

## Original article

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## Comparative analysis of surgical outcomes of arthrodesis and suspension arthroplasty of the saddle joint

A.O. Afanasyev, A.E. Chizhov<sup>✉</sup>, N.V. Abdiba, L.A. Rodomanova

Vreden National Medical Research Center for Traumatology and Orthopedics,  
Saint-Petersburg, Russian Federation

**Corresponding author:** Alexander E. Chizhov, [Sanitilabov@mail.ru](mailto:Sanitilabov@mail.ru)

### Abstract

**Introduction** Trapeziometacarpal osteoarthritis is a very common condition that leads to progressive loss of functionality of the first finger that can be surgically treated with arthrodesis of the saddle joint and suspension arthroplasty of the first metacarpal bone. There is a controversy over the surgical technique to choose without consensus in the literature.

The **objective** was to compare surgical outcomes of patients with trapeziometacarpal osteoarthritis treated with arthrodesis and suspension arthroplasty of the saddle joint.

**Material and methods** The use of both surgical options resulted in significantly reduced pain measured with the VAS ( $p < 0.001$ ) and improved upper limb function evaluated with the Quick DASH scale. The treatments differed in the median duration of plaster immobilization. The duration of postoperative immobilization in arthrodesis patients was statistically higher ( $p = 0.004$ ) than that in suspension arthroplasty group. No statistically significant differences were found between the two groups of heavy and light manual laborers (Pearson coefficient = 0.311).

**Discussion** The findings of the series indicated parameters being different from those published in the literature. The dependence between functional results and the type of working activity of patients treated with both surgical methods was not confirmed. The choice between trapezio-metacarpal arthrodesis and suspension arthroplasty of the first metacarpal bone based on the criterion of severity of work was not always correct. Increased periods of plaster immobilization in the saddle arthrodesis group are reported in the literature and associated with complications of the treatment option.

**Conclusion** No significant differences were found between the outcomes of saddle arthrodesis and suspension arthroplasty of the first metacarpal bone.

**Keywords:** osteoarthritis, trapezio-metacarpal joint, suspension arthroplasty, arthrodesis

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## INTRODUCTION

Trapeziometacarpal (saddle joint, first carpometacarpal) joint (TMJ) osteoarthritis is a very common condition, it is the second most common location for degenerative arthritis in the hand after the distal interphalangeal joint [1, 2]. Trapeziometacarpal osteoarthritis affects 20 % of the adult population over 55 years old affecting postmenopausal women in 36 % of cases [3–5]. Saddle joint arthritis is accompanied by progressive loss of function of the thumb with common symptoms of pain and loss of pinch/grip strength which is characterized by pain, impaired pinch grip and gradually increasing deformity of the bone and ligament structures [6, 7]. The Eaton-Littler radiological classification is used to assess arthrotic changes and determine the treatment strategy. It includes four stages and describes criteria for the severity of the pathology: narrowing of the joint space, subchondral osteosclerosis, the presence of osteophytes [8]. The first line of treatment of TMJ osteoarthritis is non-surgical but in most cases, patients seek medical help in the late stages of degenerative changes in the joint with severe deformity of the first ray, requiring surgical correction [9, 10].

Arthrodesis and suspension arthroplasty of the first metacarpal bone are the main surgical methods for treating TMJ osteoarthritis, but there is no consensus in the Russian and foreign literature on which surgical treatment is optimal [11–13].

Some authors consider suspension arthroplasty to be the “gold standard” in the treatment of arthrosis of the first carpometacarpal joint, while others are inclined to choose trapeziocarpal arthrodesis, which, despite the reduced range of motion of the first ray, maintains greater pinch grip strength compared to suspension arthroplasty [14–17]. Barakat et al. established the normal ranges of movements for the thumb joints and identified that a reduction in certain thumb joint movements appeared to be compensated for by an increased movement range in the other joints somewhat leveling out the functional volume reduced as a result of arthrodesis [18].

The ongoing debate about the choice of surgical treatment for arthritis of the first carpometacarpal joint in the presence of conflicting literature data led to a comparative analysis of the outcomes of surgical treatment of patients after arthrodesis and suspension arthroplasty of the saddle joint.

The **objective** was to compare surgical outcomes of patients with trapeziometacarpal osteoarthritis treated with arthrodesis and suspension arthroplasty of the saddle joint.

## MATERIAL AND METHODS

**Design of the study** A single-center, cohort, retrospective study conducted in accordance with the STROBE guidelines.

**Terms and conditions** The data of a retrospective analysis of medical records and radiological examination of 60 patients divided into two groups were included in the study. Patients of group 1 were treated with arthrodesis of the first trapezio-metacarpal joint ( $n = 29$ ) and patients of group 2 treated with suspension arthroplasty of the first metacarpal bone ( $n = 31$ ). All patients received elective surgical treatment at the R.R. Vreden National Medical Research Center for Trauma and Orthopedics between 2020 and 2023.

**Eligibility Criteria:** patients with Eaton-Littler stage III arthritis of the first carpometacarpal joint treated with arthrodesis or suspension arthroplasty.

**Non-inclusion criteria:** patients with congenital malformations of the hand, a history of severe hand injuries (mine blasts, burns, etc.), neuropathy of the upper extremities, systemic diseases including autoimmune conditions (SLE, scleroderma, seropositive rheumatoid arthritis).

**Methods of data collection and analysis** Long-term results of surgical treatment were assessed through communication with patients with remote examination and use of standard questionnaires. Hand function and pain were evaluated based on subjective criteria using the Quick DASH (Disability of the Arm, Shoulder and Hand) and VAS (Visual Analogue Scale). The volume of opposition of the first finger was measured using the Kapandji Thumb Opposition Scores test. Informed consent for data processing and inclusion in the study was obtained from all patients.

**Description of medical intervention** All surgical interventions were performed by one surgeon-researcher in the operating room, with the patient in the supine position with the upper limb placed on a side table. Conduction anesthesia in the brachial plexus and intravenous sedation were employed for monitoring patient's vital functions. The first carpometacarpal joint was approached with the tourniquet placed in the upper third of the forearm. A longitudinal incision of 5 cm was made in the trapeziocarpal joint area along the dorsal radial side performing suspension arthroplasty. The trapezium bone and visible osteophytes were removed after capsulotomy. A figured approach was performed at the site of the first bone-fibrous canal of the extensor tendons and the tendon of the long abductor muscle of the first finger could be visualized. A split was taken from the radial side of the tendon of the long abductor muscle to its distal attachment. The split was produced under the tendons of the long abductor muscle and the short extensor of the first finger. A 1 cm dissection of the tendon of the long radial extensor of the carpi radialis was performed along the midline. The split was passed through the formed opening, and the optimal tension of the tendon was determined. Then the split was wound around the tendons of the long abductor muscle of the first finger and the short extensor of the first finger and stitched with the tendon of the long extensor of the carpi radialis with a 3/0 Prolene thread. A tendon ball (tenoball) was formed from the remaining tendon split, then placed and sutured to the residual cavity after removal of the trapezium bone. The joint capsule was sutured and the wound closed. A longitudinal access was made in the joint area up to 5 cm performing arthrodesis of the first carpometacarpal joint. Resection of the articular surfaces of the base of the first metacarpal bone and the trapezium bone to the subchondral bone was performed after capsulotomy. Preliminary fixation of the first finger was performed in the functional position of 30° adduction and 15° radial deviation using two Kirschner wires. The final fixation was performed with a 1.0 mm T-plate with its wide base facing the trapezium bone and its narrow base facing the metacarpal bone, fixed with 2.0 mm screws. After that, the joint capsule was sutured and the wound closed.

Statistical data processing. Statistical analysis was performed using IBM SPSS Statistics 26. The normality of the distribution of the original data was checked using the Shapiro-Wilk test (arthrodesis group  $n = 29$ ; suspension plasty  $n = 31$ ) with the distribution considered normal at  $p > 0.05$  and different from normal at  $p < 0.05$ . Comparison of nominal binary indicators (gender, dominant limb, presence of complaints, bad habits, postoperative rehabilitation) was performed in the study groups using four-field tables with calculation of the Fisher criterion. Comparison of two independent groups according to qDASH indicators before surgery and qDASH after surgery was performed using the Student's t-test and considering the normal distribution of data, VAS before surgery and VAS after surgery, Kapandji score using the Mann-Whitney test for distribution different from normal. Dependent groups for qDASH scores before and after surgery were analyzed using the paired Student's t-test and the Wilcoxon test used for VAS scores before and after surgery. Comparative analysis of groups depending on patient activity (heavy physical labor/light physical labor) was performed by constructing four-field tables and calculating according to the Pearson criterion with visual display in normalized histograms with accumulation.

The study was approved by the institutional ethics committee and was conducted in accordance with the ethical standards set out in the Declaration of Helsinki.

## RESULTS

Surgical treatment was normally performed on the dominant hand (68.9 %, group 1; 80.6 %, group 2). Most patients complained of pain at the time of treatment (72.4 %, group 1; 80.6 %, group 2). No injuries to the operated hand were observed in the patients. Most patients did not have bad habits or chronic diseases. The majority of patients in both groups did not undergo rehabilitation with a hand therapist (72.4 %, Group 1; 64.5 %, Group 2). Heavy physical activity was common for 51.7 % patients of Group 1 and for 38.7 % of Group 2 (Table 1).

Table 1

General characteristics of the patients

Description			Group 1 ( <i>n</i> = 29)	Group 2 ( <i>n</i> = 31)	Level of statistical significance ( <i>p</i> )
Gender	male	abs.	12	7	0.166
		%	41.4	22.6	
	female	abs.	17	24	
		%	58.6	77.4	
Age, full years	M ± SD		59.79 ± 14.044	57.97 ± 12.674	0.6
	(95 % SI)		(54.45–65.14)	(53.32–62.62)	
Limb	dominant	abs.	20	25	0.376
		%	68.9	80.6	
	non-dominant	abs.	9	6	
		%	31	19.3	
Complaints at the time of hospitalization	pain	abs.	21	25	0.451
		%	72.4	80.6	
	pain + limited function	abs.	8	6	
		%	27.6	19.4	
Injuries to the operated hand			0	0	
Bad habits	none	abs.	25	22	0.213
		%	86.3	70.9	
	smoking	abs.	4	9	
		%	13.7	29.1	
Chronic diseases	none	abs.	25	27	0.561
		%	86.3	87.1	
	DM	abs.	4	3	
		%	13.7	9.7	
	CKD	abs.	0	1	
		%	0	3.2	
Duration of plaster immobilization, weeks, Me (Q1–Q3)			6 (6–8)	6 (6–6)	0.004*
Hand rehabilitation specialist	none	abs.	21	20	0.585
		%	72.4	64.5	
	yes	abs.	8	11	
		%	27.5	35.4	
Postoperative infection			0	0	
Relationship between work and loads	none	abs.	14	19	0.311
		%	48.3	61.3	
	yes	abs.	15	12	
		%	51.7	38.7	

\* — the differences in the indicators are statistically significant.

The statistical analysis showed no significant differences in the Quick DASH questionnaire, the VAS visual analog pain scale and in the Kapsandji Score in arthrodesis and suspension arthroplasty groups (Table 2).

Both surgical options resulted in a statistically significant reduction in pain intensity measured with the VAS scale ( $p < 0.001$ ) and an improved upper limb function measured with the Quick DASH scale (Table 3). The effectiveness of the treatment options differed only in the median duration of plaster immobilization.

Table 2

Comparative analysis of the treatment methods evaluated with the Quick DASH, VAS pain scale and Kapandji score

Description	Group 1 ( $n = 29$ )	Group 2 ( $n = 31$ )	Level of statistical significance ( $p$ )
Satisfaction with the results, %	100	100	
Pre-op qDASH, $M \pm SD$ (95 % CI)	$75.06 \pm 6.27$ (72.67–77.44)	$75.22 \pm 6.17$ (72.96–77.48)	0.92
Post-op qDASH, $M \pm SD$ (95 % CI)	$33.14 \pm 5.12$ (31.19–35.09)	$34.65 \pm 7.86$ (31.77–37.53)	0.38
Pre-op VAS, Me (Q1–Q3)	8 (7–8)	8 (7.5–8)	0.462
Post-op VAS, Me (Q1–Q3)	2 (1–2)	2 (1–2.5)	0.562
Kapandji score, Me (Q1–Q3)	6 (6–6)	6 (5–6)	0.448

\* – the differences in the indicators are statistically significant.

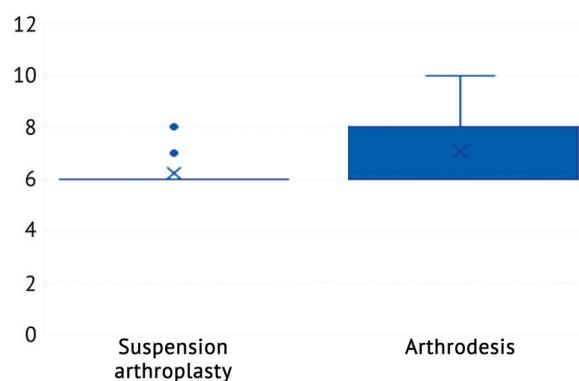
Table 3

Comparative analysis of the preoperative and postoperative functional results of the treatment methods

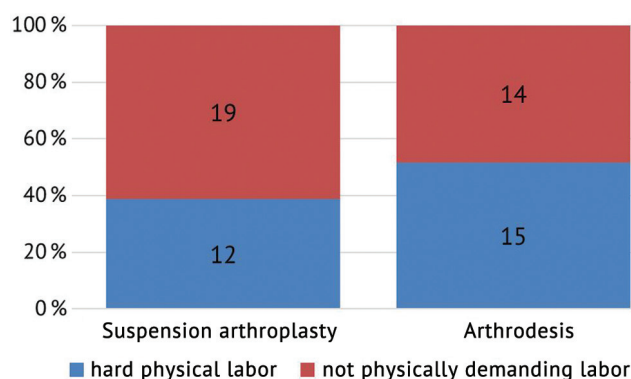
Surgical technique	Functional results		$P$
	pre-op	post-op	
Arthrodesis (calculated with qDASH)	$75.06 \pm 6.27$ (72.67–77.44)	$33.14 \pm 5.12$ (31.19–35.09)	$< 0.001^*$
Suspension arthroplasty (calculated with qDASH)	$75.22 \pm 6.17$ (72.96–77.48)	$34.65 \pm 7.86$ (31.77–37.53)	$< 0.001^*$
Arthrodesis (calculated with VAS)	8 (7–8)	2 (1–2)	$< 0.001^*$
Suspension arthroplasty (calculated with VAS)	8 (7.5–8)	2 (1–2.5)	$< 0.001^*$

\* – the differences in the indicators are statistically significant.

The duration of postoperative immobilization in the group of patients who underwent arthrodesis was significantly higher ( $p = 0.004$ ) than that in patients with suspension arthroplasty (Fig. 1). There were no statistically significant differences between the two groups of patients with heavy and light manual labor (Pearson coefficient = 0.311). Correlations identified with the Chaddock scale was not informative. The results are displayed in normalized stacked histograms (Fig. 2).



**Fig. 1** Duration of immobilization in two comparison groups represented as a box plot, weeks.



**Fig. 2** Correlation of the treatment method depending on the type of physical work

## DISCUSSION

The objective of the study was to compare surgical outcomes of patients with thumb saddle joint arthrosis after trapeziometacarpal arthrodesis and suspension arthroplasty of the first metacarpal bone. The postoperative functional efficiency findings contradict the results reported in the literature.

Various fixation methods for trapeziocarpal arthrodesis include Kirschner wires, cerclage wire, metal staples, compression screws and locking plates [17, 19]. Save et al. described a neutralizing plate used in combination with compression screws placed in the saddle joint of 10 patients with resultant fusion observed in 100 % [20]. A T-shaped locking plate without compression screws was employed in our series for trapezio-metacarpal joint fixation, because the combination of the implants may fail in case of a deformity of the trapezium bone and the basal part of the first metacarpal and loss of bone mass due to osteoporotic changes. Smeraglia et al. reported non-union as a major complication of saddle joint arthrodesis, and no statistical differences found in most of the clinical outcomes between the patients who obtained bone union in the trapezio-metacarpal joint and those who did not [17, 21]. Forseth et al. 26 reviewed 26 trapeziometacarpal arthrodeses that used plate and screw fixation with nonunions observed in 8 % and delayed fusion seen in 11 % [22]. Given the conflicting opinions about the effect of fusion on the functional outcome of saddle joint arthrodesis, this criterion was neglected with hand function being evaluated.

Suspension arthroplasty is the method of choice in most cases to treat saddle joint arthritis, despite the reduction in grip strength [23]. In our series, suspension arthroplasty suggested trapeziectomy and suspension of the first metacarpal bone using a split of the abductor longus tendon of the first finger and interposing the residual cavity with a tendon graft (tenoball). No statistically significant benefit between different types of suspension arthroplasty with or without tendon graft interposition or with ligament reconstruction was reported in a systematic review performed in 2022 [24]. Esenwein et al. showed that suspension of the first metacarpal bone using a strip of the abductor pollicis longus tendon is a less technically demanding technique, but is not inferior to the suspension option using a strip of the flexor carpi radialis tendon [25]. The comparative analysis did not reveal any statistically significant difference between the two methods of surgical treatment of trapeziocarpal joint arthritis as evidenced by the functional scales. Postoperative immobilization was longer in the group of patients who underwent trapeziocarpal arthrodesis, which suggested complications associated with the treatment method described in the literature.

Arthrodesis is indicated for young manual workers who tolerate some limitations of mobility [26] and is accompanied by a high degree of patient satisfaction, but considering the previously listed



complications, the surgical method in question cannot be the “gold standard” in the treatment of saddle joint arthritis. In our series, the ratio of hard and light physical laborers in the arthrodesis group was 51.7 % and 48.3 %, the age ranged between 54.45 and 65.14 years.

Suspension arthroplasty is recommended for patients with high functional demands on the hand and who are hard physical laborers in everyday life [27, 28], the ratio of hard and light physical laborers in the suspension arthroplasty group was 38.7 % to 61.3 %, the age ranged from 53.3 to 62.6 years.

Statistical analysis showed no significant differences in the Quick DASH questionnaire, visual analog pain scale VAS and Kapsandji Score measured in independent groups (arthrodesis and suspension arthroplasty). Patients were satisfied with the treatment results in both groups indicating the comparability of the methods regardless of the nature of the patient's activity.

A statistically significant improvement in the parameters was revealed with two types of surgical treatment, comparable with previously published research results [24, 29, 30].

### CONCLUSION

A comparative analysis of the surgical outcomes of patients with arthritis of the first carpometacarpal joint after arthrodesis and suspension arthroplasty of the saddle joint showed no significant advantage with any of the methods. The statement that arthrodesis should be performed for hard physical laborers, and suspension arthroplasty would be beneficial for those patients who aims at a greater range of motion, was not confirmed by our study. We suggest that the choice of the optimal method of treatment of the condition requires individual consideration for each clinical case.

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#### Information about the authors:

Artem O. Afanasyev — orthopaedic surgeon, afar\_kav@mail.ru, <https://orcid.org/0009-0003-6407-5888>;

Alexander E. Chizhov — orthopaedic surgeon, postgraduate student,  
Santillabox@mail.ru, <https://orcid.org/0009-0002-2019-6242>;

Nino V. Abdiba — orthopaedic surgeon, research assistant, ninoabdiba@gmail.com,  
<https://orcid.org/0000-0001-9152-5299>;

Liubov A. Rodomanova — Doctor of Medical Sciences, Professor, Head of the Department, orthopaedic surgeon,  
rodomanovaliubov@yandex.ru, <https://orcid.org/0000-0003-2402-7307>.