Joint Diseases and Related Surgery

Jt Dis Relat Surg
2026;37(3):777-784

ORIGINAL ARTICLE

Thumb carpometacarpal osteoarthritis: Arthrodesis versus trapeziectomy with ligament reconstruction and tendon interposition

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Thumb carpometacarpal (CMC) joint osteoarthritis is one of the most common degenerative conditions affecting the upper extremity and represents a major cause of pain and functional impairment, particularly in elderly women.[1-3] In the early stages, conservative management including rest, splinting, physical therapy, and corticosteroid injections is typically preferred. However, surgical intervention is considered in patients who fail to respond to non-surgical treatment.[2-4] Several

Received: April 06, 2026
Accepted: April 23, 2026
Published online: May 04, 2026

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Citation: Aldemir C, Ozturk T, Ertem H, Aydın Y, Zengin EC, Piskin A, et al. Thumb carpometacarpal osteoarthritis: Arthrodesis versus trapeziectomy with ligament reconstruction and tendon interposition. Jt Dis Relat Surg 2026;37(3):777-784. doi: 10.52312/jdrs.2026.2927.

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ABSTRACT

Objectives: In this study, we aimed to compare the clinical and radiological outcomes of patients undergoing arthrodesis and trapeziectomy with ligament reconstruction and tendon interposition (T + LRTI) for thumb carpometacarpal (CMC) osteoarthritis and to investigate whether patient-specific decision-making could offer advantages over LRTI or arthrodesis as a surgical approach.

Patients and methods: Between August 2014 and January 2025, a total of 40 patients who underwent surgical treatment for thumb CMC osteoarthritis were retrospectively analyzed. The patients were divided into two groups as the T + LRTI group (n = 22) and arthrodesis group (n = 18). Clinical outcomes were assessed using the Visual Analog Scale (VAS), Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH), grip strength (kg), and pinch strength (kg) measurements.

Results: Of the patients, 7 were male and 33 were female with a mean age of 62.9 ± 6.5 years in T + LRTI group, 60.1 ± 7.4 years in arthrodesis group (range, 40 to 75 years). Both groups demonstrated significant improvement in VAS and QuickDASH scores postoperatively ($p < 0.001$). The mean postoperative VAS scores were 2.7 ± 2.0 in the T + LRTI group and 1.9 ± 0.9 in the arthrodesis group ($p = 0.267$), while QuickDASH scores were 26.4 ± 17.3 and 19.1 ± 3.2, respectively ($p = 0.085$). No significant differences were observed in grip strength ($p = 0.358$), palmar pinch ($p = 0.104$) and key pinch strength ($p = 0.097$) between the groups. The overall complication rate was 12.5% in both groups, indicating no statistically significant difference ($p = 0.642$).

Conclusion: Our study results suggest that both T + LRTI and arthrodesis provide effective and comparable pain relief and functional outcomes in the surgical management of thumb CMC osteoarthritis and can be considered reliable surgical options.

Keywords: Arthrodesis, carpometacarpal, grip, ligament reconstruction and tendon interposition, osteoarthritis, trapeziectomy.

surgical techniques have been described for the management of advanced CMC osteoarthritis, including trapeziectomy (T), T combined with ligament reconstruction and tendon interposition [T + LRTI], arthrodesis, non-prosthetic and prosthetic joint replacement.[2-9]

Trapeziectomy and LRTI have been widely used for decades and are associated with reliable pain relief while preserving joint motion.[6] Although some studies have reported reduced or only modest improvement in grip and pinch strength following T + LRTI, functional outcome measures have usually remained satisfactory.[6-8] In contrast, CMC arthrodesis is often preferred in younger patients with higher functional demands, as it provides increased joint stability and enhanced pinch strength. It has also been associated with higher complication and revision rates.[9,10] Despite these biomechanical advantages, arthrodesis has not demonstrated clear superiority over T + LRTI in terms of pain relief and overall functional outcomes yet.[8,11-13]

In the present study, we aimed to compare the clinical and radiological outcomes of patients undergoing arthrodesis and T + LRTI for thumb CMC osteoarthritis and to investigate whether patient-specific decision-making could offer advantages over LRTI or arthrodesis as a surgical approach.

PATIENTS AND METHODS

This multi-center, retrospective study was conducted at Departments of Orthopedics and Traumatology of four healthcare centers between August 2014 and January 2025. Initially, patients who underwent surgical treatment for thumb CMC osteoarthritis were included. Inclusion criteria were as follows: age ≥ 18 years, having unilateral primary CMC osteoarthritis classified as Eaton-Littler on standard hand radiographs,[14] and having failed conservative treatment with a minimum follow-up of 12 months. Patients with rheumatoid arthritis or other inflammatory arthropathies, post-traumatic arthritis, prior surgery involving the CMC joint, bilateral surgical procedures, concomitant surgical interventions, neuromuscular disorders affecting upper extremity function and for arthrodesis group patients with Eaton IV disease were excluded. Finally, a total of 40 patients who met the inclusion criteria were recruited. The patients were divided into two groups as the T + LRTI group (n = 22) and arthrodesis group (n = 18). A written informed consent was obtained from each patient. The study protocol was approved by the Antalya Training and Research Hospital Ethics Committee (Date: 25.12.2025, No.: 22/25). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Surgical techniques

All procedures were performed by four experienced surgeons using a dorsoradial approach. After skin incision, the sensory branches of the radial nerve were carefully preserved, and the CMC joint capsule was exposed. In the T + LRTI group, complete excision of the trapezium was performed. The flexor carpi radialis (FCR) tendon was, then, harvested either partially or totally at the forearm level. The choice between partial and complete FCR tendon harvest was based on surgeon preference and intraoperative tendon characteristics, including quality, length, and thickness. The tendon was released proximally at the musculotendinous junction and retrieved through the trapeziectomy site. It was subsequently passed through a drill hole at the base of the first metacarpal, and the remaining portion was fashioned into a rolled "anchovy" configuration and interposed into the trapezial space to provide soft tissue support and stabilization.

In the arthrodesis group, the trapeziometacarpal joint surfaces were fully exposed. The articular cartilage of both the trapezium and the base of the first metacarpal was removed, and the subchondral bone surfaces were decorticated to achieve cancellous bone contact. The first metacarpal was positioned in a functional alignment (slight abduction, flexion, and pronation), and fixation was achieved using either plate (Figure 1) or a headless compression screw (Figure 2). The choice of fixation method was based on surgeon preference, bone quality, and the ability to achieve rigid fixation.

Follow-up and assessments

Postoperatively, all patients were immobilized in a short arm splint including the thumb. The splint was removed after four to six weeks. Passive range of motion exercises were initiated for two weeks, followed by active mobilization. Strengthening exercises were introduced after the eighth postoperative week.

Clinical outcomes were assessed using the Visual Analog Scale (VAS) for pain (0=no pain, 10=worst pain) and the Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) score. Grip and pinch strengths



FIGURE 1. Arthrodesis with plate fixation.



FIGURE 2. Arthrodesis with headless screw fixation.

(palmar and key pinch) were measured bilaterally using a Jamar dynamometer (Jamar Technologies Inc., Clifton, NJ, USA), and results were recorded in kg.[15,16] Grip and pinch strengths were measured using a Jamar dynamometer in standardized Position II; three consecutive measurements were obtained for each patient, and the mean value was recorded. All measurements

were expressed in kg. Radiological evaluation was performed using standard X-rays to assess bone union and proximal migration of the first metacarpal. The severity of osteoarthritis was graded preoperatively based on standard radiographic criteria.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 23.0 software (IBM Corp., Armonk, NY, USA). The distribution of the data was evaluated with the Shapiro-Wilk test. Continuous data were presented in mean ± standard deviation (SD) or median (min-max), while categorical data were presented in number and frequency. The minimal clinically important difference (MCID) was calculated by distribution-based analysis using 0.5 standard deviation. Categorical data were analyzed using the Pearson chi-square, Fisher's exact, and Fisher-Freeman-Halton tests. The parametric and non-parametric data were evaluated using the Student t-test and the Mann-Whitney U test, respectively. The dependent groups were evaluated with the paired sample t-test and Wilcoxon test. A p value of < 0.05 was considered statistically significant.

RESULTS

Of a total of 40 patients included in the study, 7 were male and 33 were female with a mean age of 62.9 ± 6.5 years in T + LRTI group, 60.1 ± 7.4 years in arthrodesis group (range, 40 to 75 years). Of the patients, 22 (55%) underwent T + LRTI and 18 (45%) underwent arthrodesis. There were no statistically significant differences between the groups in terms of age, sex, or duration of follow-up (Table I). Similarly, there was no significant difference in the number of patients who underwent surgery on the dominant hand between the groups ($p = 0.088$).

In accordance with the Eaton-Littler classification, in the T + LRTI group, four patients (18.2%) were classified as Stage II, 12 (54.5%) as Stage III, and six (27.3%) as Stage IV. In the arthrodesis group, all patients were Stage III. The primary presenting complaints in all patients were thumb pain and limited motion. In both groups, both VAS and QuickDASH scores showed significant postoperative improvement compared to preoperative values ($p < 0.001$). Although preoperative VAS scores were higher in the arthrodesis group and QuickDASH scores were higher in the T + LRTI group, no statistically significant differences were observed between the groups in postoperative assessments (Tables II and III).

During the postoperative period, no significant differences were found between the groups in terms of dynamometric measurements; i.e., grip strength ($p = 0.358$), palmar pinch ($p = 0.104$), and key pinch ($p = 0.097$) (Table II).

In the T + LRTI group, the mean proximal migration of the first metacarpal was 4.5 (range, 1.4 to 8.0) mm. Regarding tendon usage, total FCR transfer was performed in two patients, while partial FCR transfer was performed in 20 patients (90.1%). In the arthrodesis group, fixation was achieved using a plate in six patients (33.3%), two headless compression screws in 10 patients (55.6%), and a combination of one Kirschner wire and one headless compression screw in two patients (11.1%). Complete union was achieved in all cases of arthrodesis, with a median time of three months. Overall, complications occurred in five patients (12.5%), with no statistically significant difference between the groups ($p = 0.642$). In the T + LRTI group, two patients developed proximal metacarpal migration. In the arthrodesis group, complications included implant irritation in two patients and radial nerve irritation in one patient.

The mean change of QuickDASH score and VAS were 25.0 and 5.23 points respectively, indicating substantial functional improvement.

TABLE I
Comparison of demographic data between groups

	T + LRTI (n = 22)		Arthrodesis (n = 18)		
	n	Mean ± SD	n	Mean ± SD	p
Age (year)		62.9 ± 6.5		60.1 ± 7.4	0.213
Follow-up (mo)		60.5 ± 39.6		54.1 ± 38.3	0.703
Sex					0.211
Female	20		13		
Male	2		5		

T + LRTI, trapeziectomy with ligament reconstruction and tendon interposition; SD, standard deviation.

TABLE II
Comparison of functional outcomes

	T + LRTI (n = 22)	Arthrodesis (n = 18)	
	Mean ± SD	Mean ± SD	*p*
VAS	2.7 ± 2.0	1.9 ± 0.9	0.267
QuickDASH	26.4 ± 17.3	19.1 ± 3.2	0.085
Grip (kgs)	22.6 ± 4.4	21.5 ± 2.8	0.358
Palmar pinch (kgs)	4.6 ± 1.15	5.2 ± 1.13	0.104
Key pinch (kgs)	4.1 ± 1.1	3.6 ± 0.4	0.097

T + LRTI, trapeziectomy with ligament reconstruction and tendon interposition; SD, standard deviation; VAS, Visual Analog Scale; QuickDASH, Quick Disabilities of the Arm, Shoulder and Hand.

TABLE III
Evaluation of the outcomes before and after the surgery

			95 % CI		
	Mean ± SD	Mean difference	Lower	Upper	*p*
Both groups (n = 40)					
Preoperative VAS	7.6 ± 1.4	5.2	4.59	5.8	< 0.001
Postoperative VAS	2.4 ± 1.6				
Preoperative QuickDASH	49.3 ± 17.0	26.1	19.9	32.4	< 0.001
Postoperative QuickDASH	23.1 ± 13.3				
T + LRTI (n = 22)					
Preoperative VAS	7 ± 1.4	4.2	3.6	4.7	< 0.001
Postoperative VAS	2.7 ± 2.0				
Preoperative QuickDASH	55.1 ± 15.0	28.7	18.8	38.5	< 0.001
Postoperative QuickDASH	26.4 ± 17.3				
Arthrodesis (n = 18)					
Preoperative VAS	8.3 ± 1.1	6.38	5.4	7.3	< 0.001
Postoperative VAS	1.9 ± 0.9				
Preoperative QuickDASH	42.2 ± 17.0	23.1	15.1	31.0	< 0.001
Postoperative QuickDASH	19.1 ± 3.2				

CI, confidence interval; SD, standard deviation; VAS, Visual Analog Scale; QuickDASH, Quick Disabilities of the Arm, Shoulder and Hand; T + LRTI, trapeziectomy with ligament reconstruction and tendon interposition.

Distribution-based analysis using 0.5 standard deviation yielded an MCID of approximately 8.1 points for QuickDASH and 0.75 for VAS.

DISCUSSION

In the present study, we compared the clinical and radiological outcomes of patients undergoing arthrodesis and T + LRTI for thumb CMC osteoarthritis. The main finding of this study was that both T + LRTI and arthrodesis provided comparable pain relief and functional outcomes in the treatment of thumb CMC osteoarthritis, while postoperative results were not necessarily influenced by patient-specific factors. In clinical practice, arthrodesis is usually preferred in patients with higher functional demands, whereas T + LRTI is more commonly selected for those with lower functional expectations.[3] These differences in patient selection may partially explain the observed variations in functional outcomes and should be considered when interpreting the results.

In terms of patient demographics and arthrosis severity, previous studies have suggested that arthrodesis is usually preferred in younger patients with higher functional demands and more advanced disease, whereas T + LRTI is more commonly

performed in older individuals with lower to moderate functional expectations.[17-20] However, some authors have emphasized that surgical decision-making is not determined solely by age or radiographic stage, but is also influenced by patient characteristics and surgeon preference.[1-3] In our study, the mean age, sex, and dominance of the operated side were comparable between the groups. This finding may suggest that the choice of surgical procedure may not necessarily be strictly dependent on such patient-specific factors. Consistent with this, Fulton and Stern[18] reported satisfactory outcomes of arthrodesis in patients over 50 years of age in a series with a minimum follow-up of two years, supporting the notion that arthrodesis may remain a viable option beyond traditionally defined younger patient populations.

On the other hand, Eaton and Glickel[14] described a classification-based treatment approach, which is consistent with the observed preference for T + LRTI in advanced-stage cases. However, in our study, patient with Eaton Stage IV was excluded from the arthrodesis group due to relative contraindications; therefore, a stage-dependent comparison between the groups could not be performed.

Regarding functional outcomes, the systematic review by Kim et al.[3] reported that VAS scores typically improved from preoperative values of 7-9 to postoperative levels of 1-3 following both T + LRTI and arthrodesis. Similarly, DASH/QuickDASH scores are often reported within the range of 20 to 30.[8,21] These improvements in QuickDASH and VAS scores substantially exceeded the reported MCID thresholds, which are approximately 8-15 points for QuickDASH and 1.5-2 points for VAS, indicating that both surgical techniques provide clinically meaningful benefits from the patient's perspective.[22,23] Notably, the MCID values calculated in our study were lower than those previously reported, which may be explained by the substantial magnitude of clinical improvement observed and the relatively limited variability in postoperative scores. Furthermore, considering that activities of daily living require only a fraction of maximal grip and pinch strength, both procedures appear functionally comparable in practical terms. This interpretation can be further supported by randomized-controlled trials demonstrating no significant differences between the two techniques in terms of VAS (SMD −0.05) and QuickDASH (SMD 0.53).[3,11,24]

In terms of strength outcomes, review of the literature reveals that arthrodesis may provide approximately 10 to 25% higher key pinch strength, while no consistent difference has been demonstrated in grip strength.[3,8,11] Following T + LRTI, grip strength is typically reported between 10 and 20 kg, and key pinch strength between 4 and 6 kg.[7,21] In our study, there were no significant differences between the groups in terms of grip strength, consistent with the existing literature. However, in contrast to previous reports, no significant difference was observed in key pinch strength within our cohort. Contrary to prevailing reports of higher key pinch strengths frequently reported in the literature, Spekreijse et al.[12] observed no significant intergroup differences in their five-year follow-up series. Similarly, Hippensteel et al.[11] demonstrated that postoperative key pinch strength was comparable between the groups, indicating no statistically significant differences. Additionally, Smaby et al.[25] reported that the pinch strength required for activities of daily living ranges from approximately 0.14 to 3.2 kg, indicating that even lower postoperative pinch values might be functionally sufficient. Therefore, the 4 to 5 kg pinch strength achieved after T + LRTI appears sufficient for daily tasks, suggesting that the additional strength provided by arthrodesis may have limited clinical relevance, particularly in low-demand patients. In our study, the T-LRTI group achieved a mean palmar pinch strength of 4.6 kg and a key pinch strength of 4.1 kg, which appear to be sufficient for performing activities of daily living.

Proximal migration of the first metacarpal is one of the most frequently discussed radiographic parameters following T + LRTI. Although proximal migration may be considered an inevitable consequence following trapeziectomy, several studies have demonstrated only a weak correlation between the degree of migration and clinical outcomes.[7,26,27] Even in cases with a marked reduction in the scaphometacarpal distance, no significant negative impact on VAS or functional scores has been reported. In our study, the measured mean subsidence of 4.5 (range, 1.4 to 8.0) mm was consistent with values reported by Reissner et al.,[28] while postoperative functional outcomes and VAS improved significantly, further supporting the limited clinical relevance of radiographic subsidence. These findings suggest that patient-reported functional outcomes should be prioritized over radiographic parameters while evaluating surgical success.

Arthrodesis has traditionally been associated with relatively high complication rates, particularly nonunion, with reported rates ranging from 0 to 39% in the literature.[20,26,29-33] The literature demonstrates that complication rates in the arthrodesis group are approximately twice as high.[3] In contrast, complications following T + LRTI are usually less severe and can often be managed conservatively.[3,7,27] In our study, the overall complication rate was 12.5%, with no significant difference between groups. This finding suggests that, with appropriate patient selection and surgical technique, complication rates may be minimized and comparable outcomes can be achieved. No cases of nonunion were observed in our series; however, this finding may be attributable to the small sample size, and higher rates may be expected in larger patient cohorts.

One of the main strengths of this study is its comparative multi-center design, which enhances the generalizability of the findings by reflecting real-world surgical practice across different institutions. The inclusion of two commonly performed surgical techniques with standardized outcome measures (VAS, QuickDASH, and objective strength testing) provides a comprehensive assessment of both clinical and functional results. Additionally, the use of MCID analysis allows interpretation of outcomes in terms of clinical relevance rather than purely statistical significance, which strengthens the applicability of the findings in daily clinical practice. Another strength is the relatively homogeneous baseline characteristics between the groups, which reduces selection bias and allows a more balanced comparison of surgical outcomes. The inclusion of both subjective and objective parameters, as well as radiological evaluation, further increases the robustness of the outcome assessment.

The main limitation of this study is its retrospective, non-randomized design and small sample size. Additionally, surgical procedures and postoperative evaluations were performed by different surgeons, which may have introduced variability. Another limitation is the absence of preoperative dynamometric measurements; however, this was partially addressed by comparing postoperative values with the contralateral extremity.

In conclusion, both T + LRTI and arthrodesis provide effective and comparable pain relief and functional outcomes in the surgical management of thumb CMC osteoarthritis. In our study, no significant differences were observed between the two techniques in terms of functional results, and postoperative outcomes did not appear to be substantially influenced by patient-specific demographic factors. These findings suggest that both procedures can be considered reliable surgical options. However, further studies with larger sample sizes, prospective randomized designs, and longer follow-up periods are warranted to confirm these findings and to better define long-term outcomes.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: C.A., M.S.: Conception and design, drafting of the article; C.A., M.S., T.O., H.E., Y.A., E.C.Z., A.P., F.E.: Collection and assembly of data; C.A., F.E., M.S.: Analysis and interpretation of the data, statistical expertise; C.A., M.S., F.E.: Critical revision of the article for important intellectual content. All authors read and approved the final manuscript.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

AI Disclosure: The authors declare that artificial intelligence (AI) tools were not used, or were used solely for language editing, and had no role in data analysis, interpretation, or the formulation of conclusions. All scientific content, data interpretation, and conclusions are the sole responsibility of the authors. The authors further confirm that AI tools were not used to generate, fabricate, or 'hallucinate' references, and that all references have been carefully verified for accuracy.

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