

Long-Term Outcome of Arthroscopic Resection Arthroplasty With or Without Interposition for Thumb Basal Joint Arthritis

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Purpose To report results on 144 cases following arthroscopic resection arthroplasty (ARA) with or without interposition for basal joint arthritis.

Methods Cases undergoing ARA for thumb carpometacarpal osteoarthritis between 2004 and 2011 were prospectively enrolled (n = 178). Data were collected before surgery and after surgery at 1, 3, 6, and 12 months and annually thereafter. Patients were excluded for less than 1-year follow-up or concomitant procedures that interfered with evaluation of the variable of interest (interposition). Human acellular dermal matrix (GRAFTJACKET) was the most commonly used interposition. Outcomes on 19 cases of interposition using collagen bioimplant (OrthADAPT) and porous polyurethaneurea (Artelon) scaffolds were also reported. Comparative analyses were performed on 52 patients with GRAFTJACKET interposition and on 73 without. Mean follow-up was 7.4 and 5.6 years with and without interposition, respectively. Descriptive statistics were evaluated on all baseline variables. Raw change scores of grip, pinch, and pain outcomes were evaluated. Confounding variables at a significance level of *P* less than .05 were adjusted for in linear mixed models, and an analysis of covariance was employed through an unstructured type of variance-covariance matrix.

Results Change scores from baseline to 1 year for the interposition group for pain (numerical rating scale, 0–10), pinch, and grip was –5.8, 3.3, and 7, respectively, and –5.1, 2.1, and 9 for the noninterposition group. Postoperative mean satisfaction was 4.7 and 4.4 for the with- and without-interposition groups, respectively. There were 4 failures with and 2 without interposition. Artelon and OrthADAPT did poorly with unacceptably high failure rates.

Conclusions This study suggested that interposition is not necessary following ARA for thumb basal joint arthritis. Because arthroscopic interposition of material contributes to health care costs in terms of patient and facility costs without clear benefit to the patient, routine use of expensive interposition products should be abandoned or carefully evaluated with a prospective randomized controlled trial. (*J Hand Surg Am.* 2015; ■(■): ■–■. Copyright © 2015 The Authors. Published by Elsevier Inc. on behalf of the American Society for Surgery of the Hand. 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.

Key words Arthroscopic resection arthroplasty, basal joint arthritis, carpometacarpal osteoarthritis, interposition, scaphotrapeziotrapezoid arthritis.

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ARTHROSCOPIC RESECTION ARTHROPLASTY (ARA) is an effective and well-established treatment option for basal joint arthritis. Nevertheless, all series have been small. Whereas some surgeons have chosen to use interposition,^{1–5} others have reported similar results without interposition.^{6–8} Outcomes with and without interposition appear comparable.⁹ The purpose of this study was to report the results on 144 cases following ARA for basal joint arthritis and to compare subjective and objective outcomes to determine differences between those who received interposition versus those who did not.

MATERIALS AND METHODS

Procedures were in accordance with the Helsinki Declaration of 1975 (2008 revision). All human protections for this study were institutional review board approved, and informed consent was obtained.

A total of 178 cases were prospectively enrolled and underwent ARA for thumb carpometacarpal (CMC) with or without scaphotrapeziotrapezoid (STT) osteoarthritis (OA) between 2004 and 2011. The outcome of 35 of these cases following ARA of pantrapezial arthritis was previously published.⁹ Patients were excluded from final analysis if they had less than 1-year follow-up ($n = 1$), had prior CMC surgery ($n = 6$), or underwent concomitant surgical procedures ($n = 26$) that would likely interfere with outcome assessment. Human acellular dermal matrix (GRAFTJACKET, Wright Medical, Memphis, TN) was the most commonly used interposition material. Because of unfavorable outcomes, the senior author (T.K.C.) no longer uses the synthetic fiber-based polyester scaffold (Artimplant Artelon CMC-I Spacer, Small Bone Innovations LLC, New York, NY) or the equine-derived type I collagen scaffold (OrthADAPT Bio-implant, Pegasus Biologics, Irvine, CA). Therefore, 6 Artelon and 13 OrthADAPT interposition cases were excluded from the primary comparative analysis for interposition. Nevertheless, outcomes of pain, satisfaction, pinch strength, complications, reoperations, and revisions for these 2 groups were reported. One patient was lost to follow-up. This left 125 cases for comparative analysis, 52 with human acellular dermal matrix interposition and 73 without. There were 21 (40%) patients with pantrapezial arthritis with interposition and 20 (27%) without. Both the CMC and the STT joints were resected in these 41 cases. The same surgeon using the same criteria selected both groups. The decision whether or not to use interposition was based solely on changes in practice over time by the senior author (T.K.C.). Initially, interposition was

used; however, over time the senior surgeon (T.K.C.) noted no perceived benefit to interposition; therefore, later patients underwent ARA without interposition.

Demographic information is shown in Table 1. Mean follow-up was 6.5 years (range, 4–10 y). Data were collected before surgery, at postoperative intervals of 1, 3, 6, and 12 months, and annually thereafter by an occupational hand therapist. Pinch and grip strength were measured as previously described,⁹ and pain (numerical rating scale, 0–10; 0 = no pain, 10 = worst imaginable pain) and satisfaction (0–5; 0 = not at all satisfied, 5 = completely satisfied) were recorded.

Statistical analysis

Descriptive statistics were evaluated on all baseline variables. Raw change scores of grip, pinch, and pain outcomes were evaluated. Confounding variables at a significance level of P less than .05 were adjusted for in linear mixed models, and an analysis of covariance was employed through an unstructured type of variance-covariance matrix.

Indications and decision making

Diagnosis of CMC and STT OA was based on patient history of pain at the base of the thumb, positive CMC compression test, pain with palpation over the CMC and STT joints, and positive radiographic findings of CMC and STT OA.

Diagnostic injections were occasionally used to help identify the pain contributions of CMC versus STT. Diagnostic injections were performed by first injecting the CMC with 1 mL of 1% lidocaine under fluoroscopic control. The amount of pain relief and strength improvement were assessed every 5 minutes until these plateaued, usually 10 to 15 minutes after the CMC injection. The STT was then injected under fluoroscopic control. The amount of pain relief and improvement in pinch and grip strength were again evaluated. Patients who demonstrated substantial benefit from both injections were considered candidates for pantrapezial ARA.

Patients who failed conservative treatment and had considerable disability were offered surgery. In the absence of clinical progression, patients for as long as tolerated continued conservative management, this included rest, splinting, nonsteroidal anti-inflammatory drugs, corticosteroid injections, and physiotherapy.

Arthroscopic staging

Accurate arthritis staging was obtained arthroscopically.^{4,10,11} Badia⁴ described stage 1 as intact CMC articular cartilage, stage 2 as partial loss of CMC articular cartilage, and stage 3 as widespread loss of

TABLE 1. Baseline Characteristics of Patients Who Underwent ARA of the Thumb CMC Joint

Demographic	CMC With Interposition (n = 52)	CMC Without Interposition (n = 73)	Total (n = 125)
Gender			
Male, n (%)	12 (23)	16 (22)	28 (22)
Female, n (%)	40 (77)	57 (78)	97 (78)
Age (y), mean (range)	59 (42–77)	52 (35–83)	60 (35–83)
Dominant side involved, n (%)	26 (50)	39 (53)	65 (52)
Workers' compensation cases, n (%)	15 (29)	6 (8)	21 (17)
Pain, mean (range)	7 (4–10)	6 (1–10)	6 (1–10)
Pinch (kg), mean (range)	4.1 (0–17)	5.1 (1–12)	4.6 (0–17)
Grip (kg), mean (range)	21 (0–46)	20 (0–47)	21 (0–47)

articular cartilage. We modified the classification by adding stage 4, widespread loss of articular cartilage of both the CMC and the STT joints. Many radiographic stage 2 patients were found to have widespread cartilage loss (arthroscopic stage 3) at the time of arthroscopy and underwent ARA.¹² Diagnostic arthroscopy of the STT joint was helpful in establishing which radiographic stage 3 cases were actually arthroscopic stage 4.

Surgical technique

All procedures were performed with the patient under general or regional anesthesia with or without a tourniquet. A tourniquet was not used if anesthetic with epinephrine was infiltrated before surgery, allowing for vasoconstriction.^{13,14} Patients who preferred general anesthesia were injected with approximately 30 mL of 0.25% bupivacaine (or 1% lidocaine) with epinephrine after onset of anesthesia.

After sterile preparation, a traction tower was used to apply 2 to 4 kg of finger-trap traction through the thumb. Routine arthroscopy was performed using a 1.9-, a 2.3-, or a 2.7-mm 30° arthroscope (Stryker, Kalamazoo, MI). Most resection arthroplasties were performed with a 2.7-mm arthroscope for a better field of view.

Through a small skin incision, a blunt hemostat was used to gently dissect through the soft tissue with a gentle circular motion while applying gentle pressure until the hemostat penetrated the capsule. The radial artery, superficial branches of the radial nerve, and extensor tendons were all at potential risk. These structures were protected through proper technique of blunt dissection.

Volar and dorsal portals were used. Our dorsal portal was the same as the previously described 1-U portal located just ulnar to the extensor pollicis brevis

tendon.¹⁵ The volar portal was placed between the 1-R portal described by Berger (just anterior to the abductor pollicis longus tendon)¹⁵ and the thenar portal described by Walsh et al.¹⁶ The STT arthroscopy was similarly performed using portals placed approximately 1 cm proximal to the CMC portals as previously described.⁹ The portals were localized with hypodermic needles that were confirmed to be parallel on fluoroscopy. An accessory dorsal portal (dorsal ulnar portal) was created when required to view the blind area over the lateral aspect of the CMC joint or portions of the STT joint. The dorsal ulnar portal was placed using an inside-out technique⁹ by placing a blunt probe through the volar portal across the CMC or STT joint and exiting the dorsum of the hand. A cannula was placed retrograde over the probe and inserted into the joint.

A 3.5-mm full-radius shaver was used to perform synovectomy and clean the joint of debris for better visualization. Loose bodies were removed. Radiofrequency ablation (SERFAS Energy RF Ablation System, Stryker, Kalamazoo, MI) was used to perform thermal capsulorrhaphy with the goal of intra-articular joint denervation of the superficial radial sensory branch, median motor branch, ulnar motor branch, palmar cutaneous branch, and lateral antebrachial cutaneous nerves.^{17–22} Using continuous outflow to prevent overheating, the capsule was ablated along the joint line circumferentially on both proximal and distal capsular attachments. A 3.0- or 4.0-mm barrel bur (Stryker, Kalamazoo, MI) was used to resect down to cancellous bone (2–3 mm) on the distal surface of the trapezium and the proximal surface of the first metacarpal. Any bone spurs between the first and the second metacarpals were removed to prevent possible impingement. The STT resection arthroplasty was performed similarly by removing 2 to 3 mm of bone from the distal surface of the scaphoid and from the

proximal surfaces of the trapezium and trapezoid. A 4.0-mm barrel bur was used preferentially in joints large enough to accept the larger size bur. Fluoroscopy was used to confirm complete resection.

The 2 methods previously described were used to secure the interposition material within the joint.⁹ For the interposition group, when both CMC and STT joints were resected, interposition was used in both joints.

The resected joint was infiltrated with additional anesthetic with epinephrine (if not contraindicated) to provide hemostasis and postoperative pain control. The total amount (including the portion used before surgery) was calculated based on the patient's weight and coordinated with the anesthetist.

Postoperative care

The portals were closed with adhesive strips. A well-padded thumb spica orthosis was applied with a compressive elastic bandage. Patients were instructed to come to the clinic for a postoperative pain block the first postoperative day if they were uncomfortable. Preoperative, intraoperative, or postoperative blocks were performed with 1% or 0.5% lidocaine with epinephrine (up to a maximum single dose of 7 mg/kg)¹³ or 0.25% bupivacaine with epinephrine (up to a maximum dose of 225 mg). Patients were scheduled to see a hand therapist about 5 to 7 days after surgery for application of a hand-based thermoplastic orthosis and instruction for a home program of gentle range of motion.

RESULTS

Outcomes for pain, pinch, and grip for the entire group were 0.3 (range, 0–1), 6.4 kg (range, 5–7), and 31 kg (range, 21–42). Changes in outcome from preoperative to final postoperative follow-up (minimum, 1 y) for pain, pinch, and grip scores for the with-interposition and without-interposition groups are shown in Table 2. Confounding variables including hand dominance, work type, workers' compensation, and preoperative duration significantly affected outcomes and were controlled for in the analyses between the with- versus the without-interposition groups. Hand dominance ($P = .03$) and heavy labor work type ($P = .05$) positively affected grip strength. Workers' compensation status negatively affected outcomes of grip ($P = .04$) and pinch strength ($P = .02$). Greater preoperative symptom length negatively affected grip strength ($P = .02$). Unadjusted (raw) pain, grip, and pinch scores at baseline and at each postoperative interval are shown in Figures 1, 2, and 3, respectively. Raw and adjusted data (corrected for confounding

variables) showed no difference when comparing with and without interposition in pain ($P = .86$), pinch ($P = .32$), and grip ($P = .51$). Mean final satisfaction was 4.7 (range, 1–5) and 4.4 (range, 1–5) for the with- and without-interposition groups, respectively. There were 4 failures in the with- and 2 in the without-interposition groups. Subgroups of with and without interposition for CMC and pantrapezial were evaluated in the linear mixed models for pain. No differences were found within the CMC ($P = .59$) or pantrapezial ($P = .35$) groups when comparing outcomes of pain for the with- and without-interposition groups.

Of the 6 patients in the Artelon group, 2 had remarkable pain and inflammation in the early postoperative period requiring steroid treatment. One patient underwent revision for persistent pain. Radiographic cystic change was also seen after surgery. At a mean final follow-up of 5.9 years (range, 3–8 y), 5 of the patients with surviving Artelon implants had mean pain and satisfaction scores of 1.0 (range, 0–3) and 4.5 (range, 3–5), respectively. Average pinch strength was 72% of the contralateral (nonsurgical) side at final follow-up.

Of the 13 cases receiving OrthADAPT interposition, revision surgery was required in 6 of the cases because of persistent pain. Four patients had graft extrusion. The surviving OrthADAPT patients had an average final follow-up of 8.3 years (range, 6–9 y). Mean final pain and satisfaction scores for this group were 0.6 (range, 0–3) and 4.6 (range, 3–5), respectively. Average pinch strength was 88% of the contralateral (nonsurgical) side at final follow-up. Cystic changes were seen in postoperative radiographs. Four patients had cortisone injections and 1 was given methylprednisolone; all but 1 were given within 3 months after surgery for pain and inflammation.

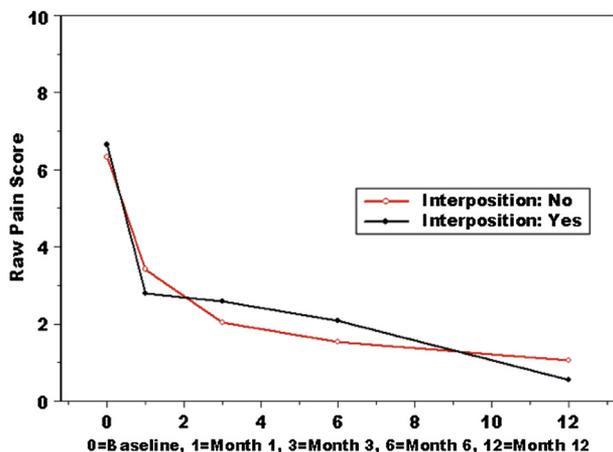
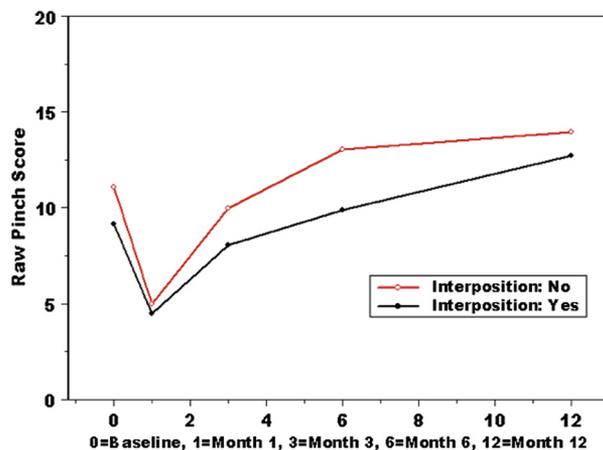
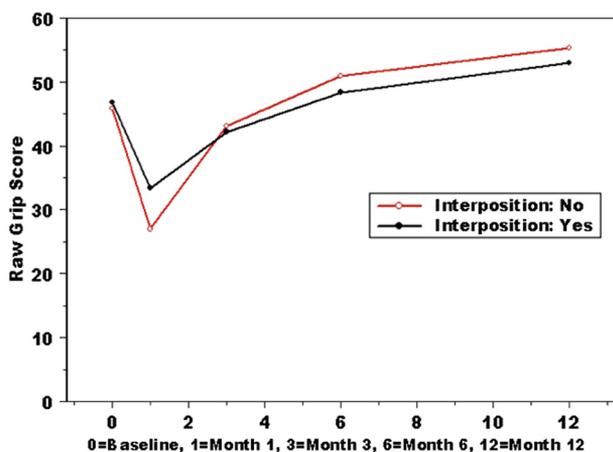
DISCUSSION

A number of biomaterials used for tissue augmentation have been used for interposition after resection arthroplasty of the thumb CMC joint. Biological scaffolds are protein-based extracellular matrices derived from human or animal tissue.²³ In our series, we used 2 biological scaffolds, GRAFTJACKET (acellular dermal matrix derived from tissue bank human skin) and OrthADAPT (derived from equine pericardium).

One limitation of these biological scaffolds is variations in biocompatibility that can cause an inflammatory response evidenced by postoperative pain, swelling, and cystic bony changes. OrthADAPT also demonstrated the unfavorable characteristic of not

TABLE 2. Mean Changes in Adjusted Pain, Pinch, and Grip Scores

Changes in Outcomes From Preoperative to Final Follow-Up (Minimum, 1 y)	With Interposition (n = 52)	Without Interposition (n = 73)	With Interposition vs Without Interposition	
	Mean (SD)	Mean (SD)	P Value	(95% Confidence Interval)
Change in pain (pre- to postoperative)	-6 (2.15)	-5 (2.24)	.86	(-1.0 to 1.3)
Change in pinch (kg)	1.5 (2.28)	1.0 (2.30)	.32	(-2.6 to 2.0)
Change in grip (kg)	3 (11.31)	4 (7.42)	.51	(-4.1 to 7.1)

**FIGURE 1:** Unadjusted raw pain scores measured at baseline and each postoperative follow-up interval for patients who received interposition versus those who did not.**FIGURE 3:** Unadjusted raw pinch scores measured at baseline and each postoperative follow-up interval for patients who received interposition versus those who did not.**FIGURE 2:** Unadjusted raw grip scores measured at baseline and each postoperative follow-up interval for patients who received interposition versus those who did not.

adhering to the host tissue, resulting in the graft being extruded. The material in GRAFTJACKET is processed to render it acellular, which may minimize inflammatory response.²⁴ Seven of the 13 patients receiving OrthADAPT in our series did well long term.

Artelon is a synthetic spacer made of a biodegradable polyurethane urea polymer. Two of our 6 patients receiving the Artelon CMC-I spacer had a noteworthy inflammatory response similar to previous reports.²⁵⁻³²

Controversy exists concerning interposition after ARA for basal joint arthritis.^{27,33} Interposition does offer theoretical advantages. Interposition may minimize metacarpal subsidence.^{34,35} The senior author (T.K.C.) has had 2 cases of spontaneous fusion of the resected CMC space (not part of this study) without interposition. Neither patient was happy with their result. This complication has not occurred to our knowledge in patients receiving interposition. We attempted to minimize the likelihood of this complication with early range of motion and judicious use of postoperative blocks. The senior author (T.K.C.) prefers the wide-awake type blocks performed in the clinic because patients are better able to participate in therapy immediately after the block and patients prefer wide-awake anesthesia to blocks by anesthesia providers.³⁶ Blocks were repeated as necessary. The incidence of chronic regional pain syndrome following surgical

treatment of thumb CMC degenerative joint disease has been reported to be as high as 19%.³⁷ In our series, the incidence of chronic regional pain syndrome was zero, which may have been attributable to the use of blocks with long-acting anesthetic. Breaking the pain cycle may prevent the progression of chronic regional pain syndrome.^{38,39}

The senior author (T.K.C.) prefers partial trapeziectomy to complete trapeziectomy because the former maintains thumb length and possibly better postoperative pinch strength.^{2,40–48} This is supported by 44% improved pinch strength in Cobb et al⁹ compared with 8%, 17%, and 33% reported by Tomaino et al,⁴⁴ Yang and Weiland,⁴⁹ and Kuhns et al,⁵⁰ respectively. The patients presented in this series had both sides of the joint resected, whereas previous authors resected only one side.^{1–8} If removal of the trapezium was responsible for the pain relief, then it stands to reason that removal of the distal arthritic surface (the proximal aspect of the first metacarpal) would provide additional pain relief. This reasoning is in contrast to those series performing arthroscopic debridement and synovectomy without ARA, although the series have been small and follow-up short.^{51–53}

We modified the original arthroscopic stages by adding stage 4 for STT OA or pantrapezial disease. Pantrapezial disease was previously considered a contraindication for ARA.^{2,7} Since this classification was proposed, ARA of the STT has been shown to be a successful option.⁹ Certainly, not all arthritic STT joints are symptomatic, and in some cases, radiographic evidence of arthritis is not clinically relevant. However, the senior author (T.K.C.) had several patients with previously asymptomatic STT OA (or with symptomatic STT OA that was not recognized) who underwent CMC procedures and subsequently became sufficiently symptomatic to request a procedure to treat the STT OA.

Placement of interposition material increases the operating time and expense.⁵⁴ At our institution, using GRAFTJACKET interposition adds an additional \$2,300 per case. Such cost is not warranted without a clear clinical benefit. A theoretical risk of disease transmission and infection also exists.

Given that there were no statistically significant differences in outcome when interposition is added, our results imply that perhaps the simpler procedure, no interposition, is the better choice. Similar findings have been found comparing simple trapeziectomy with interposition or ligament reconstruction procedures.^{42,55–59} Ligament reconstruction tendon interposition has 12% more adverse effects than simple trapeziectomy.⁶⁰ Despite the evidence, 68% of

respondents from an American Society for Surgery of the Hand survey indicated that their treatment of choice was open trapeziectomy with ligament reconstruction tendon interposition.⁶¹

One remaining question is whether ARA is superior to open treatment. The answer would require a prospective randomized controlled trial. Arthroscopic resection arthroplasty has the advantages of being minimally invasive, requiring no sutures, having short recovery time, and having low complication rates.⁹ The possible disadvantages of ARA include the need for additional surgical training by surgeons and a learning curve that can be discouraging. Although the surgical time is prolonged during the early phase of learning, once the skills are mastered, surgical time is shorter than that for open procedures, as experienced by the senior author (T.K.C.), owing to a simpler surgical exposure and closure (no sutures used) times.

Limitations of this study include comparison groups were not randomized and all forms of interposition were not evaluated. In addition, the surgeon performed noninterposition cases later in the study period, and therefore, these cases were not subjected to the initial learning curve. The later cases may have benefitted from greater surgical experience.

The Serfas ablater, which is currently used, is much more aggressive (rapid and complete tissue ablation) than the Oratek (Oratek Interventions, Inc., Menlo Park, CA) ablater, which was previously used. Therefore, the completeness of the neurectomy may have changed. The length of postoperative immobilization has gradually decreased from 3 to 4 weeks in 2004 to 5 days currently, which likely affected results. The volar portal we currently use was developed over time. In the early phase of this series, we utilized the 1-R as originally described. Finally, diagnostic injections have not been validated.

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