EDITOR'S CHOICE

A Prospective Clinical Trial Comparing Denervation With Suspension Arthroplasty for Treatment of Carpometacarpal Arthritis of the Thumb

Joshua W. Hustedt, MD, MHS,* Sorka T. Deeyor, BS,* Clayton H. Hui, BSE,* Arjun Vohra, MD,* Aaron C. Llanes, MS,* Briana L. Silvestri, MS, PA*

Purpose Trapeziectomy with suspensionplasty is the most popular treatment for thumb carpometacarpal arthritis. However, carpometacarpal denervation has recently shown promise as an alternative treatment option. This study was designed to compare functional outcomes, pain reduction, and quality of life between denervation and suspension arthroplasty in patients treated for thumb carpometacarpal osteoarthritis.

Methods We conducted a prospective clinical trial between June 2020 and December 2021. Preoperative and postoperative evaluations were conducted on patients, including the evaluation of functional outcomes via the Michigan Hand Outcomes Questionnaire, pain with the visual analog score, quality of life with the EuroQol-5D, and the evaluation of time to return to function. Outcomes and complications were compared between patients undergoing denervation versus arthroplasty.

Results Forty-eight patients were included in the study, 34 of whom underwent denervation and 14 underwent suspension arthroplasty of the thumb carpometacarpal joint. Patients in the denervation group were younger, with an average age of 59 years compared with 67 years in the arthroplasty group. All other patient characteristics were similar. Pain reduction, functional outcomes, and quality of life scores showed equal improvement in both groups. Denervation patients had a reduced time to return to function (3.3 weeks vs 4.5 months in the arthroplasty group).

Conclusions Carpometacarpal denervation appears to provide similar short-term outcomes as suspension arthroplasty for the treatment of thumb carpometacarpal arthritis. Treatment with denervation may offer a quicker return to function. The long-term outcomes of denervation remain unknown. *(J Hand Surg Am. 2023;48(4):348–353. Copyright © 2023 by the American Society for Surgery of the Hand. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).)*

Type of study/level of evidence Therapeutic IV.

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*From the *Department of Orthopedic Surgery, The University of Arizona College of Medicine—Phoenix, Phoenix, AZ.*

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Corresponding author: Joshua W. Hustedt, MD, MHS, Department of Orthopedic Surgery, The University of Arizona College of Medicine—Phoenix, 755E McDowell Rd, Floor 2, Phoenix, AZ 85006; e-mail: joshua.hustedt@arizona.edu.

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Osteoarthritis of the thumb carpometacarpal (CMC) joint is a common problem that affects nearly 1 in 10 adults and 1 in 3 postmenopausal women.[1–3] Hand surgeons have developed multiple surgical techniques, including partial or complete trapeziectomy, extension osteotomy of the thumb metacarpal, small joint arthroscopy, implant arthroplasty, and multiple suspensionplasty techniques with ligament reconstruction, hematoma block, or suture suspension.[4–11] Each of the treatment options have individual risks and benefits and researchers continue to explore options that maximize the risk/benefit ratio for CMC joint treatment.[12]

Recent attention has been placed on the role of CMC denervation in the treatment of CMC arthritis.[13] CMC denervation identifies and transects the nerves serving the CMC joint, thereby providing pain relief. This technique has been shown to provide pain relief with minimal complications and a quick return to function without the need for postoperative immobilization.[14–22] Although CMC denervation appears promising, few studies have been conducted and most are small case series. Only 1 study has compared denervation with trapeziectomy.[16] This study found similar pain relief between the 2 procedures but an increased revision rate for denervation. However, the increased risk of revision with denervation was not seen in the smaller case series, calling into question the actual revision rate of CMC denervation cases.

This study was designed to compare CMC denervation with suture suspension arthroplasty in a single surgeon's practice. We sought to understand the functional outcomes, pain reduction, and quality of life improvements of these 2 procedures. We also sought to compare complications, revision rates, and the time to return to function. Our hypothesis, based on preexisting literature, was that CMC denervation would provide equivalent outcomes to suture suspension arthroplasty.

MATERIALS AND METHODS

Patient selection and study variables

This study was designed as a prospective comparative study of denervation versus arthroplasty. All procedures were performed by a single surgeon at an ambulatory surgery center. The study was designed as a "patient-choice" comparative study. We chose to do this as opposed to a randomized trial because we found that once patients were made aware of the denervation treatment option, many desired that option over arthroplasty due to the perception that denervation was less invasive. At the time of the study design, the only other comparative study examining denervation and arthroplasty for the treatment of CMC arthritis of the thumb was by Salibi et al.[16] Salibi et al[16] also chose a prospective comparative design after failing to successfully randomize patients to the arthroplasty arm. Although a randomized study design was preferred, we felt that there would be difficulty in recruiting patients, and therefore, elected to compromise with a prospective comparative study design.

Patients were enrolled in the study between June 2020 and December 2021. The inclusion criteria included a diagnosis of CMC arthritis as well as the failure of nonsurgical management with anti-inflammatories, bracing, or corticosteroid injections. We elected to exclude patients with a concurrent diagnosis of peripheral neuropathy or cervical radiculopathy. Patients were offered the surgical option of a denervation or an arthroplasty with suture suspensionplasty; operative descriptions are provided in Appendix 1, available online on the *Journal*'s website at www.jhandsurg.org. Patient demographics, including age, sex, and Eaton-Littler osteoarthritis classification, were collected.

Study outcomes included monitoring of function determined by the Michigan Hand Outcomes Questionnaire (MHQ), pain as described on a visual analog scale (VAS), and quality of life determined by the EuroQol-5D (EQ-5D). These patient-reported outcome measures were collected before and after surgery. The primary outcome measure of the study was an improvement on the MHQ, with secondary outcome measures of VAS and EQ-5D.

Patients were also asked the following qualitative questions after surgery: (1) "Compared to before surgery, how is your hand pain currently?" and (2) "Compared to before surgery how well does your hand function?" Response options were "slightly worse," "about the same," "slightly better," or "much better." In addition, patients were asked the following questions after surgery: (1) "Do you have numbness around the incision site?" and (2) "Do you have any numbness over the distal thumb?" Response options were either "yes" or "no." Finally, patients were asked "How long after surgery did you return to full function?" and response options ranged from "never" or "worse" to several weeks.

A full surgical technique description for both the denervation and the suspension arthroplasty procedures is included in Appendix 1. A surgical technique video for the denervation procedure is also included in Appendix 2, available online on the *Journal*'s

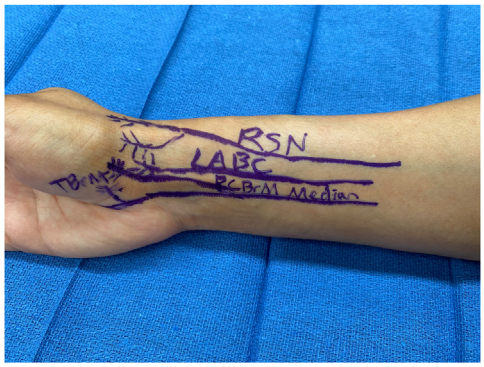

FIGURE 1: A clinical photograph depicting the branches to the CMC joint from the dorsal sensory branch of the radial nerve (RSN), the lateral antebrachial cutaneous nerve (LABC), the palmar cutaneous branch of the median nerve (PCBrM), and the thenar branch of the median nerve (TBrM).

website at www.jhandsurg.org. A clinical photo showing the branches of the nerves involved in the denervation procedure is shown in Figure 1.

Statistical analysis

The preoperative and postoperative mean scores for MHQ, VAS, and EQ-5D were first compared separately for denervation and arthroplasty patients to examine the effectiveness of the operative interventions. The success of the 2 operative approaches was then compared head-to-head against one another by calculating the average improvement on each of the standardized measures. Complications and revision rates were also compared between the 2 cohorts.

The qualitative questions were analyzed by comparing the proportion of patients reporting "much better" or "slightly better" to the proportion of patients reporting "about the same," "slightly worse," or "much worse." The proportion of patients reporting "yes" to numbness was also compared between the procedures. The reported time to return to full function was compared between the 2 groups.

This study was approved by our administration's institutional review board. Informed consent was obtained from each patient prior to inclusion in this study.

RESULTS

Forty-eight patients were included in the study, 34 of whom underwent a denervation procedure and 14 underwent suspension arthroplasty (Table 1). The denervation group was younger than the arthroplasty group (mean 59.4 years denervation vs mean 67.8 years arthroplasty). However, the 2 groups were similar in terms of sex (82% women in the denervation group vs 78% women arthroplasty group), Eaton-Littler stage of disease (69% stage III and 31% stage IV in the denervation group vs 73% stage III and 27% stage IV in the arthroplasty group), and average follow-up time (340 days in the denervation group vs 351 days in the arthroplasty group).

TABLE 1. Comparison of Patient Demographics in the Denervation and Arthroplasty Groups

Patient Demographic	Denervation, mean (SD)	Arthroplasty, mean (SD)
Age (y)	59.4 (11.9)	67.8 (11.1)
Sex, F	82%	78%
Eaton stage	3.3 (0.4)	3.4 (0.5)
Follow-up (d), mean (SD, range)	340 (106, 207−537)	351 (106, 223−691)

Patients treated with denervation showed improvements in all study outcomes (Table 2). MHQ improved from a preoperative score of 41.8 to 83.4 after surgery. VAS improved from a preoperative score of 6.8 to 1.8 after surgery. EQ-5D improved from a preoperative score of 0.52 to 0.82 after surgery. Most patients reported improvement in hand pain (91%) and function (79%). The most common postoperative complication was numbness around the incision site (experienced by 23% of patients) and numbness along the distal aspect of the thumb in the distribution of the dorsal sensory branch of the radial nerve (experienced by 11% of patients). No patients experienced postoperative infection. One patient in the denervation group initially reported good results; however, they sustained postoperative trauma to the thumb and reported increased pain. This patient was converted to a suspension arthroplasty at 24 weeks and reported a VAS pain reduction from 9 to 2 following revision via suspension arthroplasty.

Patients treated with suspension arthroplasty also demonstrated an improvement in clinical outcome scores (Table 3). MHQ improved from a preoperative score of 42.1 to 72.1 after surgery. VAS improved from a preoperative score of 6.9 to 2 after surgery. EQ-5D improved from a preoperative score of 0.44 to 0.82 after surgery. Most patients reported an improvement in hand pain (81%) and hand function (63%). Like the denervation group, the most common complication was peri-incisional numbness, observed in 18% of patients, and distal thumb numbness, observed in 36% of patients. No patients experienced

TABLE 2. Quantitative Outcomes of the Surgical Procedure in the Denervation Group

Patient-Reported Outcome Measure	Preoperative Denervation, Mean (SD)	Postoperative Denervation, Mean (SD)
MHQ	41.8 (21.7)	83.4 (13.6)
VAS	6.8 (2.1)	1.8 (1.8)
EQ-5D	0.52 (0.22)	0.82 (0.24)

TABLE 3. Quantitative Outcomes of the Surgical Procedure in the Arthroplasty Group

Patient-Reported Outcome Measure	Preoperative Arthroplasty, Mean (SD)	Postoperative Arthroplasty, Mean (SD)
MHQ	42.1 (17.7)	72.1 (20.7)
VAS	6.9 (2.5)	2.0 (2.0)
EQ-5D	0.44 (0.15)	0.82 (0.08)

postoperative infection. The average time to return to full function following suspension arthroplasty was 18.3 weeks. One patient in the arthroplasty group failed surgical management; they experienced subsidence of the metacarpal with impaction on the distal scaphoid and an increase in postoperative pain. This patient was offered a revision of the suspension arthroplasty. However, the patient declined the revision during the study period due to high rates of COVID-19 cases in our area and the perceived risk of a COVID infection.

Both procedures showed notable improvements in study outcomes (Table 4). Clinical outcome scores were similar between the denervation and suspension arthroplasty groups in terms of improvement in the MHQ scores (41.5 for the denervation group vs 30 for the arthroplasty group), VAS scores (−5.0 for the denervation group vs −4.9 for the arthroplasty group), and EQ-5D (0.29 for the denervation group vs 0.34 in the arthroplasty group). However, a larger proportion of patients experienced numbness over the distal aspect of the thumb in the distribution of the dorsal branch of the radial nerve in the suspension arthroplasty group (Table 5; 11% in the denervation group vs 36% in the arthroplasty group). Possibly of most importance, patients treated with denervation had a notably quicker return to full function (3.3 weeks in the denervation group versus 18.3 weeks in the arthroplasty group).

TABLE 4. Comparison of Quantitative Surgical Outcomes Between the Denervation and Arthroplasty Cohorts

Patient-Reported Outcome Measure	Change Denervation, Mean (SD)	Change Arthroplasty, Mean (SD)
MHQ	41.5 (26.2)	30.0 (32.6)
VAS	−5.0 (−2.7)	−4.9 (4.0)
EQ-5D	0.29 (0.30)	−0.34 (0.30)

TABLE 5. Comparison of Qualitative Outcomes of Surgical Procedures in the Denervation and Arthroplasty Groups*

Qualitative Outcome	Denervation, %	Arthroplasty, %
Improvement in Pain	91.2	81.8
Improvement in Function	79.4	63.6
Numbness at Incision	23.5	18.2
Numbness over Distal Thumb	11.8	36.4
Time to Recovery, mean (SD)	3.3 (4.4)	18.3 (6.5)

*Percentages represent patients who answered "yes" to the question.

DISCUSSION

Multiple surgical options exist for the treatment of CMC arthritis. Trapeziectomy with suspensionplasty remains a popular option, either with ligament reconstruction or suture suspension.[23] However, despite widespread use, suspensionplasty has not been shown to be superior to trapeziectomy alone or any other surgical option.[12] Denervation has been suggested as an alternative approach to treatment of the CMC joint due to its minimally invasive nature, decreased morbidity, and increased speed of recovery.[13] However, very few studies have examined the role of denervation in direct comparison with CMC suspension arthroplasty.[14–22]

This study found similar short-term surgical outcomes in patients treated with denervation and suspension arthroplasty. Both groups had improvements in MHQ function scores, reduction in VAS pain scores, and overall improvements in quality of life. Neither group had a major surgical complication. Patients treated with denervation experienced improvement in their symptoms in only 3 to 4 weeks, while arthroplasty patients required 4 to 5 months for

recovery. Patients treated with denervation also had a lower rate of postoperative paresthesia in the dorsal sensory branch of the radial nerve, likely due to reduced surgical dissection. The main finding of our study was the low need for revision in both the denervation and arthroplasty groups, with 1 revision in each group.

The findings of this study suggest that denervation may be an alternative treatment option to suspension arthroplasty. However, these findings do not necessarily imply the superiority of denervation. The data indicate that denervation may provide similar short-term outcomes as arthroplasty, with the added benefit of a quicker recovery time. However, these results have an extremely short-term follow-up. We chose to publish these results early to serve as a benchmark for future trials. However, some patients in this series have only 7 months of follow-up. The long-term outcome of denervation procedures remains unknown. Therefore, these initial results showing early benefits of denervation may be outweighed by long-term failures if many of these patients go on to failure in 4 to 5 years. This is particularly true in comparison with arthroplasty because the long-term benefit of arthroplasty has been well established.[24–26]

In addition, this study was a patient-choice trial. The nonrandomized structure of the trial raises concerns about selection and recall bias. Patients may have chosen a treatment option based on preconceived notions of perceived outcomes. This preconceived notion could have led to changes in patient-reported outcome scores. Furthermore, patients may be subject to recall bias. For example, a patient may report increased improvement at a later study point due to a perceived notion that denervation may be the newer, less invasive choice.

Finally, the outcome measures of this study were patient-reported. Patient-reported outcome scores provide important insight from the patient perspective but are subject to their own bias. Patient factors, such as central sensitization or pain sensitivity, can lead to different patient-reported outcomes.[27,28] Since this study was nonrandomized with a small sample size, there was a potential for patient reporting bias, with the possibility of some patients having a different preconceived perception of expected outcomes. Due to the very small sample size, we chose to report the outcomes of this study without statistical comparisons because the study was underpowered to make a statistical analysis. All these shortcomings could be addressed in a larger, randomized, noninferiority study comparing denervation with suspension arthroplasty. The results of the current study could provide insights into the design of such a future study.

Despite its limitations, our study offers important findings in relation to the current literature for denervation. Our results reveal that rapid reduction in pain are similar to those shown by other authors in small case series.[14–22] Notably, Tuffaha et al[14] and Ehrl et al[20] both showed improvement in pain and function with quick recovery in patients treated with denervation. However, questions remain, most notably those regarding the long-term rate of revision with denervation. Salibi et al[16] conducted the only other comparative study of denervation versus arthroplasty. They observed that 26% of denervation patients required revision to trapeziectomy. However, the cohort revision rates observed by Salibi et al[16] conflict with the observation of only 1 revision in 56 patients among 8 other case series summarized in a systematic review of denervation studies by Rezzadeh et al.[13] In addition, Ehrl et al[20] have shown the long-term potential of sustained pain relief with documentation of denervation outcomes lasting >2 years. Our study showed only 1 revision of 34 denervation procedures; however, this was with a short follow-up. The long-term revision rates with denervation remain unknown, and more studies need to establish the long-term revision rates for denervation compared with arthroplasty.

Some surgeons have expressed additional concerns over worsening of arthritis at the CMC joint with denervation as has been seen in animal models.[29] However, there are no clear studies that have been designed to examine this potential disadvantage of denervation. Another concern is the role of denervation in CMC arthritis that includes the scaphotrapezium-trapezoid joint. Outside of this trial, but in our own clinical experience, and from evidence supported by Tuffaha et al[14], patients with concurrent arthritic change at the scaphotrapezium-trapezoid joint may not experience the same pain reduction. This may be due to the scaphotrapezium-trapezoid joint being much deeper in the hand than the nerves addressed in a CMC denervation. In these cases, additional or partial volar denervation procedures may be necessary.[18]

These results, combined with other studies on denervation, offer supportive evidence that denervation may potentially offer similar pain control for patients with quicker recovery times. However, longer-term, randomized, noninferiority studies are needed to address the potential for bias in the evidence that currently exists on the use of denervation.

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