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HAND AND WRIST (DA OSEI, SECTION EDITOR)

Trapeziometacarpal joint arthritis

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Abstract Trapeziometacarpal (TM) joint arthritis is a common cause of radial-sided wrist pain that preferentially affects women. It is diagnosed by a thorough history, physical examination, and radiographic evaluation. While radiographs are used to determine the stage of disease, treatment is dependent on symptom severity. Nonoperative treatment frequently consists of activity modification, non-steroidal anti-inflammatory drugs (NSAIDs), splinting, and corticosteroid injections. After failure of conservative treatment, various surgical options exist depending on the stage of disease. This article reviews the literature supporting the various surgical treatment options. Special consideration is given to the comparison of trapeziectomy with and without tendon interposition and ligament reconstruction.

Keywords Trapeziometacarpal arthritis · Thumb carpometacarpal arthritis · Basilar joint arthritis · Trapeziectomy · LRTI · CMC arthroplasty · Trapeziometacarpal arthrodesis · MP hyperextension deformity

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Introduction

Aside from the distal interphalangeal (IP) joint, the TM joint is the most common site of osteoarthritis in the hand. In fact, the prevalence of isolated radiographic TM joint arthritis is believed to be as high as 25 %–35 % in some subsets of the population [1, 2]. Fortunately, while it is extremely prevalent, 1 study found that only 28 % of patients with radiographic TM joint arthritis had basilar joint thumb pain [1]. For those patients who experience symptoms, TM joint arthritis can be extremely debilitating as it limits opposition, which is the critical function of the thumb. In order to appropriately treat these patients, physicians need to understand the pathoanatomy, clinical evaluation, imaging, and staging of disease. Finally, surgeons must be familiar with the various nonoperative and operative treatment options currently available.

Pathoanatomy

In the early stages of TM arthritis, excessive laxity of the volar beak ligament and subsequent pathologic loading result in synovitis, which causes pain and effusion localized to the base of the thumb. Eventually, this altered loading results in articular wear and osteophyte formation. As the thumb metacarpal base subluxates dorsoradially, the metacarpal shaft flexes and adducts secondary to tethering to the index finger metacarpal by the adductor pollicis. Over time, this results in a first web space contracture. To allow pinch, the metacarpophalangeal (MP) joint compensates with hyperextension, which results in a zigzag- or Z- deformity (Fig. 1) [3].

Clinical evaluation

In evaluating the patient with radial-sided wrist pain, it is imperative to elicit a detailed history. Specifically, attention

Fig. 1 PA radiograph of patient with stage III arthritis and MP hyperextension deformity (Z-deformity)

should focus on the location, duration, onset, frequency, intensity, and quality of the pain. It is also important to identify factors that may increase or decrease the pain. For instance, in thumb carpometacarpal (CMC) arthritis, patients frequently complain of symptom exacerbation with gripping and pinching activities. Furthermore, the patient's hand dominance and occupation are relevant, especially in understanding any functional or activity limitations secondary to the pain.

On physical examination, patients have tenderness to palpation about the thumb TM joint, which should be differentiated from nearby anatomic structures, such as the first dorsal extensor compartment, the radiocarpal joint, the scaphoid, and the scapho-trapezial-trapezoid (STT) joint. As the arthritis advances, the metacarpal base becomes more prominent dorsally, and instability with crepitus may develop at the joint. Provocative maneuvers, such as the thumb CMC grind test, will further aggravate symptoms [4]. Finally, the degree of MP joint hyperextension instability should be documented and compared with the contralateral side.

Imaging

Initial evaluation of basilar joint arthritis includes posterior-anterior, lateral, and oblique radiographs of the thumb CMC joint [5]. These standard radiographic views allow evaluation for arthritis but also exclude other causes of radial-sided wrist pain, such as scaphoid fractures. Additional views can also be useful for diagnosis. Specifically, Eaton recommended stress views, in which the patient presses both thumbs together at the radial border of the distal phalanges, to evaluate CMC instability [3]. Furthermore, a Bett's view, which is taken with the forearm in neutral, the wrist in slight ulnar deviation, and the thumb in abduction, allows all 4 articulations of the trapezium to be visible without overlap [6].

Staging

In 1973, Eaton and Littler introduced a radiographic classification system for thumb CMC arthritis, which recognized 4 stages of pathology (Table 1) [3]. In stage I disease, also described as the synovitis phase, radiographs demonstrate normal articular contours, slight joint space widening due to joint effusion, and less than one-third subluxation of the joint. In stage II disease, osteophytes are less than 2 millimeters (mm) in size, and greater than one-third subluxation of the joint exists due to capsular laxity. Stage III disease demonstrates osteophytes greater than 2 mm with continued subluxation and joint space narrowing. Finally, stage IV disease exhibits pan-trapezial osteophyte formation, which involves the STT joint.

While frequently used to guide treatment for thumb CMC arthritis, the Eaton and Littler classification system has demonstrated only moderate inter-observer agreement among hand surgeons with Certificate of Added Qualification (CAQ) and orthopedic surgery residents [5]. Similar results were found among hand surgeons and musculoskeletal radiologists [7]. Dela Rosa noted that the addition of the Bett's view improved intra- and inter-observer reliability [6].

Nonoperative treatment

Initial treatment for TM arthritis is uniformly nonoperative, and a number of options are available. These treatment options include activity modification, NSAIDs, splinting, and intra-articular corticosteroid injections [8].

Splinting

While splinting has long been used as a conservative treatment option for TM arthritis, few studies have analyzed the effectiveness of this treatment modality. Swigart conducted a

Table 1 Eaton and Littler classification of TM joint osteoarthritis

Eaton and Littler Stage	Joint Space	Osteophytes	ST Joint Arthritis
I	Widening	None	None
II	Narrowing	<2 mm	None
III	Narrowing	>2 mm	None
IV	Narrowing	>2 mm	Present

retrospective study of 130 thumbs treated with a long opponens splint. Patients with stage I or II disease had more symptomatic improvement than patients with stage III or IV disease. However, this improvement was not found to be significant. The authors concluded that splinting was "a well-tolerated and effective conservative treatment to diminish, but not completely eliminate, the symptoms of thumb CMC arthritis and inflammation" [9]. Currently, multiple pre-fabricated and custom splint options exist, but little evidence favors one over another [10].

Intra-articular corticosteroid injection

Corticosteroid injections are hypothesized to decrease pain and inflammation in arthritis, including the small joints of the hand. However, accuracy is a concern for injections of the TM joint. Pollard found an intra-articular injection rate of 81.8 % without the use of fluoroscopy, but the study noted extravasion of dye outside the joint in 25 % of intra-articular injections, regardless of fluoroscopy use [11]. Even with a successful intra-articular injection, few studies have demonstrated the efficacy of corticosteroids. In a prospective study of 30 patients who received a corticosteroid injection and splinting for 3 weeks, Day found that 5 of 6 patients with stage I arthritis had significant relief for at an average of 23 months after injection. Results for patients with stage II or stage III disease were less predictable with only a 35 % probability of long-term relief. Patients with stage IV disease had poor results with this treatment protocol [8]. Finally, in a randomized, controlled, double-blinded study of 60 patients, Heyworth found no significant differences between saline, corticosteroid, and hylan injections in a number of outcome measures, including grip strength, pain relief, range of motion, Disabilities of the Arm, Shoulder and Hand (DASH), or Visual Analogue Scale (VAS) scores [12].

Operative treatment

Many operative options exist for TM arthritis. The procedure of choice is dependent on multiple factors including patient age, activity level, occupation, disease stage, and surgeon preference. Stage I and early stage II disease can be treated by volar ligament reconstruction, metacarpal extension osteotomy, or arthroscopy. Late stage II, stage III, and stage IV disease are best treated with salvage procedures that involve trapeziectomy or arthrodesis.

Stage I or early stage II treatment

Volar ligament reconstruction

Eaton first described volar ligament reconstruction for stabilization of the thumb CMC joint in 1973, and the procedure has changed little since that time. It involves harvest of half of the flexor carpi radialis (FCR) tendon, which is passed through the metacarpal base, around the abductor pollicis longus (APL) and remaining half of the FCR, and then secured to the radial side of the joint. Eaton's prospective study of 18 patients demonstrated uniformly excellent results for patients with stage I or II disease. However, only 5 of 8 patients with stage III disease had excellent results, and patients with stage IV disease had poor outcomes with continued pain [3]. Subsequently, Eaton followed an additional 50 consecutive patients for an average of 7 years. Ninety-five percent of the patients with stage I or II disease had good or excellent results, compared with 74 % of the patients with stage III or IV disease [13]. More recently, Lane noted similar results in a study of 37 stage I thumbs in 35 patients when followed up at an average of 5.2 years. Ninety-seven percent of the patients had good-to-excellent results, and 100 % had improved pinch strength with good stability [14]. Based on these studies, volar ligament reconstruction can be considered as a treatment option for stage I and II disease in order to reduce pain and restore stability [13].

Metacarpal extension osteotomy

Thumb metacarpal extension osteotomy is another treatment option for stage I and early stage II disease. This procedure restores stability to the basal joint in the setting of an incompetent anterior oblique ligament by reducing laxity in all directions. The removal of a dorsal bone wedge results in thumb extension away from the index finger. Biomechanically, this metacarpal extension osteotomy produces a shift in the primary contact area away from the diseased palmar area to the uninvolved dorsal area. This load redistribution effect of the osteotomy is more pronounced in less arthritic CMC joints [15]. Furthermore, in lateral pinch, the CMC joint has reduced laxity after extension osteotomy, due to the dorsal and posterior oblique ligaments becoming taut [16].

The short- and long-term results of thumb metacarpal extension osteotomy are relatively good in the appropriately selected patient. In a prospective study of 12 patients followed for an average of 2.1 years, Tomaino found that pain levels decreased and that grip and pinch strengths increased by an average of 8.5 and 3.0 kg, respectively [17]. Furthermore, in a retrospective review of 50 consecutive patients at mean follow-up of 6.8 years, 80 % of patients had good-excellent pain relief, and 82 % of patients had normal grip and pinch strength. As expected, patients with stage I or II disease had improved outcomes compared with patients with stage III or IV disease [18].

Arthroscopy

Small joint arthroscopy has become more popular with the development of smaller cameras and arthroscopy

equipment. TM joint arthroscopy can be used for debridement and synovectomy alone or combined with osteotomy or arthroplasty procedures. Furia compared 23 stage I or II patients treated with arthroscopic debridement and synovectomy to age- and gender-matched patients treated nonoperatively. The author found improved VAS scores, DASH scores, subjective scores, and pinch strength in the operative group at an average of 20 months. Eighty-three percent of patients had good or excellent results with operative treatment [19]. At the present time however, there are no high quality randomized studies comparing TM joint arthroscopy with other treatment options for stage I or II disease.

Late stage II, stage III, or stage IV treatment

Simple trapeziectomy

Simple trapeziectomy for basal joint arthritis was first described by Gervis in 1949 [20]. Subsequently, he followed 10 patients for 6 to 22 years and found satisfactory results including pain relief [21]. These results have been substantiated by many studies. In 1994, Dhar retrospectively reviewed the results of 39 simple trapeziectomies in 34 patients at an average follow-up of 6 years. Simple trapeziectomy was found to result in significant pain relief without loss of grip and pinch strength [22]. Furthermore, the authors noted preservation of thumb length with pseudoarthrosis at the site of trapezium excision. Subsequently, Meals described hematoma distraction arthroplasty (HDA) or trapeziectomy with K-wire stabilization and reported his results. At both 1 year and 7-year follow-up, he found HDA to be satisfactory in regards to motion, strength, dexterity, and radiographs; moreover, his results were comparable to the published results of more complex soft-tissue procedures [23, 24].

Trapeziectomy with ligament reconstruction and/or tendon interposition

Although the published results of simple trapeziectomy have been good, theoretical concerns have long persisted about the procedure including persistent thumb weakness, thumb shortening, and thumb metacarpal-scaphoid subluxation with eventual arthritis. In order to avoid these theoretical complications, many modifications have been developed for stage III and IV disease. These procedures, including interposition arthroplasty, ligament reconstruction tendon interposition (LRTI), and APL suspensionplasty, have aimed to prevent shortening of the thumb and to provide strength [25].

In 1970, Froimson developed interposition arthroplasty as a treatment option for thumb basal joint arthritis. This procedure involved trapeziectomy with interposition of a rolled-up tendon autograft into the void to combat the risk of thumb shortening and loss of strength [26]. Since its conception, a variety of autograft sources including the FCR, extensor carpi radialis longus (ECRL), APL, and palmaris longus (PL) tendons have been harvested [25].

In 1986, Pellegrini first reported the results of LRTI for thumb CMC arthritis. The rationale was to combine the stabilizing effect of ligament reconstruction with the retention of thumb length associated with interposition arthroplasty [27]. Pellegrini studied the results of LRTI on 24 thumbs at 2, 6, and 9 years postoperatively. Ninety-five percent of patients had excellent pain relief and were satisfied with the outcome. Furthermore, grip strength improved an average of 93 % [28]. Since described, the LRTI has become the most popular procedure for stage III thumb CMC arthritis [29•]. While the clinical results of the LRTI are excellent, subsidence similar to that following simple trapeziectomy does occur. Kadiyala performed a radiographic study of normal thumbs, symptomatic thumbs with CMC arthritis, and thumbs status post LRTI. The trapezial space ratio measured 0.476 in normal thumbs, 0.372 in preoperative CMC arthritis thumbs, and 0.270 in thumbs after LRTI. Overall, a 43 % loss of trapezial space ratio was noted between postoperative and normal thumbs. This study demonstrated that LRTI does not fully maintain thumb ray length [30].

Thompson described the technique of APL suspensionplasty as a salvage treatment for scaphometacarpal impingement following trapeziectomy or removal of silicone trapezium replacements [31]. He found this procedure to be technically easier than alternative surgical options, while simultaneously preserving the FCR and removing the APL as a deforming force. In a series of 21 stage III or IV thumbs treated with APL suspensionplasty and followed for greater than 1 year, Soejima found significant improvement in thumb pain, thumb range of motion, grip strength, and key-pinch strength without thumb abduction weakness [32]. Many surgeons currently use this procedure for primary thumb CMC arthritis.

Comparison of trapeziectomy with and without ligament reconstruction and/or tendon interposition

Given the good retrospective results of trapeziectomy alone and trapeziectomy with various modifications, there are many reasonable treatment options for TM arthritis. Recently, higher-level studies have been performed to compare various treatment options in an attempt to determine the best procedure.

In 1997, Davis published 1 of the first randomized, prospective studies comparing trapeziectomy alone or combined with tendon interposition or ligament reconstruction. Each thumb had a Kirshner (K-wire) stabilizing the thumb

metacarpal in 30° of palmar abduction. At 3 months and at 1 year, thumb strength, hand function, and pain relief were equivalent, regardless of the procedure performed. Furthermore, trapeziectomy alone did not result in more thumb shortening [33]. This result was substantiated by Downing, who found no difference in trapezial space ratio between trapeziectomy, trapeziectomy with ligament reconstruction, and trapeziectomy with tendon interposition at 1-year follow-up [34].

To confirm the long-term accuracy of these results, Davis subsequently published a randomized study of 174 thumbs comparing simple trapeziectomy, trapeziectomy with PL interposition, and LRTI. All groups used a K-wire across the trapezial void for 4 weeks and had the identical postoperative protocol. Similar to his earlier result but at an average follow-up of 6 years, Davis found no differences in outcomes between groups [35••]. Based on these studies, which utilized K-wire stabilization, he concluded that there appeared to be no benefit to tendon interposition or ligament reconstruction in the longer term.

In order to evaluate the importance of the K-wire, Davis compared outcomes between simple trapeziectomy without K-wire insertion and LRTI with temporary K-wire insertion in a randomized prospective study of 114 thumbs. At 6 year follow-up, this study also found no significant difference in outcomes between the 2 cohorts and questioned the importance of K-wire stabilization [36••].

Based on the current literature, it appears that the key step in the treatment of stage III or IV thumb CMC arthritis is trapeziectomy [35••]. In a Cochrane database review, Wajon supported this conclusion in finding that no procedure demonstrated superiority over any other in terms of pain, physical function, patient global assessment, or range of motion. Interestingly, LRTI was found to have 12 % more adverse effects than trapeziectomy. These complications included tendon ruptures, tendon adhesions, scar tenderness, pain, erythema, sensory changes, neuromas, instability, complex regional pain syndrome, and superficial wound infections [37].

TM arthrodesis

TM arthrodesis is a valuable treatment option for thumb CMC arthritis and is primarily indicated for young, high-demand patients who require a strong, stable thumb [38]. The optimal position of arthrodesis is approximately 20° of radial abduction and 40° of palmar abduction. It can be accomplished by several surgical techniques. Leach described a technique that created a continuous slot between the trapezium and first metacarpal that was impacted with iliac crest bone graft with optional K-wire fixation [38]. Carroll described using a ball-and-socket approach to the TM joint with K-wire fixation [38]. Schroder used a 3 or 4 hole AO mini plate bent to 90° [39]. Newer implants such as locking plates and staples can also be considered.

The outcomes for TM arthrodesis have demonstrated mixed results when compared with other treatment options. Hartigan and Stern retrospectively reviewed 141 thumbs in 109 patients who were treated with TM arthrodesis or LRTI at an average of 69 months follow-up. They found no significant difference in subjective pain, function, or satisfaction between the 2 groups. The LRTI group had greater motion in regards to opposition, but the arthrodesis group had stronger lateral and chuck pinch. However, the arthrodesis group had a higher incidence of complications with nonunion accounting for the majority [40]. Similarly, Taylor compared outcomes in 83 thumbs undergoing TM arthrodesis, trapeziectomy with or without ligament reconstruction, and silastic trapezial replacement. The authors found no difference in clinical outcomes between the groups. However, the arthrodesis group had a higher complication rate than either of the other groups studied and a 19 % reoperation rate [41]. Finally, Raven compared arthrodesis with trapeziectomy with or without tendon interposition in 74 thumbs. The authors found no difference between the groups in strength or pain on palpation, but the arthrodesis group had a higher re-operation rate than the other 2 groups [42].

Implant arthroplasty

As outcomes have improved for large joint arthroplasty, surgeons have attempted to transition these concepts to small joints, such as the thumb CMC joint. Silastic trapezial, total TM and Artelon arthroplasties have all been used as treatment options for TM arthritis with varying degrees of success [43]. While early results of many implant options have been promising, long-term results for these devices continue to be plagued with complications.

In 1968, Swanson first described his silicone implant for arthritis of various joints in the hand, including the thumb CMC joint [44]. Lovell retrospectively studied 58 patients with Swanson silastic implants at an average of 5 years and found a failure rate of 13.8 % due to joint subluxation, stem fracture, pain, stiffness, and septic arthritis [45]. Similarly, Lanzetta studied 39 patients over 5 years treated with Swanson implants and found 31 % subluxation, 15 % fracture, and 56 % radiographic synovitis [46]. Based on a recent meta-analysis of CMC treatment options, Martou concluded that the high complication rate of thumb silastic implants outweighed any short term benefit [47].

In 1979, de la Caffiniere and Aucouturier first described the outcomes with their total TM prosthesis, but since that time, multiple implants have been evaluated [48]. In a long-term study of 77 patients treated with the de la Caffiniere prostheses, van Cappelle found a 20 % revision rate among primary prostheses, a 44 % implant loosening rate, and a 72 % survival rate at 16 years [49]. Wachtl followed 88 prostheses and found an unacceptable rate of loosening of 2 ball-and-socket arthroplasty designs. The de la Caffiniere

prosthesis had a 66.4 % survival rate at 68 months, while the Ledoux prosthesis had an even lower survival rate of 58.9 % at 16 months [50].

Unlike the total TM prostheses, the Artelon spacer is a T-shaped biodegradable insert that was developed to resurface the distal part of the trapezium and to stabilize the joint capsule by augmentation. While initial results were promising [51], many recent case reports have demonstrated foreign body reactions to the synthetic spacer [52–56]. Currently, the short-term rate of adverse events following Artelon arthroplasty appears high, and further study is necessary to determine its indications [57].

MP hyperextension deformity

MP joint hyperextension deformities occur to compensate for TM joint flexion. With attenuation of the volar beak ligament, the metacarpal base subluxates in a dorsoradial position, resulting in metacarpal flexion and adduction. The MP joint compensates with a hyperextension moment and IP joint flexion [58]. In a study of 60 thumbs undergoing trapeziectomy and ligament reconstruction, Moineau found MP hyperextension deformity to be present in 42 % of the patients. Postoperatively, the patients with hyperextension deformities were more likely to have poor subjective hand function, especially if the deformity was greater than 30° [59].

Numerous surgical options exist to treat MP hyperextension deformities, including temporary MP pinning, extensor pollicis brevis (EPB) tenotomy, sesamoid arthrodesis, PL free tendon graft, volar capsulodesis, and MP joint arthrodesis. Unfortunately, little evidence is available to determine comparative outcomes or specific indications for the various techniques [60]. Poulter evaluated the management of MP hyperextension deformity in 297 thumbs undergoing trapeziectomy. Eleven of 168 hyperextension deformities less than 30° and 20 of 28 deformities greater than 35° were treated operatively. Surgeons utilized temporary K-wire fixation, sesamoid fusion or tethering, volar capsulodesis, or MP joint fusion at their discretion. For MP deformities <30°, operative treatment did not affect outcome measures, including strength, pain, stiffness, or range of motion. For MP deformities ≥35°, surgical treatment improved the residual deformity. While clinical outcomes did not improve, this study was underpowered [61•].

Author's preferred treatment

The authors recommend initial nonoperative treatment for all patients. This includes activity modification, NSAIDs, splinting, and intra-articular corticosteroid injections. However, in our experience, corticosteroid injections are of limited value, especially in advanced cases. After failure of conservative treatment, operative intervention is considered. The specific procedure is dependent on multiple factors including patient age, activity level, occupation, and disease stage.

For patients with stage I or early stage II disease, volar ligament reconstruction, metacarpal extension osteotomy, and arthroscopy are considered. Volar ligament reconstruction is favored in ligamentously lax individuals. For patients with late stage II, stage III, or stage IV disease, reconstructive procedures are not indicated. Based on recent, high quality, level 1 evidence, we favor either simple trapeziectomy or LRTI in most cases. LRTI is preferred in patients with significant metacarpal flexion deformity, which can often be attributed to previous surgery, Z-deformity, and/or severe capsular laxity. In young laborers, we strongly consider TM arthrodesis. Based on the current literature, we do not think that TM joint arthroplasty is indicated due to an unacceptably high complication rate.

Pre-operatively, we assess all patients for MP hyperextension deformity. For patients with greater than 30° of MP hyperextension, we perform MP capsulodesis with a suture anchor. If patients have greater than 60° of hyperextension deformity and/or MP arthritis, we prefer MP arthrodesis in a position of slight flexion and pronation. Our relatively poor anecdotal outcomes with capsulodesis, have led us to consider arthrodesis more frequently in patients with a lesser degree of hyperextension.

Conclusion

TM arthritis is a common problem encountered in hand surgery. While the diagnosis is relatively straightforward, the treatment must be tailored to the individual patient based on age, activity level, occupation, and disease stage. Based on the current literature, trapeziectomy is the key component of any successful salvage procedure. However, its many modifications seem to have similarly good results.

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References

Papers of particular interest, published recently, have been highlighted as:
- • Of importance
- •• Of major importance

1. Armstrong AL, Hunter JB, Davis TR. The prevalence of degenerative arthritis of the base of the thumb in post-menopausal women. J Hand Surg Br. 1994;19:340–1.

2. Dahaghin S, Bierma-Zeinstra S, Ginai A, et al. Prevalence and pattern of radiographic hand osteoarthritis and association with pain and disability (the Rotterdam study). Ann Rheum Dis. 2005;64:682–7.
3. Eaton RG, Littler JW. Ligament reconstruction for the painful thumb carpometacarpal joint. J Bone Joint Surg Am. 1973;55:1655–66.
4. Glickel SZ. Clinical assessment of the thumb trapeziometacarpal joint. Hand Clin. 2001;17:185–95.
5. Kubik III NJ, Lubahn JD. Intrarater and interrater reliability of the Eaton classification of basal joint arthritis. J Hand Surg Am. 2002;27:882–5.
6. Dela Rosa TL, Vance MC, Stern PJ. Radiographic optimization of the Eaton classification. J Hand Surg Br. 2004;29:173–7.
7. Spaans AJ, van Laarhoven CM, Schuurman AH, van Minnen LP. Interobserver agreement of the Eaton-Littler classification system and treatment strategy of thumb carpometacarpal joint osteoarthritis. J Hand Surg Am. 2011;36:1467–70.
8. Day CS, Gelberman R, Patel AA, et al. Basal joint osteoarthritis of the thumb: a prospective trial of steroid injection and splinting. J Hand Surg Am. 2004;29:247–51.
9. 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.
10. Barron OA, Glickel SZ, Eaton RG. Basal joint arthritis of the thumb. J Am Acad Orthop Surg. 2000;8:314–23.
11. Pollard MA, Cermak MB, Buck WR, Williams DP. Accuracy of injection into the basal joint of the thumb. Am J Orthop. 2007;36:204–6.
12. Heyworth BE, Lee JH, Kim PD, et al. Hylan vs corticosteroid vs placebo for treatment of basal joint arthritis: a prospective, randomized, double-blinded clinical trial. J Hand Surg Am. 2008;33:40–8.
13. Eaton RG, Lane LB, Littler JW, Keyser JJ. Ligament reconstruction for the painful thumb carpometacarpal joint: a long-term assessment. J Hand Surg Am. 1984;9:692–9.
14. Lane LB, Henley DH. Ligament reconstruction of the painful, unstable, nonarthritic thumb carpometacarpal joint. J Hand Surg Am. 2001;26:686–91.
15. Pellegrini Jr VD, Parentis M, Judkins A, et al. Extension metacarpal osteotomy in the treatment of trapeziometacarpal osteoarthritis: a biomechanical study. J Hand Surg Am. 1996;21:16–23.
16. Shrivastava N, Koff MF, Abbot AE, et al. Simulated extension osteotomy of the thumb metacarpal reduces carpometacarpal joint laxity in lateral pinch. J Hand Surg Am. 2003;28:733–8.
17. Tomaino MM. Treatment of Eaton stage I trapeziometacarpal disease with thumb metacarpal extension osteotomy. J Hand Surg Am. 2000;25:1100–6.
18. Hobby JL, Lyall HA, Meggitt BF. First metacarpal osteotomy for trapeziometacarpal osteoarthritis. J Bone Joint Surg Br. 1998;80:508–12.
19. Furia JP. Arthroscopic debridement and synovectomy for treating basal joint arthritis. Arthroscopy. 2010;26:34–40.
20. Gervis WH. Excision of the trapezium for osteoarthritis of the trapezio-metacarpal joint. J Bone Joint Surg Br. 1949;31B:537–9. illust.
21. Gervis WH, Wells T. A review of excision of the trapezium for osteoarthritis of the trapezio-metacarpal joint after twenty-five years. J Bone Joint Surg Br. 1973;55:56–7.
22. Dhar S, Gray IC, Jones WA, Beddor FH. Simple excision of the trapezium for osteoarthritis of the carpometacarpal joint of the thumb. J Hand Surg Br. 1994;19:485–8.
23. Kuhns CA, Emerson ET, Meals RA. Hematoma and distraction arthroplasty for thumb basal joint osteoarthritis: a prospective, single-surgeon study including outcomes measures. J Hand Surg Am. 2003;28:381–9.
24. Gray KV, Meals RA. Hematoma and distraction arthroplasty for thumb basal joint osteoarthritis: minimum 6.5-year follow-up evaluation. J Hand Surg Am. 2007;32:23–9.
25. Kaarela O, Raatikainen T. Abductor pollicis longus tendon interposition arthroplasty for carpometacarpal osteoarthritis of the thumb. J Hand Surg Am. 1999;24:469–75.
26. Froimson AI. Tendon interposition arthroplasty of carpometacarpal joint of the thumb. Hand Clin. 1987;3:489–505.
27. Burton RI, Pellegrini Jr VD. Surgical management of basal joint arthritis of the thumb. Part II. Ligament reconstruction with tendon interposition arthroplasty. J Hand Surg Am. 1986;11:324–32.
28. Tomaino MM, Pellegrini Jr 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;77:346–55.
29. • Wolf JM, Delaronde S. Current trends in nonoperative and operative treatment of trapeziometacarpal osteoarthritis: a survey of US hand surgeons. J Hand Surg Am. 2012;37:77–82. *This 2012 study surveyed members of the American Society for Surgery of the Hand (ASSH) to determine what procedures are used in different common clinical scenerios. This article shows that corticosteroid injections are commonly used as conservative treatment of CMC arthritis. Further, trapeziectomy with LRTI is the preferred procedure for patients with Eaton Stage III CMC arthritis*.
30. Kadiyala RK, Gelberman RH, Kwon B. Radiographic assessment of the trapezial space before and after ligament reconstruction and tendon interposition arthroplasty. J Hand Surg Br. 1996;21:177–81.
31. Thompson JS. Complications and salvage of trapeziometacarpal arthroplasties. Instr Course Lect. 1989;38:3–13.
32. Soejima O, Hanamura T, Kikuta T, et al. Suspensionplasty with the abductor pollicis longus tendon for osteoarthritis in the carpometacarpal joint of the thumb. J Hand Surg Am. 2006;31:425–8.
33. Davis TR, Brady O, Barton NJ, et al. Trapeziectomy alone, with tendon interposition or with ligament reconstruction? J Hand Surg Br. 1997;22:689–94.
34. Downing ND, Davis TR. Trapezial space height after trapeziectomy: mechanism of formation and benefits. J Hand Surg Am. 2001;26:862–8.
35. •• Gangopadhyay S, McKenna H, Burke FD, Davis TR. Five- to 18-year follow-up for treatment of trapeziometacarpal osteoarthritis: a prospective comparison of excision, tendon interposition, and ligament reconstruction and tendon interposition. J Hand Surg Am. 2012;37:411–7. *This level I 2012 article is a randomized controlled study comparing outcomes in patients treated with simple trapeziectomy, trapeziectomy with PL interposition, and LRTI. At a minimum of 5 years, there were no difference in subjective and objective outcomes of thumb pain, function, and strength. This article's significance is that trapeziectomy with PL interposition and LRTI do not offer any benefit over simple trapeziectomy.*
36. •• Salem H, Davis TR. Six year outcome excision of the trapezium for trapeziometacarpal joint osteoarthritis: is it improved by ligament reconstruction and temporary Kirschner wire insertion? J Hand Surg Eur Vol. 2012;37:211–9. *This 2012 article is a randomized prospective study comparing simple trapeziectomy with LRTI with temporary K-wire stabilization. At an average of 6. 2 years, the study found not significant differences between the groups in any objective or subjective outcome measure. This article demonstrates no significant value of LRTI with K-wire stabilization*.
37. Wajon A, Carr E, Edmunds I, Ada L. Surgery for thumb (trapeziometacarpal joint) osteoarthritis. Cochrane Database Syst Rev. 2009;4:CD004631.
38. Carroll RE, Hill NA. Arthrodesis of the carpo-metacarpal joint of the thumb. J Bone Joint Surg Br. 1973;55:292–4.
39. Schroder J, Kerkhoffs GM, Voerman HJ, Marti RK. Surgical treatment of basal joint disease of the thumb: comparison between resection-interposition arthroplasty and trapezio-metacarpal arthrodesis. Arch Orthop Trauma Surg. 2002;122:35–8.

40. Hartigan BJ, Stern PJ, Kiefhaber TR. Thumb carpometacarpal osteoarthritis: arthrodesis compared with ligament reconstruction and tendon interposition. J Bone Joint Surg Am. 2001;83–A:1470–8.
41. Taylor EJ, Desari K, D'Arcy JC, Bonnici AV. A comparison of fusion, trapeziectomy and silastic replacement for the treatment of osteoarthritis of the trapeziometacarpal joint. J Hand Surg Br. 2005;30:45–9.
42. Raven EE, Kerkhoffs GM, Rutten S, et al. 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;31:547–54.
43. Vermeulen GM, Slijper H, Feitz R, et al. Surgical management of primary thumb carpometacarpal osteoarthritis: a systematic review. J Hand Surg Am. 2011;36:157–69.
44. Swanson AB. Silicone rubber implants for replacement of arthritis or destroyed joints in the hand. Surg Clin North Am. 1968;48:1113–27.
45. Lovell ME, Nuttall D, Trail IA, et al. A patient-reported comparison of trapeziectomy with Swanson Silastic implant or sling ligament reconstruction. J Hand Surg Br. 1999;24:453–5.
46. Lanzetta M, Foucher G. A comparison of different surgical techniques in treating degenerative arthrosis of the carpometacarpal joint of the thumb. A retrospective study of 98 cases. J Hand Surg Br. 1995;20:105–10.
47. Martou G, Veltri K, Thoma A. Surgical treatment of osteoarthritis of the carpometacarpal joint of the thumb: a systematic review. Plast Reconstr Surg. 2004;114:421–32.
48. Badia A, Sambandam SN. Total joint arthroplasty in the treatment of advanced stages of thumb carpometacarpal joint osteoarthritis. J Hand Surg Am. 2006;31:1605–14.
49. van Cappelle HG, Elzenga P, van Horn JR. Long-term results and loosening analysis of de la Caffiniere replacements of the trapeziometacarpal joint. J Hand Surg Am. 1999;24:476–82.
50. Wachtl SW, Guggenheim PR, Sennwald GR. Cemented and noncemented replacements of the trapeziometacarpal joint. J Bone Joint Surg Br. 1998;80:121–5.
51. Nilsson A, Liljensten E, Bergstrom C, Sollerman C. Results from a degradable TMC joint Spacer (Artelon) compared with tendon arthroplasty. J Hand Surg Am. 2005;30:380–9.
52. Birman MV, Strauch RJ. Update on nonautogenous interposition arthroplasty for thumb basilar joint arthritis. J Hand Surg Am. 2011;36:2056–9.
53. Choung EW, Tan V. Foreign-body reaction to the Artelon CMC joint spacer: case report. J Hand Surg Am. 2008;33:1617–20.
54. Robinson PM, Muir LT. Foreign body reaction associated with Artelon: report of 3 cases. J Hand Surg Am. 2011;36:116–20.
55. Giuffrida AY, Gyuricza C, Perino G, Weiland AJ. Foreign body reaction to artelon spacer: case report. J Hand Surg Am. 2009;34:1388–92.
56. Diao E. Foreign-body reaction to the Artelon CMC joint spacer. J Hand Surg Am. 2009;34:1158–9. author reply 1159–60.
57. Clarke S, Hagberg W, Kaufmann RA, et al. Complications with the use of Artelon in thumb CMC joint arthritis. Hand. 2011;6:282–6.
58. Brogan DM, Kakar S. Metacarpophalangeal joint hyperextension and the treatment of thumb basilar joint arthritis. J Hand Surg Am. 2012;37:837–8.
59. Moineau G, Richou J, Liot M, Le Nen D. Prognostic factors for the recovery of hand function following trapeziectomy with ligamentoplasty stabilisation. Orthop Traumatol Surg Res. 2009;95:352–8.
60. Klinefelter R. Metacarpophalangeal hyperextension deformity associated with trapezial-metacarpal arthritis. J Hand Surg Am. 2011;36:2041–2. quiz 2043.
61. • Poulter RJ, Davis TR. Management of hyperextension of the metacarpophalangeal joint in association with trapeziometacarpal joint osteoarthritis. J Hand Surg Eur Vol. 2011;36:280–4. *This 2011 article studies the management of thumb MCP joint hyperextension deformity associated with CMC reconstruction. This study found that outcomes for MCP deformities less than to 30° did not improve with surgical stabilization. The few thumb MCP deformities greater than 35° treated with correction showed correction of deformity at 1 year but the clinical improvement was not significant.*