



Contents lists available at ScienceDirect

Journal of Hand Surgery Global Online

journal homepage: www.JHSGO.org

Original Research

Selective Thumb Carpometacarpal Joint Denervation for Painful Arthritis: Follow-Up of Long-Term Clinical Outcomes

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ARTICLE INFO

Article history:

Received for publication December 29, 2021

Accepted in revised form February 7, 2022

Available online March 31, 2022

Key words:

Joint denervation

Thumb CMC osteoarthritis

Purpose: Thumb carpometacarpal (CMC) joint osteoarthritis is a common problem affecting up to 85% of patients over the age of 70. The most common presenting symptom for patients with CMC arthritis is pain with joint loading. Loss of function due to subluxation or joint destruction is comparatively rare. Carpometacarpal joint denervation is a relatively novel method for managing CMC arthritis, treating the most impactful symptom: pain.

Methods: In this paper, we present a 4- to 6-year follow-up case series on patients who underwent CMC denervation between 2015 and 2017.

Results: Denervation was safe, with less downtime than trapeziectomy with ligament reconstruction with tendon interposition and provided durable complete or partial relief of pain after 5 years in 5 of 9 patients. Four of 9 patients had recurrence of pain by 5 years. Of those with recurrent pain, 3 of 5 eventually underwent trapeziectomy with ligament reconstruction and tendon interposition; the secondary surgery occurred between 17 and 66 months after denervation.

Conclusion: Thumb CMC denervation provides effective relief of arthritis pain that was durable at 5+ years after surgery in more than half of our initial cohort of patients treated. Prospective studies with validated patient-reported and objective outcome measures between distinct treatment arms, such as denervation versus ligament reconstruction with tendon interposition, are needed to firmly establish the role of CMC denervation for patients with symptomatic thumb CMC osteoarthritis.

Type of study/level of evidence: Therapeutic/Level IV.

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With its unique osteoanatomy and complex ligamentous stabilizers, the thumb carpometacarpal joint (CMC) is particularly important in hand function. Thumb CMC osteoarthritis (OA) is an extremely common problem, with an estimated prevalence of approximately 15% in patients over the age of 30 and 85% in patients aged 71 to 80.^{1,2} Subjected to enormous repetitive loads with daily activity, the thumb CMC is the second most common joint in the hand to suffer from OA. Diagnosis is based on a combination of patient-reported symptoms, physical examination, and radiographic evidence.

Early CMC arthritis can often be managed with activity modification, orthosis fabrication, and/or steroid injection. Many patients with CMC arthritis will go on to develop recalcitrant pain,

however, with poor or increasingly shorter responses to steroid injection. Patient pain and symptoms typically guide management, as there is a poor concordance of patient symptoms to radiographic staging.¹ There are a spectrum of surgical options for patients with CMC arthritis, including CMC arthroscopy with debridement, trapeziectomy with or without ligament reconstruction and tendon interposition, trapeziectomy with implant suspensionplasty, arthrodesis, and implant arthroplasty.^{3–5} While these procedures are associated with improvements in pain and functional outcomes, there is a substantial risk of postoperative complications, such as tendon rupture; loosening, extrusion, or failure of protheses; and worsening carpal instability. A review of the literature shows that rates of adverse outcomes or postoperative complications can be as high as 22%.⁵ Furthermore, even without significant complications, patients face a prolonged period of immobilization and recovery that can result in a delayed return to work and difficulty with activities of daily living.⁶ With an aging population, there is likely to be an increase in the prevalence of thumb CMC OA, with increasing health care expenditures for surgical interventions in

Declaration of interests: No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

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<https://doi.org/10.1016/j.jhsg.2022.02.005>

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Table
Summary of Patient Characteristics and Outcomes

Patient	Age at Time of Surgery, y	Gender	Eaton-Littler Stage	Duration of Follow-Up, Months	Subjective Resolution of Pain After Denervation	Duration of Time Between Denervation Procedure and Pain Recurrence, mo	Additional Notes
1	46	F	3	Lost to follow-up			Last follow-up: 25.7 mo postoperatively
2	46	F	2	77.8	Partial	6	Reports some pain in right CMC, diagnosed with rheumatoid arthritis 18 mo after original denervation procedure
3	71	F	4	Lost to follow-up			
4	63	M	2	75.3	Complete		
5	59	F	2	20.9	No	16.5	Underwent LRTI due to recurrence of pain
6	65	M	4	67.4	No	55.9	Underwent LRTI due to recurrence of pain
7	69	M	3	65.9	Complete		
8	46	F	2	63.9	Complete		
9	74	F	2	Lost to follow-up			
10	50	F	4	61.8	No	1	Reports considering LRTI for future management
11	59	F	3	54.8	No	34.6	Underwent LRTI due to recurrence of pain
12	57	F	4	58.9	Complete		

CMC, Carpometacarpal; LRTI, ligament reconstruction and tendon interposition.

symptomatic patients. Previous work examining Medicare spending on surgical interventions for CMC arthritis from 2001 to 2010 showed that the average total costs of ligament reconstruction and tendon interposition (LRTI) and CMC joint arthrodesis or joint prosthetic arthroplasty performed in hospital outpatient settings are \$4,186 and \$3,412, respectively.⁷ In providing patients with options for intervention, the hand surgeon must balance the need for symptom control with the risk of postoperative complications and with costs.

Previous work from our group examined the use of selective denervation of the thumb CMC as a safe, effective, and novel option for patients with CMC osteoarthritis.⁸ First described in 1991, thumb CMC denervation has reported success rates in the literature ranging from 35% to 87% in patients with symptomatic osteoarthritis.^{9–11} Cadaveric dissections have shown sensory contributions from branches of the lateral antebrachial cutaneous nerve, palmar cutaneous branch of the median nerve, and radial sensory nerve to the CMC joint, rendering these 3 nerves as valuable potential targets for selective denervation of this area.^{8,12,13} A previous case series published by our group examined the postoperative outcomes of 12 patients with symptomatic thumb CMC OA who underwent denervation procedures. In this current study, we report the longer-term functional outcomes of this initial group of patients over 5 to 7 years.⁸ We hypothesize that selective denervation is a safe and effective approach to treat pain and alleviate impairment associated with CMC arthritis, and offers patients a viable surgical alternative.

Materials and Methods

After obtaining institutional review board (Johns Hopkins School of Medicine) approval, we performed a retrospective chart review to identify the 12 patients with symptomatic thumb CMC arthritis who underwent selective denervation by the senior author (S.D.L.) between April 2015 and January 2017. We then conducted in-person and/or phone interviews with these patients to assess their long-term clinical outcomes at 3-week, 6-month, 1-year, 2-year, and 5-year time points. The diagnosis of CMC arthritis was initially made clinically with radiographic staging using the Eaton criteria.¹⁴ All patients who underwent denervation were deemed to

be appropriate surgical candidates by the senior author (S.D.L.) and were offered the alternative of trapeziectomy with ligament reconstruction tendon interposition. Patient characteristics and demographics are summarized in the [Table](#).

The surgical technique has been previously described.⁸ The thumb CMC joint is accessed through a single Wagner incision at the junction of the glabrous and nonglabrous skin overlying the joint, extending toward the distal wrist crease. Dissection is carried down to the thenar muscle fascia. The plane overlying the fascia is first developed dorsal-ularly to the level of the second metacarpal, from the thumb metacarpal base distally to the level of the distal radius proximally. Branches of the distal superficial radial nerve are carefully identified. Next, the anatomic snuffbox deep to the first compartment is explored to identify distal articular branches from the lateral antebrachial cutaneous nerve, all the while carefully protecting the radial artery and venae comitantes. Then, after incision of the proximal thenar muscle fascia and division of the proximal muscle fibers, articular branches from the palmar cutaneous branch of the median nerve are identified. Each articular branch is anesthetized with intraepineurial 1% lidocaine with epinephrine, cauterized with bipolar cautery, resected, and sent to pathology for confirmation. The thenar muscle fascia is closed, hemostasis is ensured after tourniquet release, and the skin is closed. The patient is then placed in a bulky thumb spica dressing for 3 days postoperatively, which is then removed by the patient at home. The first postoperative follow-up visit is 5 to 12 days after surgery, after which the patient is allowed to participate in hand therapy and use their hand in their activities of daily living. The patient is counseled to slowly increase activity over the next 3 weeks. The next postoperative follow-ups are generally at 6 weeks and 3 months.

Outcomes of interest included postoperative assessments of subjective pain resolution (complete, near-complete, partial, or none), Kapandji scores of CMC mobility, and the presence or absence of postoperative hypoesthesia, paresthesia, and neuropathic pain. The statistical analysis was performed using Stata. Descriptive statistics included means and standard deviations for continuous variables and percentages for categorical variables. An analysis for associations between Eaton-Littler scores and long-term recurrence of pain after CMC denervation was performed using the Freeman-Halton extension of Fisher exact test.¹⁵

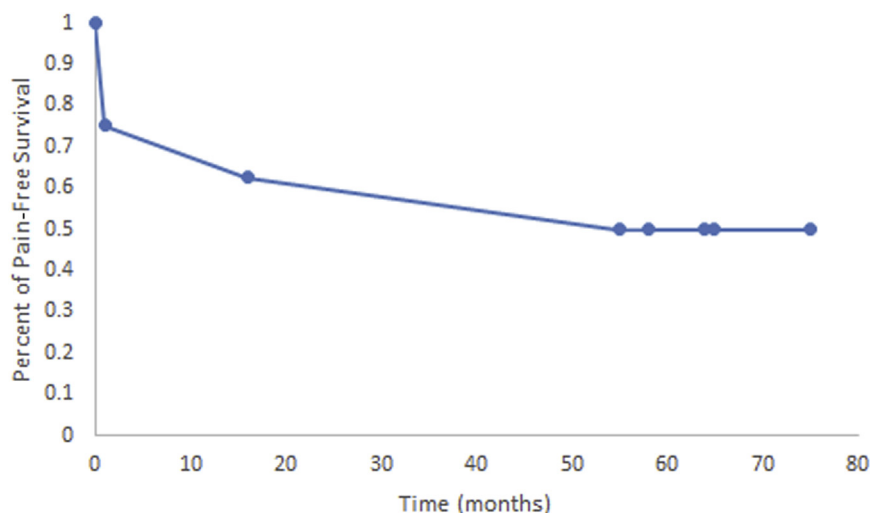


Figure 1. Long-term postoperative pain-free survival curve after CMC denervation.

Results

Of the original 12-patient cohort, 3 patients underwent in-person interviews, 6 were interviewed over the phone, and 3 patients were lost to follow-up. The mean age at the time of surgery was 59 years (range, 46–74 years). All patients demonstrated radiographic evidence of thumb CMC arthritis, ranging from Eaton stage 2 to stage 4. Nine were female. The average follow-up time was 60.7 months, with a range of 20.9 to 77.8 months. There was no clear relationship between initial Eaton-Littler staging with recurrence of pain at the end of the study period ($P = 1$).

Three patients underwent eventual CMC arthroplasty with LRTI at 17.5, 52, and 66.6 months after original CMC denervation for recurrence of pain. These patients who underwent secondary LRTI after denervation reported their recurrence of pain at 16.5, 34.6, and 55.9 months after their initial denervation procedure.

For the remaining 6 patients who did not undergo secondary LRTI, 2 also reported recurrence of pain. One patient stated that she has no pain at rest or with her activities of daily living. Two patients (patients #10 and #2) reported eventual recurrence of pain about 1 and 6 months after denervation, respectively. Patient #2 had bilateral CMC arthritis and underwent a right CMC denervation. She reported a return of mild to moderate pain in the operated thumb, although this pain was reportedly less than that in the contralateral, untreated thumb. Patient #10 rated her pain as severe and expressed interest in pursuing an LRTI in the near future for management of symptoms.

We found that the majority of patients who reported good pain relief up to 1 year after follow-up went on to continue to have minimal to no pain at the end of the study investigation period, 5 to 7 years after surgery.

Three patients were available for in-person follow-up (patient #4, #7, and #12). All 3 of these patients reported no pain at rest or with activities of daily living. All 3 patients were able to touch their thumb tip to the volar small finger metacarpal joint, which is equivalent to a score of 10 out of 10 on the Kapandji scale of thumb CMC mobility.¹⁶

Figure 1 shows the long-term postoperative pain-free survival curve after CMC denervation. Patients who underwent LRTI during this time period were categorized as having no resolution of pain. In this patient cohort, we did not have any patients experience significant postoperative complications, such as surgical site infection, wound healing issues, paresthesia, swelling, new-onset neuropathic pain, or scarring after their denervation.

Discussion

The purpose of this study was to evaluate the long-term follow-up of patients who underwent selective denervation as a treatment for thumb CMC arthritis. Of the patients included in this cohort, about half reported continued complete resolution of their pain with no postoperative numbness.

Within our small patient population, we found no clear relationship between a patient's preoperative Eaton-Littler Classification and long-term pain resolution after CMC denervation (Fig. 2). First described in 1973, the Eaton-Littler Classification of thumb arthrosis describes 4 progressive radiographic stages of CMC arthritis.^{17,18} Stage IV of arthritis was later modified to include scaphotrapezial arthritis. Multiple studies have shown poor to moderate interobserver reliability and fair to moderate intra-observer reliability with regards to this classification system.^{19–22} Furthermore, the Eaton-Littler stage of CMC arthrosis does not seem to correlate with the severity of clinical symptoms (namely pain), which is often the impetus for patients to eventually seek operative intervention for CMC OA.^{2,23} In our cohort, we had 3 patients with stage IV arthrosis preoperatively. Of these 3 patients, 1 experienced complete resolution of pain, 1 experienced no resolution, and 1 eventually underwent LRTI 66.6 months after initial CMC denervation due to return of his pain. Four patients with stage II arthrosis preoperatively also had varying long-term outcomes: 2 reported complete resolution of pain, 1 reported partial resolution, and 1 underwent LRTI 17.5 months after denervation. Our findings indicate that the Eaton-Littler Classification may not be a useful metric for determining which patients will experience long-term pain relief after CMC denervation.

A meaningful portion of patients who underwent denervation had durable relief of pain at the study endpoint. An important clinical question is trying to preoperatively predict which patients will have good results with denervation. This study did not identify preoperative characteristics that would predict success. There are several possible mechanisms for recurrence. Some anatomic papers have identified ulnar innervation of the CMC joint; it is possible patients with this anatomic variant get less complete joint denervation and are more prone to recurrence of pain.²⁴ It is also possible that joint reinnervation is occurring from the cut nerve endings reconnecting with their original target receptors.

The anterior and posterior interosseous nerves supply innervation to the wrist capsule.^{25–27} Some surgeons perform anterior and posterior interosseous nerve denervation as a standard part of

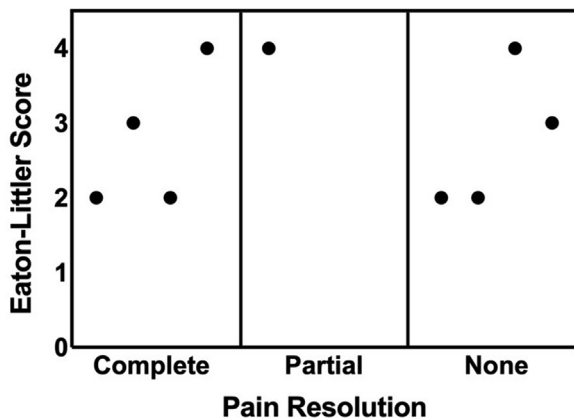


Figure 2. Eaton-Littler Classification and long-term pain resolution after CMC denervation.

CMC denervation surgery. Although we did not perform anterior and posterior interosseous nerve denervations for the patients in this cohort, it is not clear which patients should also undergo this as part of initial thumb CMC denervation surgery, and more high-level studies are required to understand indications and outcomes.

There are a number of surgical options for CMC arthritis. The most common is trapeziectomy with or without LRTI. Both procedures are effective at treating symptoms and providing durable relief. Trapeziectomy alone has been equally effective in large, level 1, randomized control studies.²⁸ Other options for CMC arthritis include arthroscopic debridement, partial trapeziectomy, arthrodesis, and implant arthroplasty.²⁹ Arthrodesis greatly reduces overall thumb range of motion and may also lead to progression to pan-trapezial arthritis.²⁹ Implant arthroplasty is prone to early failure.⁴ All of the listed methods include substantial downtime with a delayed return to work and orthosis fabrication of around 6 weeks. Carpometacarpal joint denervation, in comparison, has minimal downtime.

While developing Charcot neuroarthropathy is rare in the upper extremity, there is a theoretical risk in the setting of loss of proprioceptive sensation to a joint, especially if the patient has other underlying comorbidities. However, none of our patients within the follow-up period went on to develop the signs and symptoms of a Charcot joint even up to 5 years after their initial denervation procedures. In this patient cohort, we did not have any patients experience significant postoperative complications, such as surgical site infection, wound healing issues, paresthesia, swelling, new-onset neuromatous pain, or scarring, after their denervation. This further establishes CMC denervation as a safe and well-tolerated procedure among this patient population.

There are several limitations to our study. This is a small case series with longer-term follow-up; however, there was loss to follow-up (25%) within the sample. Additionally, there are inconsistencies across patients in the pre- and postoperative data points that were measured and in how data were obtained. Furthermore, the outcomes of interest within the original study, namely resolution of pain and numbness, were not measured using validated patient-reported outcome measures. However, the limited results from this study show that many patients who underwent CMC denervation for symptomatic thumb CMC osteoarthritis still experienced near-complete or complete resolution of pain up to 5 years postoperatively with no notable patient-reported loss of functionality. Future prospective studies with validated patient-reported and objective outcome measures between distinct

treatment arms, such as denervation versus LRTI, are needed to firmly establish the role of CMC denervation for patients with symptomatic thumb CMC osteoarthritis.

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