Retrospective Study of a Series of 20 Ivory Prostheses in the Treatment of Trapeziometacarpal Osteoarthritis

Anne J. Spaans, MD¹ L. Paul van Minnen, MD, PhD^{1,2} Marieke E. Weijns, MSc¹ Assa Braakenburg, MD¹
Aebele B. Mink van der Molen, MD, PhD^{1,2}

¹ Department of Plastic and Hand Surgery, St Antonius Hospital Nieuwegein/Utrecht, The Netherlands

² Department of Plastic, Reconstructive and Hand Surgery, University Medical Centre Utrecht, The Netherlands

Address for correspondence Anne J. Spaans, MD, Department of Plastic and Hand Surgery, St Antonius Hospital, Koekoekslaan 1, 3435 CM Nieuwegein, The Netherlands (e-mail: annespaans@gmail.com).

J Wrist Surg 2016;5:131–136.

Abstract

Background Many surgical treatment options for osteoarthritis (OA) of the trapeziometacarpal (TMC) joint exist. However, no procedure has been proven superior. Good results have been described for TMC joint replacement.

Purpose To analyze the results of the Ivory prosthesis in the treatment of symptomatic TMC OA.

Patients and Methods A retrospective single-center follow-up study was performed. Visual analogue scale (VAS) for pain, Disabilities of the Arm, Shoulder and Hand (DASH) score, Michigan Hand Outcomes Questionnaire (MHQ), active range of motion, strength, and radiological outcomes were assessed and analyzed. Differences between the operated and nonoperated hand were analyzed using paired *t*-tests. Twenty patients were included with a mean follow-up duration of 37.0 months.

Results Patients experienced minimal pain with a mean VAS pain score of 1.9. DASH and MHQ scores indicated mild to moderate impairments. Eighty-five percent of patients assessed the operation excellent or good. Significant differences were found in measurements of extension and palmar thumb abduction in favor of the contralateral hand. No significant differences in strength between both hands were found. Two patients had a dislocation of the prosthesis; one patient required open reduction and tightening of the joint capsule. The other dislocation was treated with trapeziectomy and interposition of a fascia lata allograft. One patient had a collapse of the trapezium requiring a revision procedure.

Conclusion Ivory prosthesis TMC arthroplasty can achieve good results in patients with symptomatic isolated TMC OA. In this series, however, revision surgery was required in 3 of 20 cases.

Keywords

- ▶ trapeziometacarpal
- ▶ osteoarthritis
- ▶ prosthesis
- ▶ Ivory
- ▶ arthroplasty

Osteoarthritis (OA) of the trapeziometacarpal (TMC) joint causes pain, stiffness, and weakness in the thumb which can result in significant loss of function.¹ In case conservative treatment measures fail, several surgical treatment options

are available to reduce symptoms and restore function. To date, although trapeziectomy has been considered the gold standard treatment, no particular surgical option has been proven to be superior according to recent reviews.^{2,3}

received

November 30, 2015

accepted after revision

December 16, 2015

published online

January 15, 2016

Copyright © 2016 by Thieme Medical Publishers, Inc., 333 Seventh Avenue, New York, NY 10001, USA.
Tel: +1(212) 584-4662.

DOI <http://dx.doi.org/10.1055/s-0036-1571283>.
ISSN 2163-3916.

Complete joint replacement has been shown to be an invaluable therapy in many degenerative joints in upper and lower extremities. In the past 20 years, several types of TMC prostheses have been developed. Complete joint replacement of the TMC offers a potentially good treatment option for TMC OA compared with nonarthroplasty techniques.³

Theoretical advantages of TMC joint replacement include the ability to reproduce near-normal kinematics, stability, and strength with or without the presence of intact ligaments and maintenance of thumb length.^{4,5} The first total joint TMC prosthesis was placed in 1971 by De La Caffiniere and Aucouturier.⁶ This cemented ball-and-socket prosthesis consisted of a polyethylene cup articulating with a cobalt-chrome stem. To avoid problems with cement loosening, an uncemented prosthesis was introduced in the 1990s.⁴ Over the last decades, many types of uncemented ball-and-socket TMC prosthesis have been developed, such as the Arpe, Roseland, Elektra, Moje, Maia, and Ivory prostheses.^{7–12}

The purpose of the present study is to evaluate the subjective and objective outcomes of the Ivory TMC prosthesis in a cohort of patients with symptomatic TMC OA.

Patients and Methods

Patients

In this retrospective cohort study, 24 Ivory prostheses were placed in 24 patients between December 2010 and February 2013. Patients with symptomatic isolated TMC OA were operated because of insufficient results of conservative treatment. The scaphotrapezotrapezoidal (STT) joints were evaluated clinically by direct palpation of the joint and by radiography. In four patients, an additional bone scan combined with CT (single-photon emission computed tomography) was performed to rule out STT OA.

One patient could not be included due to severe, non-related illness at the time of study follow-up, one patient deceased 20 months postoperatively due to an unrelated cause, and two other patients were lost to follow-up. The 20 available patients were asked to revisit our clinic for clinical assessment and to complete questionnaires between August 2014 and April 2015. The study was approved by the institutional review board.

Prosthesis

An Ivory prosthesis (Memometal, Bruz, France) is a noncemented modular press fit ball-and-socket prosthesis, frequently used in Europe. It consists of a hydroxyapatite-covered metal metacarpal stem, a double-coned hydroxyapatite-covered trapezium cup, and an ultra-high-molecular-weight polyethylene liner (—Fig. 1). The prosthesis is nonconstrained, that is, stability of the joint is dependent on proper alignment and the soft tissues.

Surgical Technique

All operations were performed by two senior consultant hand surgeons. A single dose of 2 g cephazolin was administered preoperatively. Operations were performed under general or regional block anesthesia and tourniquet control.

Fig. 1 Radiograph of implanted Ivory prosthesis.

A dorsoradial incision was performed to approach the TMC joint. After identifying and protecting the superficial branches of the radial nerve, the slips of the abductor pollicis longus muscle were retracted and preserved. A longitudinal arthrotomy of the TMC joint was performed, preserving capsule for closure. With an oscillating saw, a thin slice of the distal trapezium (just enough to get a flat surface) and proximal metacarpal joint surface were excised. The metacarpal was reamed to accommodate the 7, 8, or 9 mm trial stem. The distal trapezium was reamed by hand with the provided reamer to the correct size at the center of the trapezium and a trial standard cup of 8 mm was placed. The correct neck size (small, medium, or large) was fitted after which the tension, stability, and mobility were tested. If the construct was stable, mobile, and of adequate length, the fitting implant was replaced by the definitive implant of the same size. The joint capsule was reconstructed using PDS 3.0 sutures. The skin was closed with 5.0 monofilament resorbable sutures.

Postoperative Care

Postoperatively, the thumb was immobilized in abduction and the wrist in slight dorsal flexion, with a forearm plaster cast for a period of 4 weeks. Then, the plaster was replaced by a removable splint and hand therapy was started. Joint loading was allowed from 6 weeks postsurgery and all patients had regular hand therapy sessions for a period of 3 months postoperatively.

Subjective Measurements

Patients complete two questionnaires: the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire and the Michigan Hand Outcomes Questionnaire (MHQ). To evaluate subjective outcome, a visual analogue scale (VAS) was used to

assess pain (0 = no pain, to 10 = worst pain imaginable), function (0 = full function, to 10 = no function), and overall satisfaction of the hand and thumb (0 = maximum satisfaction, to 10 = lowest satisfaction).

Additionally, patients were asked to complete a previously published, but yet nonvalidated questionnaire according to Vermeulen et al, addressing pain, satisfaction, and the willingness to have the surgery again.¹³

Objective Measurements

Objective clinical assessments of thumb active range of motion and strength were performed by two investigators not involved in the operative intervention.

Radial abduction and extension of the thumb were both measured with a hand goniometer. Palmar abduction was measured with the use of a pollexograph and by measuring the maximal intermetacarpal distance. Opposition was measured using Kapandji measurements (1–10). Strength of the thumb was recorded and analyzed using a computer interface measuring grip strength, key pinch strength, three-point pinch strength, and tip pinch strength (Biometrics).

Radiographic Measurements

Preoperative and successive postoperative anteroposterior, lateral, and Betts view radiographs were analyzed. The following radiological items were scored: osteolysis, loosening of the stem and/or cup, dislocation, and periprosthetic fracture. Loosening is defined as osteolysis in two or more regions (of stem or cup) of the prosthesis.⁴

Complications

Complications were identified based on written or electronic patient records.

Statistical Analysis

Postoperative values of study variables were analyzed with IBM SPSS software version 20. Differences between operated and contralateral hand were analyzed using paired *t*-tests. Statistical significance was accepted at the level of $p \leq 0.05$.

Results

The 20 included patients had an average postoperative follow-up of 37.0 months (range, 26–52 months). The majority of these patients was female (16) and the average age was 60 years (range, 51–73 years). Twelve patients were operated on their dominant hand. Preoperatively, 7 patients were diagnosed with Eaton–Glickel stage II OA and 13 patients with stage III OA. Most of the patients had retired at the time of the measurements.

Subjective Clinical Results

Postoperative VAS pain scores were low, with an average score of 1.9. DASH and MHQ scores indicated mild to moderate impairments or difficulties in daily use of the affected hand. Answers of the nonvalidated specific personal questionnaire were generally favorable: 85% of patients experienced pain never, seldom, or only after heavy activity; 80% of

patients would choose to have this operation again under the same circumstances; and 85% of patients assessed the results excellent or good (►Table 1). Surprisingly, the patients with implant failure and revision surgery still deemed the outcome of their treatment as good or excellent.

Objective Clinical Results

Comparison of objective measurements between the operated and nonoperated, contralateral hand yielded significant differences in extension and palmar thumb abduction measured by the intermetacarpal distance in favor of the contralateral hand. No significant differences in strength between both hands were found (►Table 2).

Radiographic Results

No cases of periprosthetic fracture or loosening were identified; in two patients, there was minor osteolysis at the cup. Two stems were dislocated without obvious clinical symptoms.

Complications

Two patients had a dislocation of the stem (►Fig. 2), respectively, 8 and 10 months after the initial operation. Both patients did not experience any acute trauma. In one patient, the dislocation was identified only when follow-up X-rays of study patients were taken. This patient had complaints of

Table 1 Subjective clinical results

	N = 20
VAS (SD)	
Pain	1.9 (1.9)
Function	3.1 (2.2)
Satisfaction	2.9 (2.6)
DASH (SD)	32.1 (16.6)
MHQ (SD)	68.2 (16.6)
When do you experience pain? (%)	
Never	2 (10)
Seldom	3 (15)
After heavy activity	12 (60)
Rest pain	3 (15)
Nocturnal pain	0 (0)
Would you choose this operation again? (%)	
Yes	16 (80)
No	4 (20)
How would you assess the operation? (%)	
Excellent	9 (45)
Good	8 (40)
Acceptable	2 (10)
Moderate	1 (5)
Poor	0 (0)

Abbreviations: DASH, Disabilities of the Arm, Shoulder and Hand; MHQ, Michigan Hand Outcomes Questionnaire; N, number of patients; SD, standard deviation; VAS, visual analog scale.

Table 2 Objective clinical results

	Operated hand (SD) N = 20	Nonoperated hand (SD) N = 20	p-Value
Active ROM			
Radial thumb abduction in degrees	50.4 (12.9)	57.4 (10.6)	0.077
Palmar thumb abduction (pollexograph) in degrees	41.8 (11.2)	48.7 (10.4)	0.057
Palmar thumb abduction (intermetacarpal distance) in cm	4.7 (0.7)	5.1 (0.7)	0.028
Extension in cm	3.3 (1.0)	4.1 (1.0)	0.006
Kapandji on scale from 1 to 10	8.8 (1.0)	8.8 (1.4)	0.875
Strength			
Grip strength in kg/m ²	23.7 (9.2)	26.1 (9.5)	0.251
Key pinch strength in kg/m ²	4.5 (2.0)	4.5 (2.1)	0.889
Three-point pinch strength in kg/m ²	3.6 (1.7)	4.2 (1.9)	0.074
Tip pinch strength in kg/m ²	2.4 (1.2)	2.6 (1.2)	0.357

Abbreviations: N, number of patients; ROM, range of motion; SD, standard deviation.

pain and weakness of the thumb but did not seek surgical follow-up until called for study follow-up. The cup and neck of the prosthesis were removed, followed by trapeziectomy with interposition of a fascia lata graft. In the second patient, a reoperation was performed with open reduction of the prosthesis and tightening of the joint capsule.

Fig. 2 Dislocation of Ivory prosthesis.

One patient had a collapse of the trapezium (► **Fig. 3**). In this case, poor bone quality was noted clinically at the time of placement. Six months after the initial operation, a revision operation (removal of cup and neck and trapeziectomy with ligament reconstruction and tendon interposition using a distally based strip of flexor carpi radialis tendon) was performed.

Two other patients showed a mild adduction contracture which did not require surgical management. No other complications were registered.

Discussion

The current study shows that implantation of an Ivory TMC total joint prosthesis in patients with symptomatic TMC OA can achieve good subjective and objective results. This TMC

Fig. 3 Collapse of trapezium.

arthroplasty, however, can present with problems of implant failure in a minority of cases.

The only one other study discussing the results of the Ivory prosthesis has been published by Goubau et al. Pre- and postoperative results of 22 patients with an Ivory prosthesis were compared over a 5-year period in a single-center prospective study performed in Belgium. A good functional outcome was found, and the prosthesis showed a high survival rate of 95%.⁸

Numerous other noncemented TMC ball-and-socket prostheses have been investigated with varying results. Recently, Huang et al published a systematic review about TMC joint prostheses. They included 32 articles with studies of 14 different prostheses, both cemented and noncemented. Their overall conclusion was that total joint arthroplasty does not perform better than trapeziectomy and there is a higher complication rate and significant extra cost of using an implant.¹⁴ However, this study included many different prostheses with very varied outcomes. Also, designs of the prostheses have been subject to change and improvement in the last decades. Therefore, it is impossible to reliably compare all different TMC total joint arthroplasties.

The vast variety of prosthesis (varieties in design of cup and stem, cemented or uncemented, [semi]constrained or nonconstrained prosthesis) designed and implanted in the last decades will be reason for significant differences of outcome found in the literature. Pooling of all arthroplasty results to draw conclusions on outcome would therefore yield unreliable conclusions and is not a solution either. The only way forward is to perform prospectively randomized trials, with stratification for age since the properties of a prosthesis seem to be of value especially for younger patients with good bone stock.

There is little literature about the effect of constrained and nonconstrained prostheses in the TMC joint. Wachtl et al concluded that a constrained ball-and-socket prosthesis (such as Ledoux or de la Caffinière) is not suitable for the TMC joint.¹⁵ Newer generation nonconstrained prostheses, such as the Ivory prosthesis, have better material properties and have been shown to be effective in patients with capable adjacent soft tissues and adequate bone stock and quality.¹⁶ However, the question remains if a ball-and-socket prosthesis is the best-fitting design for the replacement of a saddle joint, since a ball-and-socket design has an indefinite number of axes to move around instead of a saddle joint, which has three planes of motion.

Unfortunately, in our study the preoperative subjective and clinical measurements were not complete and could therefore not be included. Subsequently, estimation of improvement in subjective and clinical outcomes in these patients was limited.

However, a reliable finding of the present study is that the majority of our patients (85%) rated the operation good or excellent and postoperative patient satisfaction is a very important parameter. Most patients who were (very) satisfied with the implant reported that on a daily basis they forgot about the fact the implant was there. Some patients went back to high-demand use of their hands, including activities

such as volleyball or professional carpentry. To date, their prostheses did not fail despite these high demands placed on the device. In the present study, two patients required an additional operation because of a dislocated stem in which closed reduction was not possible. The radiographic analysis did not show any signs of loosening of the implant.

We believe that the appropriate selection of patients is an important factor determining outcome. As with all operations for TMC OA, conservative treatment options should be used optimally, because all operative interventions have their drawbacks. TMC total joint arthroplasty is indicated in cases of isolated symptomatic TMC OA. Patients should not perform heavy manual labor and should not have osteoporosis. A total joint prosthesis can achieve the most anatomic restoration. However, to be really of value in the treatment of TMC OA, it seems some adjustments must be made to the design of the prosthesis.

In conclusion, placement of an Ivory prosthesis in patients with symptomatic isolated TMC OA can yield good results. As with all total joint arthroplasties, this implant is subject to failure and revision surgery in a minority of cases. The need for long-term follow-up randomized controlled trials comparing total joint arthroplasty with standard-of-care procedures such as trapeziectomy remains.

Note

The ethical review committee approved this study. This work was performed at St Antonius Hospital Nieuwegein/Utrecht.

Level of Evidence

Level 4, therapeutic cohort study.

Conflict of Interest

None.

References

- Menon J. Partial trapeziectomy and interpositional arthroplasty for trapeziometacarpal osteoarthritis of the thumb. *J Hand Surg [Br]* 1995;20(5):700–706
- Wajon A, Vinycomb T, Carr E, Edmunds I, Ada L. Surgery for thumb (trapeziometacarpal joint) osteoarthritis. *Cochrane Database Syst Rev* 2015;2:CD004631
- Vermeulen GM, Slijper H, Feitz R, Hovius SER, Moojen TM, Selles RW. Surgical management of primary thumb carpometacarpal osteoarthritis: a systematic review. *J Hand Surg Am* 2011;36(1):157–169
- Wachtl SW, Sennwald GR. Non-cemented replacement of the trapeziometacarpal joint. *J Bone Joint Surg Br* 1996;78(5):787–792
- Cooney WP, Linscheid RL, Askew LJ. Total arthroplasty of the thumb trapeziometacarpal joint. *Clin Orthop Relat Res* 1987;(220):35–45
- de la Caffinière JY. Total trapezo-metacarpal prosthesis [in French]. *Rev Chir Orthop Repar Appar Mot* 1974;60(4):299–308
- Apard T, Saint-Cast Y. Results of a 5 years follow-up of Arpe prosthesis for the basal thumb osteoarthritis [in French]. *Chir Main* 2007;26(2):88–94

- 8 Goubau JF, Goorens CK, Van Hoonacker P, Berghs B, Kerckhove D, Scheerlinck T. Clinical and radiological outcomes of the Ivory arthroplasty for trapeziometacarpal joint osteoarthritis with a minimum of 5 years of follow-up: a prospective single-centre cohort study. *J Hand Surg Eur Vol* 2013;38(8):866–874
- 9 Guardia C, Moutet F, Corcella D, Forli A, Pradel P. Roseland® prosthesis: quality of life's studies about 68 patients with a mean followed-up of 43.8 months [in French]. *Chir Main* 2010;29(5):301–306
- 10 Jager T, Barbary S, Dap F, Dautel G. Evaluation of postoperative pain and early functional results in the treatment of carpometacarpal joint arthritis. Comparative prospective study of trapeziectomy vs. MAIA® prosthesis in 74 female patients [in French]. *Chir Main* 2013;32(2):55–62
- 11 Kaszap B, Daecke W, Jung M. High frequency failure of the Moje thumb carpometacarpal joint arthroplasty. *J Hand Surg Eur Vol* 2012;37(7):610–616
- 12 Klahn A, Nygaard M, Gvozdenovic R, Boeckstyns MEH. Elektra prosthesis for trapeziometacarpal osteoarthritis: a follow-up of 39 consecutive cases. *J Hand Surg Eur Vol* 2012;37(7):605–609
- 13 Vermeulen GM, Brink SM, Sluiter J, Elias SG, Hovius SER, Moojen TM. Ligament reconstruction arthroplasty for primary thumb carpometacarpal osteoarthritis (weilby technique): prospective cohort study. *J Hand Surg Am* 2009;34(8):1393–1401
- 14 Huang K, Hollevoet N, Giddins G. Thumb carpometacarpal joint total arthroplasty: a systematic review. *J Hand Surg Eur Vol* 2015;40(4):338–350
- 15 Wachtl SW, Guggenheim PR, Sennwald GR. Cemented and non-cemented replacements of the trapeziometacarpal joint. *J Bone Joint Surg Br* 1998;80(1):121–125
- 16 Rizzo M. Metacarpophalangeal joint arthritis. *J Hand Surg Am* 2011;36(2):345–353