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Comparison between the MAIA® Implant and Trapeziectomy for Trapeziometacarpal Osteoarthritis: Outcomes at 9 Years' Follow-Up

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Background: The purpose of this retrospective study was to report and compare the outcomes of the MAIA® prosthesis and trapeziectomy for trapeziometacarpal osteoarthritis.

Methods: We included 92 consecutive patients (8 men, 84 women) with a mean age of 57 years (range 44–75 years) who underwent trapeziectomy (44 patients) or trapeziometacarpal joint replacement with a MAIA® prosthesis (48 patients) for painful osteoarthritis. All patients were evaluated (pain, range of motion, strength, function, X-rays) by an independent examiner.

Results: The two groups of patients had comparable preoperative characteristics. At the mean follow-up of 9 years (range: 8–10), we found a significant reduction in pain levels for each group. In the final data review, there were no significant differences in terms of pain levels, grip strength, thumb active motion and the Quick Disabilities of the Arm, Shoulder and Hand score between the two groups. Pinch strength and the work performance score on the Michigan Hand Questionnaire were significantly better in the MAIA® prosthesis group. The MAIA® group had a shorter postoperative recovery time of 6 weeks and fewer patients required physiotherapy. Postoperatively, the thumb column length was significantly less in the trapeziectomy group. In this group, we found a significant decrease in the trapezial cavity height between the immediate postoperative evaluation and the final assessment, with three patients having painful scaphometacarpal impingement. Two patients required surgical revision for symptomatic metacarpophalangeal joint hyperextension. In the MAIA® group, we found no implant subsidence, loosening, dislocation or fracture. None of the implants were revised.

Conclusions: From this study, we found that the both procedures can be used as a surgical treatment for trapeziometacarpal osteoarthritis. The MAIA® prosthesis is a useful alternative to trapeziectomy and appears to be a reliable and effective implant in the medium- to long-term.

Keywords: Arthroplasty, Osteoarthritis, Trapeziometacarpal joint, Trapeziectomy

INTRODUCTION

Trapeziectomy is the gold-standard procedure for surgical treatment of trapeziometacarpal (TMC) osteoarthritis.[1,2] Clinical results are good with significant pain reduction and functional thumb range of motion (ROM).[3] However, trapeziectomy has its disadvantages: it does not correct the thumb's loss of length and the recovery is long.[4,5] Moreover, surgical revision of failed cases is dif-

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ficult.

TMC total joint arthroplasty is a more recent alternative that has a relatively short recovery time, counteracts metacarpophalangeal (MCP) joint hyperextension and maintains thumb length.[6,7] The design of TMC implants has evolved greatly in recent years. Various models are available that incorporate different materials.[8] However, there is little information on the mid- and long-term outcomes for these implants. The main complications are cup loosening and dislocation with various rates depending on the studies.[9] The MAIA® prosthesis (Groupe Lépine, GENAY 69727, France) is a modular uncemented ball-and-socket hydroxyapatite-coated implant. Toffoli and Teissier[10] reported promising results with this implant after 6 years' follow-up.

To our knowledge, there is no published study comparing trapeziectomy with the MAIA® implant at medium-term. The purpose of this retrospective study was to report and compare the outcomes of these two procedures with a mean follow-up of 9 years.

METHODS

Patients

Between January 2009 and December 2011, we performed surgical treatment on 110 consecutive patients for painful advanced osteoarthritis of the TMC joint (grades III and IV to the Eaton classification[11]) that did not respond to conservative treatment (analgesics, non-steroidal anti-inflammatory drugs, orthesis). All patients were operated at the same facility by senior surgeons. These patients underwent TMC arthrodesis (8 patients), trapeziectomy (49 patients) or TMC arthroplasty with the MAIA® prosthesis (53 patients). We reviewed 92 patients (8 men, 84 women) with a mean age of 57 years (range 44–75 years). 44 patients had a trapeziectomy and 48 patients a MAIA® prosthesis, using same procedures. None had a history of previous TMC trauma or trapezial dysplasia, and none had undergone previous thumb surgery. The choice of surgical technique was left to the discretion of the surgeon and the patient; this last received systematically a complete information on these two procedures, their respective ins and outs, and operative suites.

The dominant side was involved in 49 (53%) cases. Twenty-four patients (26%) were retired and 68 (74%) were still actively working. Thirty-six patients (39%) performed manual labour.

The study was approved by our institutional review board. The patients were reviewed in person retrospectively. After obtaining their consent, an independent examiner (surgeon with 5 years' clinical experience) performed the final clinical and radiographic assessments.

Maïa® prosthesis

The MAÏA® prosthesis (Groupe Lépine, Genay 69727, France) is a modular, cementless hydroxyapatite-covered implant. The metacarpal stem and cup are composed of titanium alloy and the neck is composed of high nitrogen steel. The metacarpal stem and cup have a double layer coating consisting of a hydroxyapatite outer layer and a porous titanium inner layer that provides maximal secondary stability and bone ingrowth. The stem has an anatomical shape that follows the profile of the first metacarpal. Four sizes of metacarpal stems are available (7, 8, 9, and 10 mm). The hemispherical semi-retaining metal-backed cup is designed with a flat dome and thick rim to reinforce the press-fit effect with a polyethylene liner. Four pins stabilize the cup. Three sizes of cups (8, 9 or 10 mm) are available. The removable neck with a 4-mm-diameter head is assembled with the stem by a Morse taper. Three different neck lengths are available to achieve maximal stability. The offset necks reproduce the anatomical nonalignment of the first metacarpal with the centre of the trapezium.

Surgical technique and postoperative protocol

Two surgeons (minimum of 10 years' clinical experience) performed all the operations with the patient under regional anaesthesia and a tourniquet applied on the upper arm. A dorsolateral longitudinal incision was made along the axis of the first metacarpal, centred over the TMC joint. The joint was approached between the extensor pollicis brevis and abductor pollicis longus (APL) tendons and opened with an L-shaped capsulotomy.

For the trapeziectomy procedure, the central portion of the trapezium was roughened longitudinally with a rongeur until the trapezium was divided in two. Once completed, the two halves of the trapezium were placed in the defect, which facilitates soft tissue dissection of the remaining halves of the trapezium and makes them easy to excise. The flexor carpi radialis (FCR) tendon was identified and protected. Next, the APL tendon was split and partially transected approximately 3 cm proximal to its attachment at the base of the thumb metacarpal. The APL tendon slip was passed around the FCR tendon and axial traction applied distally to the slip which was sutured on the APL tendon's metacarpal attachment using PDS™ sutures (Ethicon®). This set the thumb metacarpal in abduction and the MCP joint in

slight flexion. Then, using the same PDS™ sutures, a palmaris longus tendon or the remaining length of the APL tendon slip was clamped and rolled up to create an "anchovy" and then placed in the trapezial cavity.

For the MAÏA® prosthesis, 4 to 5 mm was removed from the base of the first metacarpal with an oscillating saw. The metacarpal was reamed with the instruments provided by the manufacturer and an appropriate trial stem was inserted. After confirming with fluoroscopy that the trial implant was correctly positioned, the final stem was inserted. The centre of the trapezium was located visually and confirmed by fluoroscopy using a temporary K-wire. Then, the trapezium was reamed. A cup of appropriate size was impacted by press-fit. A trial head and neck implant were inserted, the implant was reduced, and the stability and motion were assessed. The definitive head and neck implants were then inserted, and the implant reduced and reassessed.

The capsule was closed with PDS™ sutures (Ethicon®) and the skin with non-resorbable sutures. Immediately following surgery, the thumb was immobilized temporary with a volar cast for 48 to 72 hours and thereafter with a short thumb spica splint for 1 month. Hand rehabilitation was started 1 month after the operation.

Clinical and functional evaluations

Subjective and objective data were collected. Pain during activity was assessed preoperatively and at the final assessment with a visual analogue scale (VAS) (score from 0 to 10). At the final assessment, active ROM was measured in degrees (accuracy of 1°) with a goniometer (Prestige® Medical, Northridge, USA), grip strength (kg) was measured with a Jamar® hydraulic hand dynamometer and pinch strength with a Jamar® hydraulic pinch gauge (Performance Health®, Charleville-Mézières, France). Thumb retropulsion (score out of 4) and opposition (score out of 10) were also measured as described by Kapandji.[12] MCP joint hyperextension values of 30° or less were desirable.

The functional outcomes were evaluated using standardized questionnaires: the Quick version of the Disabilities of the Arm, Shoulder and Hand Score (QuickDASH) (out of 100)[13] and the Michigan Hand Questionnaire (MHQ) (out of 100)[14]. The patients were asked to grade their overall satisfaction as poor, average, good, or excellent. The type of rehabilitation (self-directed or physiotherapy), the number of physiotherapy sessions and the time needed before resuming activities of daily living (ADL) were also recorded. For the working patients, the time away from work was noted.

Radiographic evaluation

Each patient underwent an imaging assessment consisting of standard radiographs with anteroposterior (AP) and lateral views of the involved thumb at the preoperative consultation, immediately after surgery and at the final review.

Osteoarthritis was assessed preoperatively on radiographic views using the Eaton classification.[11] The scaphotrapeziotrapezoid (STT) joint was also assessed using the Crosby classification.[15] Moreover, in both groups, we measured the preoperative height of the trapezium and the pre- and postoperative length of the thumb column (accuracy 1 mm) (Fig. 1A and 1B).

Postoperatively, we evaluated the height of the trapezial cavity in the trapeziectomy group (accuracy 1 mm) (Fig. 1C). In the MAÏA® group, the corresponding radiographs were assessed for cup or stem subsidence, peri-

Fig. 1. Radiographic measurements on standard radiographs with AP and lateral views. (A) Evaluation of trapezium height, in mm, on AP view. (B) Evaluation of thumb column length, in mm, on strict lateral view. (C) Evaluation of trapezial cavity height after trapeziectomy, in mm, on AP view. (D) Evaluation of cup subsidence by comparing the A/B ratio in % on AP views immediately after surgery and at the time of review. (E) Evaluation of stem subsidence by comparing the C/D ratio in % on strict lateral views immediately after surgery and at the time of review. A difference of more than 25% was indicative of implant subsidence.

prosthetic radiolucent lines and other signs of osteolysis, implant fracture, wear of the polyethylene component, periprosthetic ossification, prosthetic dislocation or subluxation, and STT joint osteoarthritis. Subsidence was evaluated by comparing the A/B ratio in % on AP views (cup) and the C/D ratio in % on strict lateral views (stem), immediately after surgery and at the final assessment (Fig. 1D and 1E). We considered a difference of more than 25% as indicative of implant subsidence.[16]

Statistical analysis

Quantitative variables were described by their mean and confidence interval. Qualitative variables were described by their counts and percentages. The Student's t-test was applied for between-group comparisons of continuous data. The Pearson's Chi-squared test and Fisher's exact test were used to compare categorical data. The significance level was set at $p < 0.05$. Survival rate (without further surgery) was estimated using the Kaplan-Meier method.

RESULTS

The two groups of patients had comparable preoperative characteristics without significant differences ($p > 0.05$) (Table 1). The mean follow-up was 9 years (range: 8–10 years) for both groups.

The surgical wound had healed in all patients after 2 weeks. Hand rehabilitation was initiated at 1 month postoperative in all patients. In the trapeziectomy group, 89% of patients had physiotherapy while 58% did in the MAÏA® group ($p < 0.01$). On average, 20 sessions (range: 0–40) were performed in the trapeziectomy group and 10 sessions (range: 0–25) in the MAÏA® group. All patients resumed their ADL after a mean of 3 weeks. The time away from work was significantly shorter (6 weeks) for the MAIA® group ($p < 0.01$) (Table 2).

Table 1. Patient Characteristics

Characteristics	Trapeziectomy group (n = 44)	MAIA® group (n = 48)	*p*
Age (years ± SD)	58 ± 9	56 ± 5	0.16
Gender F/M	39/5	45/3	0.47
Dominant side (%)	24 (55%)	25 (52%)	0.98
Patients actively working (%)	31 (71%)	37 (77%)	0.49
Patients performing manual labour (%)	20 (45%)	16 (33%)	0.09
Patients retired (%)	13 (30%)	11 (23%)	0.49

SD: standard deviation, F: female, M: male.

Clinical outcomes

The clinical outcomes are listed in Table 2. For both groups, the pain levels were significantly reduced at the follow-up ($p < 0.01$). There were no significant differences ($p > 0.05$) between the two groups in terms of pain level, grip strength, thumb active ROM, opposition and retropulsion scores, the QuickDASH and MHQ (final) scores. The pinch strength and the MHQ work performance score were significantly better in the MAÏA® group ($p < 0.01$). In the trapeziectomy group, 3 patients had 30° or more MCP joint hyperextension while no patients did in the MAIA® group. In terms of the overall satisfaction, all patients in the two groups said the outcome was "good" or "excellent".

Table 2. Comparison of Outcomes between the Two Groups

	Trapeziectomy group (n = 44)	MAIA® group (n = 48)	*p*
Rehabilitation (n): physiotherapy/self-directed	39/5	28/20	< 0.01*
Time before resuming ADL (weeks)	3 ± 0.2	3 ± 0.2	0.40
Time away from work (weeks)	14 ± 1.6	8 ± 2.1	< 0.01*
Preoperative pain on VAS (/10)	7.5 ± 0.5	7.9 ± 0.4	0.20
Postoperative pain in VAS (/10)	0.9 ± 0.4	0.9 ± 0.3	0.78
Grip strength (kg)	21 ± 2.2	23 ± 2.8	0.30
Pinch strength (kg)	3 ± 0.6	5 ± 0.5	< 0.01*
TMC radial abduction (°)	44 ± 2.4	47 ± 1.5	0.18
TMC palmar abduction (°)	38 ± 1.9	41 ± 1.2	0.11
Opposition score (/10)	10 ± 0	10 ± 0	0.09
Retropulsion score (/4)	3 ± 0.3	3 ± 0.2	0.10
MCP joint hyperextension ≥ 30° (n)	3	0	0.06
QuickDASH (/100)	23.45 ± 5.5	21.36 ± 5.6	0.59
MHQ final score (/100)	80 ± 4.4	81 ± 4.5	0.96
MHQ overall hand function (/100)	79 ± 5.1	78 ± 5.7	0.92
MHQ activities of daily living (/100)	80 ± 6.7	81 ± 6.3	0.93
MHQ work performance (/100)	67 ± 8.0	81 ± 6.6	< 0.01*
MHQ pain (/100)	28 ± 5.6	22 ± 5.3	0.09
MHQ aesthetics (/100)	95 ± 3.3	94 ± 3.7	0.57
MHQ satisfaction with hand function (/100)	77 ± 5.5	76 ± 4.9	0.77

The data shown are mean values ± confidence interval ($\alpha = 95\%$).
*Significantly less than 0.05.
ADL: activities of daily living, VAS: visual analogue scale, TMC: trapeziometacarpal, MCP: metacarpophalangeal, QuickDASH: The Quick version of the Disabilities of the Arm, Shoulder and Hand Score, MHQ: Michigan Hand Questionnaire.

Radiographic outcomes

Osteoarthritis was Eaton grade III and IV in 84% and 16% of patients in the trapeziectomy group; 92% and 8% in the MAIA® group ($p = 0.34$).

In the trapeziectomy group, the STT joint was Crosby grade 0 in 13%, I in 32% and III in 55%. In the MAIA® group, 79% of STT joints were grade 0 and 21% were grade I ($p < 0.01$).

Preoperatively, there was no significant difference between the two groups in terms of trapezium height (12 ± 2 mm and 13 ± 1.4 mm, $p = 0.19$) and thumb column length (56 ± 5.4 mm and 56 ± 3.2 mm, $p = 0.39$). Postoperatively, thumb column length was significantly decreased in the trapeziectomy group (46 ± 3.4 mm, $p < 0.01$) but not in the MAIA® group (57 ± 5.1 mm, $p = 0.64$).

In the trapeziectomy group, the height of the trapezial cavity decreased significantly between the immediate postoperative evaluation and the final assessment (7 ± 1.1 mm and 4 ± 1.4 mm, $p < 0.01$).

In the MAIA® group, there were no signs of implant subsidence, periprosthetic radiolucent lines, implant fracture or polyethylene wear at the final assessment (Fig. 2). Thirteen patients had small asymptomatic periprosthetic ossifications near the joint. None of the implants were dislocated or subluxed. At the time of review, two patients had developed asymptomatic STT joint arthritis.

Complications and surgical revisions

There were no cases of wound dehiscence or infection. No patients reported symptoms of complex regional pain syndrome.

In the trapeziectomy group, one patient had tendinitis of the flexor carpi radialis treated with a corticosteroid injection. Two patients required surgical revision for symptomatic MCP joint hyperextension within 2 years of surgery; volar capsulodesis was performed. Those patients' VAS went from 6 to 0 and the deformity was corrected. Furthermore, three patients had painful scaphometacarpal impingement, but none wished to undergo another surgical procedure (Fig. 3).

In the MAIA® group, one patient had de Quervain's tenosynovitis treated with a corticosteroid injection. Another patient required surgical revision during the 1st postoperative year because of a symptomatic osteophyte on the medial horn of the trapezium. At the time of review, no recurrence was present. No implant components were revised.

Fig. 3. Radiographs showing a case of a scaphometacarpal impingement at 9 years' follow-up after a trapeziectomy.

Fig. 2. (A) Radiographs of a right thumb with Eaton grade III osteoarthritis. (B) Radiographs immediately after implantation of a MAIA® prosthesis. (C) Radiographs at 10 years' follow-up.

The survival rate without reoperation was 95% in the trapeziectomy group and 98% in the MAIA® group.

DISCUSSION

At a mean follow-up of 9 years, we found no significant differences in terms of pain levels, grip strength, thumb ROM and the QuickDASH or MHQ (final) scores between patients who underwent trapeziectomy and patients who underwent arthroplasty with a MAIA® prosthesis. However, the pinch strength and the MHQ work performance score were significantly better in patients with the MAIA® prosthesis.

There are few published studies comparing the outcomes of trapeziectomy and TMC total joint arthroplasty.[4,6,17-22] The sample size and the average follow-up of these studies were typically less than in ours. Jager et al.[6] had an average follow-up of 6 months and Ulrich-Vinther et al.[4] of 12 months. The mean was 24 months for De Smet et al.,[18] Santos et al.,[19] Craik et al.[21] and Thorkildsen and Rokkum[17] while it was 60 months for Vandenberghe et al.[20] and Robles-Molina et al.[22] In our study, we had two groups with comparable characteristics and similar sizes. Moreover, the mean follow-up was the same between groups and nearly 10 years.

Nevertheless, our clinical and functional results were comparable to those of other published studies. De Smet et al.,[18] Santos et al.,[19] Craik et al.[21] and Vandenberghe et al.[20] reported pain levels, active motion and QuickDASH scores that did not differ significantly between groups. Thorkildsen and Rokkum,[17] De Smet et al.,[18] Ulrich-Vinther et al.,[4] Jager et al.[6] and Robles-Molina et al.[22] found better pinch strength in the patients who received a prosthesis. The pinch strength was higher 17% for Thorkildsen and Rokkum,[17] 15% for De Smet et al.,[18] 50% for Ulrich-Vinther et al.[4] and Jager et al.,[6] and 41% for Robles-Molina et al.[22] In our study, we found a 40% higher value in the group prosthesis. Furthermore, Ulrich-Vinther et al.,[4] Santos et al.[19] and Craik et al.[21] found a shorter postoperative recovery time in the patients who received a prosthesis. The time savings was on average 6 weeks for Ulrich-Vinther et al.[4] and 4.5 weeks for Santos et al.[19] and Craik et al.[21] This was comparable to our study with a significantly shorter time away from work of 6 weeks for the MAIA® group and fewer patients requiring physiotherapy. Thereby, although the initial cost of the implant is higher, it could allow significant savings on postoperative costs shifting also the debate into the field of public health.

Only Jager et al.[6] has previously compared trapeziectomy with the MAIA® implant. While the trends were like our study, their samples size was smaller (27 vs 47) and the mean follow-up was only 6 months.

According to Degeorge et al.,[7] TMC total joint arthroplasty provides a better MCP joint stabilization by restoring thumb length, than the trapeziectomy. In their comparative study, patients with postoperative MCP hyperextension had a significant lower grip and pinch strength compared with patients without MCP hyperextension. The authors reported a greater reduction of the MCP hyperextension in all hyperextension subgroups, especially hypertension > 30°, with the TMC total joint arthroplasty than with the trapeziectomy. Their radiographic analysis showed patients with postoperative MCP hyperextension had a significant lower thumb height than patient without MCP hyperextension. We confirmed these findings with a significant decrease in thumb column length in the trapeziectomy group but not in the MAIA® group. Moreover, the height of the residual trapezial cavity was significantly decreased at the final assessment and three patients had scaphometacarpal impingement. In this group, three patients had 30° or more MCP joint hyperextension and two patients required surgical revision.

In our study, the MAIA® prothesis provided significant pain reduction and good thumb ROM. These clinical outcomes are comparable to published studies on the MAIA® implant at a mean follow-up of 3.5 years for Kubat et al.,[23] 5 years for Andrzejewski and Ledoux[24] and 6 years for Toffoli and Tessier.[10] We found no implant subsidence, loosening, dislocation or fracture, and no implants were revised. In these other studies, the incidence of complications was relatively low. Kubat et al.[23] reported implant dislocation in 1 out of 36 cases, Andrzejewski and Ledoux[24] reported it in 7 out of 113, and Toffoli and Tessier[10] in 1 out of 96 cases. Kubat et al.[23] had a cup loosening rate of 3%, Andrzejewski and Ledoux[24] of 2% and Toffoli and Tessier[10] of 4%. These cases required surgical revision.

Our study has its limitations. Since it was a retrospective study, we had no preoperative data on strength or ROM. Secondly, we had small number of patients in each group, although the sample size was consistent with other published studies.

Despite the mean age of our patients (trapeziectomy group: 58 ± 9 years and MAIA® group: 56 ± 5 years), we cannot generalize our results to younger patients who have high work demands. Nevertheless, a large share of our patients was actively working (71% in the trapeziectomy group and 77% in the MAIA® group) and

many performed manual labour (45% in the trapeziectomy group and 33% in the MAIA® group). Because of the shorter time away from work and better MHQ work performance score, we believe the MAIA® prosthesis is suited to these patients. Importantly, we found no radiological complications related to the implant components at mean 9 years' follow-up.

Trapeziectomy remains the gold standard for the surgical treatment of TMC joint osteoarthritis.[1] While the failure rate of trapeziectomy is low, revision of failed cases is difficult. Moreover, failed TMC joint arthroplasty can successfully be converted to a secondary trapeziectomy with comparable results to primary trapeziectomy.[25]

Our study confirms the good clinical outcomes of trapeziectomy and the MAIA® prosthesis on a medium- to long-term basis. This prosthesis is a useful alternative to trapeziectomy and yields good patient satisfaction with a relatively short postoperative recovery and maintains the thumb column length, which probably explains the better pinch strength.

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CONFLICT OF INTEREST

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INFORMED CONSENT

All patients gave their informed consent for this study.

INSTITUTIONAL REVIEW BOARD

This study was approved by our institutional review board.

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