Factors Associated With Reoperation After Silicone Metacarpophalangeal Joint Arthroplasty in Patients With Inflammatory Arthritis

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Abstract

Background: Silicone metacarpophalangeal (MCP) joint arthroplasty has a high revision rate. It has been suggested that the preoperative degree of ulnar drift and radial wrist deviation influences the durability of MCP silicone arthroplasties. The goal of this study was to evaluate what factors are associated with reoperation after silicone MCP arthroplasty. **Materials and Methods:** We retrospectively evaluated all adult patients who underwent MCP silicone arthroplasty between 2002 and 2016 at one institutional system for inflammatory arthritis. After manual chart review, we included 73 patients who underwent 252 arthroplasties. Fingers treated included 66 index, 67 long, 60 ring, and 59 small fingers. **Results:** The overall reoperation rate was 9.1% (N = 23). Indications for reoperation were implant breakage (n = 11), instability (n = 4), soft tissue complications (n = 4), infections (n = 3), and stiffness (n = 1). There was a trend that patients who underwent single-digit arthroplasty had higher rates of revision (19% vs 3.5%, $P = .067$). Radiographic follow-up demonstrated joint incongruency in 50% of cases, bone erosion in 58% of cases, and implant breakage in 19% of cases. There was a trend toward higher rates of revision in patients without preoperative MCP joint subluxation (19% vs 6.7%, $P = .065$). The 1-, 5-, and 10-year implant survival rates were 96%, 92%, and 70%, respectively. Revision surgery occurred at <14 months in 15 patients (65%) and after 5 years in 8 (35%) patients. **Conclusions:** Revision surgery after silicone MCP arthroplasty appears to be bimodal. Patients with greater hand function preoperatively may be at higher risk of revision surgery.

Keywords: allograft, basic science, cartilage, basic science, arthroplasty, arthritis, diagnosis, inflammatory arthritis, rheumatoid arthritis, finger, fracture/dislocation, hand

Background

Rheumatoid arthritis has a prevalence that varies between 0.3% and 1%, with a 1:3 male to female distribution.^{1,2} This leads to chronic inflammation of the metacarpophalangeal (MCP) joint and proximal interphalangeal (PIP) joint destruction causing joint deformity and pain. Although disease-modifying anti-rheumatic agents have drastically decreased joint replacement, arthroplasty remains the treatment of choice in patients unresponsive to medical treatment or when severe deformities occur.³ Metacarpophalangeal joint replacement is favored above arthrodesis as it allows for a better hand function. Silicone implants do not depend on soft tissue support to the same extent as pyrocarbon implants do and are therefore preferred in this population.³

Good long-term implant survival rates have been reported, and although implant fractures are common (up to

67%), they rarely require revision.⁴ Reoperation rates of up to 11% have been reported.⁵⁻⁹ Besides reoperation, other complications include bone erosion (14%-100%), recurrent ulnar deviation (0%-43%), and dislocation (17%).^{5-7,10-15}

Soft tissue balancing plays an important role in arthroplasty survival.⁴ The preoperative degree of ulnar deviation has shown to be prognostic for reoperation and should be addressed intraoperatively.^{16,17} Extensor mechanism

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Table 1. Factors Associated With Reoperation After Metacarpophalangeal Arthroplasty.

Variable	All patients N = 73	Reoperation		P value
		Yes n = 5	No n = 68	
Age, y, median (interquartile range)	0	64 (60-70)	65 (53-70)	.90 ^b
Sex, No. (%)				>.99 ^c
Male	9 (12)	0 (0)	9 (100)	
Female	64 (88)	5 (7.8)	59 (92)	
Race, No. (%) ^a				>.99 ^c
Caucasian	63 (96)	5 (7.9)	58 (92)	
Non-Caucasian	3 (4.6)	0 (0)	3 (100)	
Bilaterally operated, No. (%)				>.99 ^c
Yes	20 (27)	1 (5.0)	19 (95)	
No	53 (73)	4 (7.6)	49 (92)	
Number of fingers operated at initial surgery, No. (%)				.067 ^c
One finger	16 (22)	3 (19)	13 (81)	
More than one finger	57 (78)	2 (3.5)	55 (97)	
Smoking, No. (%)				.58 ^c
Yes	13 (18)	0 (0)	13 (100)	
No	60 (82)	5 (8.3)	55 (92)	
Diabetes, No. (%)				>.99 ^c
Yes	8 (11)	0 (0)	8 (100)	
No	65 (89)	5 (7.7)	60 (92)	
Prior wrist surgery, No. (%)				>.70 ^c
Arthrodesis	10 (33)	2 (20)	8 (80)	
Total wrist arthroplasty	2 (6.7)	0 (0)	2 (100)	
Other	18 (60)	2 (11)	16 (89)	

^an = 66.^bUsing Mann-Whitney U test.^cUsing Fisher exact test.

centralization by itself may be insufficient to restore this, as flexion forces may rapidly deviate the finger again, redistributing the forces at the level of the arthroplasty.⁴ Furthermore, radial deviation of the wrist may increase revision rates, as higher degree of radial deviation increases phalangeal ulnar drift.^{4,18,19}

Several predictors for MCP arthroplasty reoperation have been described but are inconsistent. Therefore, the aim of this study was to assess what factors are associated with reoperation after MCP arthroplasty in patients diagnosed with inflammatory arthritis.

Materials and Methods

After approval of our institutional review board, we used the *International Classification of Diseases, Ninth Revision* procedure code “81.71” and *Current Procedural Terminology* codes “26530” and “26531” to identify patients who underwent MCP arthroplasty between January 1, 2002, and April 30, 2016, at one institutional system in the Northeastern United States. This yielded 343 patients, of which 199

had undergone PIP arthroplasty and 47 patients were mis-coded. After manual chart review, we identified 97 patients with 283 MCP arthroplasties. We excluded 24 patients who underwent arthroplasty for noninflammatory arthritis.

A medical chart review was performed to collect explanatory variables, including age at surgery, sex, race, hand dominance, smoking, diabetes, diagnosis, operated finger, operated hand, bilateral surgery, surgical approach, and concomitant periarticular soft tissue surgery of the same joint at initial surgery. Our primary outcome was reoperation, which was defined as any additional surgery of the previously operated MCP joint. Implant failure was defined as implant removal or revision arthroplasty. Major reoperations were defined as arthroplasties, arthrodeses, or amputations and minor reoperations as soft tissue surgery. Secondary outcomes of interest were complications and radiographic outcomes.

Study Population

Our cohort consisted of 73 patients, who underwent a total of 337 MCP arthroplasties, of which 252 fingers were

Figure 1. Preoperative indication for metacarpophalangeal arthroplasty.

operated during the patients' initial surgery. Twenty-seven percent of patients underwent bilateral surgery. There were 9 men and 64 women with a median age of 64 (interquartile range [IQR]: 54-70) years and a database query follow-up of 10 (IQR: 5.9-12.6) years (Table 1). Indications for primary surgery consisted of deformity, pain, stiffness, or a combination of the before-mentioned indications (Figure 1). Digits operated included 66 (26%) index, 67 (27%) middle, 60 (24%) ring, and 59 (23%) small fingers (Table 2). The surgical approach was dorsal in most patients, except in 2 where a lateral approach was used. Prior wrist surgeries included 10 wrist arthrodeses, 2 total wrist arthroplasties, and 18 other wrist procedures, specified in Table 3. The most often performed concomitant periarticular soft tissue surgery was reconstruction of the collateral ligament (56%, $n = 142$), of which 20 patients had this in combination with a PIP joint arthrodesis and one in combination with reconstruction of the extensor tendon (Supplemental Figure 1). Other additional surgeries consisted of reconstruction of the extensor tendon ($n = 18$), PIP arthrodesis ($n = 4$) or arthroplasty ($n = 3$), or a combination of the before-mentioned procedures ($n = 21$).

Radiographic Evaluation

Preoperatively, radiographs of 37 patients and 131 fingers were available for evaluation. On these radiographs, the radiocarpal deviation was measured, and MCP joint subluxation was assessed by the senior author.

Postoperatively, radiographs were available of 52 patients who had 73 fingers treated, at a median follow-up of 26.1 (IQR: 26.1-81.4) months postoperatively. Lateral and anterior-posterior radiographs were reviewed independently by 2 physician researchers, and disagreements were resolved by the senior author. Postoperative radiographic parameters evaluated were joint congruency, bone erosion, and implant breakage. Joint congruency was defined as alignment of the joint on lateral and anterior-posterior radiographs and classified as congruent or incongruent. Bone erosion was defined as the presence of cortical wear of the metacarpal bone or proximal phalanx. Implant breakage was defined as break in the contour and discontinuity of the prosthesis on any x-ray view.

Statistical Analysis

Nonnormally distributed continuous variables were reported as median and IQRs. Categorical data were described as frequencies and percentages. To address within-individual correlations, only fingers operated at the initial surgery were included for analysis ($N = 252$). The Fisher exact test was used for dichotomous and categorical variables and the Mann-Whitney U test for nonnormally distributed continuous variables to evaluate the association between explanatory variables and reoperation. A value of $P < .05$ was set as statistically significant. A Kaplan-Meier survival curve was used to display survival of silicone prostheses, using implant failure as end point. All analyses

Table 2. Factors Associated With Reoperation After Metacarpophalangeal Arthroplasty—Finger Specific.

Variable	All fingers N = 252	Reoperation		P value
		Yes n = 23	No n = 229	
Operated finger, No. (%)				.32 ^b
Index	66 (26)	4 (6.1)	62 (94)	
Middle	67 (27)	10 (15)	57 (85)	
Ring	60 (24)	4 (6.7)	56 (93)	
Small	59 (23)	6 (10)	53 (90)	
Operated hand, No. (%)				.18 ^b
Left	96 (38)	12 (12)	84 (88)	
Right	156 (62)	11 (7.1)	145 (93)	
Operated on dominant hand, No. (%) ^a				.82 ^b
Yes	135 (61)	15 (11.1)	120 (89)	
No	88 (40)	8 (9.1)	80 (91)	
Additional surgery of the same finger at initial surgery, No. (%)				.36 ^b
Yes	167 (66)	13 (7.8)	154 (92)	
No	85 (34)	10 (12)	75 (88)	

^an = 223.^bUsing Fisher exact test.**Table 3.** Other Wrist Procedures (n = 18).

Procedure	No.
Darrach	4
Trapezectomy	3
Synovectomy	2
Tendon surgery	1
Combination of multiple ^a	8

^aAbove-mentioned surgeries + carpal tunnel release, nodule excision, and distal radioulnar joint arthroplasty.**Table 4.** Type of Reoperation (n = 23).

Type of Surgery	Number of Reoperations
Major surgery, No. (%)	
Revision arthroplasty	17 (74)
Implant removal	3 (13)
Minor surgery, No. (%)	
Tenolysis	1 (4.3)
Capsulectomy	1 (4.3)
Reconstruction extensor tendon	1 (4.3)

Table 5. Complications After Metacarpophalangeal Arthroplasty.

	Fingers N = 252
Complication, No. (%)	
Ulnar deviation	94 (37)
Stiffness	33 (13)
Extensor lag	15 (6.0)
Wound infection ^a	4 (1.6)

^aOne treated conservatively, 3 required implant removal.

were performed using Stata (StataCorp 2013, Stata Statistical Software: Release 13; StataCorp LP, College Station, Texas).

Results

In this study, 23 fingers (9.1%) in 5 patients (6.9%) underwent reoperation at a median time of 12.4 (IQR: 6.0-90.8) months (Table 4). There was a trend toward higher reoperation rates when only one finger was treated than when more than one finger was treated (19% vs 3.5%, $P = .067$). Reoperations consisted of major and minor reoperations, which are displayed in Table 4. Indications for reoperation included implant breakage (n = 11), instability (n = 4), soft tissue complications (n = 4), infections (n = 3), and stiffness (n = 1). No factors were predictive of reoperation.

Overall, 20 fingers (7.9%) in 8 patients had implant revision or removal at a median of 1.0 (IQR: 0.53-7.6)

year. Nine fingers in 3 patients underwent a second reoperation, all consisting of a revision arthroplasty because of dislocation (n = 4), postinfection (n = 1), and breakage (n = 4). The 1-, 5-, and 10-year implant survival rates were 96%, 92%, and 70%, respectively (Supplemental Figure

Table 6. Radiographic Parameters.

	All	Reoperation		P
	N = 252	Yes	No	
Preoperative radiographs				
Radial deviation, median (interquartile range) ^a	8.7 (4.9-14.8)	7.4 (7.3-31.1)	8.7 (4.4-14.8)	.50 ^d
Finger subluxation, No. (%) ^b				.065 ^e
Yes	89 (68)	6 (6.7)	83 (93)	
No	42 (32)	8 (19)	34 (81)	
Postoperative radiographs ^c				
Joint incongruency, No. (%)				.77 ^e
Yes	36 (49)	7 (19)	29 (81)	
No	37 (51)	6 (16)	31 (84)	
Bone erosion, No. (%)				.54 ^e
Yes	42 (58)	9 (21)	33 (79)	
No	31 (42)	4 (13)	27 (87)	
Implant breakage, No. (%)				.014 ^e
Yes	14 (19)	6 (43)	8 (57)	
No	59 (81)	7 (12)	52 (88)	

^an = 37 patients.^bn = 131 fingers.^cn = 73 fingers.^dUsing Mann-Whitney *U* test.^eUsing Fisher exact test.

2). Most common postoperative complications consisted of ulnar deviation (37%), stiffness (13%), extensor tendon-related problems (6.0%), and infection (1.6%) (Table 5). Three out of 4 patients with an infection required removal of their implant. Only one patient underwent arthroplasty during a third operation, 8 months after removal.

Radiographic results are displayed in Table 6. Preoperative radiographs showed that 89 (68%) MCP joints were subluxated, and there was a trend of lower reoperation rates in patients without subluxation ($P = .065$). Median radial deviation of the wrist was 8.7° (IQR: 4.9°-14.8°). Postoperative radiographic outcomes demonstrated joint incongruency in 49% of cases, bone erosion in 58% of cases, and implant breakage in 19% of cases. Of these radiographic variables, only implant breakage was associated with reoperation ($P = .014$). Of the 14 broken implants, only 11 were revised. Patient record text search yielded no additional reports of implant breakage.

Discussion

The aim of this study was to assess factors associated with reoperation in patients, who had an MCP silicone arthroplasty for inflammatory arthritis. We evaluated 73 patients who had treatment of 252 fingers and found a reoperation rate of 9.1%. There was a trend toward higher reoperation rates in patients who had treatment of only one finger compared with patients who had treatment of more than one finger (19% vs 3.5%) and if preoperative radiographs showed no subluxation (19% vs 6.7%).

There are some limitations to this study that require consideration. First, because there were not that many reoperations, the influence of covariates could not be assessed in multivariable analysis. Second, there was no standardized radiographic follow-up protocol, leading to a preoperative and postoperative availability of radiographs in 48% and 29% of patients, respectively, limiting the evaluation of the radiographic outcomes. Because of the retrospective design of this study, no surgical outcomes were assessed besides reoperation, and patients could be missed due to miscoding. We considered 2 definitions of follow-up: (1) time from surgery to the database query; and (2) time from surgery to the last clinical note in the database. We considered time of surgery to query as the follow-up interval with the assumption that patients with difficulty would present to the original surgeon; however, there would be some expected loss from patients moving or seeking care elsewhere. Finally, we reported on arthroplasties performed by 10 surgeons, where 3 surgeons accounted for 79% of the surgeries, each of whom uses different surgical techniques. This improves the generalizability of our results to actual practice.

Previous studies have reported long-term reoperation rates ranging from 5.7% to 11%, which is comparable with our study.^{4,6,8,15,20} The most common indication for reoperation among these studies was implant breakage. Less common causes included deformity, decreased range of motion, and infection. Besides revision of implants, other series report reoperations consisting of implant removal and

tenolysis. Time from index surgery until reoperation varies from immediately⁷ to 17 years postoperatively.⁴ In this study, we found a comparable percentage of reoperations consisting of revisions, also mostly for implant breakage.

Reoperations occurred after a median time of 12.4 (IQR: 6.0-90.8) months, of which 65% (n = 15) were performed at <14 months after the initial surgery. All other reoperations took place more than 5 years postoperatively. We found no differences in patient characteristics or surgery-related variables between the early and late reoperations, except for patient age. Patients with an early reoperation were older than patients who underwent a late reoperation (65 years, IQR: 60-70 vs 54 years, IQR: 46-63; $P = .044$).

This study identified a trend toward higher reoperation rates in the following cases: (1) when a single finger was treated; and (2) in the absence of preoperative MCP joint subluxation. Both of these factors are consistent with mild rheumatoid arthritis.⁸ This may suggest that patients with less severe rheumatoid arthritis have better functionality of the hand and finger, leading to increased wear of the prosthesis. In addition, patients with greater disease activity report more postoperative pain, further restricting motion and wear of the implant.⁸

Interpretation of these findings is complex. Prior studies suggest that: (1) less preoperative ulnar deviation is associated with increased survival; and (2) increased ulnar deviation of the fingers is associated with implant fracture.^{4,5} It is suggested that torque of the implant from soft tissue imbalance may lead to instability, dislocation, and implant fracture.²¹ Weiss et al²² found that anatomically aligned implants experience less stress on the silicone implant, which results in less wear and implant failure. Ancillary cross-intrinsic transfer appears to increase long-term survival by about 15% and reduces the rate of revision arthroplasty.^{4,17} In our series, 37% of patients had postoperative ulnar deviation, but not all patients progressed to implant failure or revision. Patients without MCP subluxation had a higher revision rate. In these cases, patients likely have better collateral stability postoperatively; however, this stability may be overwhelmed by increased functional activity.

Kirschenbaum et al⁷ suggest that reconstruction of the collateral ligaments has no influence on the recurrence of ulnar deviation. Despite reconstruction of the collateral ligament in most patients in our cohort, we found a recurrent postoperative ulnar deviation in 37% (n = 94) of patients. Of these, 24 patients with implants in 80 fingers did not request a reoperation. The primary indication for reoperation in the remaining fingers (n = 14), however, did not include ulnar deviation, but consisted of implant breakage (n = 10), infection (n = 3), and stiffness (n = 1). Others suggest radial collateral ligament reconstruction combined with ulnar collateral ligament or intrinsic tendon release for the restoration of ulnar deviation. Despite these

techniques, there is a significant recurrence of ulnar deviation.^{5,14} We did not have adequate power to identify a relationship between additional soft tissue procedures and revision.

Implant breakage is reported in some series in up to 76% of MCP arthroplasties. In this cohort, the percentage of fractured implants on radiographs was 19%, which we would expect to increase over time with longer follow-up. On our radiographic review, we found a number of fractured implants within the first year postoperatively. However, broken implants do not necessarily lead to pain or decreased function, as the implant can still function as a spacer.^{14,23} In our series, 11 out of 14 patients with broken implants underwent reoperation. While interpreting these numbers, it has to be kept in mind that implant breakage can be defined based on clinical and/or radiological criteria.

Overall, we found a reoperation rate of 9.1% in our study interval of 12.4 years (range: 3.1-108.6 years) after MCP silicone arthroplasty for inflammatory arthritis. Patients with less severe disease—those who underwent single-digit arthroplasty or did not have preoperative subluxation—had a higher rate of revision, suggesting that caution should be taken in patients with greater hand function when considering silicone MCP arthroplasty.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects.

Statement of Informed Consent

Data were collected from the Research Patient Data Registry (RPDR). No additional informed consent was obtained.

Declaration of Conflicting Interests

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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