

# Outcomes of Double-Mobility Prosthesis in Trapeziometacarpal Joint Arthritis With a Minimal 3 Years of Follow-Up: An Advantage for Implant Stability

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## Abstract

**Background:** New generation of total trapeziometacarpal joint prosthesis using double mobility concept has been used for several years. The aim of this study was to evaluate the dislocation rate with this implant after a minimal 3 years of follow-up.

**Methods:** From September 2013 to August 2015, 200 trapeziometacarpal prostheses were implanted in 179 patients. Clinico-radiological follow-up was performed with an average of 48.2 months (36-60 months). Survival rate and dislocation rate were analyzed. Loosening of the implants and other intercurrent events were noticed.

**Results:** Visual analog scale, Quick-DASH, strengths and range of motion improved significantly. We report a survival rate of 97% with only 0.5% of dislocation of prosthesis at 48 months of follow-up. Intercurrent events rate were similar to the ones found in literature or other studies.

**Conclusions:** After a minimal of 3 years of follow-up, prosthesis with double mobility seemed to bring better stability in implant for thumb prosthetic replacement.

**Keywords:** dislocation, double mobility, prosthesis, trapeziometacarpal joint arthroplasty

## Introduction

Prevalence of trapeziometacarpal (TMC) joint arthritis is high in the general population (29%-76%) and symptomatic in 6% of the cases, particularly in menopausal women.<sup>1,2</sup> Surgery is considered after failure of nonsurgical modalities to relieve pain symptoms or deformity associated with TMC joint's osteoarthritis (OA).

Trapeziectomy for TMC joint OA was first described 65 years ago by Gervis.<sup>3</sup> Trapeziectomy, with or without tendon interposition, or suspension arthroplasty, remains the most widely used surgical procedure because of its efficiency in pain relief.<sup>4,5</sup> However, postoperative recovery and long-term results (deformity, lack of strength, etc.) are the main limits to this approach.<sup>6,7</sup> That is why TMC prosthesis is attractive, since rehabilitation and strength recovery are obtained faster after the procedure and last longer.<sup>8,9</sup> Currently, survival rate of thumb prosthesis increases with each new generation of prosthesis, but dislocation was one of the obstacles for a wider use.<sup>10</sup> The main hypothesis of this study was that the TMC total-joint replacement with a

double-mobility prosthesis could reduce the rate of dislocation.

We assessed the clinical and radiological outcomes of TMC total-joint replacement with double-mobility prosthesis in patients with TMC joint OA with a minimal of 3 years follow-up.

## Materials and Methods

### Patients

This two-center prospective study involved patients who underwent double-mobility TMC prosthesis implantation

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from September 2013 to August 2015, with a minimum of 3 years of follow-up (average 48.2 months, range 36-60). Indications for the procedure were painful TMC joint OA affecting activities of daily living. Failures after a minimum of 6 months of non-surgical treatment including immobilization, systemic anti-inflammatories, or corticosteroid injections were necessary before a surgical treatment. Pre-operative radiography assessed TMC OA stage according to the Dell classification and the median height of the trapezium thanks to Saffar-Goffin index on ability of trapezium cup implantation. If both hands were affected, the most painful side was operated first and a delay of 6 months was observed before the second thumb surgery. The exclusion criteria were as follows: past history of surgical implant into TMC joint (pyrocarbon implant), height of trapezium <8 mm, patient <40 years of age, and uncontrolled evolution of OA. Informed consent was obtained from all individual participants included in the study.

### Prosthesis Description

The Moovis TMC prosthesis (Stryker European Holdings I, LLC) is a dual-motion, ball socket type, no-stained, modular, cementless hydroxyapatite-coated implant. The modular implant neck is made of high-nitrogen-content steel. Trapezial cup and metacarpal stem components have a double layer coating with a hydroxyapatite upper layer and a porous titanium lower layer that provide maximal secondary stability and bone ingrowth.

Only one size of trapezium implant is commercialized (diameter of 9 mm and height of 6.5 mm). This trapezium implant is composed with mobile polyethylene insert hinging on steel cup in the bone. The second axis of motion is between the neck of the prosthesis and the mobile polyethylene inserted in the cup. There are no pins on the cup for stabilization. The theoretical range of motion is 110°.

Three different lengths of implant neck (small (S), medium (M), and large (L)) are available to provide maximal stability and avoid impingement or mechanical conflicts. The metacarpal stem was initially Electra® implant (Stryker European Holdings I, LLC).

### Operative Technique

The intervention, always performed by experienced surgeon, was carried out under regional anesthesia and with a pneumatic tourniquet on the arm (250 mmHg). The surgical way was antero-lateral approach focus on the trapezo-metacarpal joint space and to avoid damaging the dorsal branch of the radial sensory nerve (Figure 1).

We performed a disinsertion of the abductor pollicis longus and the proximal part of thenarian muscles that stay in continuity. A capsulo-ligamentar flap at the dorsal side of the TMC joint was performed. A minimal resection of the



Figure 1. Surgical approach.

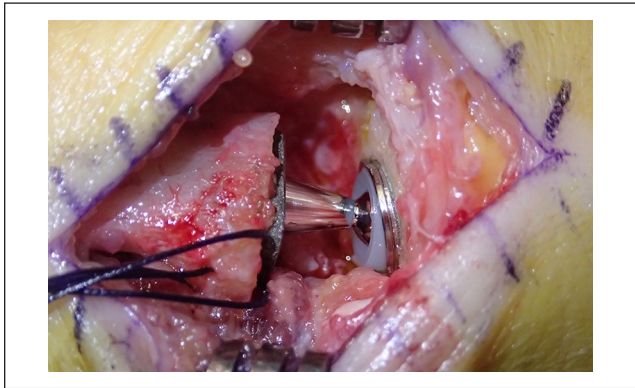


Figure 2. Peri-operative view of double-mobility prosthesis.

metacarpal base was performed with resection of osteophytes, and it was freed from capsular/ligament attachments. The definitive metacarpal stem size was chosen.

Trapezium was prepared with manual bone burrs after resection of the articular surface. The definitive implants were inserted (Figure 2). The tendon of abductor pollicis longus was reinserted with transosseous absorbable 0 sutures. The surgical wound was closed with or without suction drain. An immediate postoperative x-ray was done. After surgery, the wrist and the thumb were not immobilized (no cast or splint). The dressing was removed after 2 weeks. Normal activities were encouraged as soon as possible. No physiotherapy and no specific exercises were advised.

### Follow-Up

Clinico-radiological follow-up was standardized for each patient: preoperative consultation, postoperative consultations at 1, 3, 6 and 12 months, and every year thereafter (Figures 3 and 4).

Postoperative results were compared with the contralateral thumb and with the preoperative data. Only one investigator for two centers, distinct from the operators, performed clinical and radiological assessments in order to avoid biases.



**Figure 3.** Postoperative X-ray at 1 month.



**Figure 4.** Postoperative X-ray at 60 months.

### Main Assessment

The primary outcome of this study was the incidence of postoperative TMC prosthetic dislocation.

### Declarative Assessment

Declarative evaluation assessed the following:

- Age, sex, hand laterality, in activity or retired;
- Daily painful sensation with visual analog scale (VAS);
- Quick Disabilities of the Arm, Shoulder, and Hand (Quick-DASH) questionnaire;
- Time of convalescence between surgery and recovery with usual activities or normal function with the operated hand.

### Clinical Assessment

Clinical evaluation assessed measurements of the grip strength with Jamar dynamometer (Asimov Engineering, Los Angeles, CA), pinch strength measured with Key-grip (Preston, Clifton, NJ) and mobility with Kapandji opposition scale. Each value was compared with the nonoperative side data.

### Radiographic Assessment

An independent radiologist analyzed the files. At the time of pre- and postoperative evaluation, frontal and profile views of the TMC joint were obtained as described by Kapandji and ideally performed in the same center. Another radiologist was solicited in case of doubt.

The fracture of trapezium, the apparition of component loosening (peri-prosthetic radiolucent lines), implants displacement (the threshold criteria were set at a value over of 1 mm) and heterotopic ossifications were compared with previous X-rays.

### Intercurrent Event Assessment

Every postoperative event and time of occurrence was recorded: trapezium fracture, prosthesis dislocation, sensitive radial nerve paresthesia, carpal tunnel syndrome, complex regional pain syndrome and Quervain's disease.

### Statistical Analysis

Differences between pre- and postoperative data were analyzed by student t test or a Wilcoxon non-parametric test. Survival without iterative surgery or reoperation was estimated with the Kaplan-Meier method. Statistical significance was defined at  $P$  less than .05.

### Results

In total, 179 patients were included, corresponding to 200 procedures with double mobility TMC prostheses implanted from September 2013 to August 2015. Seventeen patients had implants in both hands. Overall, four patients were lost to follow-up: one died and three could not be contacted.



**Table 1.** Clinical Results.

Criteria	Preoperative values	Postoperative values at 48 months	P value	Controlateral side	P value postoperative versus controlateral side
Pain—VAS: 0-10 (mean)	6.2 (3-10)	0.76 (3-8)	<.05	—	—
QuickDASH/100 (mean)	79.3 (31-80)	35 (25-45)	.02	—	—
Grip Strength—kg (mean)	18.2 (7-29)	26.8 (18-47.5)	<.05	26.1(17-49)	0.76
Key pinch, kg (mean)	4.2 (2-6.5)	7.5 (5-9.5)	<.05	7.7 (5-10)	0.83
Kapandji opposition scale /10 (mean)	5.46 (3-10)	9.1 (7-10)	<.05	—	—

VAS: visual analog scale.

Only one TMC prosthesis dislocation happened at 5 postoperative months.

### Patient Characteristics

Most patients were women (n = 142; 79%). Mean age at the time of surgery was 66 years (range: 40-92 years). In all, 124 patients were retired (69%) and 55 patients were in activity. The dominant hand was operated for 108 patients (54%). Average follow-up was 48.2 months (range: 36-60).

### Preoperative Radiographic Assessment

According to the Dell radiological classification, 98 TMC joint cases were graded III (49%), 97 were graded II (48.5%), and 5 were graded IV (2.5%). Radiological mean height of the trapezium was  $10.6 \pm 1.9$  mm in women compared to  $12.6 \pm 2.1$  mm in men ( $P < .05$ ).

### Clinical Assessment

Results of clinical assessment are summarized in Table 1.

All patients had significant daily pain relief ( $P < .02$ ) after the surgery (1-48 months). Their average postoperative QuickDASH score at 48 months was 35 (25-45) with a significant improvement comparative to preoperative measures ( $P < .05$ ). After 48 months of follow-up, mean Kapandji opposition score was 9.1 of 10 (7-10). Average Key grip and pinch strength were 7.5 (5.1-9.7) and 26.8 (18.1-47.4), respectively. Among the 55 patients who were working, all returned to work within 3 months.

### Radiographic Results

There was no radiographic abnormalities except for one patient who had a trapezium bone fracture 4 months post surgery after a hand trauma. Another patient had a postoperative TMC prosthetic dislocation 5 months after the surgery. X rays featured a shifting of the metacarpal implant. Sinking of metacarpal stem was observed without loosening. An open surgical reduction was performed, the prosthesis neck was replaced with a bigger

size without metacarpal stem removing. Indeed, this implant was completely fixed. No polyethylene wear was observed.

### Postoperative Events

Dislocation, loosening, and infection represented postoperative complications. Other events were considered as intercurrent events (trapezium failure, carpal tunnel syndrome, sensitive superficial radial nerve paresthesia, complex regional pain syndrome and Quervain Disease).

We observed 6 (3%) estimated prosthesis failures, and the estimated implant 3-year survival rate (Kaplan-Meier method, intent- to -treat analysis) was 97%. One TMC prosthesis dislocation happened at 5 postoperative months imposing a prosthetic neck substitution. We had no cases of infection in our study.

A trapezium fracture with implant occurred at 4 postoperative months. This case has benefited of a secondary trapeziectomy. Four patients were lost to follow-up. Most frequent postoperative events (Table 2) were carpal tunnel syndrome (n = 8) and sensitive superficial radial nerve paresthesia (n = 4) that healed spontaneously. (Everyone has declined spontaneously or was operated after 6 months of evolution). Two patients had complex regional pain syndrome that fully recovered 18 months later.

### Discussion

We report a survival rate of 97% with only 0.5% of prosthesis dislocation after 3 years of follow-up. This result is similar to those reported by other authors<sup>10</sup>: Dehl et al<sup>11</sup> reported a 10-year survival rate of 86.8% for Rubis II prosthesis, 91% for Roseland prosthesis with Semere et al,<sup>12</sup> 93.9% for ARPE prosthesis with Martin-Ferrero<sup>13</sup> and 97% with Vander Eecken et al.<sup>14</sup>

Indeed, total TMC joint arthroplasty results equal other surgical procedures such as trapeziectomy with tendon interposition and/or ligament reconstruction.<sup>6,15</sup> Trapeziectomy is considered as the gold standard procedure for the treatment of TMC joint OA. Trapeziectomy with or without ligament reconstruction and tendon interposition has a

**Table 2.** Postoperative Events.

Events	n (%)	Postoperative time of occurrence or recovery (in months)
Postoperative complications:		
Luxation of prosthesis	1 (0.5)	5
Loosening of Trapezium	0	0
Infectious	0	0
Postoperative intercurrent events:		
Carpal tunnel syndrome	8 (4)	<6
Complex regional pain syndrome	2 (1)	<18
Quervain's disease	9 (4.5)	<6
Paresthesia	4 (2)	<1
Fracture of Trapezium	1 (0.5)	6

lower rate of revision surgery.<sup>4,5</sup> But the restoration of functional range of motion and strength, and pain relief were already demonstrated for the prosthesis and similar to other studies,<sup>16,17</sup> particularly in laborers.<sup>8</sup> These improvements are significantly quicker with TMC joint arthroplasty than trapeziectomy 6 months after surgery.<sup>17</sup> Ulrich-Vinther et al<sup>18</sup> obtained comparable results after 1 year of follow-up. After this period, the differences are not significant.

TMC arthrodesis was efficient on pain relief or strength but limited the mobility of the thumb, with the stimulation of scaphoid-trapezium-trapezoid (STT) and metacarpophalangeal joint arthritis.<sup>19</sup> The pyrocarbon interposition in trapezo-metacarpal space contributes to maintaining the trapezium height, without functional improvement but with a higher risk of displacing.<sup>20</sup>

Treatment of coexisting STT joint OAs is still a crucial topic of debate between trapeziectomy and prosthetic arthroplasty.<sup>21,22</sup> However, no correlations between radiological STT and TMC joint arthritis and clinical symptoms are reported.<sup>23</sup> TMC joint replacement may be sufficient in order to relieve pain and improve the function without specific treatment of STT joint arthritis.

The preoperative deformity of the thumb and the position of the cup in trapezium are significantly associated with complications.<sup>24</sup> Preservation of the trapezium cortices, in order to prevent loosening,<sup>25</sup> and intraoperative bone quality has to be taken into consideration.<sup>26</sup> Dislocation and loosening of the cup remain the major problems with TMC prosthesis.<sup>27</sup>

Dislocation rate is low in our series compared to other series such as ARPE prosthesis in the study by Jacoulet<sup>28</sup> (8%), Rubis II by Maes et al<sup>29</sup> (5%) and Maia prosthesis by Bricout and Rezzouk<sup>24</sup> (4.5%). A 2% to 5% dislocation rate was reported in a multicenter study of the Ivory prosthesis.<sup>30</sup> The same tendency with Moovis prosthesis was reported by Roux and Dreant on 39 patients with 1 year<sup>9</sup> and 27.5 months<sup>31</sup> of follow-up.

We attributed the low dislocation rate to several factors:

- Anterolaterale surgical approach permits a complete release of the first metacarpal basis capsule-ligament insertions.
- This surgical way offers a direct view of the trapezium area that facilitates the insertion of the cup perpendicularly to the trapezium axis

The double-mobility prosthesis offers several benefits<sup>31-33</sup>:

- An enlargement of the radius of the prosthetic head increases the dislocation way.
- It offers a decrease of direct constraints on the ledge of the trapezium cup neck due to range of motion increase.
- It reduces the cup-loosening rate, thanks to the partition of mechanical constraints between each layer of the prosthesis and the bone, diminishing the dislocation rate.
- Double mobility absorbs the pressure on trapezium implant and primary fixation without cement is strong and sustainable.

Trapezium loosening results in failure of cup osseointegration (early loosening) on low-quality bone or trapezium osteolysis (delayed loosening). The delay of surgery may be pejorative with intrinsic bone quality altered. Thus, the prosthesis indication should be set earlier during the evolution of TMC joint arthritis. The trapezium height evaluated with Saffar-Goffin index has to be adequate in order to contain or hold the implant. Thus, the grade 4 according to the Dell classification isn't a contraindication. Besides, cup form of the trapezium implant permits a primary fixation even if it is suspended.<sup>34</sup> Like in Alnot et al,<sup>35</sup> intraoperative damage of the trapezium walls and poor bone quality were reasons to switch to trapeziectomy. These two issues were not found in our series.

One case of cup loosening occurred in our series, after an upper limb trauma. A trapezium fracture was responsible for prosthetic loosening. The trapezium fracture with prosthesis imposes a secondary trapeziectomy. In this case, a secondary trapeziectomy is indicated and has the same results than in first intention surgery.<sup>36</sup>

Goubau et al<sup>37</sup> and Bricout and Rezzouk<sup>24</sup> described a high rate of Quervain's disease, 17% and 16%, respectively. This rate is higher than in our study, with no explanation for this difference. However, the alignment of the thumb column, lengthening and increased tension on adjacent structures may have caused these tenosynovitis cases. Reutilization of the hand without painful sensation may be an explanation for the incidence of carpal tunnel syndrome.

TMC joint arthroplasty with prosthesis is a growing therapeutic option: as a matter of fact, it appears beneficial for the patients, and prostheses have evolved and allowed better control of thumb replacement with fewer complications. The double mobility concept handles dislocation problems. Obviously, our follow-up was not long enough to assess long-term complications or life expectancy. A long-term follow-up is essential particularly after 5 years of follow-up.<sup>38</sup>

### 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

Informed consent was obtained from all individual participants included in the study.

### Declaration of Conflicting Interests


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