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Long-term effects of carpometacarpal arthrodesis on pain, clinical functions and quality of life

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Abstract

The aim of this study was to evaluate the effect on pain and functional results, and potential complications, of arthrodesis applied to the carpometacarpal (CMC) joint of the thumb because of osteoarthritis. This single-centre, retrospective study included patients who presented at the polyclinic between 2003 and 2018 with complaints of pain and/or deformity at the base of the thumb, clinically and radiographically consistent with osteoarthritis of the CMC joint of the thumb. Before treatment and at the final examination, pain at rest and during activity (daily living activities) was evaluated with a visual analog scale (VAS), and the functional results were evaluated with the patient-reported DASH and PRWE scores.The study included 26 patients with a mean age of 55.4 years and mean follow-up period of 8.3 ± 4.1 years. Surgery was performed on the dominant hand in 73.1% of the patients. A significant improvement was determined postoperatively with mean VAS score of 3.5 (IQR: 2 - 5), mean DASH score of 26.1 (IQR: 20.5- 37.0), and mean PRWE score of 22.5 (IQR: 15.1–29.6). In the cases with surgery applied to the non-dominant hand, no significant correlation was determined postoperatively between the PRWE function score and VAS (p=0.053). In one patient applied with revision surgery with autograft because of pseudarthrosis during follow-up, there were complaints of pain because of the development of osteophytes. Patients applied with arthrodesis for osteoarthritis of the thumb CMC joint, showed a high level of satisfaction in the long-term follow up measured with DASH and PRWE. In the light of these results, arthrodesis for osteoarthritis of the thumb CMC joint can be evaluated as a reliable and effective treatment method.

Keywords: carpometacarpal osteoarthritis, arthrodesis, surgery, basal thumb joint

1. Introduction

Arthritis in the thumb basal joint is one of the most frequently seen localisations of osteoarthritis. In individuals aged > 75 years, degeneration is seen radiographically in the first carpometacarpal (CMC) joint in 25% of males and 40% of females (1). The majority of cases of CMC joint osteoarthritis are seen at an advanced age, and it may develop as primary osteoarthritis or secondary to rheumatoid arthritis. Conditions such as cartilage damage and instability resulting from fractures and dislocations, or loosening in the ligaments which can be idiopathic or hormone-related, can cause the development of osteoarthritis at younger ages (2). It is typically seen in females aged 50-70 years, and patients most often present with complaints of pain that affect daily living activities. Although it is a reason for the common complaint of pain localised over the tenar region muscles and thumb abductors, many patients are asymptomatic in the early stages. On examination, there is sensitivity with palpation in the dorsal of the joint. There may also be seen to be protrusion at the base of the thumb due to ligament laxity and the APL pulling the metacarpal base, and increased swelling and heat associated with inflammation. Other reasons for pain at the base of the thumb are considered in the differential diagnosis. These other reasons include De Quervain tenosynovitis, flexor carpi ulnaris tenosynovitis, scaphoid pathologies (fracture, osteonecrosis), trigger finger, and radial sesamoids. In addition, carpal tunnel syndrome, and osteoarthritis in the MCP joint, scaphotrapeziotrapezoid joint, and radiocarpal joint are other common causes of pain along the thumb.

To reduce the pain in the early stages of the disease conservative treatments are used (eg., splinting, non-steroidal anti-inflammatory drugs [NSAID]), but at advanced stages, reconstructive procedures are applied to regain the movement capability of the thumb. These procedures include volar ligament reconstruction metacarpal osteotomy, CMC joint

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arthroscopy, prosthetic arthroplasty, tendon interposition together with resection arthroplasty, and CMC joint arthrodesis.

The aim of this study was to evaluate patients applied with CMC joint arthrodesis because of advanced grade CMC joint osteoarthritis in the thumb, in respect of the clinical, functional, and radiological outcomes, and complications.

2. Patients and Method

The study included 26 patients who presented at our hospital between 2003 and 2018 with the complaint of pain at the base of the thumb, were diagnosed with advanced grade CMC joint osteoarthritis, and after not gaining any benefit from conservative treatment, were applied with CMC joint arthrodesis. Approval for the study was granted by the Clinical Research Ethics Committee of our Institute on 09.02.2022 with the decision number 2022/52.

The arthrodesis procedure was performed on all the patients by a single surgeon using the same surgical technique. A vertical incision was made at the base of the thumb on the radiodorsal surface, then the skin and subcutaneous layers were passed, preserving the cutaneous nerves, and the CMC joint capsule of the thumb was reached. The capsule was opened and osteophytes and synovia were cleaned. Cancellous bone was exposed with curettage of the cartilage surfaces. The arthrodesis procedure was applied with plate -screw osteosynthesis using a miniplate for the thumb position to be 35° radial abduction, 35° palmar abduction, 15° pronation, and 10° dorsiflexion.

In the postoperative period, immobilisation was obtained with a short-arm splint with thumb support for the thumb to be in abduction, which was applied for 4 weeks. After removal of the splint, rehabilitation was started.

The examination findings and direct radiographs obtained preoperatively and at the final follow-up examination of the patients who attended routine follow-ups were evaluated. Age, gender, and the surgical procedure applied were recorded from the patient files. The patients were recalled for follow up and under polyclinic conditions, the functional and pain scores, examination results, and preoperative and postoperative radiographic findings were updated.

For the functional scoring of the patients, in addition to the routine hand examination, the Patient Rated Wrist Evaluation (PRWE) and the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaires were applied. After completion of the questionnaires before and after the operation, the levels of pain were evaluated using a Visual Analog Scale (VAS).

2.1. Statistical Analysis

Data obtained in the study were analyzed statistically using SPSS vn. 25 software (IBM Corp., Armonk, NY, USA). Conformity of the data to normal distribution was assessed with the Kolmogorov-Smirnov test and histograms. In the evaluation of the data, descriptive statistical methods were used and data were stated as mean ± standard deviation, median, minimum and maximum values. As the data were not normally distributed, mean values with interquartile range (IQR) and absolute values and proportions (%) were used to present the results for the whole group of patients. Correlations between VAS and DASH/PRWE were calculated using Spearman's rank correlation test for non-parametric data. A value of $p<0.05$ was considered statistically significant.

3. Results

Evaluation was made of 26 patients, comprising 17 (65.3%) females and 9 (34.6%) males with a mean age of 55.46±6.93 years and mean follow-up period of 8.3±4.1 years (range, 3.1-14.7 years). The operation was performed on the right hand of 20 (76.9%) patients and the left hand of 6 (23.1%). The rate of operations on the dominant hand was determined to be 73.1%. The demographic characteristics of the patients are shown in Table 1.

Table 1. Demographic and clinical characteristics

Categories	N	%
Age at treatment (years)		
Mean	55.46±6.93	
Gender		
Male	9	65.3
Female	17	34.6
Follow-up (years)		
Mean	8.3	(3.1- 14.7)
Operated hand		
Right	20	76.9
Left	6	23.1
Dominant hand operated		
Yes	19	73.1
No	7	26.9
Complications		
Pseudo arthritis	1	3.8
Pain in MCP	1	3.8
None	24	92.3

The VAS, DASH, and PRWE scores of the patients preoperatively and at the final postoperative examination are shown in Table 2. The mean DASH scores showed a statistically significant decrease from 59.3 preoperatively to 26.1 postoperatively. The mean VAS scores, representing the pain felt by the patients, showed a statistically significant decrease from 6.7 preoperatively to 3.5 postoperatively.

The mean PRWE total and sub-group (pain, activity) scores showed a statistically significant improvement postoperatively. As the groups analyzed (dominant hand and operated side) were heterogenous, the scores were compared within the groups. Accordingly, a significant negative

correlation was determined between the postoperative PRWE total scores and VAS in the non-dominant hand (p=0.03), and this negative correlation was not seen between the PRWE function score and VAS (p=0.053).

Table 2. Preoperative and postoperative comparison of pain and functional results of patients who underwent CMC joint arthrodesis

	Total Patients	Dominance	
		Yes	No
Categories	**Mean (IQR)**	**Mean (IQR)**	**Mean (IQR)**
DASH			
Pre- op	59.3 (52.3- 68.5)	61.7 (54.6- 69.4)	52.2 (48.4-57.8)
Post- op	26.1 (20.5- 37.0)	21.8 (18.3- 33.4)	37.7 (31.3-46.9)
PRWE - Pain			
Pre- op	49.7 (42.3- 58.5)	51.2 (43.8- 58.4)	46.1(36.3- 55.7)
Post- op	20.4 (18.5- 34.1)	21.3 (17.9- 24.7)	18.5(15.2-22.8)
PRWE-Activities			
Pre- op	39.2 (35.3- 47.9)	40.2 (34.2- 47.1)	36.3(30.1- 43.5)
Post- op	16.4 (12.5- 25.6)	14.9 (10.4- 22.5)	20.2(17.6- 26.8)
PRWE - Total			
Pre- op	37.3 (34.6- 53.7)	38.2 (33.1- 52.2)	35.1(31.1- 48.9)
Post- op	22.5 (15.1- 29.6)	21.6 (17.3- 31.5)	24.9(20.3- 34.2)
VAS			
Pre- op	6.7 (5.0- 9.0)	6.9 (6.0- 9.0)	6.1(5.0- 7.0)
Post- op	3.5 (2.0- 5.0)	3.5 (3.0- 7.0)	3.3(5.0- 7.0)

Abbreviation: IQR, interquartile range.

In the dominant hand, a significant negative correlation was determined between the total PRWE scores, the PRWE pain scores, and VAS (p=0.01). When the DASH scores were examined, there was seen to be a significant improvement in the relationship with VAS irrespective of the dominant side (p=0.01). The PRWE pain scores were determined to have decreased more than the DASH scores, irrespective of the dominant side, and a more statistically significant correlation was determined ($p<0.05$) (Table 3).

Table 3. Correlation between DASH/PRWHE and dominance

	VAS after surgery (CC/ *p* -value)a	
Categories	Dominant Hand	Non - Dominant Hand
DASH Final	−0.22/ p = 0.041	−0.32/ p = 0.044
PRWHE Total	−0.38/ p = 0.029	−0.45/ p = 0.036
PRWHE Pain	−0.47/ p = 0.024	−0.66/ p = 0.021
PRWHE Function	−0.49/ p = 0.025	−0.19/ p = 0.053

[a] Measured by Spearman's rank correlation.

Within one year postoperatively, a diagnosis of non-union was made in one patient following the development of pain, and this patient underwent arthrodesis surgery again with autograft taken from the iliac wing. One patient had complaints of pain because of osteophyte development adjacent to the CMC joint, and corticosteroid injection was applied to the region in this case. Including these two patients who developed complications during follow up, all the patients were satisfied with the treatment results, and full union was observed on the radiographs of all the patients taken at the final follow-up examination. No complications were observed in the long term in any patient.

4. Discussion

Thumb arthritis is common with ageing and develops with a tear in the cartilage from the ends of the bones forming the joint at the base of the thumb. It is also known as CMC joint osteoarthritis.

Thumb arthritis causes severe pain, swelling, and decreased strength and range of movement, which can make simple taks difficult, such as turning a door handle or opening a jar. The treatment plan varies according to the degree of osteoarthritis in the CMC joint (3). In early stage CMC, a combination of activity modification, drugs, intra-articular injection (corticosteroid, PRP) and splinting can be applied as conservative treatment to ameliorate pain. Severe cases may need surgical procedures such as hemitrapeziectomy, soft tissue interposition, CMC joint arthroplasty or joint arthrodesis (4, 5). Traditionally, arthrodesis of the trapeziometacarpal joint is used in the treatment of patients following trauma or younger

(<50 years) patients with osteoarthritis with higher expectations. Arthrodesis of the trapeziometacarpal joint was first recommended for osteoarthritis by Muller in 1949, and successful results have been reported in many case series since then (6).

In the current study, the patient-reported pain scores and functional test results were evaluated in patients applied with CMC joint arthrodesis for advanced grade CMC joint arthritis that did not benefit from conservative treatment. Although various methods can be used for an arthrodesis procedure (K-wire, compression screws, and plate), it was applied with a plate to all the patients in the current study.

The main aim of surgical treatment of osteoarthritis in the CMC joint is to eliminate pain. In the current study, the VAS scoring system was used and the PRWE scoring for pain subgroups. In both scoring systems there was determined to be a statistically significant improvement in the pain values compared to the preoperative period.

In studies by Rizzo et al. (7) and Rubino et al. (8), lower VAS scores were reported after surgery. The VAS scores reported in a study by Smeraglia et al. (9) were simiilar to those of the current study, and all the patients in the current study were satisfied with the results of the operation.

A secondary aim is preservation of or improvement in thumb function in respect of sufficient stability and strength (7, 10). Both pain and function can be measured with patient-reported questionnaires. In the evaluation of the long-term results of 15 patients in the current study, a statistically significant improvement was determined in the functional results (DASH, PRWE) in addition to a significant decrease in pain scores ($p<0.05$). The DASH scores in this patient series are similar to those of other studies reported in literature (11, 12). Van Laarhoven et al. (13) also determined a significant improvement in the DASH and PRWE scores following CMC joint arthrodesis, similar to the current study results.

The current study patients were separated into two groups according to surgery performed on the dominant or non-dominant hand. By analysing the VAS, DASH, PRWE total and sub-group (pain, activity) scores, separately, comparisons were made within the groups. Accordingly, a significant negative correlation was determined between the postoperative PRWE total scores and VAS in the non-dominant hand ($p=0.03$), and this negative correlation was not seen between the PRWE function score and VAS ($p=0.053$). The statistical difference causing this difference was thought to be due to problems in the PRWE activity section being related to the dominant hand in most patients. Therefore, the response given for non-dominant hand function of the patients probably does not reflect reality and may have affected the results.

In the dominant hand, a significant negative correlation was determined between the total PRWE scores, the PRWE pain scores, and VAS ($p=0.01$). When the DASH scores were examined, there was seen to be a significant improvement in the relationship with VAS irrespective of the dominant side ($p=0.01$).

There are several studies in literature in respect of function and pain measured using the DASH and PRWE questionnaires in patients applied with CMC joint arthrodesis to the thumb (REF). In the 5-year follow-up of patients applied with arthrodesis, Spekreijse et al. reported DASH and PRWE scores worse than those of the current study (14). In contrast, Van Laarhoven et al. reported higher DASH and PRWE scores than those of the current study in a retrospective cohort study with a median follow-up period of 10.8 years (13).

The most common problems related to arthrodesis are implant failure and non-union. Non-union rates in literature vary between 0% and 48% (9, 15-18). Singh et al. (15) compared the results of arthrodesis procedure with K-wire, plate, screw, and staple, and reported higher rates of non-union in cases that had undergone arthrodesis with K-wire. In the current study, the procedure was applied with plate fixation in all the patients.

Non-union was observed in one case in the current study. This patient had less improvement in DASH and PRWE scores than all other patients, as expected. Singh et al.(15) also determined less improvement in the DASH scores of cases that developed non-union. Even if those patients underwent a revision procedure, worse DASH scores were obtained compared to cases with primary union.

In a study by Smeraglia et al. (9) comparing bone union and fbrous non-union, similar function and pain results were reported for both groups following arthrodesis, and it was concluded that non-union had no effect on the outcome. Spekreijse et al. (14) also stated that non-union did not affect functional results in a randomised, controlled study, and it was thought that the failure in the arthrodesis group could be attributed to treatment indications, surgical techniques such as fusion methods and types of bone cuts, and postoperative management.

In the current study, complaints of pain were observed in one patient because of the development of osteophytes and pseudarthrosis complications within one year postoperatively. The implant was removed from this patient with non-union, who then underwent arthrodesis surgery again with autograft taken from the iliac wing. Another patient had complaints of pain because of osteophyte development adjacent to the CMC joint, and corticosteroid injection was applied to the region in this case. The results were excellent.

This study had some limitations, primarily the retrospective design. There is a need for further studies with greater numbers of patients to compare patient groups applied with CMC joint arthodesis using different surgical methods.

In conclusion, the results of this study demonstrated that arthrodesis performed with an appropriate surgical technique

and plate fixation is a reliable method with successful results in the treatment of CMC joint osteoarthritis in the thumb.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Authors' contributions

Concept: İ.B., A.P., Design: H.Ç., Data Collection or Processing: H.Ç., Analysis or Interpretation: H.Ç., S.K., Literature Search: F.E., Writing: F.E.

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