure. Rather than a very limited focal point of tethering that can feel very rigid to the patient at first but also fail easily over time,

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Figure 1. The extensor pollicis brevis is detached proximally in the trapeziometacarpal arthroplasty wound and retrieved distally.

constraint to hyperextension is distributed over a long spiral path (less rigid) but firmly anchored at the proximal end with the EPB woven into the capsule and accessory abductor pollicis longus (APL).

Materials and Methods

We prospectively analyzed a consecutive case series of 55 TMC arthroplasty patients (mean age, 60 years; 7 males) who simultaneously underwent the EPB spiral tenodesis stabilization procedure for the MP joint. Inclusion criteria were patients with Eaton grade III or IV osteoarthritis of the TMC joint, thumb adduction contracture, and a preoperative passive MP hyperextension angle of 50° or greater. Measurements were made by goniometer (range, 50°-75°). Exclusion criteria were patients with inflammatory arthritis or inheritable disorders of ligament laxity (Ehlers-Danlos). All procedures followed were in accordance with the ethical standards of the responsible institutional committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. Informed consent was obtained from all patients for being included in the study. Preoperative/postoperative (mean, 24 weeks; range, 13-78 weeks) objective measurements and Disabilities of the Arm, Shoulder and Hand (DASH) scores were compared using paired *t* tests with *P* < .05.

Surgical Technique

Through a 2-cm incision at the dorsal-ulnar MP joint, the EPB (detached proximally) was dissected distal to the axis of MP motion (Figure 1), routed deep to the extensor pollicis longus, volar to the adductor aponeurosis, deep to the neurovascular bundles, and external to the flexor

Figure 2. A hemostat is passed from the radial base of the metacarpal to reach the ulnar side of the metacarpophalangeal joint in the distal wound, grasp the free end of the extensor pollicis brevis tendon, and establish the spiral path.

Figure 3. Once tested for flexion moment arm acting on the metacarpophalangeal (MP) joint and after pinning the MP joint, the extensor pollicis brevis is tensioned and secured to the accessory abductor pollicis longus.

sheath in a spiral path (Figure 2) to reach the radial base of the thumb metacarpal (Figure 3) where it was anchored to the joint capsule and the accessory APL with slow-absorbing 4-0 monofilament suture (Figure 4). The digital nerves are neither visualized nor touched during the routing of the graft. Traction is applied to the EPB to verify that it exerts the intended flexion moment arm on the MP joint, confirming correct routing. Inadequate demonstration of MP flexion upon EPB tensioning indicates revising the path to a more volar position from an overly lateral initial route. Before final tensioning and anchoring of the tenodesis, the MP joint was pinned in 20° of flexion with a 1.4-mm Kirschner wire (K-wire), removed at 4 weeks postoperatively.

Figure 4. The path of the extensor pollicis brevis tendon passes deep to the extensor pollicis longus at the base of the proximal phalanx, wrapping ulnarly to begin the long spiral route that takes it volar to the axis of the metacarpophalangeal joint, external to the flexor sheath, deep to the neurovascular bundles, to ultimately reach the radial base of the metacarpal where it is sutured to the radial leaf of joint capsule and the accessory abductor pollicis longus.

The associated TMC arthroplasty procedure consists of complete trapeziectomy and suspension of the thumb metacarpal with 1 slip of distally based APL through a drill tunnel in the index metacarpal (metadiaphyseal junction), locked with an interference screw, and a tenocapsulodesis to prevent transverse plane shifts in the base of the thumb metacarpal.

Patients are maintained in a thumb spica splint for the first 4 weeks, working only thumb interphalangeal (IP) full range of motion. At 4 weeks, the K-wire is removed, and all joints are actively ranged through their normal arcs of motion, avoiding only passive hyperextension force to the MP joint. Light pinch loading and hand grip strengthening are initiated at 6 weeks, and the splint is weaned. High-force pinch and grip are avoided until after 10 weeks of healing.

Results

Mean preoperative/postoperative measurements were as follows: MP hyperextension, $62.0^{\circ}/-1.7^{\circ}$; MP flexion, $52.1^{\circ}/50.1^{\circ}$; interphalangeal arc of motion, $66.4^{\circ}/65.5^{\circ}$; key pinch, 3.6/5.4 kg; grip strength, 14.1/20.1 kg; DASH score, 56.6/8.4. Differences were statistically significant for MP hyperextension, key pinch, grip strength, and DASH score. Differences were not significant for MP flexion or interphalangeal arc of motion. No patient demonstrated paresthesias or hypersensitivity of the digital nerves. All patients achieved stability at the MP joint. One K-wire was removed earlier than planned after migration and penetration through the skin.

Discussion

To demonstrate that a particular method of stabilizing the MP joint is advantageous when used in conjunction with TMC arthroplasty, a randomized controlled trial including one or more alternative stabilization techniques and a group with no MP stabilization is required. For the time being, only uncontrolled comparisons can be made between existing series, as there appear to be no such controlled studies currently in publication.⁴

A retrospective analysis of 297 thumbs undergoing trapeziectomy (only some which had MP hyperextension surgically addressed with varying procedures) concluded that MP hyperextension of less than 30° did not influence outcome but that hyperextension of greater than 35° can be improved with formal stabilization.⁶

Assessment of 12 thumbs with volar capsulodesis demonstrated correction only to a 19° hyperextension deformity at 1 year postoperatively from the preoperative deformity of 45° , and the result worsened to a 30° hyperextension deformity by 9-year follow-up.⁵ Furthermore, MP flexion was limited to 37° , and the patients demonstrated no improvement in pinch or grip strength compared with preoperative values.

A case report describes a patient where 50° hyperextension of the MP joint was considered so severe that the authors chose MP fusion as the means of stabilization.¹⁰ Hyperextension instability of greater than 40° has been discussed as an indication to choose MP fusion rather than a motion-sparing procedure.⁴

The significant reduction in DASH scores seen in our patients likely represents mostly the pain relief afforded by the TMC arthroplasty. However, the low DASH score also means that the patients perceive a high degree of function (which would be unlikely with untreated MP hyperextension instability of 60°) and that no new source of substantial pain (such as scarred digital nerve hypersensitivity) was introduced with the procedure. Similar conclusions may be drawn about the objective improvements in grip and pinch strength, where the majority of improvement should be attributed to the TMC arthroplasty, but the good scores also indicate the stability of the MP joint during pinch. The lack of any statistically significant change in MP flexion and interphalangeal arc of motion means that the spiral tenodesis procedure has not added any functional morbidity, in contrast to MP fusion and some volar capsulodesis procedures. The average follow-up of only 24 weeks in this study does not permit commentary as to the long-term stability afforded the MP joint; however, the diffuse scarring of EPB tendon along the entire spiral path is expected to be far less subject to failure over time in comparison with single point tethers. In comparison with the historical literature overall, this series has a large number of patients, whose initial degree of hyperextension instability was much greater than

the other reported series but still achieved equal or better measured outcomes.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

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

Statement of Informed Consent

Informed consent was obtained from all patients for being included in the study.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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