

Volar Plate Capsulodesis for Metacarpophalangeal Hyperextension With Basal Joint Arthritis

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Abstract

Basal joint arthritis leads to thumb metacarpophalangeal (MCP) hyperextension that may prevent physiologic pinch. Various techniques have been used to address this hyperextension, but most are technically challenging, time-consuming, and not supported by long-term follow-up results. Furthermore, few groups have reported subjective, patient-based outcomes after such procedures.

In a retrospective study, we evaluated a cohort of 14 patients who underwent a novel technique of thumb MCP capsulodesis in conjunction with basal joint arthroplasty. A mean of 4.74 years after surgery, subjective outcome measures (Disabilities of the Arm, Shoulder, and Hand questionnaire; visual analog scale for pain; patient satisfaction) and objective outcome measures (range of motion, grip and pinch strengths) all reflected excellent function.

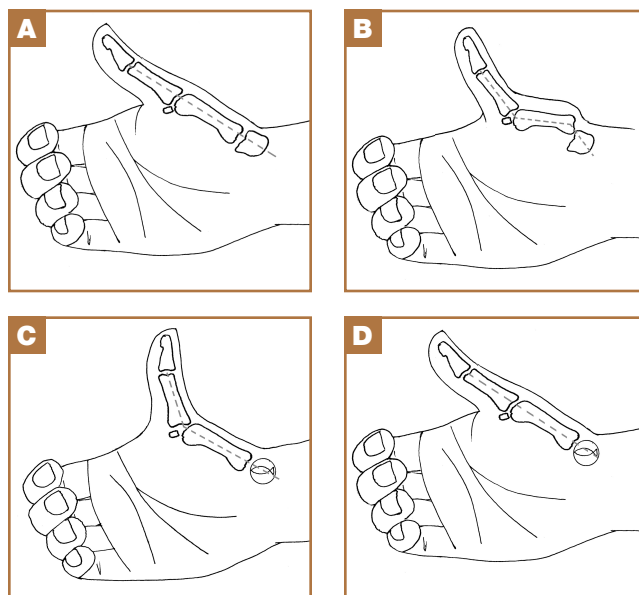
The described technique for MCP capsulodesis is an attractive adjunct to basal joint arthroplasty, but further prospective studies are needed to establish specific operative indications.

Hyperextension of the thumb metacarpophalangeal (MCP) joint has long been associated with carpometacarpal (CMC) joint, or basal joint, osteoarthritis. Surgical treatment of this deformity, however, has traditionally focused on neurologic causes. In 1957, Zancolli¹ described a technique of volar plate advancement for MCP capsulodesis in patients with claw-hand deformities secondary to lesions of the ulnar and median nerves. Others have since reported their experiences with a variety of techniques for treating MCP hyperextension having other neurologic, congenital, and traumatic causes.²⁻⁸

In the setting of CMC arthritis, both cause and effect of MCP hyperextension remain controversial. Conventional wisdom holds that MCP hyperextension is a secondary deformity

that arises after significant arthritis at the trapeziometacarpal (TMC) joint.^{9,10} As the anterior oblique ligament becomes attenuated, the metacarpal adducts and subluxes dorsally onto the trapezium.¹¹ This results in a loss of thumb abduction, with reduced CMC range of motion (ROM) and compensatory MCP hyperextension. Over time, this hyperextension may become severe, producing a characteristic zigzag collapse pattern (Figures A, B).¹² Alternatively, MCP hyperextension may in fact contribute to CMC arthritis. In a cadaveric study, Moulton and colleagues¹³ found that MCP hyperextension preferentially loads the palmar TMC joint surfaces and that this load shifts dorsally with MCP flexion. As early arthritic changes occur at the palmar TMC joint surface, stabilizing the MCP joint may

Figure. (A) Normal alignment of thumb carpometacarpal (CMC) and metacarpophalangeal (MCP) joints. (B) Characteristic zigzag collapse deformity. Dorsal subluxation of first metacarpal onto trapezium accompanied by hyperextension at MCP joint. (C) CMC “anchovy” arthroplasty without correction of MCP hyperextension. Normal pinch is not restored. (D) CMC arthroplasty with MCP capsulodesis restores normal anatomy.



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actually limit basal joint degeneration.^{13,14}

Disagreement also exists with respect to the degree of MCP hyperextension that may be accepted in the arthritic thumb. Deviations from neutral of 0° to 10° may be treated conservatively, whereas hyperextension of more than 30° may require Kirschner-wire pinning of the MCP joint in flexion at the time of CMC arthroplasty.¹⁵ Although evidence does not provide more precise indications, many believe that patients with the most advanced zigzag collapse require surgical repair at the MCP joint.^{4-7,15-17} Failure to perform this surgery may not only abnormally stress the CMC arthroplasty but may also produce an ineffective pinch (Figures C, D).

In 1988, Eaton and Floyd¹⁷ described a variation of the technique of Zancolli¹ for MCP capsulodesis as an adjunctive procedure to basal joint arthroplasty. Of their 13 patients, 9 had excellent results 39 months after surgery. They noted that, though MCP arthrodesis facilitates more pinch strength than MCP capsulodesis does, the latter allows for functionally superior ROM.^{17,18} Tonkin and colleagues¹⁹ reported performing 21 procedures using a variation of Zancolli's technique with sesamoid arthrodesis. Mean preoperative MCP hyperextension was 23°. Twenty-four months after surgery, mean MCP extension was 4° of flexion.

There is little patient-based outcome data for MCP capsulodesis with CMC arthroplasty. Furthermore, in reported studies, follow-up has been limited—an issue in light of concerns that MCP capsulodesis may lose its efficacy over time.^{3,5,17,19} We conducted a study to provide long-term follow-up using objective and patient-based measures in cases of MCP hyperextension and basal joint arthritis treated with a novel technique of MCP capsulodesis and CMC arthroplasty.

Materials and Methods

Patient Population

After obtaining institutional review board approval for this study, we reviewed the practice records of Dr. Rosenwasser for cases of thumb MCP capsulodesis as an adjunct to CMC arthroplasty performed between May 1998 and August 2009. Of the 23 patients identified, 14 answered our call and agreed to participate in the study. Of the 9 excluded patients, 2 were deceased, 2 were confined to acute-care facilities, and 5 could not be reached.

The group consisted of 11 women and 3 men. Mean age at time of surgery was 63.7 years (range, 47-89 years). All patients had been diagnosed with basal joint osteoarthritis based on clinical examination and radiographic assessment. Twelve patients showed evidence of advanced, Eaton stage IV arthritis, and 2 showed evidence of Eaton stage III arthritis. In all cases, conservative treatment (eg, thumb spica splinting, physical therapy, use of oral nonsteroidal anti-inflammatory drugs, CMC intra-articular corticosteroid injection) had failed. Indications for MCP capsulodesis included (a) MCP hyperextension of 10° to 30° with a grossly unstable MCP joint and (b) MCP hyperextension of more than 30°.

As part of CMC arthroplasty, tendon transfer was performed

to increase joint stability and opposition, as previously described.²⁰ Eight patients had transfers of the flexor carpi radialis (FCR) tendon to the abductor pollicis brevis (APB) tendon, and 6 had transfers of the abductor pollicis longus (APL) tendon to the APB tendon. The CMC arthroplasties performed in 3 patients used a Gelfoam insert (Pharmacia and Upjohn Company, Kalamazoo, Michigan) with a free palmaris longus graft for the interpositional graft. Out of a change in preference, Dr. Rosenwasser then discontinued use of Gelfoam. One patient had a partial carpectomy of the trapezoid. For symptoms unrelated to their basal joint arthritis, 4 patients underwent additional procedures at the time of the index procedure: Two

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had trigger-finger releases; 1 had a trigger-finger release and an ipsilateral carpal tunnel release; and 1 had concomitant cheilectomy and osteophyte removal at distal and proximal interphalangeal joints for osteoarthritis.

We reviewed the operative and clinical records to identify any complications and revision procedures and asked patients to come in for a follow-up visit. Physical examinations were performed, and subjective patient-based outcome instruments were administered. Patients provided informed consent and HIPAA (Health Insurance Portability and Accountability Act) consent.

Surgical Technique

The surgical technique is described elsewhere.²¹ In short, first, with the patient anaesthetized, the thumb MCP joint is examined, and the amount of hyperextension and the quality of the endpoint are documented. Then, the basal joint arthroplasty is performed in its entirety, according to surgeon preference. The MCP joint is reexamined before beginning.

The MCP joint is approached through a volar incision in the MCP crease. The incision is extended at its ulnar edge into the palm. The distal third of the A1 pulley is released centrally, and the flexor pollicis longus tendon is retracted to visualize the volar plate. A step cut is made, with long arm of the cut dividing the sesamoids. Distally, it exits radially just distal to the radial sesamoid; proximally, it exits ulnarly.

With the thumb flexed, the volar plate is sutured together in a shortened position using 3-0 absorbable monofilament

Table I. Objective Evaluation

Outcome	Mean	Minimum	Maximum
Metacarpophalangeal joint			
Flexion, °	29.6	10	55
Extension, °	15	0	30
Interphalangeal joint			
Flexion, °	67.5	35	85
Extension, °	11.1	0	35
Abduction			
Radial, cm	4.5	3.5	6
Palmar, cm	4.2	3	5.6
Strength			
Grip, kg	24.7	12	44
Pinch, kg	3.7	1	9.3

sutures, which are tied with the thumb in approximately 20° to 30° of flexion. Then the capsulodesis is augmented with figure-of-8 stitches along the longitudinal seam of the step cut. The repair is gently stressed to ensure that it has been appropriately tensioned. The skin is closed, and a thumb spica splint is placed with the thumb MCP joint in slight flexion.

Objective Evaluation

Thumb MCP flexion was measured with a standard goniometer by grasping the first metacarpal and asking the patient to actively flex the proximal phalanx into the plane of the palm. An analogous technique was used for MCP extension. Interphalangeal joint flexion and extension were measured by stabilizing the thumb proximal phalanx and actively flexing and extending the distal phalanx. Radial abduction and palmar abduction were measured as the distance from the interphalangeal crease to the transverse palmar crease with the thumb passively extended in or perpendicular to the plane of the palm, respectively. Opposition was measured by asking each patient to oppose the thumb against the distal phalanges of each finger, as well as the small-finger middle phalanx, proximal phalanx, and distal end of the fifth metacarpal. Grip strength was measured as the mean of 3 values of maximum grip on a Jamar dynamometer (Therapeutic Equipment Corporation, Clifton, New Jersey). Thumb key pinch strength was measured as the mean of 3 values on a pinch strength meter.

Subjective Evaluation

Patients completed the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, which has been specifically validated in patients with basal joint arthritis.^{22,23} In addition, patients rated their thumb pain at rest and with activity on a visual analog scale (VAS) with response points ranging from 0 (no pain) to 100 (the worst pain). Patients also completed a study-

Table II. Subjective Evaluation

Outcome	Mean	Minimum	Maximum
DASH score	11.8	0	45
VAS pain at rest, 0-100	4.8	0	34
VAS pain with activity, 0-100	9.3	0	47.5

Abbreviations: DASH, Disabilities of the Arm, Shoulder, and Hand questionnaire; VAS, visual analog scale.

specific questionnaire that asked about medical history, ability to return to work after surgery, any new complications, and overall satisfaction with the procedure.

Results

Objective Evaluation

Mean postoperative follow-up was 4.7 years (range, 0.9-11.5 years). Results of the objective evaluations are listed in **Table I**. According to preoperative chart review, 6 patients had MCP hyperextension of 10° to 30° with gross instability, and the other 8 had hyperextension of more than 30°. By final postoperative visit, hyperextension had improved to a mean of 15° (range, 0°-30°). Thirteen patients were able to oppose their thumbs against the distal end of the fifth metacarpal, and 1 patient was able to oppose her thumb against the fifth proximal phalanx but not against the distal end of the fifth metacarpal. Mean grip strength was 24.7 kg (range, 12-44 kg). Mean thumb key pinch strength was 3.7 kg (range, 1-9.3 kg).

Subjective Evaluation

Subjective, patient-based results are listed in **Table II**. At time of surgery, 8 patients had jobs, and 6 were retired. After surgery, the 8 patients were able to return to their previous level of employment, which in the case of 2 patients involved daily heavy lifting. Only 1 patient was taking pain medication for the thumb. All patients answered that overall they were happy with the surgery and how the thumb was feeling and working. No intraoperative or postoperative complications were reported, and no patient underwent revision surgery.

Discussion

Since Zancolli¹ originally described MCP capsulodesis for patients with claw-hand deformities, several surgical techniques have been used in the management of MCP hyperextension.^{2-8,21} With the exception of a recent cadaveric study, however, little has been published to elucidate the pathomechanics of the disease, the indications for MCP capsulodesis, or the clinical results at long-term follow-up.¹³

The hand surgeon's decision making with respect to MCP capsulodesis remains poorly founded in evidence-based medicine. Indications for this adjunctive procedure have yet to be clearly defined, and there is obvious difficulty in finding a suitable comparison group for patients who undergo the procedure. Patients often have bilateral basal joint arthritis, obviating the possibility of comparison with the contralateral hand.²⁴ Surgeons choose from a variety of techniques for both the CMC

arthroplasty and the correction of thumb MCP hyperextension, predictably producing heterogenous results between studies.

We consider thumb MCP hyperextension of less than 10° a mild deformity that does not warrant intervention. Thumb MCP hyperextension of 10° to 30° is a moderate deformity, and the decision to operate is based on presence or absence of a solid endpoint on examination under anesthesia. Thumb MCP hyperextension of more than 30° is a severe deformity and a clear indication for capsulodesis. Dr. Rosenwasser has yet to regret performing this adjunctive procedure on any patient, though in retrospect he thinks more patients could have benefited from MCP capsulodesis.

Adjunctive thumb MCP capsulodesis is an appealing option. It is relatively simple, easy to replicate, and adds very little operative time or morbidity. Unlike other techniques that aim to correct MCP hyperextension, it also allows the surgeon to titrate the amount of capsulodesis by controlling how far the flaps of the volar plate are advanced.

It is important to clearly identify the sesamoid bones so that the step cut can be well planned. It is also key to tie the sutures with the thumb in 20° to 30° of flexion. We recommend practicing thumb MCP capsulodesis in a cadaver laboratory. In this setting, one must examine the thumb carefully before and after the step cut, and again after sutures are tensioned. The difference in thumb hyperextension is marked. We have not routinely immobilized the MCP joint with a Kirschner wire. Although doing so would be reasonable, we think it is unnecessary. The patient must be immobilized with 20° to 30° of flexion at the thumb MCP joint. The postoperative regimen for this adjunctive procedure is exactly the same as that for simple basal joint arthroplasty.

The present study demonstrates that the described technique for thumb MCP capsulodesis is safe and reproducible when performed by a single surgeon. When the technique is used as an adjunct to basal joint arthroplasty in the presence of severe thumb MCP joint hyperextension, long-term results are excellent. The reported mean DASH score, 11.8, is slightly lower than that reported by Heyworth and colleagues²⁰ in a study of a similar cohort of patients who underwent CMC arthroplasty with APB-FCR tendon transfer. Our DASH score is also comparable to what is expected in a cohort of 50- to 65-year-old patients without any specific history of orthopedic disease.²⁵ Thumb ROM was good as well. Our mean MCP hyperextension, 15.0°, is comparable to the 12.0° reported by Heyworth and colleagues²⁰ in patients who did not have MCP capsulodesis. This is encouraging, as the patients in that study did not have MCP hyperextension or instability before surgery. All patients in the present study were able to touch their thumbs to the base of the fifth proximal phalanges, which demonstrates opposition slightly better than that found in other published results.²⁶ Mean grip strength and key pinch strength are similar to those reported in similar cohorts of patients.^{20,26} Mean VAS scores showed minimal pain, both at rest and with activity. Patient satisfaction with the procedure was universal.

One limitation of this study is that preoperative measurements of MCP hyperextension and stability were not collected

prospectively but by chart review. This limits the accuracy of a comparison to postoperative function and prevents us from precisely defining the indications for MCP capsulodesis. Furthermore, Dr. Rosenwasser modified his technique for basal joint arthroplasty—favoring a dynamic tendon transfer involving FCR-to-APB over APL-to-APB tendons—making for a heterogenous group of patients. Use of this technique should be validated in a prospective, comparative fashion before it is adopted on a wide scale. However, conducting such a level I study is inherently difficult. The patient cohort will be small because of the relatively strict indications, and the CMC arthroplasties may be varied because of surgeon preference.

Conclusion

The subjective and objective findings of this retrospective case series suggest that use of adjunctive thumb MCP joint capsulodesis in select patients with severe thumb MCP hyperextension deformity is safe and effective. The procedure produces adequate thumb MCP joint ROM with stable volar structures that provide a solid endpoint for pinch. Most notably, patients' subjective outcome scores fall within the range of the normal population, and the patients are all satisfied with their function. All patients with jobs at time of intervention were able to return to their previous level of employment. Use of thumb MCP joint capsulodesis in the treatment of basal joint arthritis with MCP hyperextension is an attractive adjunct to basal joint arthroplasty in that it is simple and effective, adds little operative time, and does not alter postoperative management. Further prospective studies are needed to establish closely matched cohorts in order to delineate specific indications for this procedure.

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References

1. 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(5):1076-1080.
2. 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(5):667-670.
3. Eiken O. Palmaris longus-tenodesis for hyperextension of the thumb metacarpophalangeal joint. *Scand J Plast Reconstr Surg.* 1981;15(2):149-152.
4. Hofer SO, Robinson PH. Palmar capsulodesis for treatment of symptomatic hyperextensibility of the metacarpophalangeal joints. *J Hand Surg Br.* 1999;24(4):468-470.

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- Kessler I. A simplified technique to correct hyperextension deformity of the metacarpophalangeal joint of the thumb. *J Bone Joint Surg Am.* 1979;61(6):903-905.
- Schuurman AH, Bos KE. Treatment of volar instability of the metacarpophalangeal joint of the thumb by volar capsulodesis. *J Hand Surg Br.* 1993;18(3):346-349.
- Zancolli ER 3rd, Perrotto CJ. New transfer for correction of thumb metacarpophalangeal hyperextension in cases with associated surgery for basal thumb osteoarthritis (transfer of the volar half of the abductor pollicis brevis). *Tech Hand Up Extrem Surg.* 2011;15(2):92-93.
- Poulter RJ, Davis TR. Management of hyperextension of the metacarpophalangeal joint in association with trapeziometacarpal joint osteoarthritis. *J Hand Surg Eur Vol.* 2011;36(4):280-284.
- Van Heest AE, Kallemeier P. Thumb carpal metacarpal arthritis. *J Am Acad Orthop Surg.* 2008;16(3):140-151.
- Matullo KS, Ilyas A, Thoder JJ. CMC arthroplasty of the thumb: a review. *Hand (N Y).* 2007;2(4):232-239.
- Pellegrini VD Jr, Olcott CW, Hollenberg G. Contact patterns in the trapeziometacarpal joint: the role of the palmar beak ligament. *J Hand Surg Am.* 1993;18(2):238-244.
- Landsmeer JM. The coordination of finger-joint motions. *J Bone Joint Surg Am.* 1963;45:1654-1662.
- Moulton MJ, Parentis MA, Kelly MJ, Jacobs C, Naidu SH, Pellegrini VD Jr. Influence of metacarpophalangeal joint position on basal joint-loading in the thumb. *J Bone Joint Surg Am.* 2001;83(5):709-716.
- Koff MF, Shrivastava N, Gardner TR, Rosenwasser MP, Mow VC, Strauch RJ. An in vitro analysis of ligament reconstruction or extension osteotomy on trapeziometacarpal joint stability and contact area. *J Hand Surg Am.* 2006;31(3):429-439.
- Armbruster EJ, Tan V. Carpometacarpal joint disease: addressing the metacarpophalangeal joint deformity. *Hand Clin.* 2008;24(3):295-299, vii.
- Brogan DM, Kakar S. Metacarpophalangeal joint hyperextension and the treatment of thumb basilar joint arthritis. *J Hand Surg Am.* 2012;37(4):837-838.
- Eaton RG, Floyd WE 3rd. Thumb metacarpophalangeal capsulodesis: an adjunct procedure to basal joint arthroplasty for collapse deformity of the first ray. *J Hand Surg Am.* 1988;13(3):449-453.
- Eaton RG. Replacement of the trapezium for arthritis of the basal articulations: a new technique with stabilization by tenodesis. *J Bone Joint Surg Am.* 1979;61(1):76-82.
- Tonkin MA, Beard AJ, Kemp SJ, Eakins DF. Sesamoid arthrodesis for hyperextension of the thumb metacarpophalangeal joint. *J Hand Surg Am.* 1995;20(2):334-338.
- Heyworth BE, Jobin CM, Monica JT, Crow SA, Lee JH, Rosenwasser MP. Long-term follow-up of basal joint resection arthroplasty of the thumb with transfer of the abductor pollicis brevis origin to the flexor carpi radialis tendon. *J Hand Surg Am.* 2009;34(6):1021-1028.
- Zouzias IC, Doft MA, Uzumcugil A, Rosenwasser MP. Treatment of hyperextension deformity of the thumb metacarpophalangeal joint in basal joint arthritis: a novel technique based on an anatomic study. *Tech Hand Up Extrem Surg.* 2011;15(2):119-124.
- Beaton DE, Katz JN, Fossel AH, Wright JG, Tarasuk V, Bombardier C. Measuring the whole or the parts? Validity, reliability, and responsiveness of the Disabilities of the Arm, Shoulder and Hand outcome measure in different regions of the upper extremity. *J Hand Ther.* 2001;14(2):128-146.
- De Smet L. Responsiveness of the DASH score in surgically treated basal joint arthritis of the thumb: preliminary results. *Clin Rheumatol.* 2004;23(3):223-224.
- Shuler MS, Luria S, Trumble TE. Basal joint arthritis of the thumb. *J Am Acad Orthop Surg.* 2008;16(7):418-423.
- Jester A, Harth A, Germann G. Measuring levels of upper-extremity disability in employed adults using the DASH questionnaire. *J Hand Surg Am.* 2005;30(5):1074.e1-1074.e10.
- Tomaino MM, Pellegrini VD Jr, Burton RI. Arthroplasty of the basal joint of the thumb. Long-term follow-up after ligament reconstruction with tendon interposition. *J Bone Joint Surg Am.* 1995;77(3):346-355.