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ORIGINAL ARTICLE

What is the clinical and functional effect of performing suspension arthroplasty with abductor pollicis longus tendon slip to carpometacarpal joint osteoarthritis of the thumb?

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Thumb function is achieved through painless movement and stability. An important part of the thumb's wide range of motion (ROM) originates from the carpometacarpal (CMC) joint, which uniquely enables for lateral and rotational movements.[1] Over the age of 75 years, thumb CMC joint osteoarthritis is radiographically detected in approximately 25% of males and 40% of females.[2] Thumb CMC joint osteoarthritis may develop due to rheumatoid arthritis, post-traumatic, various acquired and congenital ligament disorders, or it may be observed primarily.[3] The diagnosis can be made simply by

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ABSTRACT

Objectives: This study aims to investigate the clinical, radiological, and functional results of trapeziectomy, ligament reconstruction and suspensionplasty surgery with abductor pollicis longus (APL) tendon slip autograft to thumb carpometacarpal (CMC) osteoarthritis.

Patients and methods: Between January 2011 and June 2017, a total of 25 hands of 25 patients (4 males, 21 females; mean age: 63.6±5.8 years; range, 54 to 76 years) were included. All patients underwent trapeziectomy and ligament reconstruction and suspensionplasty procedure due to the diagnosis of thumb CMC joint osteoarthritis. The patients were administered the Patient-Rated Wrist Evaluation Questionnaire (PRWE), Quick Disabilities of the Arm, Shoulder, and Hand (Q-DASH), and Visual Analog Scale (VAS). Scaphometacarpal distance (SMD), Kapandji opposition score, thumb range of motion (ROM), grip strength, tip pinch, lateral pinch, and palmer pinch values were measured for both hands. The values calculated for the operated and contralateral hands of the patients were compared.

Results: The ROM measurements, Kapandji opposition scores, and pinch values of the operated hands of the patients were found to be statistically significant lower compared to the contralateral hands ($p<0.001$, $p<0.001$, $p=0.002$; respectively). The grip strength values were similar for both hands ($p=0.147$). The median SMD in the operated hand was found to be 7.5 mm and 12.1 mm in the contralateral hand ($p<0.001$).

Conclusion: The ROM, strength and functional results were reached a satisfactory level, particularly in the patients with a follow-up period of ≥36 months. In patients with thumb CMC joint osteoarthritis, ligament reconstruction and suspensionplasty using APL tendon slip are considered to be a useful and preferable surgical technique modification.

Keywords: Carpometacarpal joint osteoarthritis, suspension arthroplasty, thumb, trapeziectomy.

conventional radiography. In radiographic staging, defined by Eaton and Glickel[4] & Eaton and Littler[5] in 1973 and modified later by including scaphotrapezial joint evaluation, is used most commonly.

In the early stages of thumb CMC osteoarthritis, conservative methods are often sufficient to reduce pain such as immobilization and pain relief drugs. However, surgical procedures are required in severe stages to relieve pain and regain the mobility of the thumb.[6,7]

Trapeziectomy is the first surgical procedure described in thumb CMC joint arthritis.[8] Although treatment methods such as thumb CMC joint arthroscopy, arthrodesis, arthroplasty, and metacarpal osteotomy are discussed in the literature. Tendon grafts are an important alternative that can be used as a supportive structure in hand and wrist pathologies.[9] Trapeziectomy with intermetacarpal ligament reconstruction and tendon interposition (LRTI) or suspensionplasty is among the methods preferred by hand surgeons.[10-14]

In the present study, we aimed to investigate the clinical, radiological, and functional results of trapeziectomy, ligament reconstruction and suspensionplasty with abductor pollicis longus (APL) tendon slip in thumb CMC osteoarthritis.

PATIENTS AND METHODS

This single-center, retrospective, descriptive cohort study was conducted at Gazi University Faculty of Medicine, Department of Ortopedics and Traumatology between January 2011 and June 2017. Initially, data of 41 patients with a diagnosis of thumb CMC joint osteoarthritis were reviewed. Patients who underwent additional surgeries (such as revision surgery or arthrodesis) and those with missing data were excluded from the study. Finally, a total of 25 hands of 25 patients (4 males, 21 females; mean age: 63.6±5.8 years; range, 54 to 76 years) were included. All patients underwent trapeziectomy and intermetacarpal ligament reconstruction and suspensionplasty procedure due to the diagnosis of thumb CMC joint osteoarthritis. A written informed consent was obtained from each patient. The study protocol was approved by the Gazi University Faculty of Medicine Ethics Committee (Date: 24/09/2018, Decision No: 685). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Current examinations and tests of the patients were performed by two different orthopedic surgeons experienced in hand surgery. Patients included in the study were administered the Patient-Rated Wrist Evaluation Questionnaire (PRWE) and Quick Disabilities of the Arm, Shoulder, and Hand (Q-DASH), and Visual Analog Scale (VAS) for both hands. The Kapandji opposition score, thumb ROM, grip strength (JAMAR hydraulic hand dynamometer - Sammons Preston, Inc., Bolingbrook, IL, USA), tip pinch, lateral pinch and palmer pinch (B&L pinch gauge - B&L Engineering, Santa Ana, CA, USA) values were measured. Besides, patients' demographic information, follow-up period and routinely assessed pretreatment VAS scores were recorded from patient files.

A digital X-ray device (Ralco R225 Collimator, Ralco X-Ray Equipment's, Biassono, Italy) was used for pre- and postoperative conventional radiographs. The evaluation of conventional radiographies was done with Enlil PACS System-2.5 (Enlil PACS Viewer, Eroglu Software, Eskisehir, Turkey). For inter-observer reliability of the measurements and to minimize technical errors, the assessments were performed twice (two weeks apart) by two different orthopedic surgeons experienced in hand surgery. The inter-observer reliability of measurements was between 0.820 (95% confidence interval [CI]: 0.604-0.918) and 0.983 (95% CI: 0.961-0.992). In the preoperative radiographs of the patients, thumb CMC joint osteoarthritis was evaluated according to the modified Eaton staging system. In the postoperative final control radiographs, scaphometacarpal distance (SMD) measurements were done and recorded separately on both hands.

For the evaluation of the relationship between the pain and functional status of the patients and the follow-up period, the patients were divided into two groups (<36 months and ≥36 months) by taking the mean follow-up time as a reference and, the difference between the groups was statistically analyzed.

Surgical procedures

The surgical technique used in the current study was similar to the procedure described by Thompson,[15] and it was differentiated by opening transvers tunnels in the first and second metacarpal base and suspending the first metacarpal by forming a hammock with APL tendon slip, between the flexor carpi radialis (FCR) and the APL tendons. This technique is a new modification of APL usage.

The incision described by Wagner[16] was made over the thumb CMC joint. The dorsal capsule of the thumb CMC joint was reached by passing through the APL and abductor pollicis brevis (APB) tendons. The capsule was opened, and the trapezium bone was

excised. The radial slip of the APL tendon was, then, selected and released with a mini-incision opened at the middle third of the forearm, and the tendon was pulled into the thumb CMC joint space. Then tunnels were opened in the bases of the first and second metacarpals, parallel to the joints and approximately 3 to 4 mm above the articular cartilage (Figure 1). The tendon was passed through the tunnels opened with a mini dorsal incision made over the base of the second metacarpal bone. After exiting the tunnel, the tendon was pulled into the trapeziectomy area from the second web. The tendon was, then, stretched while the thumb was distracted distally to level the joint lines, and a hammock was formed by wrapping it between the preserved APL and FCR tendons several times and sutured using non-absorbable sutures. Thus, the first metacarpal was suspended and the trapeziectomy cavity was filled with a hammock consisting of FCR, APL and APL slip. The CMC joint gap was closed by suturing the joint capsule over the hammock and tendon fold (Figure 2). At the end of surgery, a thumb-supported short arm splint was used for six weeks.

Statistical analysis

Statistical analysis was performed using the IBM SPSS for Windows version 20.0 software (IBM Corp., Armonk, NY, USA). Continuous variables were presented in mean ± standard deviation and median (min-max), while categorical variables were presented in number and frequency. Compliance of the variables to normal distribution was performed by visual (histogram and probability charts) and analytical methods (Shapiro-Wilk tests). The data of continuous variables did not show a normal distribution. The Wilcoxon signed-rank test was used to compare measurements between operated hands and contralateral hands. The Mann-Whitney U test was preferred to compare parameters between the subgroups (<36 months *vs.* ≥36 months). The chi-square test was used to compare categorical variables. A p value of <0.05 was considered statistically significant.

RESULTS

The mean follow-up was 36.8±23.4 (range, 12 to 88) months. Besides, the follow-up time of 12 (48%) patients was less than 36 months, but it was ≥36 months for the other 13 (52%) patients. While all of the 10 operated right hands were the dominant hand of the patients, two of 15 operated left hands were dominant hands. All the operated hands of the patients were determined as Eaton Grade III-IV osteoarthritis. Patient characteristics and baseline demographics are presented in Table I.

The ROM measurements and Kapandji opposition scores of the operated hands of the patients were found to be statistically significantly lower compared to their contralateral hands with small amounts (p<0.001).

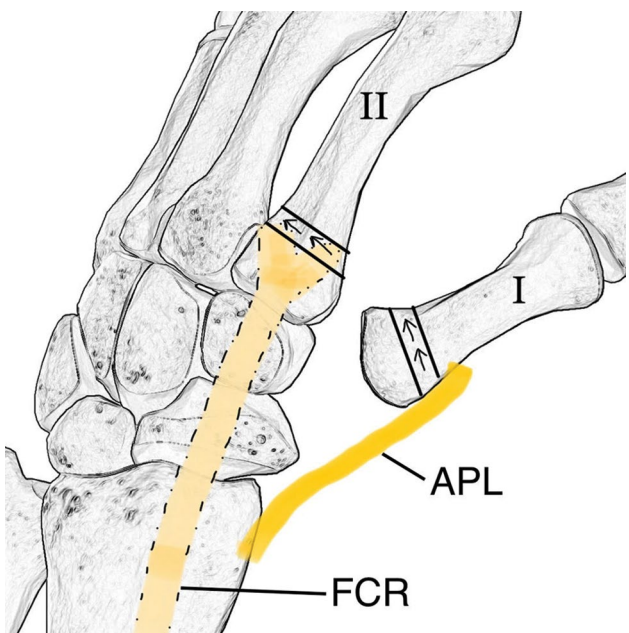

FIGURE 1. Representation of the tunnels opened in the first and second metacarpal bones.
APL: Abductor pollicis longus; FCR: Flexor carpi radialis.

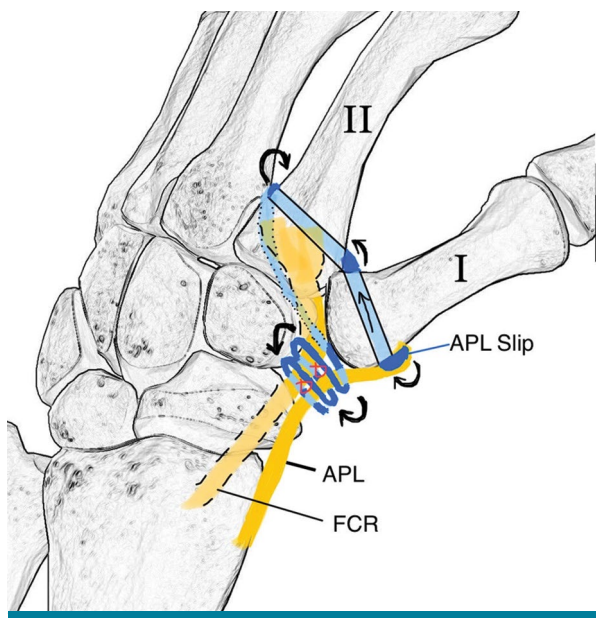

FIGURE 2. The APL slip is passed through the tunnels and undergone below the second web to the volar, pulled into the trapeziectomy cavity and the hammock is formed.
APL: Abductor pollicis longus; FCR: Flexor carpi radialis.

TABLE I
Baseline demographics and patient characteristics

	n	%	Mean±SD	Median	Min-Max
Age (year)			63.6±5.8	63	54-76
Follow-up period (month)			36.8±23.4	36	12-88
Sex					
Male	4	21			
Female	16	84			
Dominant side					
Right	23	2			
Left	92	8			
Operated side					
Right	10	15			
Left	40	60			
Follow up period group					
<36 m	12	13			
≥36 m	48	52			

SD: Standard deviation.

The tip pinch, lateral pinch, and palmar pinch values of the operated hands of the patients were found to be statistically significantly lower than the contralateral hands (p=0.002, p<0.001, and p<0.001, respectively). The grip strength values were lower than the contralateral hands, although it did not reach statistical significance (p=0.147) (Table II).

In the functional scores of the patients, the mean PRWE score of the patients was 5.96±6.75, while the mean Q-DASH score was 6.73±5.33. When the VAS pain scores were compared preoperatively (median=8, min=7, and max=9) and postoperatively (median=1, min=0, and max=4), there was a statistically significant decrease (p<0.001).

As a result of the comparison of SMD measurements performed between the operated hands and the contralateral hands of the patients, the median SMD in the operated hand was found to be 7.5 mm in the operated hand, but 12.1 mm in the contralateral hand. This difference was statistically significant (p<0.001) (Table II).

Considering the duration of patients' postoperative period, statistically significant positive changes in clinical and functional values were detected in almost all parameters, particularly in patients who exceeded 36 months after surgery. In particular, the change mentioned in the patient-related outcome scores of the patients was observed (Table III).

DISCUSSION

The current study showed that patients who underwent trapeziectomy and ligament reconstruction and suspensionplasty for thumb CMC

TABLE II
Comparison of operated and contralateral hands on clinical and radiological parameters

	Operated side		Contralateral side		
	Median	Min-Max	Median	Min-Max	*p**
Flexion (°)	19	13-23	23	15-25	<0.001
Extension (°)	14	9-17	15	13-25	<0.001
Abduction (°)	61	50-70	67	63-72	<0.001
Kapandji score	9	8-10	10	9-10	<0.001
Tip to tip pinch	4	2.5-7.5	4.5	3-7.5	0.002
Lateral pinch	4.5	3.5-7	5.5	3.5-8.5	0.001
Palmar pinch	5.5	3.5-8	6	3.5-8.5	0.001
Grip strength	22	14-34	22	16-34	0.147
Scaphometacarpal distance	7.5	5.1-9.8	12.1	9.8-14.3	<0.001

* Wilcoxon signed rank test.

TABLE III
Comparison of the clinical and radiological results between patients who were followed for <36 months versus ≥36 months

	<36 months		≥36 months		
	Median	Min-Max	Median	Min-Max	*p**
PRWE	8	0-25	0.5	0-15.5	0.010
Q-DASH	9.09	2.27-25	4.55	0-9.09	0.014
VAS	2	1-4	0.5	0-2	<0.001
Flexion (°)	19	14-20	22	13-23	0.023
Extension (°)	12	9-15	14.5	10-17	0.048
Abduction (°)	58	50-65	65	60-70	<0.001
Kapandji score	9	8-10	9	8-10	0.481
Grip strength	20	14-34	24	18-34	0.011
Tip to tip pinch	4	2.5-7	4.25	3-7.5	0.554
Lateral pinch	4.5	3.5-8.5	5.25	3.5-8.5	0.641
Palmar pinch	5	3.5-8.5	6	3.5-8.5	0.278
Scaphometacarpal distance	8.5	5.1-9.8	7	6-9	0.003

* Mann-Whitney U test; PRWE: Patient-Rated Wrist Evaluation Questionnaire; Q-DASH: Quick Disabilities of the Arm, Shoulder, and Hand, and VAS: Visual analog scale.

joint osteoarthritis achieved satisfactory functional results. These results improved depending on the time taken postoperatively. In particular after 36 months, the patients had improved patient-related outcome scores, increased ROM, and had higher thumb grip strength values, indicating a statistically significant difference.

One of the first defined methods in thumb CMC joint osteoarthritis is only the total excision of the trapezium. In that method, weakness in the movements and instability of the thumb are the most commonly observed complications. Besides, metacarphoscaphoid osteoarthritis can be observed due to proximal migration of the metacarpal bones in the long-term period.[12,17,18] The proximal migration of the first metacarpal may also cause instability and weakness in the kinematic analysis of hand.[19,20] The suspension of the first metacarpal and tendon interposition to the remaining area after trapeziectomy can be preferred to avoid the mentioned long-term effects. However, ligament reconstruction and suspensionplasty with APL slips are more popularized, as the effect of thumb ROM and wrist flexion strength is negligible.[21]

The functional capacity of the affected hands of patients who suffer from thumb CMC osteoarthritis decreases due to the reasons related to the disease itself and the avoidance of use. After the treatment of the disorder, one of the important control techniques that can be taken as a reference following upper extremity interventions to determine the status in function is the comparison of the measurement values of the patients' contralateral hand with the affected hand.

Although some authors have claimed that osteoarthritis may affect both hands of patients and an independent group should be formed as a control, no limitation was observed about contralateral hand selection for comparing, as contralateral hand conditions of the patients were checked clinically and radiologically and patients with symptoms or radiologic findings of bilateral thumb CMC osteoarthritis were excluded from the study.[22,23]

The ROM measurements and Kapandji opposition scores of the operated hands of the patients were found to be very close, but slightly lower compared to the contralateral hands. However, we considered that the clinical significance of this statistical difference was limited, since the Q-DASH and PRWE scores were close to the scores evaluated as normal in the literature. In the current study, the mean PRWE score was calculated as 5.96±6.75. In the literature, the mean value of PRWE was reported to be 7.7±15 in a study involving 1,042 individuals aged between 18 and 90 to determine the normative level of the PRWE score in normal population.[24] In a study involving 1,098 volunteers over the age of 18 years with an average age of 50, the average Q-DASH score was calculated as 4.8; however, the authors reported that the score increased in female sex (mean score: 6) and older ages.[25] In the aforementioned study, the average QDASH score of women between the ages of 50 to 65 was calculated as 7.4. The average age of the current study was 63.6±5.8 years and 84% of the patients were women, and the

mean Q-DASH questionnaire score was calculated as 6.73±5.33. The normative values stated in the literature can be regarded as similar, when the current study scores are matched demographically to normative data study.[25,26]

Although it was difficult to measure the exact numerical value of the thumb joint ROM with a goniometer, further values of the thumb joint ROM were determined in our study, when it was compared to the studies with similar follow-up periods in the literature.[27-30] The Kapandji opposition scores were evaluated and it was observed that the mean score was above 9, indicating that the thumb could be moved comfortably in almost full ROM.

Among the most important findings showing the functionality of a hand are the grip strength and thumb pinch strength. We observed minimal changes in the grip strength of the operated hands, which were not statistically significant compared to the contralateral hands, similar to the literature ($p=0.147$).[23,29,31] Although the values increased slightly as the follow-up period lengthened, no statistically significant difference was observed. However, grip strength decreased, as the follow-up period lengthened at Yaffe et al.[29] study. It can be attributed to the decrease in muscle strength, as the patients get older. However, in a study with a control group from the same age group, the grip strength of the operated hands was found to be 9% higher than the control group, while a decrease in pinch strength was observed.[32] When the thumb pinch strengths were compared, a statistically significant decrease was observed in all three values. However, functional scoring tests showed that it did not significantly affect the daily life of the patients.

When the results were examined according to the time elapsed after surgery, the ROM analysis, patient-related outcome scores, and grip strength values improved significantly, particularly in patients who completed the 36-month follow-up period. Another important result was the reduction of pain. The mean preoperative VAS pain score of the patients was 8.22±0.73, while the mean postoperative pain level decreased to 1.48±1.27 even reached 0 in seven patients. Besides, the mean VAS score of the patients who completed the 36-month follow-up period was significantly lower than the other group.

In the literature, a decrease in the SMD in the postoperative period has been observed in many studies conducted with various techniques.[29,33-36] In studies in which the first metacarpal was suspended, no significant difference was found between the patient groups with or without tendon interposition.[37-39] The relationship between SMD difference and functional status (pain, strength and ROM) has been examined several times and, although a study showed that there was a correlation between the lateral pinch value and SMD, this finding was not supported by additional studies.[19,28,37]

The retrospective design of the study and limited sample size are the main limitations of the current study. The use of only APL tendon radial slip for suspensionplasty as a tendon autograft prevented the comparison with other techniques described in the literature.[40] The FCR and split FCR tendons are frequently selected as autografts in the LRTI procedure. Therefore, a comparison of the effects of donor field problems and the absence of the autograft selected tendon on wrist function after tendon harvesting could not be done. Another limitation of the study is that the subjects included in the study were evaluated only cross-sectionally, not at regular intervals. Due to these limitation, evaluation of the effect of time on healing was aimed by dividing the patient group into two according to the 36-month follow-up period in the current study. As a result, the mid-term results of the thumb CMC joint osteoarthritis patients treated with the trapeziectomy and suspensionplasty with APL tendon slip were found to be satisfactory. It was observed that the ROM, strength examinations and functional results of patients was improved with a follow-up period of ≥36 months.[41]

In conclusion, trapeziectomy and suspensionplasty is a useful and preferable treatment strategy in patients with thumb CMC joint osteoarthritis. Nevertheless, further large-scale, long-term, prospective studies are needed to confirm these findings.

Declaration of conflicting interests

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