

## Arthroscopic Debridement and Synovectomy for Treating Basal Joint Arthritis

John P. Furia, M.D.

---

**Purpose:** To determine whether arthroscopic debridement and synovectomy of the thumb carpometacarpal joint improves subjective and objective outcomes in patients with stage I and stage II basal joint arthritis. **Methods:** Twenty-three patients with stage I or stage II basal joint arthritis were treated with arthroscopic synovectomy and joint debridement. Twenty-one age- and gender-matched patients were treated with additional forms of nonoperative therapy (control group). Change in visual analog scale (VAS), Disabilities of the Arm, Shoulder and Hand (DASH), and subjective scores and change in pinch strength were evaluated 12 months after treatment. **Results:** The pretreatment mean VAS, DASH, and subjective scores for the surgical and control groups were 7.7 and 7.5, respectively ( $P = .3$ ); 55.6 and 54.4, respectively ( $P = .3$ ); and 4 and 4, respectively ( $P = .9$ ). At follow-up, the mean VAS, DASH, and subjective scores for the surgical and control groups were 2.7 and 7.3, respectively ( $P < .001$ ); 26 and 53.1, respectively ( $P < .001$ ); and 1.8 and 3.8, respectively ( $P < .001$ ). At follow-up, mean pinch strength for the surgical and control groups was  $6.2 \pm 1.3$  kg and  $4.9 \pm 1.1$  kg, respectively ( $P < .001$ ). Eighty-three percent of the surgical patients reported their result as either good or excellent. There were no significant complications. **Conclusions:** This study shows that arthroscopic debridement and synovectomy improve pain scores, functional scores, subjective outcome, and pinch strength more so than traditional nonoperative therapy. **Level of Evidence:** Level III, case-control study.

---

The carpometacarpal joint (CMC) of the thumb is the second most common site of arthritis in the hand.<sup>1-3</sup> The age-adjusted prevalence of CMC arthritis based on radiographic evidence has been reported to be 15% for the female population and 7% for the male population.<sup>4</sup> Radiographic evidence of early (stage I

or stage II) thumb CMC arthritis is particularly common in postmenopausal women.<sup>5</sup> Most of these patients are symptomatic.<sup>5,6</sup>

Nonoperative treatment of stage I and stage II basal joint arthritis usually begins with functional education and activity modification.<sup>1,7</sup> Less forceful pinching and alternating hand use may help decrease pain when performing activities of daily living.<sup>1</sup> Anti-inflammatory medications are frequently prescribed, but there is no evidence that these medications actually stop or reverse the disease process.<sup>7</sup> Intra-articular steroid injections may provide short-term pain relief, but their long-term efficacy is questionable.<sup>7,8</sup> Yao and Park<sup>7</sup> reported that intermittent use of custom-fitted splints may also help decrease symptoms in early stages of CMC arthritis. They acknowledged, however, that compliance with a long-term splinting protocol can be challenging. As noted by several authors, incomplete relief, progression of symptoms, and recurrence are

---

From SUN Orthopedics and Sports Medicine, Lewisburg, Pennsylvania, U.S.A.

The author reports no conflict of interest.

Received January 3, 2009; accepted June 29, 2009.

Address correspondence and reprint requests to John P. Furia, M.D., SUN Orthopedics and Sports Medicine, 900 Buffalo Rd, Lewisburg, PA 17837, U.S.A. E-mail: [jfuria@ptd.net](mailto:jfuria@ptd.net)

© 2010 by the Arthroscopy Association of North America

0749-8063/10/2601-0910\$36.00/0

doi:10.1016/j.arthro.2009.06.031

Note: To access the video accompanying this report, visit the January issue of *Arthroscopy* at [www.arthroscopyjournal.org](http://www.arthroscopyjournal.org).

common sequelae of nonoperative treatment of basal joint disease.<sup>9-11</sup>

Although numerous surgical techniques have been described to treat basal joint arthritis,<sup>12-23</sup> stage I and stage II disease is usually managed with either volar ligament reconstruction, metacarpal extension osteotomy, or tendon interpositional arthroplasty with or without some type of suspension arthroplasty.<sup>12,14,15,18-20</sup> Results vary from series to series and range from “mostly satisfactory” to good or excellent results in 88% of cases.<sup>12,14,15,18-20</sup> Martou et al.<sup>2</sup> in a review of the literature concluded that there were insufficient data to recommend one surgical procedure over another. Most open surgical procedures are technically demanding, are associated with lengthy postoperative recovery, and often require postoperative immobilization for as long as 4 to 6 weeks.<sup>12,14,15,18-20</sup>

Complications after traditional open surgery for basal joint arthritis are not uncommon. Basal joint subluxation, pin site infection, neurovascular injury, early dislocation of an implant, and persistent pain can compromise the final outcome.<sup>3,24,25</sup>

CMC joint arthroscopy has emerged as another surgical method for the treatment of basal joint arthritis.<sup>7,26-31</sup> Uncontrolled pilot studies suggest that arthroscopy and debridement of the first CMC joint, alone or with combined procedures, such as first metacarpal osteotomy or implant arthroplasty, can yield satisfactory results.<sup>7,27,29-31</sup>

Badia and Khanchandani<sup>27</sup> described their experience with arthroscopic synovectomy, debridement, and corrective dorsoradial closing wedge osteotomy of the thumb metacarpal in a series of 43 patients with stage II disease. They reported “satisfactory results in terms of pain relief, stability, and pinch strength,” but no quantitative data were reported.

Menon<sup>30</sup> reported improved pinch strength and complete pain relief in 75.7% of patients treated with combined arthroscopic joint debridement, partial resection of the trapezium, and interpositional arthroplasty. Culp and Rekan<sup>29</sup> reported good or excellent results in 88% of cases in a cohort of 24 patients with a minimum follow-up of 1.4 years treated with either arthroscopic synovectomy and electrothermal shrinkage of the basal joint capsule in those with early arthritis or arthroscopic hemitrapeziectomy or complete trapeziectomy in those with advanced arthritis.

Unfortunately, each of these case series lacked a control group, and the same surgical procedure was not performed for each patient in the trial.<sup>27,29-30</sup>

The aim of this study was to determine whether a standard arthroscopic procedure, basal joint debride-

ment and synovectomy, is a safe and effective technique for treatment of stage I and stage II thumb CMC joint arthritis. The hypothesis was that arthroscopic debridement and synovectomy would improve pain, function, patient-reported outcome, and pinch strength in patients with stage I and stage II disease as compared with conservative treatment.

## METHODS

From January 1 to December 31, 2007, all patients with an established diagnosis of stage I or stage II chronic basal joint arthritis who were treated with arthroscopic CMC joint synovectomy and joint debridement by me were considered for inclusion in the study. All procedures were performed at an ambulatory surgical center or in the 1-day surgical suite of a community hospital.

During the same time interval, a similar group of patients with stage I or stage II chronic basal joint arthritis who were also offered arthroscopic CMC joint surgery but declined and instead chose to receive traditional nonoperative treatment for their condition were enrolled in the control group. Traditional nonoperative therapies consisted of activity modification, anti-inflammatory medications, basal joint splinting, physical therapy modalities, and a corticosteroid and local anesthetic injection. Both the surgical and control groups were derived from my clinical practice.

The patients in the control group were selected from a cohort of 60 patients treated by me during the time of the study. All surgical and control patients were offered surgery or traditional nonoperative therapy. After making an informed decision, the control patients chose to undergo treatment for their condition with traditional nonoperative methods; the surgical patients chose to undergo treatment for their condition with surgery. Therefore the surgical patients were enrolled in the surgical group because they chose to treat their condition with surgery. The control patients were enrolled in the control group because they chose to treat their condition without surgery. The control patients were selected to match the age and gender of the patients in the surgery group. Selection of the control patients was blinded to outcome at the time they were selected.

## Inclusion Criteria

All patients were diagnosed with stage I or stage II basal joint arthritis based on the physical findings of tenderness over the basal joint, pain with axial loading

of the basal joint, and my review of standard posteroanterior, lateral, and posteroanterior 30° oblique radiographs. The inclusion criteria included patients with an established diagnosis of chronic (symptoms for 6 months) stage I or stage II basal joint arthritis. By use of the radiographic staging system described by Eaton and Littler,<sup>12</sup> stage I disease was defined as normal radiographs or radiographs with only slight widening of the trapezium metacarpal joint. Stage II disease was defined as mild trapezium metacarpal joint space narrowing, minimal CMC joint subchondral sclerosis, and osteophytes, if present, measuring less than 2 mm in diameter with a normal-appearing scaphotrapezial joint.<sup>32</sup>

### Exclusion Criteria

Exclusion criteria included patients with fixed deformities of the CMC joint, complete loss of the CMC joint space, scaphotrapezial disease, metacarpophalangeal joint hyperextension, prior CMC joint surgery, rheumatoid arthritis, neurologic conditions, and local infection.

### Surgical Group

Twenty-three patients (twenty-three thumbs) with basal joint arthritis were available for analysis. There were 20 women and 3 men in the surgical group, with a mean age of 53.7 years (range, 30 to 70 years; SD, 10 years).

### Control Group

Twenty-one patients matched for gender and age were enrolled in the control group. There were 19 women and 2 men, with a mean age of 55.4 years (range, 36 to 72 years; SD, 9.1 years). All patients in the control group voluntarily declined surgery. The patients in the control group were managed nonoperatively throughout the study period. Nonoperative treatment consisted of various forms of activity modification, initiation and/or dose adjustment of prescription anti-inflammatory medication, intermittent basal joint splinting, physical therapy modalities, and a corticosteroid and local anesthetic injection. There was no difference in mean age ( $P = .6$ ) between the surgical and control groups.

### Surgical Technique

The procedure was performed with the patient under general anesthesia. A tourniquet was applied to the upper arm but was inflated during only 2 of 23 pro-

cedures. The patient was positioned supine on the operating room table, and the arm was positioned on a standard arm table. A sterile single Chinese finger trap was used on the thumb and a second Chinese finger trap was used on the index digit to apply 7 lb of longitudinal traction. An assistant held the forearm in pronation. The thumb CMC joint was found by palpating proximally along the thumb metacarpal until a depression was felt. The abductor pollicis longus and extensor pollicis brevis tendons were then palpated. At the level of the basal joint, the location of the 1-R (radial to the abductor pollicis longus tendon) and 1-U (ulnar to the extensor pollicis brevis tendon) portals, as described by Menon,<sup>30</sup> were marked with a marking pen. The fluoroscope was then brought into the field to confirm the location of the basal joint and to guide the placement of a 22-gauge needle from the 1-U portal into the basal joint. The joint was inflated with approximately 3 mL of normal saline solution. A No. 11 scalpel was used to incise only the skin of the 1-U portal. A forceps was used to raise the skin to the blade so as not to incise too deeply and risk injury to the radial artery or branches of the radial sensory nerve. A blunt hemostat was used to carefully spread down to the level of the basal joint.

The 1.9-mm arthroscope cannula was then inserted into the basal joint. A distinct pop was palpated. The position of the arthroscope in the basal joint was confirmed with fluoroscopy. Constant inflow by use of an arthroscopy pump set at 40 mm Hg was used to maintain joint distension. Diagnostic arthroscopy was performed. Rotation of the thumb identified the base of the first metacarpal. The 22-gauge needle was then inserted into the basal joint from the skin overlying the location of the 1-R portal. The fluoroscope was used to guide this maneuver. Once proper positioning of the needle was confirmed, the needle was removed and the 1-R portal was established by the same atraumatic technique.

A 2.0-mm full-radius resector was passed through the 1-R portal into the basal joint. Loose segments of articular cartilage and hypertrophic synovial tissue were debrided. The metacarpal and trapezial surfaces were assessed with a small probe, and the chondral flaps were debrided. Loose bodies were excised. Prominent and impinging spurs were resected. Adequate debridement was confirmed with the fluoroscope. The joint was lavaged, the instruments were removed, and No. 4-0 monofilament sutures were used to close the portals. A sterile dressing and fiberglass thumb spica splint were applied. Video 1 shows the surgical technique (available at [www.arthroscopyjournal.org](http://www.arthroscopyjournal.org)).

**Postoperative Protocol**

Patients were assessed in the postanesthesia care unit for hematoma, swelling, and neurovascular status and were discharged after meeting standard ambulatory surgical criteria. The splint was removed at the first postoperative appointment (typically 5 days postoperatively), and patients received instruction in hand therapy. Patients were allowed unrestricted active range of motion, and no functional restrictions were imposed. Strengthening exercises were progressed as tolerated. No additional immobilization or interventions were used.

Activity was advanced as symptoms dissipated. Patients who worked in a sedentary occupation were allowed to immediately return to their pretreatment work status. The time to return to heavy-labor occupations and athletic activities that required use of the affected extremity was determined on a case-by-case basis.

**Outcome Measures**

The subjective and objective results were recorded by the patient and surgeon, respectively. Outcome measures included the visual analog scale (VAS) score, the Disabilities of the Arm, Shoulder and Hand (DASH) score, a custom-designed subjective questionnaire, and assessment of pinch strength. The DASH score has been shown to be a useful tool for evaluating the outcome of surgery for basal joint arthritis.<sup>33</sup> The VAS and DASH scores were collected before treatment and at 12 months after treatment during the follow-up examinations. On the VAS, 10 points indicated severe pain, and 0 points indicated no pain.

The subjective questionnaire consisted of a 4-point scale on which patients were simply asked how they rated the overall status of their thumb. On the scale, 1 point indicated an excellent result with the patient having no symptoms. Two points indicated a good result with the patient being significantly improved from the pretreatment condition and satisfied with the

**TABLE 1. Patient Occupation**

	Surgical (n = 23)	Control (n = 21)
Homemaker	6	6
Sales	3	2
Secretary	0	1
Self-employed	2	0
Farmer	2	2
Retired	6	7
Teacher	2	1
Office worker	2	2

**TABLE 2. Patient Activity Level**

	Surgical (n = 23)	Control (n = 21)
Active	7	6
Moderately active	10	8
Sedentary	6	7

result. Three points indicated a fair result with the patient being somewhat improved from the pretreatment condition and partially satisfied with the treatment outcome. Four points indicated a poor outcome with symptoms identical to or worse than the pretreatment condition and with dissatisfaction with the treatment result.

Presurgical and postsurgical pinch strength testing was performed with a Jamar Digital Hand Dynamometer (Therapeutic Equipment, Clifton, NJ).

**Statistical Analysis**

A power analysis showed that a sample size of 23 would be required to establish the statistical significance with  $\alpha = .05$  and power of 0.9, with calculations based on the outcomes of surgery and nonoperative treatment of basal joint arthritis. Statistical analysis for the comparison of the means between groups was performed by use of the paired Student *t* test and  $\chi^2$  analysis. The significance level was  $P < .05$ . All analyses were conducted with SAS software, version 8.2 (SAS, Cary, NC).

**RESULTS**

The mean age for the surgical and control groups was 53.7 years (range, 30 to 70 years; SD, 10 years) and 55.4 years (range, 36 to 72 years; SD, 9.1 years), respectively ( $P = .6$ ). Five patients in the surgical group and four patients in the control group had stage I disease, whereas eighteen patients in the surgical group and seventeen patients in the control group had stage II disease. Patient occupation, activity level, and handedness are summarized in Tables 1, 2, and 3,

**TABLE 3. Patient Handedness**

	Surgical (n = 23)	Control (n = 21)
Right handed	14	12
Left handed	9	9
Dominant hand treated surgically	12	Not applicable
Nondominant hand treated surgically	11	Not applicable

respectively. Mean follow-up for the surgical and control patients was 20 months (range, 14 to 24 months) and 21 months (range, 14 to 23 months), respectively. None of the control patients underwent a surgical procedure for their arthritic thumb during the study period. All of the surgical patients were treated with arthroscopic joint debridement and synovectomy only; no additional surgical procedures were performed. As of May 1, 2009, to my knowledge, none of the surgical patients underwent an additional surgical procedure for their arthritic thumb. As of May 1, 2009, to my knowledge, 5 of the control patients underwent a surgical procedure for their arthritic thumb at a time after this study was complete.

### VAS Score

The mean preoperative VAS scores for the surgical and control groups were  $7.7 \pm 1.4$  and  $7.5 \pm 1.2$ , respectively ( $P = .3$ ). At final follow-up, the mean VAS score decreased to  $2.7 \pm 1.1$  ( $P < .001$ ) for the surgical group and  $7.3 \pm 0.9$  ( $P = .3$ ) for the control group.

The mean follow-up VAS score for the surgical group was significantly less than the corresponding VAS score for the control group ( $P < .001$ ).

### DASH Score

The mean preoperative DASH scores for the surgical and control groups were  $55.6 \pm 13.4$  and  $54.4 \pm 9.6$ , respectively ( $P = .3$ ). At final follow-up, the mean DASH score decreased to  $26 \pm 5.9$  ( $P < .001$ ) for the surgical group and  $53.1 \pm 8.5$  ( $P = .3$ ) for the control group.

The mean follow-up DASH score for the surgical group was significantly less than the corresponding DASH score for the control group ( $P < .001$ ).

### Subjective Score

At the onset of the study, all surgical and control patients rated the condition of the affected thumb as 4 (poor) (Table 4). The 12-month mean subjective scores for the surgical and control groups were 1.8 and 3.8, respectively ( $P < .001$ ). Overall, at final follow-up, 82% of patients in the surgical group described having an excellent or good result compared with 0% of patients in the control group.  $\chi^2$  Analysis showed that the percentage of patients with excellent or good subjective scores (i.e., successful results) at final follow-up was statistically greater in the surgical group compared with the control group ( $P < .001$ ).

**TABLE 4.** Subjective Scores for Surgical and Control Groups

	Before Treatment		After Treatment	
	Surgical (n = 23)	Control (n = 21)	Surgical (n = 23)	Control (n = 21)
Excellent (1)	0 (0%)	0 (0%)	8 (35%)	0 (0%)
Good (2)	0 (0%)	0 (0%)	11 (48%)	0 (0%)
Fair (3)	0 (0%)	0 (0%)	4 (17%)	4 (19%)
Poor (4)	23 (100%)	21 (100%)	0 (0%)	17 (81%)

### Pinch Strength

The mean preoperative pinch strengths for the surgical and control groups were  $4.2 \pm 1.5$  kg and  $4.6 \pm 1.1$  kg, respectively. At final follow-up, the mean pinch strength increased to  $6.2 \pm 1.3$  kg ( $P < .001$ ) for the surgical group and  $4.9 \pm 1.1$  kg ( $P = .2$ ) for the control group.

The mean follow-up pinch strength for the surgical group was significantly greater than the corresponding pinch strength for the control group ( $P < .001$ ).

### Complications

There were only 2 minor complications. One patient had slight erythema and pruritus near the 1-U portal, which developed approximately 48 hours after the procedure and resolved after a 5-day course of oral antibiotics. One patient had transitory numbness near the 1-R portal that resolved within 48 hours without intervention. No other complications were detected.

## DISCUSSION

With the advent of better instrumentation and the increasing popularity of minimally invasive surgery, there has been heightened interest in the use of arthroscopic techniques to treat many orthopaedic conditions, including basal joint arthritis. Early reports using a variety of arthroscopic techniques to manage basal joint arthritis have been promising.

Nearly all patients in the series of Menon,<sup>30</sup> Culp and Rekan,<sup>29</sup> and Badia and Khanchandani<sup>27</sup> had subjective and/or objective improvement in their symptoms after arthroscopic basal joint surgery. Yao and Park<sup>7</sup> reported good or excellent results in 88% of cases in their series of patients with stage I and early stage II arthritis treated with a combined arthroscopic synovectomy, joint debridement, and hemitrapeziectomy or complete trapeziectomy. Pegoli et al.<sup>31</sup> reported significantly improved MAYO scores in 12 of

16 patients with either stage I or stage II basal joint arthritis.

Unfortunately, an inconsistent intervention (i.e., a variety of surgical procedures) was used in 4 of the aforementioned trials.<sup>7,27,29,30</sup> No quantitative data were reported in 2 of these trials.<sup>7,29</sup> Each of these trials also lacked a control group.<sup>7,27,29-31</sup> As noted by Shuler et al.<sup>34</sup> in a recently published focused review regarding the management of basal joint arthritis, little evidence-based medicine can be gleaned from these case series reports primarily because different options were not directly compared.

In contrast to the aforementioned preliminary trials, this study used a consistent surgical procedure, and the surgical results were reported by use of several standardized outcome measures, including the DASH score. After a review of multiple clinical, generic, and condition-specific outcome questionnaires, Angst et al.<sup>35</sup> recommended use of the DASH score to assess surgical outcome in patients who had undergone basal joint arthroplasty. Perhaps most importantly, this trial compared one intervention, arthroscopic basal joint debridement and synovectomy, with another form of treatment, traditional nonoperative modalities consisting of activity modification, anti-inflammatory medication, a single local anesthetic and steroid injection, and intermittent basal joint splinting. The finding of good or excellent results in 83% of patients in the surgical group is comparable to that reported in the aforementioned preliminary trials and was better than that in the control group.

Arthroscopic treatment of basal joint arthritis offers several potential advantages over traditional open surgery. The clinical symptoms of basal joint arthritis are often much more pronounced than plain radiographs would suggest.<sup>26</sup> CMC joint arthroscopy allows for precise evaluation of articular surfaces and synovium, information that may then be used to guide further treatment.

Arthroscopic surgery can be performed through very small incisions. This less invasive approach minimizes tissue trauma, helps preserve motion, and ultimately may lessen pain and expedite recovery. Other potential advantages of arthroscopy include decreased healing time, minimal violation of capsular structures, and the potential for shorter surgical times.

This study evaluated the safety and efficacy of basal joint arthroscopy, synovectomy, and joint debridement in a cohort of patients with stage I or stage II disease. The outcome in the surgical group was compared with that in a control group. The mean VAS and DASH scores and the mean pinch strength for the

surgically treated patients were statistically improved at a minimum of 1-year follow-up compared with the presurgical condition. At follow-up, 83% of the surgically treated patients rated the status of their thumb as either good or excellent. None of the surgical patients required additional surgical procedures, and there were no significant complications.

This study is a retrospective cohort study and, as such, has some inherent limitations. There was no randomization, and like prior studies involving the arthroscopic treatment of basal joint arthritis, the number of patients was relatively small. The patients themselves selected which treatment they received and were only controlled with regard to age and gender. It is possible that the patients in the surgical group has more motivation to become healthier or perceive that they had become healthier. It is also possible that those who chose not to have an operation may have ultimately wanted an operation and thus continued to record their dissatisfaction by reporting lower subjective scores. However, this would not explain their lower pinch strength. The mean length of follow-up was only 12 months; however, a positive treatment effect was already evident at this time. Staging was based only on my review of the radiographs, as is frequently the case in the clinical setting.

## CONCLUSIONS

Acknowledging these weaknesses, this series contributes valuable information. This study shows that arthroscopic debridement and synovectomy improve pain scores, functional scores, subjective outcome, and pinch strength more so than traditional nonoperative therapy.

## REFERENCES

1. Barron OA, Glickel SZ, Eaton RG. Basal joint arthritis of the thumb. *J Am Acad Orthop Surg* 2000;8:314-323.
2. Martou G, Veltri K, Thoma A. Surgical treatment of osteoarthritis of the carpometacarpal of the thumb: A systematic review. *Plast Reconstr Surg* 2004;114:421-432.
3. Polatsch DB, Paksima N. Basal joint arthritis: Diagnosis and treatment. *Bull NYU Hosp Jt Dis* 2006;64:178-184.
4. Haara MM, Heliovaara M, Kroger H, et al. Osteoarthritis in the carpometacarpal joint of the thumb: Prevalence and associations with disability and mortality. *J Bone Joint Surg Am* 2004;86:1452-1457.
5. Armstrong AL, Hunter JB, Davis TRC. The prevalence of degenerative arthritis of the base of the thumb in postmenopausal women. *J Hand Surg Br* 1994;19:340-341.
6. Croog AS, Rettig ME. Newest advances in the operative treatment of basal joint arthritis. *Bull NYU Hosp Jt Dis* 2007; 65:78-86.

7. Yao J, Park MJ. Early treatment of degenerative arthritis of the thumb carpometacarpal joint. *Hand Clin* 2008;24:251-261.
8. Joshi R. Intra-articular corticosteroid injection for first carpometacarpal osteoarthritis. *J Rheumatol* 2005;32:1305-1306.
9. Day CS, Gelberman R, Patel AA, Vogt MT, Ditsios K, Boyer MI. Basal joint osteoarthritis of the thumb: A prospective trial of steroid injection and splinting. *J Hand Surg Am* 2004;29:247-251.
10. Heyworth BE, Lee JH, Kim PD, Lipton CB, Strauch RJ, Rosenwasser MP. Hylan versus corticosteroid versus placebo for treatment of basal joint arthritis: A prospective, randomized, double-blinded clinical trial. *J Hand Surg Am* 2008;33:40-48.
11. Swigart CR, Eaton RG, Glickel SZ, Johnson C. Splinting in the treatment of arthritis of the first carpometacarpal joint. *J Hand Surg Am* 1999;24:86-91.
12. Eaton R, Littler JW. Ligament reconstruction for the painful thumb carpometacarpal joint. *J Bone Joint Surg Am* 1973;55:1655-1666.
13. Davis DI, Catalano L. Treatment of advanced carpometacarpal joint disease: Carpometacarpal arthroplasty with ligament interposition. *Hand Clin* 2008;24:263-269.
14. Gwynne-Jones DP, Penny ID, Sewell SA, Hughes TH. Basal joint metacarpal osteotomy for trapeziometacarpal osteoarthritis. *J Orthop Surg* 2006;14:58-63.
15. Tomaino MM. Treatment of Eaton stage I trapeziometacarpal disease with thumb metacarpal extension osteotomy. *J Hand Surg Am* 2000;25:1100-1106.
16. Fitzgerald BT, Hofmeister EP. Treatment of advanced carpometacarpal joint disease: Trapeziectomy and hematoma arthroplasty. *Hand Clin* 2008;24:271-276.
17. Earp BE. Treatment of advanced CMC joint disease: Trapeziectomy and implant arthroplasty (silastic-metal-synthetic allograft). *Hand Clin* 2008;24:277-283.
18. Froimson AI. Tendon interposition arthroplasty of carpometacarpal joint of the thumb. *Hand Clin* 1987;3:489-505.
19. Burton RI, Pellegrini VD Jr. Surgical management of basal joint arthritis of the thumb. Part II. Ligament reconstruction with tendon interposition arthroplasty. *J Hand Surg Am* 1986;11:324-332.
20. Tomaino MM, Pellegrini VD, 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;77:346-355.
21. Gervis WH. Excision of the trapezium for osteoarthritis of the trapeziometacarpal joint. *J Bone Joint Surg Br* 1949;31:537-539.
22. Raven EE, Kerkhoff GM, Rutten S, Marsman AJ, Marti RK, Albers GH. Long term results of surgical intervention for osteoarthritis of the trapeziometacarpal joint: Comparison of resection arthroplasty, trapeziectomy with tendon interposition and trapezio-metacarpal arthrodesis. *Int Orthop* 2007;31:547-554.
23. Hartigan BJ, Stern PJ, Kiefhaber TR. Thumb carpometacarpal osteoarthritis: Arthrodesis compared with ligament reconstruction and tendon interposition. *J Bone Joint Surg Am* 2001;83:1470-1478.
24. Athwal GS, Chenkin J, King GJ, Pichora DR. Early failures with a spheric interposition arthroplasty of the thumb basal joint. *J Hand Surg Am* 2005;29:1080-1084.
25. Cook GS, Lalonde DH. MOC-PS CME article: Management of thumb carpometacarpal joint arthritis. *Plast Reconstr Surg* 2008;121:1-9 (Suppl).
26. Badia A. Trapeziometacarpal arthroscopy: A classification and treatment algorithm. *Hand Clin* 2006;22:153-163.
27. Badia A, Khanchandani P. Treatment of early basal joint arthritis using a combined arthroscopic debridement and metacarpal osteotomy. *Tech Hand Up Extrem Surg* 2007;11:168-173.
28. Berger RA. A technique for arthroscopic evaluation of the first carpometacarpal joint. *J Hand Surg Am* 1997;22:1077-1080.
29. Culp RW, Rekant MS. The role of arthroscopy in evaluating and treating trapeziometacarpal disease. *Hand Clin* 2001;17:315-319.
30. Menon J. Arthroscopic management of the trapeziometacarpal joint arthritis of the thumb. *Arthroscopy* 1996;12:581-587.
31. Pegoli L, Parolo C, Ogawa T, Toh S, Pajardi G. Arthroscopic evaluation and treatment by tendon interpositional arthroplasty of first carpometacarpal joint arthritis. *Hand Surg* 2007;12:35-39.
32. Eaton RG, Glickel SZ. Trapeziometacarpal osteoarthritis: Staging as a rationale for treatment. *Hand Clin* 1987;3:455-471.
33. De Smet L. Responsiveness of the DASH score in surgically treated basal joint arthritis of the thumb: Preliminary results. *Clin Rheumatol* 2004;23:223-224.
34. Shuler MS, Luria S, Trumble TE. Basal joint arthritis of the thumb. *J Am Acad Orthop Surg* 2008;16:418-423.
35. Angst F, John M, Goldhahn J, et al. Comprehensive assessment of clinical outcome and quality of life after resection interposition arthroplasty of the thumb saddle joint. *Arthritis Rheum* 2005;53:205-213.