

Comparing Outcomes of Two Different Interposition Materials and Two Different Bone Anchors in Patients Who Have Undergone a Modified Carpometacarpal Resection Arthroplasty

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ABSTRACT

AIM: The goal of this study is to compare clinical outcomes in patients with carpometacarpal arthritis who have undergone a modified carpometacarpal resection interposition arthroplasty using two different interposition materials and two different bone anchors.

MATERIALS AND METHODS: We conducted a retrospective review of 58 patients between 23-87 years old with an Eaton-Littler Stage II, III, or IV carpometacarpal arthritis who had undergone modified carpometacarpal resection interposition arthroplasty using either acellular dermal collagen allograft or native flexor carpi

radialis tendon and received either the Stryker Sonic Anchor or Depuy Mitek Anchor. Preoperative and postoperative assessments were done using the Disability of the Arm, Shoulder, and Hand, Brief Pain Inventory Wong Baker FACES Pain Rating Scale and Numeric pain scale. Effect of anchor type and interposition material were statistically assessed.

RESULTS: A total of 46 patients with a 2 year follow up were included. Each anchor type showed significant clinical and statistical differences between preoperative and postoperative measurements of the assessment scales. However, no statistically significant differences were observed when assessing outcome variables between the bone anchor types or between interposition materials.

CONCLUSION: A modified carpometacarpal resection interposition arthroplasty using either acellular dermal collagen allograft or native flexor carpi radialis tendon with the use of a bone anchor is a viable option for the treatment of carpometacarpal arthritis.

Key words: Bone anchors; Arthroplasty; Carpometacarpal joint; Arthritis

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INTRODUCTION

Basal thumb arthritis, a type of osteoarthritis at the first carpometacarpal joint, is the second most common cause of arthritis in the hand. Laxity of the ligamentous structures surrounding the joint and lack of bony constraints contribute to the condition. It is a debilitating disease that results in severe pain, swelling, weakness, and decreased range of motion of the thumb. It more commonly affects postmenopausal women, affecting 11% of men and 33% of

women in their 50's and 60's^[1-2]. Conservative treatment includes joint protection with splinting or bracing, analgesics, steroid injections, and strengthening exercises of the thenar eminence. If these measures fail to improve late-stage symptoms of stiffness and pain at rest, there are various surgical options that may be considered.

Trapeziectomy with ligament reconstruction and tendon interposition is an established surgical treatment option for severe cases of basal thumb arthritis that have failed conservative treatment as it has been shown to help improve hand function, pinch and grip strength, and reduce overall pain levels^[2]. Bone anchors, recognized predominantly for application in the shoulder, can also be used in the hand, wrist, and joints of the lower extremity. The anchor allows rapid, efficient, and stable fixation of soft tissue to bone in order to expedite rehabilitation and recovery and increase subjective strength^[3]. The Stryker Sonic Anchor is a type of fixation anchor used for extremity repairs. It uses sonic energy to liquefy and integrate into the cancellous bone. The Depuy Mitek Anchor is a suture anchor that uses dual thread technology to attach to cancellous and cortical bone, resulting in maximum strength and fixation of joints without external fixation (i.e. K-wire). Few studies have examined the use of suture bone anchors that attach the native flexor carpi radialis tendon to the base of the first metacarpal after the tendon is passed through a bone tunnel. This study will compare clinical outcomes in patients who have undergone a modified carpometacarpal resection interposition arthroplasty using either acellular dermal collagen allograft or native flexor carpi radialis tendon and received either the Stryker Sonic Anchor or Depuy Mitek Anchor.

Anatomy and Classification

The first carpometacarpal joint is a diarthrodial saddle joint that allows motion in three planes: abduction and adduction, flexion and extension, and opposition allowing for performance of tasks that involve grip strength and active pinch with release^[4]. It is comprised of two major articulations, the trapeziometacarpal and scaphotrapezium articulations to the thumb, with several ligament stabilizers that play a role in thumb stability and motion. The anterior oblique (beak) ligament arises from the volar tubercle of the trapezium which inserts on the volar aspect of the thumb metacarpal and is crucial for function in assisting the thumb in movements of extension, pronation, and abduction^[5]. Bettinger et al^[6] and Edmunds^[7] report the dorsal radial ligament to be equally important as the anterior oblique ligament for joint stability. Repetitive tasks or activities that involve forceful gripping or fine pinching add significant stress to the carpometacarpal joint about its planes of motion and increase ligamentous stabilizer laxity leading to abnormal joint positioning and axial loading. The biochemical alterations in hyaline cartilage predisposes the joint to increased load stress and degenerative changes, leading to joint space narrowing, osteophytes, and eventual dorsal radial subluxation of the joint^[5,8]. Eventually, the altered biomechanics of the basal joint can lead to hyperextension of the metacarpophalangeal joint leading to further joint instability and pain. The Eaton staging system^[9] has been determined to be the most useful for clinical purposes and will be utilized for the remainder of the current paper.

MATERIALS AND METHODS

The study was conducted as a retrospective review of previously collected data. Following Institutional Review Board (IRB) approval, we identified 58 patients between 23-87 years old with

an Eaton-Littler Stage II, III, or IV carpometacarpal joint arthritis. Each patient underwent a modified carpometacarpal joint resection interposition arthroplasty using either FCR tendon or collagen allograft and received either the Stryker Sonic Anchor or Depuy Mitek Anchor.

The only criteria of exclusion for patients in this study was insufficient data collection (12 patients). All operations were performed by the same surgeon to minimize differences in surgical technique.

Surgical Technique

A 5.5 cm axial incision is made at the base of the thumb between the extensor pollicis longus and abductor pollicis longus tendons. The subcutaneous tissues are then divided, and the periosteum is reflected at the base of the trapeziometacarpal joint to expose the trapezium with a beaver blade. The trapezium is excised via morcellation with a bur, rongeur, and curette until all fragments are removed. The flexor carpi radialis tendon is then visualized, and an incision is made in the flexor carpi radialis tendon sheath. The incision mobilizes half of the tendon, which creates a flap (12 cm long) and maintains its insertion at the second metacarpal. An osseous tunnel is created at the base of the first metacarpal at an angle of 30 degrees going from medial to lateral. It is anchored on the lateral side of the first metacarpal by means of a bone anchor. The post-trapeziectomy space is filled with an acellular dermal collagen allograft or native flexor carpi radialis tendon and sealed with fibrin glue followed by closure of the capsule with 3-0 vicryl. The skin is closed with a single layer of 5-0 monocryl subcuticular sutures, reinforced with steri-strips, and the patient is placed in a thumb spica splint. Intraoperative X-Ray imaging is obtained to ensure adequate resection of the trapezium and confirm the radiographic position of the first metacarpal in line with the scaphoid.

Preoperative and postoperative assessments were performed at a minimum of 3-month follow-up period and included the Disability of the Arm, Shoulder, and Hand (DASH); Brief Pain Inventory (BPI), Wong Baker FACES Pain Rating Scale (WBFRS), and Numeric Pain Scale (NPS). Post-operative follow-up evaluations were taken from 3 months to 2 years post carpometacarpal repair. Post-operative data from each group were compared to assess differences in outcomes by anchor type and interposition material type.

RESULTS

A total of 46 patients and 46 extremities were included within the final analysis.

The Depuy Mitek Anchor was used in 16 patients between 2007-2019 and the Stryker Sonic Anchor was used in 30 patients between 2016-2020. Results are shown in Table 1.

Comparison of pre and post operative results for acellular dermal collagen allograft and native flexor carpi radialis allograft are shown in Table 2.

Comparison of average post-op results for acellular dermal collagen allograft and native flexor carpi radialis allograft combined with anchor type is shown in Table 3.

Function and Activity

Analyses of recorded data for the 46 patients used in this study showed significant clinical and statistical difference from preoperative to postoperative results for each anchor type used when evaluating return to activity. For both anchors, an

Table 1 Comparisons of pre and post-operative results. Depuy Mitek Anchor and Stryker Sonic Anchor.

	Depuy Mitek Anchor (n=16)					Stryker Sonic Anchor (n=30)				
	Preop	3 months	6 months	24 months	P-value	Preop	3 months	6 months	24 months	P-value
DASH	74	44	62	42	0.075	76	59	50	42	<0.001
BPI	43	22	38	16	0.064	49	30	25	13	<0.001
NPS	6	2	4	2	<0.001	6	3	3	0	<0.001
WBPS	3	2	2	1	<0.001	3	2	2	0	<0.001

Table 2 Comparisons of pre and post-operative results: Interposition material.

	Acellular Dermal Collagen Allograft (n=25)					Native Flexor Carpi Radialis (n=21)				
	Preop	3 months	6 months	24 months	p-value	Preop	3 months	6 months	24 months	p-value
DASH	79	55	54	47	<0.001	69	47	42	34	0.004
BPI	50	26	23	31	0.01	37	20	15	4	0.021
NPS	6	2	2	1	0.006	6	1	1	0	<0.001
WBPS	4	2	2	1	<0.001	2	1	1	0	0.052

Table 3 Comparisons of average post-operative results by anchor and interposition type.

	Acellular Dermal Collagen Allograft (n=25)	Native Flexor Carpi Radialis (n=21)	p-value	Depuy Mitek Anchor (n=16)	Stryker Sonic Anchor (n=30)	p-value
DASH	45	38	0.41	45	50	0.9
BPI	19	6	0.11	29	22	0.6
NPS	1	0	0.41	2	2	0.7
WBPS	0	0	0.99	2	1	0.3

improvement was seen at 3 and 24 months for both DASH and BPI. No clinical or statistical differences were observed between the Stryker Sonic Anchor and Depuy Mitek Anchor when comparing postoperative activity and function (Table 1) or between acellular dermal collagen allograft and native flexor carpi radialis allograft (Table 2). There were also no differences in average post-operative results when acellular dermal collagen allograft and native flexor carpi radialis was combined with anchor type (Table 3).

Pain

There were significant clinical and statistical differences with respect to pain when comparing preoperative and postoperative measures for both anchor types. Postoperatively, no clinical or statistical differences were observed when comparing patients that received either the Stryker Sonic Anchor or the Depuy Mitek Anchor as measured with WBFPS ($p = 0.3$) or Numeric Pain Scale ($p = 0.7$).

DISCUSSION

This retrospective study compares the clinical outcomes of patients with carpometacarpal arthritis who underwent a modified carpometacarpal resection interposition arthroplasty using either acellular dermal collagen allograft and native flexor carpi radialis allograft and received either the Stryker Sonic Anchor or Depuy Mitek Anchor.

This study found significant clinical and statistical differences between the preoperative and postoperative measurements of functional impact of pain (DASH), psychosocial impact of pain (BPI), and subjective measures of pain (WBFPS and NPS) for both anchors. However, postoperatively, differences were not significant. Based on our findings, the pull-out strength of the anchor does provide adequate support to stabilize the carpometacarpal joint and provides improved patient satisfaction through decreased pain, disability, and no neurological deficits.

Additionally, post-operative assessment of either acellular dermal collagen allograft or native flexor carpi radialis allograft as interposition material showed no statistical difference.

The outcomes from this study were favorable in that our patient population did not experience radial nerve injuries, infection, foreign body reaction to the interposition material or bone anchor, and did not require surgical revision throughout the 2-year follow up period.

CONCLUSION

Our findings suggest a modified carpometacarpal resection interposition arthroplasty using either acellular dermal collagen allograft or native flexor carpi radialis tendon with the use of a bone anchor is a viable option for the treatment of carpometacarpal arthritis.

When selecting anchor type to be used, the decision may be influenced by surgeon preference or anchor availability. Moreover, insurance coverage and cost may affect the patient's decision when choosing between anchors as the cost of the Stryker Sonic Anchor is nearly double that of the Depuy Mitek Anchor. Although our study results were favorable, there were several limitations including its retrospective design and a small sample size. Future large-scale prospective randomized controlled studies with adequate sample size and longer duration follow up is warranted to confirm our findings for an alternative option in the surgical management of basal thumb osteoarthritis.

In addition, revision of all referred cases to my practice for revision due to subsidence over the past 10 years were successfully performed with the use of dermal allografts.

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