Original Article Clinics in Orthopedic Surgery 2025;17:317-323 • https://doi.org/10.4055/cios24034

Surgical Outcomes of Suspension Arthroplasty with Dermal Allograft Interposition after Trapeziectomy: Comparison with Ligament Reconstruction and Interposition Using the Flexor Carpi Radialis Tendon

Shin Woo Choi, MD, Joo-Yul Bae, MD, Hyun June Lee, MD*, Ha Sung Park, MD†, Yun Jae Kim, MD†, Jae Kwang Kim, MD†

Department of Orthopedic Surgery, Gangneung Asan Hospital, University of Ulsan College of Medicine, Gangneung,
**Department of Orthopedic Surgery, Hyemin Hospital, Seoul,*
†Department of Orthopedic Surgery, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea

Background: Trapeziectomy with suspension arthroplasty is a reliable treatment for thumb carpometacarpal (CMC) osteoarthritis. We modified the suture suspension technique to add further support to maintain the arthroplasty space by interposition of the dermal allograft. Our aim was to investigate the surgical outcomes of our technique of suspension arthroplasty with dermal allograft interposition (SADI) compared with those of traditional ligament reconstruction with tendon interposition (LRTI) using a half-sling of the flexor carpi radialis (FCR) tendon.

Methods: This retrospective study enrolled 26 patients (29 thumbs) with thumb CMC arthritis who underwent trapeziectomy with traditional LRTI using the FCR tendon (15 thumbs; LRTI group) or SADI (14 thumbs; SADI group) between January 2017 and May 2022. Patient-reported outcomes (visual analog scale; the Disabilities of the Arm, Shoulder and Hand score; and patient-rated wrist evaluation), grip strength, and scaphometacarpal distance were measured at baseline and 3 and 12 months postoperatively. The operation time was checked by reviewing medical records. All measurements were compared between the 2 groups.

Results: Between baseline and 12-month postoperative follow-up, all patient-reported outcomes significantly improved in both groups. Patient-reported outcomes, grip strength, and scaphometacarpal distance showed no differences between the 2 groups at all follow-up assessments, except for the scaphometacarpal distance being significantly greater in the SADI group at 3 months postoperatively. The operation time was significantly shorter in the SADI group. No complication was observed in either group.

Conclusions: Our modified suture suspension arthroplasty technique using dermal allograft interposition results in markedly shorter surgical times with similar surgical outcomes compared with those of traditional LRTI using the FCR tendon. This procedure appears to be an effective alternative treatment for thumb CMC arthritis.

Keywords: *Trapeziectomy, Arthroplasty, Carpometacarpal joint, Osteoarthritis, Thumb*

Received January 23, 2024; Revised October 14, 2024; Accepted December 17, 2024

Correspondence to: Jae Kwang Kim, MD
Department of Orthopedic Surgery, Asan Medical Center, University of Ulsan College of Medicine, 88 Olympic-ro 43-gil, Songpa-gu, Seoul 05505, Korea
Tel: +82-2-3010-3523, Fax: +82-2-3010-855, E-mail: orth4535@gmail.com

Osteoarthritis of the thumb carpometacarpal (CMC) joint is a very common disease with prevalence rates of up to 10% in women in the middle years of life.[1] Numerus procedures have been introduced, and the most common option for advanced patients is resection arthroplasty of the trapezium. Although trapeziectomy alone can provide good pain relief for most patients, there are concerns regarding functional problems such as loss of pinching and grip strength due to thumb metacarpal subsidence.[2] Accordingly, trapeziectomy with ligament reconstruction with tendon interposition (LRTI) using the flexor carpi radialis (FCR) tendon has been the standard surgical treatment for advanced cases.[3,4] However, this technique has potential drawbacks, such as donor-site morbidity and prolonged surgical time.[5-7]

DelSignore et al.[8] introduced suture suspension arthroplasty using a non-absorbable suture that passed from the insertion of the abductor pollicis longus (APL) and the FCR. This technique produces a suture sling that suspends the first metacarpal without interposition. We developed a suture suspension technique through interposition of a dermal allograft to add further support to maintain the arthroplasty space, avoiding bone and tendon damage. In this study, we aimed to investigate the surgical outcomes of our technique of suspension arthroplasty with dermal allograft interposition (SADI) after trapeziectomy and to compare with those of traditional LRTI using a half-sling of the FCR tendon.

METHODS

This study was approved by the Institutional Review Board of the Asan Medical Center (IRB No. 2022-0927). As this was a retrospective study, the requirement for informed consent was waived.

Patient Selection

This retrospective study enrolled 26 patients (29 thumbs) with thumb CMC arthritis who underwent trapeziectomy with traditional LRTI using the FCR tendon (15 thumbs; LRTI group) or SADI (14 thumbs; SADI group) between January 2017 and May 2022. All patients had failed conservative treatment, including medication and intra-articular steroid injection for a minimum period of 6 months. The inclusion criterion was patients who underwent primary surgery for symptomatic Eaton stage III or IV thumb CMC joint arthritis with a follow-up period of at least 12 months. All surgical procedures were performed by a senior author (JKK). Patient characteristics are listed in Table 1.

Clinical Measurement

Clinical assessments included the use of a visual analog scale (VAS), measurement of grip strength, calculation of the Disabilities of the Arm, Shoulder and Hand (DASH) score, and patient-rated wrist evaluation (PRWE). PRWE is a 15-item questionnaire consisting of questions related to pain and functional disability, with scores ranging from 0 to 10. The DASH questionnaire consists of 30 items that evaluate abilities to perform specified activities (21 items) or symptoms (9 items), with scores ranging from 0 to 100, and higher scores indicate greater disability. Grip strength was measured using a dynamometer (Takei Corp.) with the elbow flexed at 90° and the forearm in neutral rotation. Each hand was measured 3 times and the average value

Table 1. Patient Characteristics

Variable	LRTI group	SADI group	*p*-value
Number of patients	15	14	-
Female (%)	100	100	-
Age (yr), mean ± SD	60 ± 9	61 ± 7	0.65
Eaton stage III : IV	11 : 4	11 : 3	1.00
Dominant hand (%)	27	36	0.70

LRTI: ligament reconstruction with tendon interposition, SADI: suspension arthroplasty with dermal allograft interposition, SD: standard deviation.

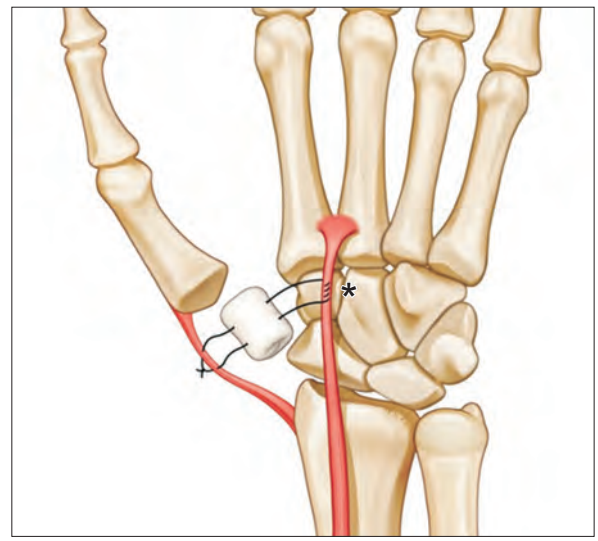

Fig. 1. Schematic diagram of the surgical technique using an allograft. The allograft was stabilised by single looping using 4-0 non-absorbable sutures around the abductor pollicis longus and flexor carpi radialis (FCR) tendon. The suture was backhanded after grasping a bundle of FCR tendon fibers to obtain additional stability (asterisk).

was calculated in kilograms.

Radiographic Measurement

The scaphometacarpal distance was measured as radiographic data. The scaphometacarpal distance from the scaphoid distal pole to the first metacarpal base was measured in a posteroanterior view perpendicular to the scaphoid distal pole.[9]

Surgical Technique

Trapeziectomy with LRTI using an autologous FCR tendon was performed as a standard method.[3] The harvested half sling of FCR was passed through the base of the first metacarpal, and the excess tendon was sutured together to create a ball to provide stable support for the thumb and interposed. SADI surgery was conducted using a modified suture sling technique. Fig. 1 is a schematic of the surgical technique using an allograft. We used AlloDerm (LifeCell) with a thickness of 3–4 mm as the allograft material (Fig. 2A). The allograft was sutured together to create a cylindrical shape (Fig. 2B), and the allograft was interposed into the void created by trapeziectomy (Fig. 2C). We stabilised the allograft by single looping using 4-0 non-absorbable sutures around the APL and FCR tendon to create a suture sling. The suture entered the dorsum of the APL, passed through the allograft, and then backhandedly grasped a bundle of FCR tendon fibers to obtain additional stability. The knot was secured dorsally at the APL tendon, and the capsule was repaired.

A thumb spica splint was applied immediately after surgery for 2 weeks. The stitches were removed 2 weeks after surgery, the splint was changed to a thumb spica brace, and range of motion exercise was started. Sports activities and heavy lifting were allowed at 3 months after surgery.

Statistical Analysis

Continuous data are expressed as mean and standard deviation. The VAS score, DASH score, PRWE score, grip strength, and scaphometacarpal distance were compared before and after 12 months of treatment in each group using the Wilcoxon signed-rank test. Differences between the 2 groups at each time point and comparison of operative time between the 2 groups were analyzed using the Mann-Whitney test.

RESULTS

Between the baseline examination and 12-month postoperative follow-up, all patient-reported outcomes, including VAS, DASH, and PRWE scores, significantly improved in both groups (Table 2). The average grip strength increased after surgery in both groups, although the difference did not reach significance. The scaphometacarpal distance decreased in both groups after surgery, indicating that subsidence had progressed in both groups (47% in the SADI group and 56% in the LRTI group).

There were no differences in patient-reported outcomes (VAS, DASH, and PRWE scores), grip strength, and scaphometacarpal distance between both groups at all follow-up assessments, except for the 3-month postoperative scaphometacarpal distance, which was significantly shorter in the LRTI group than in the SADI group (5.7 vs. 7.3 mm, respectively; $p = 0.006$) (Table 3, Fig. 3). The operative time was significantly shorter in the SADI group (57 minutes; range: 34–78 minutes) than in the LRTI group (81 minutes; range: 49–110 minutes) ($p < 0.001$). No infections, immunological reactions, or other tendon-related complications were observed in either group.

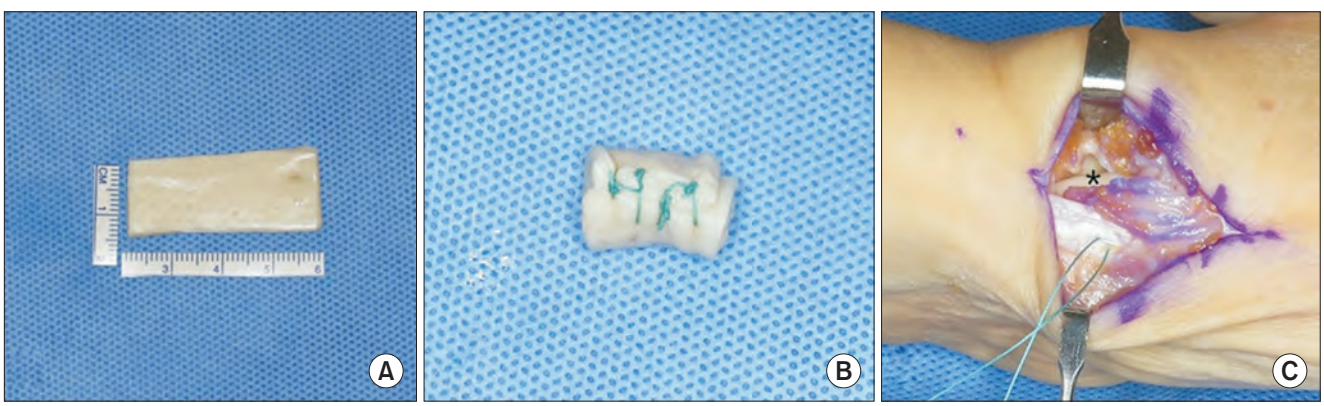

Fig. 2. (A) An allograft with a thickness of 3–4 mm, which was cut to fit the size of the space after trapeziectomy. (B) The allograft was sutured together to create a cylindrical shape. (C) The allograft (asterisk) was interposed into the space created by trapeziectomy.

Table 2. Comparison between Baseline and 1-Year Postoperative Outcomes in Both Groups

Variable	Baseline	Postoperative 1 yr	*p*-value
LRTI group			
VAS score	5.0 ± 2.8	2.3 ± 1.3	0.02*
DASH score	48.8 ± 11.8	23.6 ± 16.4	< 0.001*
PRWE symptom	45.6 ± 26.4	19.0 ± 11.9	0.008*
PRWE function	46.0 ± 27.4	18.0 ± 13.0	0.006*
Grip strength (kg)	12.2 ± 7.4	12.7 ± 6.0	0.374
Sc–MC distance (mm)	11.5 ± 1.0	5.1 ± 1.6	< 0.001*
SADI group			
VAS score	5.4 ± 2.5	2.1 ± 1.4	0.04*
DASH score	56.1 ± 17.1	24.4 ± 9.3	< 0.001*
PRWE symptom	38.0 ± 11.3	14.0 ± 7.5	0.012*
PRWE function	34.5 ± 11.5	13.0 ± 9.6	0.012*
Grip strength (kg)	12.4 ± 4.5	16.0 ± 3.9	0.123
Sc–MC distance (mm)	11.6 ± 1.7	6.1 ± 0.9	0.008*

Values are presented as mean ± standard deviation.
LRTI: ligament reconstruction with tendon interposition, VAS: visual analog scale, DASH: Disabilities of the Arm, Shoulder and Hand, PRWE: patient-rated wrist evaluation, Sc–MC: scaphometacarpal, SADI: suspension arthroplasty with dermal allograft interposition.
*Statistically significant, $p < 0.05$.

Table 3. Comparisons of Patient-Reported, Clinical, and Radiographic Outcomes between the Two Groups

Variable	Baseline			Postoperative 3 mo			Postoperative 1 yr		
	LRTI	SADI	*p*-value	LRTI	SADI	*p*-value	LRTI	SADI	*p*-value
VAS score	5.0 ± 2.8	5.4 ± 2.5	0.65	4.1 ± 2.2	3.0 ± 2.2	0.22	2.3 ± 1.3	2.1 ± 1.4	0.71
DASH score	48.8 ± 11.8	56.1 ± 17.1	0.20	32.4 ± 8.6	41.1 ± 13.0	0.08	23.6 ± 16.4	24.4 ± 9.3	0.42
PRWE symptom	45.6 ± 26.4	38.0 ± 11.3	0.60	35.5 ± 25.7	23.9 ± 8.3	0.53	19.0 ± 11.9	14.0 ± 7.5	0.30
PRWE function	46.0 ± 27.4	34.5 ± 11.5	0.28	34.7 ± 26.5	21.5 ± 10.1	0.30	18.0 ± 13.0	13.0 ± 9.6	0.37
Grip strength (kg)	12.2 ± 7.4	12.4 ± 4.5	0.48	7.8 ± 5.3	11.2 ± 3.3	0.22	12.7 ± 6.0	16.0 ± 3.9	0.08
Sc–MC distance (mm)	11.5 ± 1.0	11.6 ± 1.7	0.79	5.7 ± 1.9	7.3 ± 1.0	0.006*	5.1 ± 1.6	6.1 ± 0.9	0.10

Values are presented as mean ± standard deviation.
LRTI: ligament reconstruction with tendon interposition, SADI: suspension arthroplasty with dermal allograft interposition, VAS: visual analog scale, DASH: Disabilities of the Arm, Shoulder and Hand, PRWE: patient-rated wrist evaluation, Sc–MC: scaphometacarpal.
*Statistically significant, $p < 0.05$.

DISCUSSION

Our modified suture suspension arthroplasty technique resulted in comparable surgical outcomes to those of LRTI using an autograft FCR tendon after trapeziectomy in patients with thumb CMC arthritis. Nevertheless, the surgery with SADI was associated with significantly reduced surgical time compared with LRTI using autograft FCR harvest without any complications. Trapeziectomy with LRTI using an autograft tendon is widely used for thumb CMC arthritis, but donor-site morbidity has been reported in the literature.[6] Autograft harvesting requires more sur-

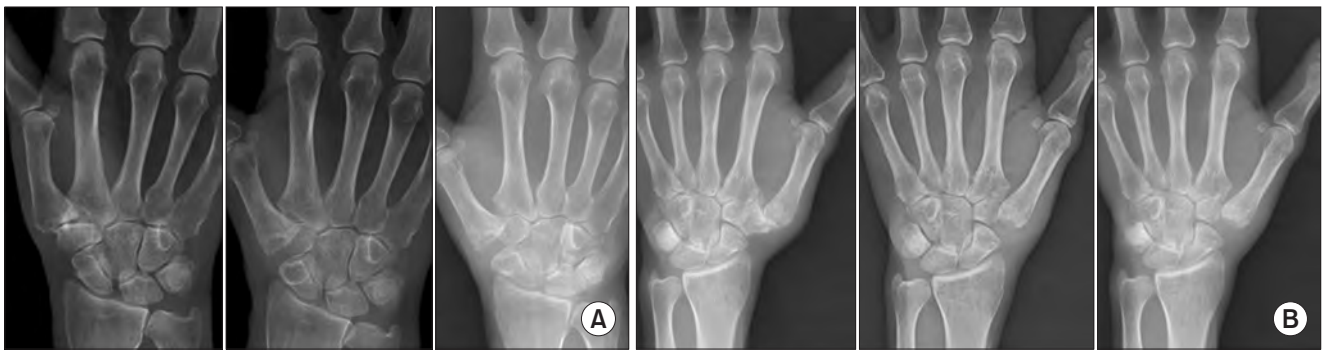

Fig. 3. Representative radiographs of the trapeziectomy with ligament reconstruction and tendon interposition (A) and suspension arthroplasty with dermal allograft interposition after trapeziectomy (B) groups preoperatively, 3 months postoperatively, and at the final follow-up.

gical time and extensive dissection, which can be associated with tendinitis, tendon rupture, scar tenderness, and complex regional pain syndrome.[5,10] Furthermore, several patients have reservations concerning the potential functional loss caused by autograft harvesting. Naidu et al.[11] reported that harvesting the entire FCR tendon significantly decreased the wrist flexion extension peak torque ratio and wrist flexion fatigue resistance compared with the contralateral extremity in their biomechanical study.

Suture suspension arthroplasty has several advantages such as decreased operative time and shorter, less painful recovery process compared with those of LRTI.[8] This technique does not require the sacrifice of autologous tendons, drilling of bone holes, or pin fixation. It generates a suture sling that functions as a "hammock" supporting the arthroplasty space. However, a concern is the inadvertent overtightening of the tendons, causing impingement pain and abduction contracture.[12,13] Moreover, despite efforts to preserve the trapezial space, there is a risk of thumb subsidence due to the lack of a space-occupying material. We modified the suture suspension technique to add further support to maintain the arthroplasty space by interposition of a thick dermal allograft. Although mild subsidence appeared to have no correlation with both symptoms and functional outcome, significant subsidence may cause metacarpal impingement and joint pain. Our SADI procedure could provide additional support to the thumb metacarpal base, and it can be considered a reasonable rationale for the addition of dermal allograft interposition to suspension arthroplasty.

Acellular dermal allografts are commonly used in orthopedic surgery. They are made from human cadaveric tissue processed to remove the cellular components to reduce adverse immunological reactions.[14] Successful surgical results have been demonstrated in diverse orthopedic surgeries, such as the repair of massive rotator cuff tears and Achilles tendon ruptures.[15,16] The use of an allograft allows surgeons to reduce the operative time required for tendon harvest. Moreover, the volume of the acellular dermal matrix could be much larger than the average volume of the harvested FCR tendon, which may be advantageous in preventing thumb subsidence. To support a thumb metacarpal strongly, we used an allograft with a thickness of 3–4 mm, which is the thickest product among the dermal allograft materials available for thumb CMC arthritis. Consequently, the average of thumb subsidence in the SADI group was less than that in the LRTI group throughout the 12-month postoperative period.

A few surgical techniques using an allograft have been described for the treatment of advanced CMC arthritis, which differ from our technique. Most of those techniques require extensive bone tunnelling or looping of the allograft tendon. Kokkalis et al.[17] conducted a surgical technique involving drilling and resection of the base of the first metacarpal, along with stabilization of the allograft looping around the FCR and the base of the first metacarpal, similar to traditional LRTI using autograft FCR. In another study, the allograft was sutured and looped around the intact FCR tendon, which may cause tension and constrict the FCR tendon, consequently resulting in a high incidence of FCR-related complications.[18] In our technique, we stabilised the allograft using a simple suture sling without bone and tendon damage, causing no tendon-related complications.

This study had several limitations. First, it was a retrospective study that included a small number of patients at a single center. Second, the follow-up period was short, with a minimum of 12 months. Therefore, additional long-term studies with a large sample size are required to evaluate more valid outcomes of this surgical procedure. Third, we used grip strength for the outcome measures, which may not capture specific aspects of thumb function. In future studies, it would be beneficial to include more specific out-

come measures, such as pinch strength, which are directly relevant to the first CMC surgery. This would provide a more comprehensive assessment of the effectiveness of surgical techniques in restoring thumb function and strength. Finally, this study involved only female patients, which may have affected the external validity of our findings.

SADI after trapeziectomy results in markedly shorter surgical time with similar surgical outcomes compared with those of traditional LRTI using the FCR tendon. This technique can be used as an effective alternative surgical method for patients with thumb CMC osteoarthritis.

CONFLICT OF INTEREST

Jae Kwang Kim is an editorial board member of the journal but was not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflicts of interest relevant to this article were reported.

ORCID

Shin Woo Choi https://orcid.org/0000-0002-4641-7413
Joo-Yul Bae https://orcid.org/0000-0002-4602-7829
Hyun June Lee https://orcid.org/0000-0002-3165-5849
Ha Sung Park https://orcid.org/0000-0002-9869-2329
Yun Jae Kim https://orcid.org/0009-0002-7190-7577
Jae Kwang Kim https://orcid.org/0000-0001-5104-4634

REFERENCES

1. Parker WL. Evidence-based medicine: thumb carpometacarpal arthroplasty. Plast Reconstr Surg. 2013;132(6):1706-19.
2. Yang SS, Weiland AJ. First metacarpal subsidence during pinch after ligament reconstruction and tendon interposition basal joint arthroplasty of the thumb. J Hand Surg Am. 1998;23(5):879-83.
3. Burton RI, Pellegrini VD Jr. Surgical management of basal joint arthritis of the thumb: part II: ligament reconstruction with tendon interposition arthroplasty. J Hand Surg Am. 1986;11(3):324-32.
4. Hamasaki T, Harris PG, Bureau NJ, Gaudreault N, Ziegler D, Choiniere M. Efficacy of surgical interventions for trapeziometacarpal (thumb base) osteoarthritis: a systematic review. J Hand Surg Glob Online. 2021;3(3):139-48.
5. Davis TR, Brady O, Dias JJ. Excision of the trapezium for osteoarthritis of the trapeziometacarpal joint: a study of the benefit of ligament reconstruction or tendon interposition. J Hand Surg Am. 2004;29(6):1069-77.
6. Low TH, Hales PF. High incidence and treatment of flexor carpi radialis tendinitis after trapeziectomy and abductor pollicis longus suspensionplasty for basal joint arthritis. J Hand Surg Eur Vol. 2014;39(8):838-44.
7. Rab M, Gohritz A, Gohla T, Krimmer H, Lanz U. Long-term results after resection arthroplasty in patients with arthrosis of the thumb carpometacarpal joint: comparison of abductor pollicis longus and flexor carpi radialis tendon suspension. Handchir Mikrochir Plast Chir. 2006;38(2):98-103.
8. DelSignore JL, Accardi KZ. Suture suspension arthroplasty technique for basal joint arthritis reconstruction. Tech Hand Up Extrem Surg. 2009;13(4):166-72.
9. Reissner L, Marks M, Schindele S, Herren DB. Comparison of clinical outcome with radiological findings after trapeziectomy with ligament reconstruction and tendon interposition. J Hand Surg Eur Vol. 2016;41(3):335-9.
10. Wajon A, Vinycomb T, Carr E, Edmunds I, Ada L. Surgery for thumb (trapeziometacarpal joint) osteoarthritis. Cochrane Database Syst Rev. 2015;2015(2):CD004631.
11. Naidu SH, Poole J, Horne A. Entire flexor carpi radialis tendon harvest for thumb carpometacarpal arthroplasty alters wrist kinetics. J Hand Surg Am. 2006;31(7):1171-5.
12. Mirza A, Mirza JB, Klingbeil L, Pavlik JF 3rd, Muratori J, Thomas T. A modified suture suspension arthroplasty technique for the treatment of basal joint arthritis: short- to intermediate-term outcomes. Hand (N Y). 2021;16(6):797-803.
13. Gottschalk MB, Patel NN, Boden AL, Kakar S. Treatment of basilar thumb arthritis: a critical analysis review. JBJS Rev. 2018;6(7):e4.
14. Kim JY, Yang KM, Youn JH, Park H, Hahn HM, Lee IJ. In vitro analysis of histology, mechanics, and safety of radiation-free pre-hydrated human acellular dermal matrix. J Breast Cancer. 2020;23(6):635-46.
15. Barber FA, McGarry JE, Herbert MA, Anderson RB. A biomechanical study of Achilles tendon repair augmentation using GraftJacket matrix. Foot Ankle Int. 2008;29(3):329-33.
16. Derwin KA, Badylak SF, Steinmann SP, Iannotti JP. Extracel-

lular matrix scaffold devices for rotator cuff repair. J Shoulder Elbow Surg. 2010;19(3):467-76.

17. Kokkalis ZT, Zanaros G, Weiser RW, Sotereanos DG. Trapezium resection with suspension and interposition arthroplasty using acellular dermal allograft for thumb carpometacarpal arthritis. J Hand Surg Am. 2009;34(6):1029-36.

18. Marks M, Hensler S, Wehrli M, Scheibler AG, Schindele S, Herren DB. Trapeziectomy with suspension-interposition arthroplasty for thumb carpometacarpal osteoarthritis: a randomized controlled trial comparing the use of allograft versus flexor carpi radialis tendon. J Hand Surg Am. 2017;42(12):978-86.