Stabilization of the Thumb Carpometacarpal Joint Utilizing a Minimally Invasive Approach: A Novel Technique

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Abstract: Treatment of symptomatic thumb carpometacarpal (CMC) joint synovitis can be challenging. Surgical options in these patients are often limited due to the patient's youth and lack of arthrosis. One of the most commonly used techniques involves the use of the flexor carpi radialis to reconstruct the ligamentous complex of the thumb CMC joint. This technique is technically challenging and involves a wide exposure to the CMC joint. Furthermore, outcomes data on this technique are relatively lacking. We propose a novel minimally invasive technique to confer stability to the thumb CMC joint in the setting of persistent subluxation/synovitis using the Arthrex MiniTightrope system. Our clinical results are encouraging at mean 24 months postoperative with nearly all patients experiencing both statistically and clinically meaningful improvements in QuickDASH and Visual Analog Scale pain scores.

Key Words: thumb carpometacarpal, synovitis, arthritis, stabilization, minimally invasive

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The treatment of thumb carpometacarpal (CMC) joint pain in the absence of marked arthrosis continues to present a challenge to patients and surgeons alike.[1,2] One of the earliest described treatments to address this issue was written in 1973 by Eaton and Littler, who utilized the flexor carpi radialis to stabilize and reconstruct the volar "beak" ligament of the CMC joint.[3] Since this initial publication, few corroborating reports of the techniques' efficacy have been reported. In the past decade, techniques describing repair or reconstruction of the dorsoradial ligament complex have shown promising results in limited patient populations.[4,5] Additional techniques have been described including arthroscopic debridement and capsulorrhaphy; however, these techniques suffer from either a lack of long-term follow-up or poor outcomes.[6–8] Thus, in the presence of failure of conservative management, a reliable treatment option has yet to be popularized for the treatment of thumb CMC synovitis or "early" arthritis. Given the high degree of function usually exhibited by these patients, the ideal technique would provide durable pain relief while minimizing morbidity during the recovery period.

Our study was approved by the Institutional Review Board (protocol# 2024P000461). All patients gave consent for their clinical photos and radiological images to be included in the manuscript.

ANATOMY

The technique to be described utilizes a technological innovation already used for thumb CMC arthroplasty (Arthrex Mini TightRope Fixation System (Arthrex)[9–11] This device has been conceptually tested in a cadaveric model and shown to possess equivalent efficacy with regard to stabilization of the thumb CMC joint when compared with the Eaton/Littler beak ligament reconstruction.[12] In many of the patients who experience thumb CMC joint pain/synovitis a high degree of radial subluxation is noted due to laxity in the capsuloligamentous complex that stabilizes the thumb CMC joint (Fig. 1). Many of the techniques described to date seek to tighten or reinforce these ligaments, particularly the volar "beak" ligament and

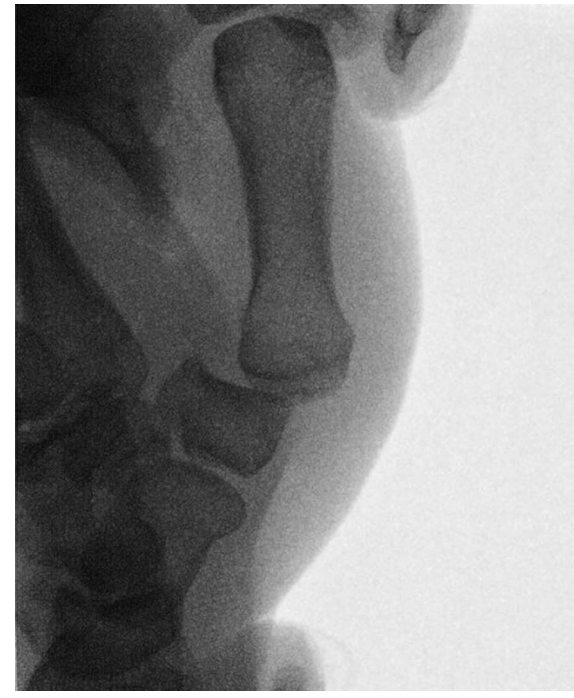

FIGURE 1. 24-year-old patient with notable radial subluxation of the thumb carpometacarpal joint.

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the dorsal radial ligament which effectively reduces this subluxation (Fig. 2).[13] By placing the Mini TightRope™ with a trajectory which runs from the radial aspect of the thumb metacarpal through the base of the index metacarpal this subluxation can be corrected while maintaining traction on the joint to prevent subsidence, potentially avoiding chondral irritation.

Indications/Contraindications

Nonoperative treatment remains the mainstay of treatment for these patients. Occupational therapy and splinting are used for a minimum of 3 months before any additional intervention. Should therapy and activity modifications fail to provide durable relief a corticosteroid injection into the thumb CMC joint is offered. All patients are engaged in a minimum of 6 months of combined occupational therapy and activity modifications (± injections) before consideration of surgical intervention. Anecdotally we have found that if, during a physical examination, the patient reports subjective improvement in pain with manual reduction/stabilization of the CMC joint, they can expect a positive outcome after surgical stabilization as described in this technique.

Technique

Two small incisions are made, one about the radial border of the thumb metacarpal at the glabrous/non-glabrous border (Fig. 3). Skin is retracted with small skin hooks, and dissecting scissors is used to identify the slips of the abductor pollicis longus tendon. Care is taken to avoid injury to any branches of the superficial radial sensory nerve in the area. Once the nerves are protected a scalpel is then used to enlarge the interval between the slips exposing the base of the thumb metacarpal about its' radial border.

The proximal ulnar border of the second metacarpal is exposed through a small linear incision ulnar to the common digital extensor tendons. Crossing veins are protected as are the dorsal sensory nerves. A dissecting scissors is used to expose the ulnar border of the index metacarpal, and a freer or similar elevator is used to separate the second dorsal interosseous muscle from the metacarpal.

Once the thumb and second metacarpal bases are adequately exposed the thumb CMC joint is reduced in an abducted position with the aid of fluoroscopy (Fig. 4) to ensure that the thumb metacarpal base and trapezium are concentrically reduced. Care is taken to avoid over-distraction of the thumb CMC joint by aligning the thumb metacarpal base with that of the second metacarpal. Utilizing the Arthrex Mini Tightrope™ system a guidewire is driven across the metaphyseal region of the thumb metacarpal taking care to avoid violation of the thumb CMC joint. The wire is then advanced through the adductor muscle and the base of the second metacarpal. The Mini Tightrope system is then deployed, advancing the braided suture through the use of the wire loop at the end of the guidewire. Care should be taken to ensure that the thumb CMC joint remains well reduced and that the joint is not overly distracted. The first endobutton should rest about the proximal aspect of the thumb metacarpal, and the second endobutton about the ulnar border of the proximal aspect of the second metacarpal taking care to secure the knot to the ulnar border of the metacarpal in such a manner that the knot is not prominent (Fig. 5).

A 4-0 absorbable monofilament suture is used to close the epimysium of the APL and second dorsal interosseous

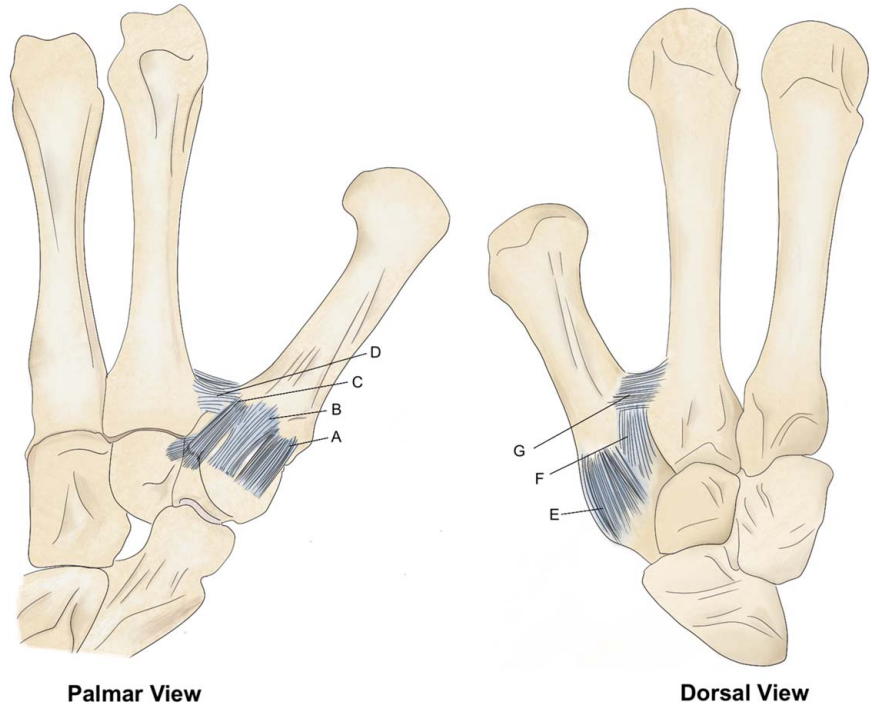

FIGURE 2. Palmar and dorsal view of the thumb carpometacarpal ligament complex. A: capsule B: anterior oblique Ligament (volar "Beak" ligament) C: ulnar collateral ligament D: intermetacarpal ligament E: dorsoradial ligament F: posterior oblique ligament G: intermetacarpal ligament.

FIGURE 3. Small incisions are made about the radial aspect of the thumb metacarpal base at the glabrous/non-glabrous border and about the ulnar aspect of the index metacarpal.

muscle over the endobuttons. The skin is then closed with a layered monofilament suture. Incisions are dressed, and the patient is placed into a thumb spica splint.

Patients return to clinic at 10 to 14 days postoperative at which point in time they are transitioned from their postoperative splint to a removable thumb spica splint or cast (depending upon patient preference). The splint or cast is worn continuously with the exception of showering (in the case of the splint) for an additional 4 weeks. During that time patients are given a self-directed thumb and digital range of motion protocol to avoid excessive stiffness. Patients return to clinic 6 weeks postoperatively and are allowed to liberalize activities as tolerated. Formal post-operative hand therapy is not routinely used.

Expected Outcomes

Eleven patients were available for follow-up at a mean of 24 months postoperatively. Patients experienced both a statistically and clinically meaningful improvement in QuickDASH score of ~40 points (Preoperative: 64.8.

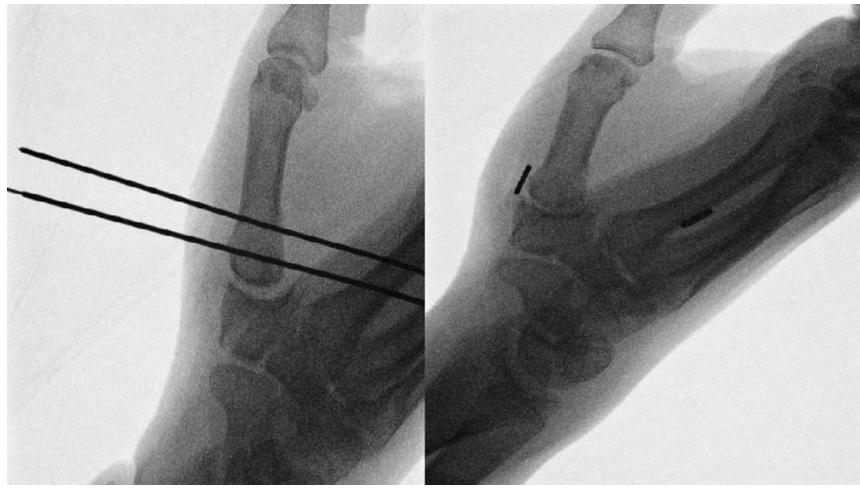

FIGURE 4. The thumb carpometacarpal joint is reduced and provisionally stabilized by 1 or 2 K wires as the Mini Tightrope is deployed.

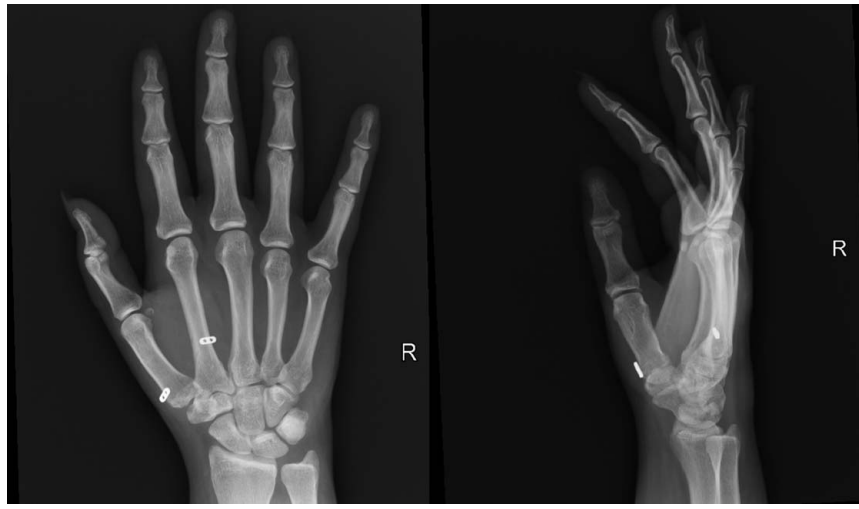

FIGURE 5. The endobuttons should be positioned such that they lay flush on the first and second metacarpal respectively but are buried deep to muscle if possible.

Postoperative: 20.7, $P < 0.05$). Similarly, both a statistically and clinically meaningful improvement in Visual Analog Scale pain score of ~5.5 points was observed (Preoperative: 7.2. Postoperative: 1.6). $P < 0.05$). At the time of final follow-up 1 patient had been converted to a CMC arthroplasty (at 18 months postoperative). The other 2 patients with Eaton Grade 2 disease did not require further intervention (Table 1). This may be due to the correction of joint reactive forces with stabilization of the CMC joint, which, even in the presence of < 2 mm osteophytes, may serve to diminish synovitis. Range of motion was not assessed; however, the cadaveric model previously discussed demonstrated no significant changes in the range of motion at the level of the thumb CMC joint.[10] The outcome of this procedure mirrors that of other described techniques such as the Eaton/Littler ligament reconstruction, arthroscopic partial trapeziectomy, and dorsal capsular imbrication with predictable improvements in Visual Analog Scale and functional outcome scores.[4,5,14] Our mean follow-up of 24 months exceeds that of some studies including the original description by Littler/Eaton (8 to 18 months) but is < 5 year follow-up described in 1 series on arthroscopic partial trapeziectomy.[3,14]

Complications

In the authors' estimation the greatest risk for complication postoperatively is periprosthetic fracture. Numerous "passes" with the guidewire to achieve optimal positioning can weaken either the thumb or second metacarpal. Proceeding in a stepwise and methodical manner utilizing fluoroscopy at each critical step is helpful in reducing multiple passes with the guidewire. We encountered one postoperative complication early in our experience whereby a patient was exercising by lifting weights and sustained a periprosthetic fracture to her second metacarpal 4 weeks postoperatively (Fig. 6). The fracture was treated conservatively, and the patient did not require revision. After that incident we have limited patients to

TABLE 1. Patient Demographics & Functional Outcome Scores

Age	Sex	Eaton stage	Follow-up (mo)	Preoperative VAS	Preoperative DASH	Postoperative VAS	Postoperative DASH
48	F	2	36	8	75	1	27
65*	F	2	12	7	65	5	45
48	F	1	36	8	68	2	18
52	F	1	24	6	64	0	10
38	F	1	36	7	86	1	18.2
57	F	1	24	8	68	2	22
34	M	1	14	8	65.8	1	25
39†	F	1	24	7	68	1	12
52	M	1	22	6	45	2	23
58	M	2	20	7	54	1	16
24	F	1	24	7	54	2	12

After a mean follow-up of 24 months patients experienced an improvement of ~40 points on their QuickDash and 5.5 point improvement on their VAS pain scale. Both improvements were clinically and statistically significant.

*This patient was converted to a thumb CMC arthroplasty at 18 months postoperatively due to persistent pain and diminished function evidence by her DASH of 45.

†This patient sustained a second metacarpal fracture early in her postoperative course. She went on to heal without further surgical intervention and experienced significant improvement in DASH and VAS score.

DASH indicates disability of the arm, shoulder and hand; F, female; M, male, VAS; visual analog scale.

FIGURE 6. Note the fracture of the second metacarpal with interval callous formation. The fracture healed with conservative treatment. The endobuttons exhibited a minor change in positioning. The patient remains relatively asymptomatic both from her fracture and the thumb carpometacarpal synovitis.

cardiovascular exercises and maximum weight bearing with the operative hand of 20 pounds for the first 6 weeks postoperatively and ensure all patients are immobilized in a thumb spica splint or cast at all times. No other complications were observed.

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