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Thumb Arthroplasty as Reliable Long-term Solution for Trapeziometacarpal Osteoarthritis: A Minimum of 15 Years of Follow-up

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Abstract

Background: In patients with symptomatic trapeziometacarpal (TMC) joint arthritis resistant to conservative treatment, surgical treatment can be advised. One of the many surgical treatment options is TMC arthroplasty. The Arpe prosthesis is one example of these TMC arthroplasties. **Methods:** This retrospective study evaluated patients who underwent TMC arthroplasty with the Arpe prosthesis after a minimum of 15 years of follow-up. Clinical, radiologic, and qualitative outcomes were assessed for 43 Arpe arthroplasties in 41 patients, of whom 2 had bilateral arthroplasties. The female to male ratio was 39:4. The mean follow-up time was 197 months (range = 180-225). **Results:** The cumulative survival rate after a mean of 16.5 years was 84%. Seven failures (16%) were registered, of which 5 during the first 3 years after primary surgery. All patients were successfully converted to a trapeziectomy. Quick Disabilities of the Arm, Shoulder and Hand score improved with 44.9 points and visual analogue pain score with 97% and 91% at rest and during exercise, respectively. **Conclusions:** This series demonstrates that thumb arthroplasty is a reliable long-term solution for thumb base arthritis, with significant pain reduction and functional improvement, even after 15 years of follow-up.

Keywords: trapeziometacarpal arthroplasty, trapeziometacarpal joint osteoarthritis, Arpe prosthesis, long-term results, rhizarthrosis

Introduction

Osteoarthritis of the trapeziometacarpal (TMC) joint is a common disease of the aging hand. Patients often respond to rest, night splinting, and nonsteroidal anti-inflammatory drugs. Symptoms decrease temporarily; nevertheless, in many patients, significant disablement persists.[1] In case of failure of conservative therapy, a wide variety of surgical options is available to treat this condition: arthrodesis of the TMC joint, simple trapeziectomy, trapeziectomy with ligament reconstruction, and thumb base arthroplasty.[2-6] Over the years, multiple types of ball and socket arthroplasties have been manufactured: Arpe, Maïa, Elektra, and Ivory are some examples.[7-10] Although trapeziectomy remains the commonest surgical treatment for TMC joint arthritis, TMC joint arthroplasty treatment may result in better function with equal pain scores. However, the odds of complications, especially those requiring revision surgery, are typically greater in joint replacement.[11] A more recent development in TMC joint arthroplasties is the dual-mobility principle. A mobile polyethylene insert implies less wearing out and a higher degree of mobility. Furthermore, the dual-mobility design results in higher intra-prosthetic stability, thanks to the increased diameter of the ball.[12,13] We present a long-term evaluation of the Arpe arthroplasty for advanced TMC joint arthritis.

Materials and Methods

Study Design

We performed a retrospective single-center cohort study in which patients received an Arpe arthroplasty (Zimmer-Biomet,

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Warsaw, Indiana) for TMC joint arthritis. Clinical outcome, radiologic outcome, and qualitative outcome after a minimum of 15 years of follow-up were evaluated. Ethical approval for this study was obtained from the local Ethics Committee (study number 21060, registration number B1172021000021).

Patients

Patients treated with an Arpe arthroplasty between January 2003 and December 2006 were evaluated. All patients provided written informed consent. A total of 58 consecutive thumbs were operated in 56 patients. Indications for surgery were advanced TMC joint arthritis stage II, III, and occasionally stage IV, according to the Dell classification. The Dell classification as described by PC Dell in 1978 includes 4 stages. In stage I, there is a decrease in joint height, slight sclerosis, and no subluxation. In stage II, there is a small osteophyte at the ulnar border of the trapezium. The first metacarpal is subluxated less than one-third of the diameter of its base. In stage III, there is a prominent osteophyte at the ulnar border, and the first metacarpal is subluxated more than one-third. In stage IV, there is a total loss of joint space.[14] Criteria for patient inclusion were severe pain at rest and during activity, resistant to conservative therapy for more than 3 months. This conservative treatment consisted of nonsteroidal anti-inflammatory drugs, night splinting, refraining from physically stressful activities, and intra-articular corticosteroid infiltration. The patient's choice of treatment was free; however, the advice to consider an Arpe arthroplasty over trapeziectomy was given in patients with a high demand for thumb function.

An arthroplasty was considered to be a failure whenever one or more of the arthroplasty components necessitated revision surgery. Dislocation of the cup, fracture of the neck, chronic dislocation, and symptomatic poly wear were all considered to be a failure.

The Surgical Procedure

The Arpe arthroplasty has a ball and socket design with a hydroxyapatite-coated metacarpal stem, a hemi-spherical, hydroxyapatite-covered cup with an ultrahigh-molecular-weight polyethylene insert. Its modular design comes with different neck heights (eg, medium, long, and extra-long) and the necks are typically straight or with an offset.[15,16] The TMC joint was approached through a posterolateral approach, which allows optimal access to the trapezium. The surgical technique has been described in detail.[16] Particular attention should be paid to central positioning of the cup and testing stability after trail reduction. Working with trial components allows for the appropriate prosthetic neck length adjustment.

Assessments

Qualitative outcome (including satisfaction and overall survival), overall function (including pain score), and radiographic outcome were evaluated for each patient.

Overall function was assessed using the Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) scale. Pain was assessed with a visual analogue scale (VAS), with scores from 0 to 10—"0" indicates that a patient is pain free, whereas "10" implies intolerable sufferance. Pain scores in rest and during exercise were registered as well as patient satisfaction after a minimum of 15 years of follow-up.

Radiographic evaluation consisted of preoperative, immediate postoperative, and a minimum of 15 years postoperative frontal and profile views of the TMC joint as described by Kapandji.[17] The degree of preoperative thumb base arthritis (Dell classification) and scapho-trapezio-trapezoid (STT) joint arthritis (Crosby classification) were assessed.[14,18] The postoperative evaluation after 15 years allowed for an assessment of the development of STT joint arthritis and periprosthetic osteophytes. The presence of loosening and/or secondary displacement of cup and stem, as well as decentralization of the neck in the cup, suggesting polyethylene wear, was assessed as well. The systematic approach used to evaluate displacement was described in detail by Goubau et al.[19] Analysis of preoperative, immediate postoperative, and postoperative after a minimum of 15 years radiographs was performed by an independent radiologist.

Statistical Analysis

Kaplan-Meier curves were used to assess the survival with 95% confidence interval using the following as criteria for failure: failure of one or more of the arthroplasty components necessitating revision surgery, dislocation of the cup, fracture of the neck, chronic dislocation, and symptomatic poly wear.

D'Agostino-Pearson test and paired-samples *t* test were used to evaluate differences in QuickDASH scores. Paired-samples Wilcoxon signed rank tests were used to compare VAS scores. A P value of $<.05$ was considered statistically significant.

Results

Initially, 56 patients were enrolled in the study, but 15 were subsequently excluded. One patient had died, 4 others were lost to follow-up, and 10 patients were excluded from participation because of a variety of reasons (immobility, Alzheimer disease, concomitant medical issues). Forty-one patients remained included, of which 39 had a unilateral prosthesis and 2 had a bilateral prosthesis. The female to male ratio was 37:4. The mean age at surgery was 55 years

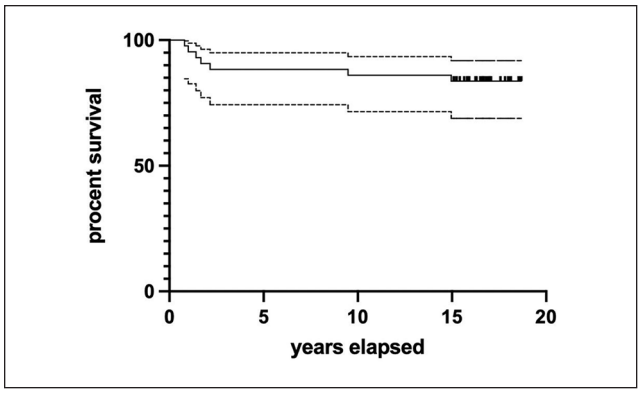

Figure 1. Kaplan-Meier survival curve with 95% confidence interval of 43 thumb arthroplasties using the following as criteria for failure: Failure of one or more of the arthroplasty components necessitating revision surgery, dislocation of the cup, fracture of the neck, chronic dislocation, and symptomatic poly wear.

(range = 40-68). The mean follow-up time was 197 months (range = 180-225). The survival of the arthroplasty after a mean of 16.5 years was 84% (Figure 1). Failure occurred in 7 out of 43 arthroplasties (16%). All were converted to a trapeziectomy. Three patients had cup loosening, of which 1 was originally fixated in the trapezium with bone cement. Three patients experienced dislocation of the arthroplasty, of which 2 within 1 year from primary surgery and a third one after a traumatic insult 15 years postoperatively. One patient underwent a trapeziectomy because of symptomatic STT arthritis. An overview of the failures and mode of revision can be found in Table 1. The mean VAS score at rest was 6.9 preoperatively (range = 3-10) and 0.2 fifteen years postoperatively (range = 0-3). The mean VAS during exercise was 8.1 preoperatively (range = 4-10) and 0.7 fifteen years postoperatively (range = 0-4). The mean QuickDASH was 53.4 preoperatively (range = 22.7-93.2) and 8.5 fifteen years postoperatively (range = 0-29.5). The VAS at rest and during exercise improved with 97% and 91%, respectively, and QuickDASH with 44.9 points. D'Agostino-Pearson test for normality indicated a normal distribution for the QuickDASH score. Paired-samples *t* test demonstrated a significant difference in QuickDASH score before surgery and 15 years after surgery ($P < .001$). For the VAS score, both at rest and during exercise, no normal distribution was assessed. Paired-samples Wilcoxon signed rank tests demonstrated a significant reduction in pain sensation at rest and during exercise ($P < .0001$).

Radiographic analysis of these patients demonstrated the presence of preoperative STT arthritis in 10 of 36 arthroplasties. This number increased to 24 at the late follow-up. Significant osteophytes at the level of the arthroplasty were present in 22 arthroplasties. Furthermore, loosening of the stem was diagnosed in 1 patient, cup loosening in 2 patients, and asymmetrical neck positioning in the cup, indicating polyethylene wear, in 5 patients. As some abnormalities were simultaneously present in the same patient, a total of 6 of 36 arthroplasties displayed prosthesis-related radiographic anomalies (Figure 2). All patients were asymptomatic and none of them requested revision surgery. These patients were informed about the radiographic findings and the possible clinical implications in the long term. They were offered close follow-up at the outpatient clinic. Overall patient satisfaction was graded excellent in all but one patient.

Discussion

Other long-term results on modern TMC prostheses have recently been reported and are starting to challenge trapeziectomy as reference procedure for TMC osteoarthritis.[20] Trapeziectomy with or without ligamentoplasty has its limitations, and failed thumb arthroplasty can be revised with implant exchange or converted to trapeziectomy with similar results as primary trapeziectomy.[21-23]

Our survival rate at a mean follow-up of 197 months was 84%. To the author's knowledge, this is the first study on such long-term survival on thumb arthroplasty. Other studies reported similar survival rates at a shorter follow-up or a slightly lower rate of 80% at 15 years for the Arpe prosthesis.[7,24,25] Other new-generation thumb arthroplasties also show good long-term outcome. Tchurukdichian et al,[26] looking at long-term results of the Ivory prosthesis, reported a survival rate of 95% after 10 years. Chiche et al[27] also observed a high survival rate of 88% at 12-year follow-up for the Maïa prosthesis.

Survival declined mainly in the first year. Two of the 3 dislocations occurred within the first year and the third one was due to a trauma 15 years after surgery. Early dislocations are known to be caused by surgical errors as incomplete resection of osteophytes and poor cup positioning.[21] The dual-mobility TMC joint arthroplasties might solve this problem of early postoperative instability.[12,28]

Patients showed a significant reduction in pain sensation, at rest and during exercise, and a significant difference in QuickDASH score, as established by Jørgensen and Nyring,[29] before and 15 years after surgery. Patient satisfaction was graded excellent in all but one patient. De Smet et al[25] and Dumartinet-Gibaud et al[7] also reported good subjective outcomes after 10 years for the Arpe prosthesis.

The limitations of our study are that it is a single-center cohort study with a retrospective design. Also, no functional results are available and the study included a relatively small number of participants. This is partly due to the long follow-up time which conversely is a major strength of this study. Pain scores at rest and during activities were separately obtained and showed both a significant reduction. Another strength is the radiological examination that

Table 1. Failures of the Arpe Prosthesis.

Patient no.	Age, y	Gender	Time since surgery	Cause of failure	Mode of revision
1	61	F	9,5 y	Cup loosening	Trapeziectomy
2	65	F	1,5 y	Cup loosening	Trapeziectomy
3	53	M	<1 y (10 mo)	Early dislocation	Trapeziectomy
4	54	F	<1 y (11 mo)	Early dislocation	Trapeziectomy
5	60	F	1,5 y	Cup loosening	Trapeziectomy
6	69	F	15 y	Dislocation	Trapeziectomy
7	43	F	2,5 y	STT arthritis	Trapeziectomy

Note. Age = age at time of revision surgery; y = years; F = female; M = male; mo = months; STT arthritis = symptomatic scapho-trapezio-trapezoid arthritis.

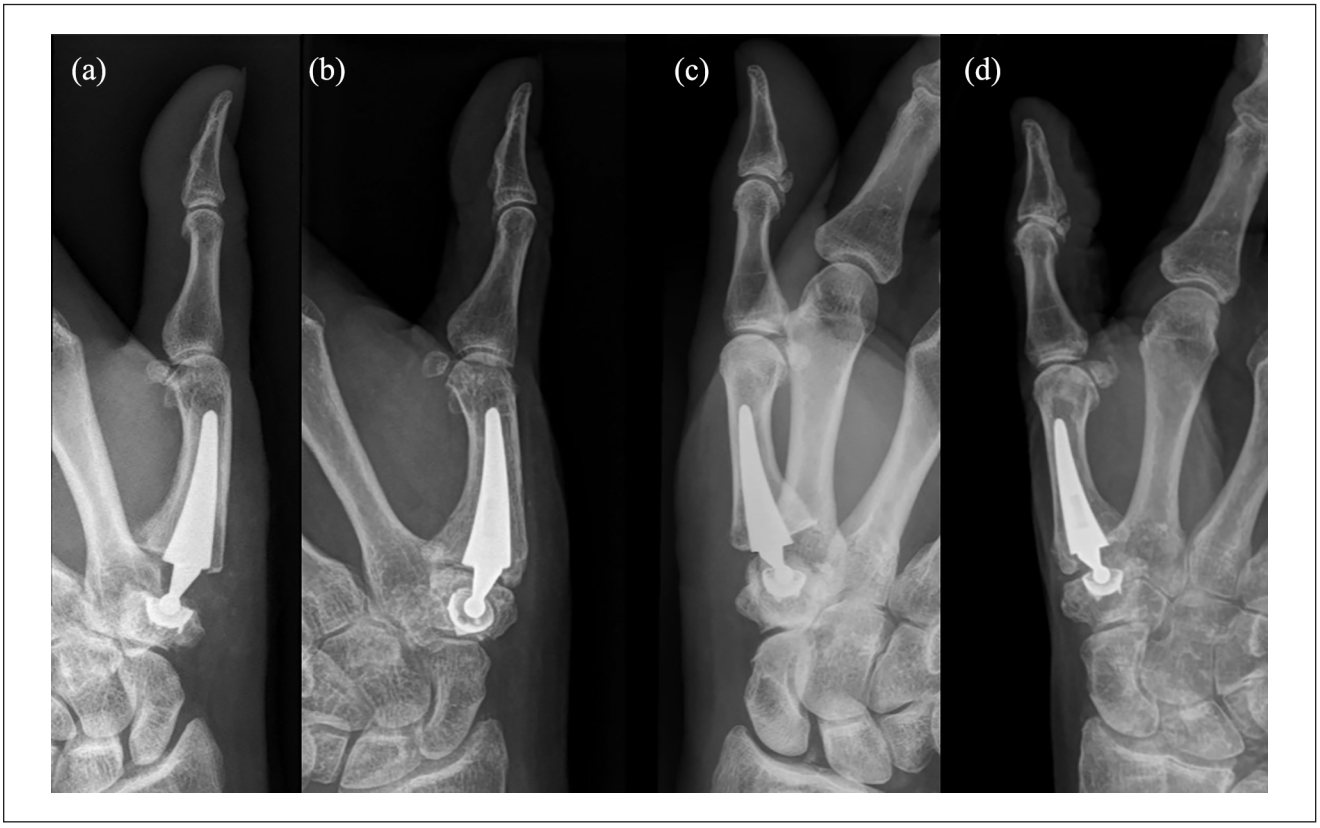

Figure 2. Radiographic view of the prostheses immediate (a and c) and 15 years after surgery (b and d). Note the osteophytes at the level of the prosthesis (b and d) and cup loosening in (b) and stem loosening in (d).

allowed us to identify asymptomatic implant failure. Six patients with radiographic anomalies were all asymptomatic and graded their satisfaction as excellent. Vanmierlo et al[30] also reported that none of their patients with radiographic failure of the prosthesis required explantation.

The authors advocate for the use of nationwide thumb arthroplasty registries to be able to compare the multiple types of ball and socket arthroplasties. Arthroplasty registries exist for more than 5 decades for hip and knee and are associated with a decreased burden of revision.[31] Furthermore, these registries can lead to better health outcomes at a lower cost for the society and help health care professionals identify best practices.[32] The Norwegian Arthroplasty Registry was the first to collect national data on hand surgery.[33] Currently, several national registries exist (Norway, Australia, Sweden, the United Kingdom, the Netherlands, and Germany), but data remain scarce and more information is needed to compare techniques and implants.[34]

Hansen does not yet see thumb arthroplasty replacing trapeziectomy as reference procedure for TMC osteoarthritis in

the near future, considering the problems with the early-generation prostheses and their comparable results with a simple trapeziectomy.[35] However, our study confirms TMC prostheses as a reliable long-term solution and its advantages over other surgical procedures are well described.[21,26,36-40] For these reasons, the authors believe that in the next years, thumb arthroplasty will become more and more dominant in the treatment of thumb base osteoarthritis.

Contributorship

BV conceived the study. PVG, AT, and BV were involved in protocol development, gaining ethical approval and patient recruitment. PVG and BV performed the data analysis. PVG wrote the first draft of the manuscript. All authors reviewed the manuscript and approved the submitted manuscript.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008. Informed consent was obtained from all patients for being included in the study.

Statement of Informed Consent

Written informed consent was obtained from all subjects before the study.

Declaration of Conflicting Interests

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