The Effect of Metacarpophalangeal Joint Hyperextension on Outcomes in the Surgical Treatment of Carpometacarpal Joint Arthritis

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Abstract

Purpose In the surgical treatment of thumb carpometacarpal (CMC) joint arthritis, the effect of mild preoperative metacarpophalangeal (MCP) hyperextension on postoperative functional outcomes is unknown. We sought to examine outcomes after surgical treatment of CMC arthritis in patients with and without mild preexisting MCP deformity.

Methods A retrospective review was conducted to analyze the functional outcomes of patients treated for CMC arthritis at a single institution from March 1998 to May 2009. All patients were treated with one of two standard CMC arthroplasty procedures—either ligament reconstruction tendon interposition (LRTI) or a Weilby procedure—and none had additional procedures to address MCP hyperextension. Pre- and postoperative assessments included pinch and grip strength, degree of MCP hyperextension, and thumb radial and palmar abduction. A *t*-test was used to assume unequal variances.

Results A total of 203 patients were followed for an average of 27.3 months. Patients were divided into two groups: (1) patients without preoperative MCP hyperextension (167 patients) and (2) patients with mild but untreated preoperative MCP hyperextension (≤ 30 degrees; 36 patients). All patients underwent either a Weilby procedure (118 patients) or an LRTI; 85 patients). The main difference between techniques was the use of the abductor pollicis longus tendon as a post to secure the flexor carpi radialis (Weilby) or the use of a bone tunnel in the first metacarpal (LRTI). Analysis of the preoperative data showed no difference in the baseline parameters among both the groups, with the exception of MCP hyperextension. Postoperatively, neither the type of CMC procedure nor the presence of MCP hyperextension demonstrated any significant differences in key pinch, tip pinch, grip strength, and radial or palmar abduction of the thumb between the groups.

Conclusion There were no statistically significant differences in improvement of functional outcomes after surgery when comparing patients without preoperative MCP hyperextension to patients with untreated MCP hyperextension of less than 30 degrees.

Level of Evidence Level III, retrospective comparative study.

Keywords

- MCP joint hyperextension
- outcomes
- CMC joint arthritis

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Basilar thumb joint arthritis is a common and debilitating condition that affects both men and women in an age-dependent fashion.¹ Reports from longitudinal studies of hand arthritis demonstrate a radiographic prevalence of first carpometacarpal (CMC) arthritis ranging from 0 to 7% of adults in the fifth decade of life. The prevalence has been found to steadily increase with each passing decade to include up to 36% of adults by the age of 80 years, with a tendency to affect women more than men.^{1,2} A recent study that examines the prevalence of CMC arthritis in a distal radius fracture population suggests that it is even more common than previously thought. The authors found an 85% incidence in patients in the eighth decade of life, with 100% prevalence in women over 90 years of age.³

The complex ligamentous architecture surrounding the first CMC joint has been well described.⁴⁻⁷ With advancing CMC arthritis, there is progressive dorsoradial subluxation at the trapeziometacarpal joint, forcing the thumb into a flexed and adducted position⁸ (→Fig. 1A). This may be a biomechanically inferior position for prehensile function, causing the affected patient to hyperextend the metacarpophalangeal (MCP) joint to increase the functional capacity for grip, given the decreased effective volume in the first web space. The subluxation of the metacarpal also leads to an increase in pull of the extensor pollicis brevis, contributing to MCP hyperextension.⁸⁻¹⁰

Eaton and Floyd noted that this hyperextension posture diminished the force of pinch and therefore “restoration of mechanical efficiency requires stabilization of both the basal and MP joints.”¹¹ Furthermore, they found that 30 degrees of hyperextension was a critical threshold, above which the collapse of the first ray accelerated, with the metacarpal head flexing and adducting.¹¹ Some surgeons believe that if this hyperextension is left untreated, it may lead to weakness and potentially worsen postoperative hand function after surgical

treatment of CMC arthritis.¹² Concerns of persistent functional deficit from MCP hyperextension have resulted in a myriad of described treatments for this, including extensor pollicis brevis transfer, volar plate advancement, and MCP fusion¹³ (→Fig. 1B).

Despite concerns that MCP hyperextension may diminish outcomes after CMC arthritis surgery, Poulter and Davis reported no difference in 1-year clinical outcomes after trapeziectomy between patients with untreated preoperative MCP hyperextension up to 45 degrees and those without preoperative MCP hyperextension. They also found that surgical correction of preoperative MCP hyperextension below 30 degrees did not improve outcome.¹⁴

Given the stark contrast between conventional wisdom and recent evidence, we investigated whether untreated MCP hyperextension deformity influenced functional outcomes after surgical treatment of CMC arthritis.

Materials and Methods

An Institutional Review Board approved retrospective chart review was conducted to evaluate all patients who underwent surgical treatment for basilar thumb joint arthritis between March 1998 and May 2009. Inclusion criterion was any patient who had undergone primary surgical treatment of osteoarthritis of the CMC joint without concomitant surgical treatment of an MCP joint hyperextension deformity. Patients with prior CMC joint surgery and those with inflammatory arthritis were excluded. Additionally, if preoperative or postoperative functional outcomes were not recorded, or if follow-up was less than 3 months, the patients were excluded from the study. Procedure choice performed at the CMC joint depended on the surgeon, but all patients underwent either a ligament reconstruction tendon interposition (LRTI) or a Weilby procedure. In group 1, a Weilby procedure was

Fig. 1 (A) Preoperative film of patient with Eaton stage 3 carpometacarpal arthritis and mild to moderate hyperextension deformity. (B) Postoperative film after ligament reconstruction tendon interposition and metacarpophalangeal fusion.

performed in 93 patients and LRTI in 74 patients, whereas in group 2, 25 patients had a Weilby procedure and 11 patients had an LRTI performed. The technique for the Weilby procedure was performed as previously described.¹⁵ An incision was made along the junction of the glabrous and nonglabrous skin, overlying the thumb CMC joint, angling proximally to the flexor carpi radialis (FCR) tendon sheath. The FCR was identified and protected as the trapezium was freed of all ligamentous attachments and removed, either en bloc or piecemeal, according to the surgeon's preference. The ulnar 50% of the FCR tendon was then harvested from proximal to distal using multiple incisions or a percutaneous technique. The distal attachments to the second metacarpal was left undisturbed, and the FCR was then woven in a figure of eight fashion multiple times around the abductor pollicis longus and itself, just proximal to the first metacarpal base. The weave was secured with nonabsorbable suture and the remnant FCR tendon secured into the trapezial space as an interposition.

The LRTI technique was performed as described by Burton and Pellegrini.¹⁶ The approach to the CMC joint was as described earlier, and the decision as to whether to use the entire FCR or a slip of the tendon was left to surgeon discretion. The distally based FCR tendon was then passed through a bone tunnel drilled through the base of the first metacarpal, from dorsal to volar. The tendon was sutured to itself using nonabsorbable suture and an interposition was made from the tendon remnant, as noted previously.

Radiographs and clinical records were reviewed, and information pertaining to patient demographics, Eaton score, type of surgery at the CMC joint, and postoperative complications were recorded. Preoperative MCP joint hyperextension (defined as MCP joint extension beyond neutral) was measured in the clinic using a finger goniometer and recorded along with pre- and postoperative thumb radial and palmar abduction. Pre- and postoperative measurements of key and tip pinch were measured with a 13.6-kg pinch gauge. Grip strength was evaluated with a JAMAR dynamometer (Patterson Medical, Bolingbrook, IL) set on the third ring.

Statistical Analysis

Two separate analyses were performed: one to determine the effect of the CMC procedure and the other to examine the effect of the presence or absence of preoperative MCP hyperextension. In the first analysis, patients were separated into two groups based on their CMC procedure, LRTI or Weilby, to ensure that the choice of procedure did not significantly affect outcomes. In the second analysis, patients were divided into two cohorts based on MCP hyperextension, irrespective of their CMC procedure, and labeled as groups 1 and 2, as defined in the following:

- Group 1: Without preoperative MCP hyperextension deformity.
- Group 2: With preoperative MCP hyperextension deformity but without subsequent treatment of the MCP joint.

The change (delta) between pre- and postoperative values for all of the previously mentioned functional outcomes was

calculated for each patient when available. These values were averaged within each cohort, and a two-tailed *t*-test was performed to look for differences among the cohorts in each analysis. For all tests, a significance level was set at α of 0.05.

Results

Patient Demographics

A total of 203 patients met inclusion criteria: average age was 61.2 years (range: 40–86 years); 163 females and 40 males participated. There were 167 patients without preoperative MCP hyperextension (group 1) and 36 patients with preexisting MCP hyperextension who were not treated (group 2). All patients underwent either an LRTI (83 patients) or Weilby (118 patients) at the discretion of the treating surgeon. The average follow-up was 27.3 months (range: 3 months to 13.8 years).

Our preoperative functional parameter analysis found that there were no statistically significant differences between groups 1 and 2 regarding baseline grip, key or tip pinch, or thumb range of motion (►Table 1). A statistically significant difference did exist, however, between the preoperative hyperextension deformities, as expected, with an average hyperextension of 13.4 degrees in group 2 (range: 3–30 degrees) ($p < 0.01$) (►Fig. 2). The preoperative parameters and breakdown of Eaton stages between groups can be found in ►Table 1.

The improvement from preoperative function to final follow-up visit was calculated for each patient for each of the following parameters: key pinch, tip pinch, grip strength, radial abduction of the thumb, and palmar abduction of the thumb. In the first analysis, there was no significant difference found between the postoperative functional parameters when the groups were stratified based on CMC procedure performed (►Table 2).

In the second analysis of the effect of MCP hyperextension, both groups demonstrated an overall improvement in functional parameters after surgery, with the exception of key pinch in group 2, which worsened postoperatively, although this was not statistically significant when compared with postoperative key pinch in group 1 ($p = 0.07$). There was no statistically significant difference in improvement between groups found for any of the functional outcomes measured (►Table 3). Pinch strength improvement was modest at best for both groups, and key pinch postoperatively was decreased in group 2, but this did not meet statistical significance. The average improvement in thumb palmar and radial range of motion showed no significant difference between groups ($p = 0.55$ for palmar abduction and $p = 0.66$ for radial abduction). Similarly, no significant difference in relative improvement in strength between groups was found for grip ($p = 0.37$) regardless of preexisting MCP hyperextension deformity.

Complications were also noted for each of the groups (►Table 4). Overall, the most common complications were dysesthesias of the dorsal sensory branch of the radial nerve and recurrent pain. Of note, the rate of development of postoperative MCP hyperextension in group 1 was 5% during the study follow-up period.

Table 1 Preoperative average functional values

	Group 1 (no preoperative hyperextension) value	Group 2 (preoperative hyperextension, no correction) value	p-Value (two-tailed)
No. of patients	167	36	
Preoperative hyperextension (deg)	0	13.4 (3–30)	0
Preoperative key (appositional) pinch (kg)	4.3 (0.1–12)	4.9 (0.3–15)	0.16
Preoperative tip (oppositional) pinch (kg)	3.5 (0–12)	3.3 (0.2–8)	0.80
Preoperative grip (kg)	18.8 (2–50)	21.7 (8–62)	0.14
Preoperative radial abduction (deg)	40.8 (15–90)	41.7 (20–128)	0.72
Preoperative palmar abduction (deg)	42.5 (20–73)	43.5 (25–100)	0.16
Eaton stage	3 (2–4)	3 (1–4)	0.87

Discussion

The decision of whether or not to address a mild to moderate MCP hyperextension deformity at the same time as an arthritic CMC joint is a common one often faced by hand surgeons. Poulter and Davis examined treatment effects of the MCP hyperextension deformity on clinical outcome when they performed a trapeziectomy with or without additional ligamentous reconstruction or tendon interposition. They found that surgical treatment of the deformity with capsulodesis showed no improvement in 1-year postoperative outcomes in patients with deformities up to 30 degrees. In patients with MCP deformity of >30 degrees, the authors reported no difference with regard to functional outcomes between those undergoing correction of the MCP hyperextension with either a capsulodesis or fusion and those without any MCP surgery. However, given the small sample sizes (less than a dozen patients in each group), the authors did not make any conclusions as to the necessity of addressing the MCP joint in patients with more severe deformities.¹⁴

In deciding whether to simultaneously address the pre-existing MCP joint hyperextension during primary basilar thumb arthritis surgery, several algorithms have been described.^{8,9} Many suggest that MCP hyperextension of <10 degrees can be left alone, whereas those between 10 and 20 degrees can be treated with temporary MCP joint pinning or alternatively with transfer of the EPB to lessen its

deforming force.¹⁷ For hyperextension between 20 and 40 degrees, without arthritis at the MCP joint, there are advocates for a soft tissue reconstruction, consisting of a volar plate advancement or capsulodesis.^{11,18,19} For patients with greater than 40 degrees of hyperextension or those with significant arthritis of the MCP joint, arthrodesis has been recommended.^{8,9} These algorithms are based largely on anecdotal experience with little quality evidence available to definitively guide clinicians. The premise is that by correcting the zigzag deformity of the thumb, this will improve the biomechanical efficiency of pinch and maximize functional outcomes of the treatment for CMC joint arthritis.¹¹

Results from our study suggest that the existence of mild preoperative MCP hyperextension (defined here as less than 30 degrees), if left untreated, does not show a significant impact on improvement in functional outcome measures compared with patients without MCP hyperextension. We did exclude all patients with hyperextension greater than 30 degrees and can therefore make no recommendations as to how to treat this degree of MCP joint deformity. Previous studies have shown that a large postoperative deformity correlates with worse hand function.¹² It could be that the difference in preoperative MCP hyperextension between groups 1 and 2 may have been small enough to not demonstrate a detrimental effect on clinical outcomes. However, we advise caution with this interpretation, as we did not systematically analyze the postoperative MCP deformity amongst study patients.

Fig. 2 Box plot of preoperative metacarpophalangeal hyperextension in group 2. MCP, metacarpophalangeal.

Table 2 Postoperative improvement in functional outcomes (analysis 1: LRTI vs. Weilby)

	Increase from preoperative to postoperative		p-Value (two-tailed)
	Weilby	LRTI	
Palmar abduction (deg)	5.3 (-15 to 40)	2.9 (-55 to 35)	0.62
Radial abduction (deg)	4.5 (-25 to 40)	5.9 (-88 to 37)	0.79
Oppositional pinch (kg)	-0.1 (-4.5 to 6)	0.6 (-5.5 to 4.5)	0.10
Appositional pinch (kg)	0.1 (-7 to 14)	0.1 (-7 to 6.5)	0.88
Grip (kg)	1.3 (-26 to 23.5)	2.6 (-20 to 29)	0.35

Abbreviation: LRTI, ligament reconstruction tendon interposition.

Table 3 Postoperative improvement in functional outcomes (analysis 2: no MCP hyperextension vs. MCP hyperextension)

	Increase from preoperative to postoperative		p-Value (two-tailed)
	Group 1	Group 2	
Palmar abduction (deg)	5.2 (-25 to 40)	2.1 (-55 to 25)	0.55
Radial abduction (deg)	5.9 (-25 to 40)	3.1 (-88 to 35)	0.66
Oppositional pinch (kg)	0.3 (-5.5 to 6)	0.2 (-2 to 3.8)	0.86
Appositional pinch (kg)	0.3 (-7 to 14)	-0.7 (-7 to 4.2)	0.07
Grip (kg)	2.1 (-20 to 29)	0.5 (-26 to 16)	0.37

Abbreviation: MCP, metacarpophalangeal.

Table 4 Incidence of complications

	Group 1 % (N)	Group 2 % (N)
Infection	5.4 (9)	2.8 (1)
Revision	3.6 (6)	2.8 (1)
Reoperation for neuroma	1.2 (2)	0
Dysesthesias	19.2 (32)	11.1 (4)
Recurrence of pain	9.0 (15)	2.8 (1)
Complex Regional Pain Syndrome/Reflex Sympathetic Dystrophy	4.8 (8)	0
Tendinitis	2.4 (4)	2.8 (1)
Rupture of tendons	0.6 (1)	0
Evidence of postoperative MCP hyperextension	4.8 (8)	N/A

Abbreviations: MCP, metacarpophalangeal; N/A, not applicable.

We do note several limitations to this study. The relatively small patient numbers in this cohort limit the conclusions that can be drawn from this analysis. In addition, there was a significant variation within the number of patients within the groups. Multiple surgeons were involved in the surgical treatment of these patients, yet these were all fellowship-trained hand surgeons, thereby decreasing their technical heterogeneity. Residents or attending physicians measured the range of motion in clinic and their technique may have varied with respect to use of the goniometer. Another limitation is that a validated outcome measure, such as the Disabilities of Arm, Shoulder and Hand score, was not used.

Future work should compare functional outcomes between patients who did and those who did not have

surgical correction of concomitant MCP joint hyperextension with preoperative deformities greater than 30 degrees. Poulter and Davis concluded that it was unnecessary to address the MCP joint if hyperextension was less than 30 degrees.¹⁴ The data we present here seem to support this assertion and are in line with the generally accepted clinical guidelines previously discussed. Further study is needed to determine an appropriate threshold value above which MCP hyperextension must be addressed.

Despite these limitations, we discovered that the degree of improvement in postoperative functional outcome measures was not affected by the presence or absence of a preoperative MCP hyperextension deformity less than 30 degrees.

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Conflict of Interest

None.

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