

## Original Article

# Ligament reconstruction and tendon interposition in comparison with hematoma distraction arthroplasty for the treatment of arthritis in the trapeziometacarpal joint

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**Abstract:** Introduction: Arthritis in trapeziometacarpal joint is one of the most common types of osteoarthritis which do not respond to conservative therapies in progressed cases and require surgical processes. The current study compares the two successful techniques, ligament reconstruction and tendon interposition (LRTI) versus hematoma distraction arthroplasty (HDA). Methods: The current randomized clinical trial has been conducted on 56 patients with trapeziometacarpal joint osteoarthritis whom were randomly divided into two groups undergone surgical procedures of LRTI (n=28) and HDA (n=28). The patients were evaluated regarding hand function, pain intensity and pinching power using The Disabilities of the Arm, Shoulder and Hand (DASH), VAS and pulp pinching test, respectively, as well as radiological findings, including (proximal migration, lateral migration, and first web space) at baseline, within 3, 6 and 12 months postoperatively. Results: Pain intensity, pinching power, function based on DASH and radiological findings, including proximal and lateral migration and first web space significantly improved in a-year follow-up assessments ( $P$ -value  $<0.001$ ). The comparison of the techniques showed superior results of HDA regarding pinching power ( $P$ -value =0.004) and DASH ( $P$ -value =0.03). Conclusion: Based on this study, both LRTI and HDA were accompanied by significant improvement in function, pinching power and decrease in pain among the patients with the first carpometacarpal (CMC) joint osteoarthritis; however, the outcomes of HDA were generally superior.

**Keywords:** Osteoarthritis, trapeziometacarpal joint arthritis, HDA, LRTI

## Introduction

Arthritis of the trapezoid-carpal joint (first Carpometacarpal joint) is one of the most common types of osteoarthritis, occurring in 15% of the general population [1]. This complication, which is more common in women over the age of 45, affects about one-third of postmenopausal women [2]. Patients with mild osteoarthritis generally respond well to conservative therapies; however, advanced cases of the disease, as well as in those who do not respond to conservative treatments, require surgical interventions [3].

So far, various surgical methods have been proposed to solve this issue, the common denomi-

nator of these methods is the elimination of abrasion between two joint surfaces [4]. These methods include trapezium excision, joint fusion and total joint replacement. The most common surgical procedure is ligament reconstruction and tendon interposition (LRTI); that was introduced in 1986 [2, 5].

The results of this surgery have been promising, and while there have been no significant complications, patients have expressed satisfaction with improved function and acceptable pain relief [6]. However, it was found that the LRTI method could not prevent proximal metacarpal migration; therefore, in 2003, a new method called hematoma distraction arthroplasty (HDA) was introduced, which used tra-

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pectomy with joint immobilization with K-wire. The results of this method also improved patients' pain and also helped them to maintain optimum hand functions [7-9].

So far, various studies have evaluated the efficacy of these surgical procedures and different results have been reported. It has been reported in 2013 that HDA method is satisfactory in regards to motion, strength, dexterity, and radiographs while LRTI is the preferred procedure for patients with Eaton Stage III carpometacarpal (CMC) joint arthritis [10, 11]. Another study claimed that both procedures are beneficial and associated with improvements in clinical outcomes of patients but the use of HDA method could bring better results within 5-years follow-up [12]. It has also been suggested that more studies on different populations are required to determine the best surgical procedure for patients [13].

We should note that limited studies have evaluated and compared these two treatments so far, and most studies in this field have been limited to evaluating one of the methods as a group. Here for the first time in our country, we aimed to evaluate and compare the results of HDA and LRTI procedures in a clinical trial on patients with trapeziometacarpal joint arthritis.

### Methods and material

#### *Study design*

This is a prospective clinical trial that was performed in 2019-2021 in Al-Zahra and Sepahan hospitals affiliated to Isfahan University of Medical Sciences. The current study was conducted on 70 patients with first carpometacarpal joint osteoarthritis referred to our medical centers. The protocol of this study was designed based on the Helsinki Treaty and approved by the Ethics Committee of Isfahan University of Medical Sciences (Ethics number: IR.MUI.MED.REC.1398.406).

#### *Inclusion and exclusion criteria*

The inclusion criteria were age more than 18 years, diagnosis of first carpometacarpal joint osteoarthritis by expert orthopedic surgeons confirmed by imaging studies and clinical examinations, non-responsive to medical treatments

and signing the written informed consent to participate in this study. The exclusion criteria were having any rheumatic diseases involving the joints, a previous history of joint surgery, incomplete data, lack of proper follow-up and patient's will to exit the study.

#### *Randomization and blinding*

Subjects who met the inclusion criteria were included in the study based on available sampling. Each of them was then assigned a number using random allocation software, which included them in one of the intervention groups (LRTI or HDA). None of the patients was aware of the allocated group and only the surgeon and surgical team were not blinded. The health-care provider, clinical assessor, data collector and data analyzer were also blinded to the groups of patients. After the analyses, the groups were decoded.

#### *Pre-operative assessments*

Demographic data of patients including age, gender, BMI and side of involved limb were collected. We also assessed pain of patients using visual analog scale (VAS), pulp pinching power in the involved hand, the Disabilities of the Arm Shoulder and Hand Score (DASH), proximal and lateral migration and the first web space before operations. Patients were randomized into the surgical groups.

#### *Measuring tools*

Pain in patients was assessed using VAS score. VAS is a validated, subjective measure for acute and chronic pain by which the pain is scored from 0 (least pain) to 10 (worst pain).

Shoulder joint symptoms were also assessed by the means of DASH score [14]. DASH score includes a questionnaire that examines symptoms (such as pain, weakness, etc.) as well as the patient's ability to perform some physical activity, and patients answer all the questions according to their health status last week. The minimum score is 30 and the maximum score is 150.

The pulp pinching power was measured using pulp pinching test. This test is calculated by a manometer and the person is asked to do his ability to pinch with maximum power and the

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**Figure 1.** Treatment of patients using hematoma distraction arthroplasty method.

manometer number was recorded. This operation was performed three times in each visit and its average was reported.

In order to investigate the proximal migration, anterior-posterior graphs were taken in the wrist view with lateral thumb in two positions: resting and maximum tip pinch effort. The proximal migration was calculated by dividing the length of the trapezoidal distance by the length of the proximal phalanx.

Stress and non-stress thumb graphs were used to examine lateral migration. The lateral margin of both thumbs was placed together and the percentage of the metacarpal thumb that passed through the lateral border of the longitudinal axis of the scaphoid was calculated and recorded as lateral migration.

The first web space was calculated by taking a graph with Robert view with maximum thumb abduction and the inter-metacarpal thumb-index angle was calculated to evaluate the restoration of the first web space.

### *Interventions*

**Hematoma distraction arthroplasty (HDA):** In this surgical procedure, a dorsal and radial inci-

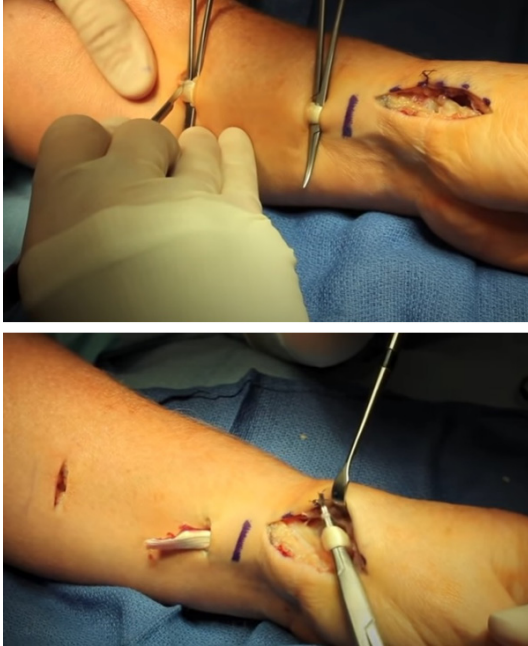
sion was first made in the CMC joint. In the next step, subcutaneous tissue separation and dissection was performed until it reached the surface of the CMC joint capsule. The joint capsule was then restored by making an incision from the base of the first metacarpal to the scaphoid surface, and due to the subluxation commonly seen in patients with CMC osteoarthritis, distraction of the thumb was performed to better expose the trapezium bone. After the bone was freed from the connective tissue, a trapectomy was performed with the help of an osteotomy.

After the trapectomy, the metacarpal bone was placed at its anatomical location at a 30-degree angle of palmar abduction and slight opposition. In the next step, a 1.6 mm K-wire was inserted through the skin from the base of the first metacarpal to the base of the second metacarpal, trapezoid or scaphoid (**Figure 1**). If necessary, more than one pin was used to provide better endurance. The joint capsule was then repaired and the surgical incision was sutured. After the surgery, the patient was splinted with a Spike tombe splint for 4 weeks, and ten days after the patient's surgery, the patient's suture was removed and K-wire was removed four weeks later.

**Ligament reconstruction with tendon interposition (LRTI):** In LRTI surgery, access to the trapezium metacarpal joint was made using incisions in the dorsoradial along the first metacarpal and then curvature toward the palm. After tissue dissection, the joint capsule was accessed and the trapezium bone and the articular surface of the first metacarpal were removed after opening the capsule. A tunnel was created by the connection between the first metacarpal medulla and the radial cortex. With a separate longitudinal incision, the flexor carpi radialis (FCR) tendon was split in two with a healthy distal connection, and one half was moved from the trapezium space to the dorsoradial. The tendon was removed from inside the metacarpal tunnel and exited the radial side and was fused with the radial periosteum.

For greater strength, the carpal radialis flexor tendon was passed around the polycystic laryngeal tendon and sutured to the origin of the polycystic laryngeal tendon, and then the tendon was repositioned to cover the metacarpal base. The rest of the tendon gathered on itself

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**Figure 2.** Treatment method using ligament reconstruction with tendon interposition.

and was placed inside the trapezius space. The intensity of tendon strain was adjusted to the extent that it did not restrict the CMC joint movements (**Figure 2**). In order to stabilize the first metacarpal in the abduction position, the immobilized pin was finally sutured and the patient's hand was supported with a splint for 4 weeks. The pins were pulled in week 4 and the abduction and extension movements began. In week 6, strengthening the tendon muscles and in week 8, Pinch and Grip movements began.

### *Post-operative measurements*

Patients were regularly visited within 3 months, 6 months and 12 months after surgeries. The pain intensity, pulp pinching power, DASH score, proximal and lateral migration and the first web space were measured in each visit. We also collected data regarding any possible complications.

### *Data analysis*

The obtained data were entered into the Statistical Package for Social Sciences (SPSS) version 24. Descriptive data were reported as mean, standard deviation, absolute frequency and percentage. Independent t-test, chi-square,

ANOVA and repeated measure ANOVA were used to analyze the data. *P*-value less than 0.05 was defined as the significance level.

## **Results**

### *Study population*

In the present study, 70 patients entered based on inclusion criteria. Eleven patients were excluded due to patient's will to exit the study ( $n=7$ ) and diagnosis of rheumatic diseases ( $n=4$ ). Of the remaining 59 patients, 30 were treated with LRTI and 29 with HDA. Four patients were then excluded from the first group (1 did not complete the questionnaire and 3 did not refer for follow-up) and 3 patients from the second group (1 with a defect in radiological evaluations and two patients did not participate in follow-up). Finally, 56 patients in two groups, including 28 in the LRTI group and 28 in the HDA group, completed the study. The CONSORT flow diagram of the patients is indicated in **Figure 1**.

### *Demographic data*

The mean age of the participants was  $54.52 \pm 11.42$  years and 18 patients (32.1%) were male and 38 patients (67.9%) were female. Primary analysis of demographic data showed no significant differences between two groups of patients regarding age ( $P=0.81$ ), BMI ( $P=0.91$ ), gender ( $P=0.56$ ), side of the involved hand ( $P=0.19$ ) and involvement of the dominant hand ( $P=0.77$ ). These data are indicated in **Table 1**.

### *Pre-operation assessments*

Investigating the pain intensity showed no significant differences between two groups at the beginning of the study ( $P=0.65$ ). No significant differences were also observed between two groups regarding the following items: pulp pinching power ( $P=0.95$ ), DASH score ( $P=0.06$ ), proximal migration ( $P=0.90$ ), lateral migration ( $P=0.08$ ) and first web space ( $P=0.33$ ).

### *Post-operative assessments*

Assessments of variable items showed that both groups had significant improvement over time in one year in terms of pain ( $P$ -value  $< 0.001$  for both groups); while the comparison

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**Table 1.** Comparison of the demographic data between two groups

Variable		Groups		P-value
		LRTI	HDA	
Age (years) (mean ± SD)		54.64±21.04	54.32±11.22	0.81*
BMI (kg/m <sup>2</sup> ) (mean ± SD)		26.42±4.06	26.67±3.44	0.91*
Gender (N (%))	Male	10 (17.9%)	8 (14.3%)	0.56**
	Female	18 (32.1%)	20 (35.7%)	
Involved hand (N (%))	Left	8 (14.3%)	4 (7.1%)	0.19**
	Right	20 (35.7%)	24 (42.9%)	
Involvement of the dominant hand (N (%))	Yes	9 (16.1%)	8 (14.3%)	0.77**
	No	19 (33.9%)	20 (35.7%)	

LRTI: ligament reconstruction and tendon interposition, HDA: hematoma distraction arthroplasty, \*Independent-T, \*\*Chi-square.

of the two groups in general did not show a significant difference in terms of pain relief ( $P$ -value =0.66). Evaluation of pulp pinching power in the two groups showed significant improvements in both groups compared to the beginning of the study ( $P$ -value <0.001 for both groups); but patients in the HDA treatment group had higher pulp pinching power ( $P$ -value =0.004). In all subsequent evaluations and in total, we indicated higher DASH score in patients treated with HDA method ( $P$ -value <0.001). It is noteworthy that both treatments significantly led to functional improvement in patients ( $P$ -value <0.001 for both groups).

Evaluations of lateral and proximal migration showed significant improvements in both items in all patients ( $P$ <0.01), however, patients in the LRTI group had more improvements in lateral migration compared to HDA group ( $P$ =0.04). Analysis of data regarding first web space also showed significant improvements in both groups ( $P$ <0.01) but no significant differences between groups. These data are summarized in **Table 2.**

### Discussion

In the present study, the two treatment groups were not different in terms of demographic characteristics, which indicates the elimination of the possible confounding role of these factors in the final conclusion obtained by comparing the two treatments. At the end of this study, we observed that both LRTI and HDA significantly reduced pain, improved hand function, and significantly increased pinching power as the main function of the first carpometacarpal joint, improved condition in radiographic find-

ings. However, the comparison of these two methods with each other in general indicates the superiority of HDA treatment over the other method in terms of pinching power and functional status.

According to our research, so far only three studies have compared these two methods, and other studies have evaluated only each method separately.

In a 2006 study, Tolo compared the two treatments and stated in his assessments of pain and performance improvement that both treatments effectively improved patients, while not reporting a significant difference between the two. He further emphasized the need for more studies for HDA due to the less invasiveness of the HDA method and the promising results of this method as an alternative to the older LRTI method, but due to the lack of long-term follow-up of patients, they did not introduce any method over the other [15].

In another study conducted by Sandvall and colleagues with a two-year follow-up design of patients, in line with the present study, they stated that LRTI and HDA therapies significantly improved function, increased pinching power, and reduced patient pain. They did not even find a significant difference between the two interventions, except that they stated that the duration of surgery in LRTI treatment was about one hour longer [16]. Our findings were somehow in line with these results emphasizing the effectiveness of both methods in the treatments of arthritis in the trapeziometacarpal joint.

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**Table 2.** Comparison of pre and post-operative variables between two groups

Variable (mean ± SD)		Time intervals				P-value (time)	P-value (intervention)
		Before	3 months	6 months	12 months		
VAS	LRTI	8.03±1.97	5.39±1.52	2.21±0.59	0.82±0.49	<0.001	0.66
	HDA	7.82±1.67	4.96±1.24	2.10±0.59	1.28±1.18	<0.001	
P-value		0.65	0.23	0.67	0.04		
Pinching power	LRTI	2.08±0.60	2.75±0.39	3.84±0.49	4.71±0.96	<0.001	0.004
	HDA	2.10±1.50	3.90±0.98	4.25±0.77	5.41±0.58	<0.001	
P-value		0.95	<0.001	0.08	0.001		
DASH	LRTI	38.71±11.06	25.75±6.19	19.71±6.96	16.11±6.21	<0.001	0.03
	HDA	37.02±10.57	21.42±6.97	15.61±7.51	12.25±6.52	<0.001	
P-value		0.05	0.02	0.03	0.02		
Proximal migration	LRTI	7.16±0.39	5.18±1.09	4.66±1.39	3.94±1.82	<0.001	0.84
	HDA	7.22±1.37	5.37±1.05	4.72±1.37	3.98±1.51	<0.001	
P-value		0.90	0.60	0.91	0.89		
Lateral migration	LRTI	6.78±1.24	4.47±1.81	4.04±1.52	2.82±0.72	<0.001	0.04
	HDA	7.45±1.44	5.02±1.13	4.65±1.92	3.13±0.46	<0.001	
P-value		0.08	0.10	0.88	0.04		
First web space	LRTI	36.49±6.51	41.73±6.57	45.01±5.17	47.89±4.37	<0.001	0.54
	HDA	34.72±7.11	43.28±7.36	46.81±4.98	49.50±4.08	<0.001	
P-value		0.33	0.40	0.19	0.16		

LRTI: ligament reconstruction and tendon interposition, HDA: hematoma distraction arthroplasty, DASH: The Disabilities of the Arm, Shoulder and Hand.

A 6.8-year-old cohort study by Corain and others showed that the two therapies were similar in function, pain relief, and radiological evaluations. He did not report superiority in either method over the other, although both methods improved patients' symptoms well [4]. One of the advantages of his study, which is superior to our study, is the study of the complications of each surgery. Short follow-up period in our study is another limitation of our study and tenosynovitis may have occurred in long-term evaluations.

One of the relatively common complications of LTRI surgery is damage to the cutaneous branch of the median nerve of the median nerve, a finding that causes a tingling sensation [17].

Studies show that this condition improves over time. However, perhaps the reason for the significant difference in DASH score after this surgery could be paresthesia and patients could not cope with these conditions within the first year after surgeries [16, 18]. Studies evaluating the severity of pain in each of the study methods have shown significant and even complete improvement in pain in the long-term fol-

low-up of both methods [16, 19, 20]. However, most studies have yielded these results in the long run. But the findings of our study yielded similar results only in the one-year evaluation.

Other studies evaluating pinching have found that both methods are increasingly associated with improved pinching power. It has been indicated that the increasing trend of pulp pinching power continued for about 6-7 years followed by a plateau afterwards [4, 17, 19, 21]. Radiographic assessments are limited in terms of migration, especially in the context of HDA. However, migration has been suggested as an uncommon complication of both methods, and studies suggest that proximal migration has nothing to do with pinching power in LTRI surgery and, as a complication, is not significantly associated with significant surgical concerns [20]. Lateral migration has also been found in long-term follow-up studies in less than 12% of patients over 10 years [18]. Regarding HDA surgery, Gray and colleagues in a 6.4-year follow-up reported migration and relaxation in 13.6% of patients [19]. Corain and others did not report any cases of lateral or proximal migration in their two-year follow-up [4]. However, the

long-term consequences of HDA and the impact of possible migration on osteoarthritis joint function still need further evaluation. The first web space was preserved in both methods, a finding that other studies have noted in longer follow-ups [4, 16, 18].

Short-term follow-up and failure to evaluate DASH subscales are some of the limitations of the present study. In addition, patients have not been evaluated for complications of surgery, which can be valuable findings with further studies.

### Conclusion

According to the present study, both LTRI and HDA methods in a one-year follow-up significantly improved performance, increased pinching power and reduced pain in patients with first CMC osteoarthritis; but in general, the HDA method was associated with better results.

### Disclosure of conflict of interest

None.

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### References

- [1] Crisco JJ, Patel T, Halilaj E and Moore DC. The envelope of physiological motion of the first carpometacarpal joint. *J Biomech Eng* 2015; 137: 101002.
- [2] Halilaj E, Rainbow MJ, Moore DC, Laidlaw DH, Weiss AP, Ladd AL and Crisco JJ. In vivo recruitment patterns in the anterior oblique and dorso-radial ligaments of the first carpometacarpal joint. *J Biomech* 2015; 48: 1893-1898.
- [3] Lahiji F, Zandi R and Maleki A. First carpometacarpal joint dislocation and review of literatures. *Arch Bone Jt Surg* 2015; 3: 300.
- [4] Corain M, Zampieri N, Mugnai R and Adani R. Interposition arthroplasty versus hematoma and distraction for the treatment of osteoarthritis of the trapeziometacarpal joint. *J Hand Surg Asian Pac Vol* 2016; 21: 85-91.
- [5] Robles-Molina MJ, Lopez-Caba F, Gomez-Sanchez RC, Cardenas-Grande E, Pajares-Lopez M and Hernandez-Cortes P. Trapeziectomy with ligament reconstruction and tendon interposition versus a trapeziometacarpal prosthesis for the treatment of thumb basal joint osteoarthritis. *Orthopedics* 2017; 40: e681-e686.
- [6] Donato D, Abunimer AM, Abou-Al-Shaar H, Willcockson J, Frazer L and Mahan MA. First carpometacarpal joint denervation for primary osteoarthritis: technique and outcomes. *World Neurosurg* 2019; 122: e1374-e1380.
- [7] Özçelik İB, Uğurlar M and Sarı A. Arthroscopic hemitrapeziectomy and suture button suspensionplasty in the treatment of first carpometacarpal joint eaton-littler stage 2-3 arthrosis. *J Wrist Surg* 2019; 8: 132-138.
- [8] Bakri K and Moran SL. Thumb carpometacarpal arthritis. *Plast Reconstr Surg* 2015; 135: 508-520.
- [9] Seyhan H. Konservative und operative behandlung der rhizarthrose. *Praxis Handreha* 2020; 1: 62-67.
- [10] Patel TJ, Beredjikian PK and Matzon JL. Trapeziometacarpal joint arthritis. *Curr Rev Musculoskelet Med* 2013; 6: 1-8.
- [11] Muramatsu K, Tani Y, Seto T, Arcinue J, Rayel F, Hashimoto T, Iwanaga R and Sakai T. Partial trapeziectomy for Eaton stage III thumb carpometacarpal arthritis: ligament reconstruction with tendon interposition using the entire flexor carpi radialis and interference screw fixation. *Eur J Orthop Surg Traumatol* 2021; [Epub ahead of print].
- [12] Yao J and Cheah AE. Mean 5-year follow-up for suture button suspensionplasty in the treatment of thumb carpometacarpal joint osteoarthritis. *J Hand Surg Am* 2017; 42: 569.e561-569.e511.
- [13] Berger AJ and Meals RA. Surgical treatment of carpometacarpal arthritis: what does the science show? *Curr Orthop Pract* 2014; 25: 420-425.
- [14] Hammond A, Prior Y and Tyson S. Linguistic validation, validity and reliability of the British English versions of the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire and QuickDASH in people with rheumatoid arthritis. *BMC Musculoskelet Disord* 2018; 19: 118.
- [15] Tolo ET. Ligament reconstruction and tendon interposition versus trapeziectomy and hematoma distraction arthroplasty for treatment of trapeziometacarpal arthritis. *Curr Opin Orthop* 2006; 17: 283-287.
- [16] Sandvall BK, Cameron TE, Netscher DT, Epstein MJ, Staines KG and Petersen NJ. Basal joint osteoarthritis of the thumb: ligament reconstruction and tendon interposition versus hematoma distraction arthroplasty. *J Hand Surg Am* 2010; 35: 1968-1975.
- [17] Johnson J and Goitz RJ. Ligament reconstruction and tendon interposition. *Oper Tech Orthop* 2018; 28: 16-22.

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- [18] Tomaino MM, Pellegrini VD Jr and Burton RI. Arthroplasty of the basal joint of the thumb. Long-term follow-up after ligament reconstruction with tendon interposition. *J Bone Jt Surg* 1995; 77: 346-355.
- [19] Gray KV and Meals RA. Hematoma and distraction arthroplasty for thumb basal joint osteoarthritis: minimum 6.5-year follow-up evaluation. *J Hand Surg Am* 2007; 32: 23-29.
- [20] Huang YC, Huang HK, Liu YA, Wang JP and Chang MC. Long-term results of modified ligament reconstruction and tendon interposition for thumb basal joint arthritis. *J Chin Med Assoc* 2019; 82: 655-658.
- [21] Lafaye G, Rongières M, Mansat P, Grolleau JL and Riot S. Functional outcomes after surgical treatment of isolated scaphotrapeziotrapezoid osteoarthritis: retrospective single-center 24-case series. *Hand Surg Rehabil* 2020; 39: 107-112.