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Original Research

Suture Suspensionplasty Compared With Ligament Reconstruction and Tendon Interposition for Surgical Treatment of Thumb Carpometacarpal Arthritis

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Purpose: Thumb carpometacarpal (CMC) arthritis is the most common arthritis of the hand, with most studies demonstrating little difference in outcomes between various surgical treatment techniques. However, trapeziectomy, followed by ligament reconstruction and tendon interposition (LRTI), remains the technique of choice among hand surgeons in the United States. In 2009, suture suspensionplasty (SS) was first described as a less invasive alternative to LRTI. The purpose of this study was to compare surgical details as well as patient-reported and radiographic outcomes between SS and LRTI for thumb CMC arthroplasty.
Methods: Following Institutional Review Board approval, 111 extremities were retrospectively identified in 104 patients who underwent carpometacarpal arthroplasty. Two age-matched cohorts were developed for patients having undergone LRTI (n = 58) or SS (n = 53) by one of three fellowship-trained hand surgeons. Tourniquet times were compared, and outcome measures included first metacarpal scaphoid space (FMSS) measured on 2-week postoperative radiographs, as well as Quick Disabilities of the Arm, Shoulder, and Hand (*Quick*DASH) score and pain score on a 10-point visual analog scale (VAS) from the preoperative visit as well as at 2 weeks, 6 weeks, and 3 months following surgery.
Results: There were no demographic differences between the two cohorts. There was no statistical difference between cohorts in VAS scores at any point in time. The SS cohort reported better *Quick*DASH scores at the 6-week postoperative visit; otherwise, *Quick*DASH scores did not differ between cohorts. The SS technique had shorter tourniquet times, and patients had less radiographic subsidence as evidenced by larger postoperative FMSS.
Conclusions: The SS arthroplasty technique demonstrated comparable early clinical results to LRTI. Furthermore, SS arthroplasty, which alleviates the need for tendon transfers and additional incisions with LRTI, had shorter tourniquet time, with less subsidence of the first metacarpal in the first 2 weeks.
Type of study/level of evidence: Therapeutic IV.

Osteoarthritis at the thumb carpometacarpal (CMC) joint is the most common degenerative arthritic condition in the hand; as a result, the thumb CMC joint is the most likely upper-extremity joint to undergo arthroplasty.[1,2] Many surgical techniques exist for surgical management of thumb CMC osteoarthritis.[1,3] Traditionally, these alternatives have included ligament reconstruction alone, metacarpal extension osteotomy, partial or complete trapeziectomy, implant arthroplasty, and full or partial flexor carpi radialis ligament reconstruction tendon interposition (LRTI).[1] On numerous occasions, comparative studies have demonstrated similar outcomes between these various procedures.[3–11] Despite these findings, LRTI remains the most widely adopted reconstruction technique following CMC arthroplasty.[4] A 2012 survey completed by over 1,100 members of the American Society for Surgery of the Hand to assess trends in nonsurgical and surgical treatment of trapeziometacarpal arthritis

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found that roughly 62% of participating surgeons performed trapeziectomy with LRTI for Eaton stage III arthritis.[12] A similar survey administered 2 years prior revealed consistent practice patterns, with 68% of respondents selecting LRTI as the preferred surgical treatment for end-stage CMC arthritis. Of note, only 30% of surgeons classified ligament reconstruction as "extremely important" to the success of CMC arthroplasty.[13]

Suture suspensionplasty (SS) has more recently been described for thumb CMC joint reconstruction.[2,14] Following trapeziectomy, SS reconstruction involves the use of suture tape to secure the flexor carpi radialis to the insertion of the abductor pollicis longus tendon.[14] The resulting "hammock" serves to maintain the height of the trapezial space, preventing subsidence of the thumb metacarpal and resulting adduction deformity.[2,14] In comparison to LRTI that requires one or more incisions for harvesting the flexor carpi radialis tendon, SS is theoretically a less morbid technique for thumb CMC joint reconstruction.[2] Other potential advantages of SS may include measures of efficiency, such as decreased cost and shorter surgical times.[15] However, there is a paucity of literature comparing these two techniques.

This retrospective chart review serves to compare surgical, patient-reported outcomes (PROs), and radiographic outcomes of LRTI and SS. It is hypothesized that SS will perform as well as LRTI with respect to patient-reported outcome measures and radiographic thumb metacarpal subsidence. It is further hypothesized that SS will result in shorter surgical and tourniquet times than LRTI.

Methods

Following institutional review board approval, this retrospective chart review was completed for three hand and upper-extremity fellowship-trained surgeons (J.F., Robert Goitz, and Robert Kaufmann) within a single academic hospital system. Before surgery, the surgeons obtained informed consent from each patient for inclusion in clinical research. All patients received preoperative diagnoses of thumb CMC osteoarthritis and subsequently underwent thumb CMC arthroplasty between February 2016 and July 2020. Throughout this period, one surgeon (J.F.) performed SS for CMC joint reconstruction, whereas the others (Robert Goitz and Robert Kaufmann) performed LRTI in all cases. The surgeons who use LRTI have done so for the entirety of their respective careers, whereas the other has chosen SS as their preferred method of CMC joint reconstruction since 2018. Initially, 133 cases in 126 patients were included, with 11 SS patients and five LRTI patients excluded because of extensive concurrent procedures performed at the time of trapeziectomy. Patients were not excluded if they had concurrent ganglion excision, carpal tunnel release, hemitrapezoidectomy, or extensor pollicis brevis transfers with or without volar capsulodesis. In addition, one SS and one LRTI case were revision procedures and were also excluded. Thus, 53 SS patients and 58 LRTI patients remained for inclusion in the review. In addition, to better control for confounding factors between groups, further pairwise comparisons were performed between the surgeon performing SS and one of the surgeons performing LRTI assessing tourniquet times for patients who solely had SS or LRTI performed at the time of operation. Power analysis was performed with an α of 0.05 and a β cutoff set to 20% to ensure adequate sample size was achieved after exclusions.

For each patient, demographic information, including age at the time of surgery, sex, surgical side, and hand dominance, was recorded. Surgical information, such as details of concurrent operations, tourniquet time, length of procedure, and operating room (OR) time, was included in the review. Patient-reported outcomes of interest included the Quick Disabilities of the Arm, Shoulder, and Hand (*Quick*DASH) questionnaire and pain scores as measured on a 0–10 visual analog scale (VAS), both recorded before surgery and at 2 weeks, 6 weeks, and 3 months after surgery. Additionally, radiographic measurement of first metacarpal scaphoid space (FMSS) with the hand at rest was recorded on preoperative and 2-week postoperative posteroanterior hand radiographs. For all radiographs, the FMSS was defined as the measured distance between the midpoint of the proximal aspect of the thumb metacarpal and the midpoint of the distal edge of the scaphoid. All ruler measurements were performed by the same member of the research team blinded to the surgical technique used. Raw pre- and postoperative FMSS measurements were recorded, and a simple ratio between postoperative and preoperative FMSS was calculated. Student *t*-tests were computed using Microsoft Excel (version 16.51) for all statistical comparisons between these SS and LRTI cohorts, with significance set at $P = .05$. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for standardized reporting were followed.

Results

There were no differences in demographic characteristics between the two cohorts (Table 1). Attrition for PRO completion at 3 months was 50% for the SS cohort and 80% for the LRTI cohort. Although the *Quick*DASH and VAS scores were not different between the cohorts before surgery, the SS cohort did demonstrate a lower *Quick*DASH score at 6 weeks after surgery compared with the LRTI cohort ($P = .009$; Table 2). Otherwise, the PRO scores did not differ between the two cohorts at any point in the postoperative course (Table 2); however, both cohorts had notable missing data by the longer time points. When the PRO preoperative scores were compared with those at any point in the postoperative course, there were no significant differences between the SS or LRTI cohorts (Table 3).

In comparison to LRTI, SS cases demonstrated significantly lower tourniquet time, length of procedure, and time in the OR (all $P < .001$; Table 4). This difference was also found when assessing tourniquet times between the surgeon performing SS and one of the surgeons performing LRTI without concurrent procedures performed at the time of operation (all $P < .001$; Table 5; Fig.). Although the preoperative FMSS did not differ between the two cohorts, SS demonstrated less first metacarpal subsidence at 2 weeks, as demonstrated by larger postoperative FMSS ($P < .001$) and post-pre-FMSS ratio ($P < .001$; Table 6).

Discussion

Regardless of specific approach, surgical treatment for advanced CMC arthritis predominantly involves trapeziectomy. This procedure is often paired with a stabilization measure, with the goal of preventing postoperative subsidence and subluxation of the first metacarpal.[2] Although SS is not a well-established practice among all hand surgeons, potential patient-centered and systems process benefits of this stabilization measure warrant further investigation and comparison to other surgical techniques for CMC arthritis. Rather than solely focusing on radiographic evidence of subsidence, this study compared intraoperative timing as well as pre- and postoperative PRO measures as a representation of patient experience and clinical function. Overall, there was not a significant difference in PROs between the two groups, whereas SS did demonstrate consistently shorter measures of procedural timing in our one surgeon versus one surgeon comparison.

Demographic characteristics did not differ between the SS and LRTI cohorts (Table 1) nor did preoperative *Quick*DASH or VAS

Table 1
Comparison of Demographic Factors Between the SS and LRTI Cohorts

Surgical Technique	Female	Age (y)	Right-Sided Surgery	Dominant-Sided Surgery	Concurrent Procedure(s) Performed
SS	40/53 (75.5%)	59.8	24/53 (45.3%)	22/53 (41.5%)	19/53 (35.8%)
LRTI	46/58 (79.3%)	59.8	20/58 (34.5%)	22/58 (37.9%)	16/58 (27.6%)
P value	.63	.99	.25	.70	.36

Table 2
Comparison of PROs Between the SS and LRTI Cohorts

Surgical Technique	Before Surgery		Two Weeks After Surgery		Six Weeks After Surgery		Three Months After Surgery	
	*Quick*DASH	VAS	*Quick*DASH	VAS	*Quick*DASH	VAS	*Quick*DASH	VAS
SS (n)	52.4 (40/53)	7.2 (44/53)	68.2 (26/53)	4.3 (35/53)	44.3 (29/53)	3.8 (32/53)	27.1 (17/53)	3.5 (20/53)
LRTI (n)	51.5 (47/58)	6.9 (53/58)	71.9 (24/58)	5.1 (27/58)	56.7 (33/58)	3.2 (36/58)	32.3 (9/53)	3.2 (9/58)
P value	.82	.57	.38	.27	.009	.33	.33	.79

Table 3
Comparison of PRO Changes Over Time Between the SS and LRTI Cohorts*

Surgical Technique	Two Weeks After Surgery		Six Weeks After Surgery		Three Months After Surgery	
	*Quick*DASH	VAS	*Quick*DASH	VAS	*Quick*DASH	VAS
SS (n)	17.0 (22/53)	−2.6 (30/53)	−2.8 (22/53)	−3.2 (26/53)	−26.3 (12/53)	−4.6 (17/53)
LRTI (n)	20.1 (23/58)	−1.5 (26/58)	2.2 (27/58)	−3.0 (29/58)	−14.6 (9/53)	−3.0 (9/58)
P value	.61	.11	.46	.78	.21	.14

* All differences are reported with respect to the preoperative PRO measurements.

Table 4
Comparison of Timing Parameters Between the SS and LRTI Cohorts

Surgical Technique	Tourniquet Time (Min)	Length of Procedure (Min)	Time in OR (Min)
SS	30.1	32.2	47.6
LRTI	47.5	53.2	71.8
P value	<.001	<.001	<.001

Table 5
Comparison of Timing Parameters Between the SS and LRTI Cohorts Without Concurrent Procedure at the Time of Operation

Surgical Technique	Tourniquet Time (Min)	Length of Procedure (Min)	Time in OR (Min)
SS	27.1	28.2	43.4
LRTI	44.6	47.2	65.3
P value	<.001	<.001	<.001

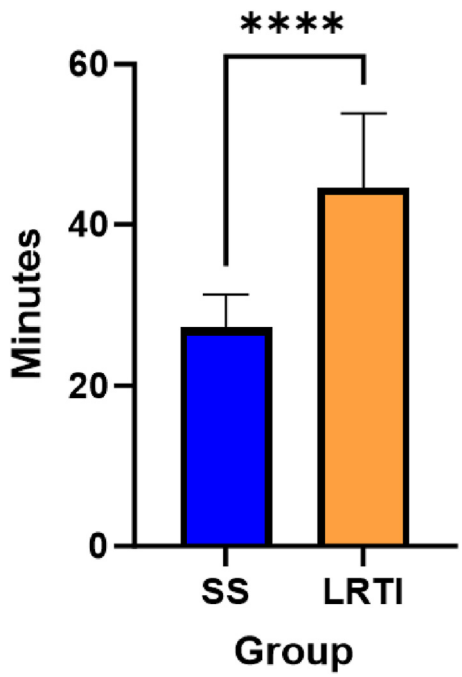

Figure. Comparison of tourniquet times between the SS and LRTI cohorts without concurrent procedure at the time of operation. ****$P < .0001$.

scores (Table 2). Previous studies have demonstrated improvement of *Quick*DASH and VAS scores after surgery in patients undergoing SS.[16] Additionally, a recent study conducted over a 4-year period found that at their 6-month postoperative visit from SS, over half of patients self-reported a pain score of 0.[17] These findings indicate that SS leads to favorable postoperative PROs. However, without a direct comparison between the two techniques, it has been unclear whether the benefits associated with SS exceed those found after surgery in LRTI patients.

Although the pre- to postoperative differences in *Quick*DASH and VAS scores were not different between the two cohorts at any point in time (Table 3), the *Quick*DASH scores were lower in the SS cohort at 6 weeks after surgery (Table 2). Thus, although SS may not reduce patient-reported pain early in the postoperative period compared with LRTI despite differences in technique, patients may experience a functional difference in tasks assessed by the *Quick*-DASH survey.

Among both the *Quick*DASH and the VAS, there was loss to follow-up of PRO documentation at each successive postoperative time point. Specifically, the SS and LRTI cohorts, respectively, experienced 50% and 80% attrition for PRO completion at 3 months. Therefore, it is possible that some PRO comparisons were not sufficiently powered to detect true differences in PROs between the two cohorts. However, based on the available data, the groups were not notably different.

Unsurprisingly, SS cases reduced tourniquet time, procedural length, and time in OR by at least one-third in

Table 6
Comparison of Radiographic Measurements of First Metacarpal Subsidence Between the SS and LRTI Cohorts

Surgical Technique	First Metacarpal Scaphoid Space		
	Before Surgery (mm)	After Surgery (mm)	Post-Pre Ratio
SS (n)	11.9 (48/53)	6.5 (50/53)	0.54 (45/53)
LRTI (n)	11.9 (56/58)	4.8 (50/58)	0.40 (49/58)
P value	.82	<.001	<.001

comparison to LRTI (Table 4). The substantial decrease in surgical time with SS may prove beneficial; although previously documented complication rates for SS and related techniques in the treatment of thumb CMC arthritis appear favorable when compared with those reported for LRTI, future work should discern whether these differences can be attributed to decreased surgical time.[18] In addition, shorter surgical and OR times with implementation of SS suggest that this technique provides opportunities for logistical, environmental, financial, and socioeconomic benefits. A recent study found that both trapeziectomy alone and LRTI were cost effective compared with nonsurgical management of CMC arthritis; however, trapeziectomy alone was dominant compared with LRTI when assessing base case total cost.[19]

The clinical significance regarding prevention of postoperative radiographic subsidence following CMC arthroplasty remains a topic of debate. One study of surgical management for thumb basilar joint arthritis compared radiographic outcomes of flexor carpi radialis with abductor pollicis longus side-to-side tendon transfer with and without SS, revealing less subsidence of the metacarpal axis over time with SS.[20] Long-term follow-up of postoperative SS patients has indicated relative preservation of FMSS, as well as improvements in *Quick*DASH scores and grip and pinch strength performance.[15] Although both patient cohorts in this study display similar FMSS before surgery, SS patients showed superior maintenance of FMSS at 2 weeks after surgery as reflected by raw FMSS and post- to preoperative FMSS ratio (Table 5). This finding suggests that at least in the early postoperative period, SS may be more effective than LRTI at the prevention of thumb metacarpal subsidence.

As alluded to previously, limitations of this study include relatively brief follow-up time, radiographic imaging at only 2 weeks after surgery, and loss to follow-up in the postoperative period, particularly at 3 months, which limited PRO data. In addition, differences in the duration of practice among the surgeons and procedural variations between surgeons could have also influenced outcome measures, including FMSS ratio and tourniquet times.

In comparison to LRTI, SS is a less invasive surgical technique. It was found to have shorter surgical and tourniquet times in our one surgeon to one surgeon comparison. Patient-reported outcomes associated with SS were not notably different from those with LRTI, and SS demonstrates less radiographic subsidence of the first metacarpal in the immediate postoperative period. Larger studies with longer follow-ups should be conducted to confirm our findings and perhaps elicit further differences between LRTI- and SS-associated outcomes.

Conflicts of Interest

Dr Fowler is the Editor-in-Chief for *Journal of Hand Surgery Global Online* and was not involved in the editorial review or the decision to publish this article. No benefits in any form have been received or will be received by the other authors related directly to this article.

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