


A specific dual-mobility prosthesis design in trapeziometacarpal joint osteoarthritis

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ABSTRACT

Purpose: Many prosthetic designs have been developed for treated trapeziometacarpal joint (TMJ) osteoarthritis (OA). The aim of the study was to analyze the clinical, functional, and radiological outcomes and complications of a specific dual-mobility prosthesis for TMJ OA to support the correct hand surgeon decision.

Methods: Between January 2019 and January 2022, a retrospective study was conducted on a consecutive series of 14 patients affected by TMJ OA and treated with the implantation of TOUCH® dual mobility TMJ prosthesis (KeriMedical Switzerland-HQ, Geneva, Switzerland). The follow-up period was 12–36 months. Evaluation criteria included the trapeziometacarpal axis, the Visual Analogue Scale (VAS), the pulp-to-pulp modified pinch test, the Kapandji score, and the Michigan Hand Outcomes Questionnaire (MHQ).

Results: Clinical, functional, and radiological improvements were found in all outcomes analyzed. The post-operative values of VAS and pulp-to-pulp modified pinch test were statistically significant ($p < 0.05$). A non-statistically significant postoperative improvement was found in the Kapandji score ($p < 0.05$). Regarding complications, only one EPL injury was found, but no infection or prosthetic dislocation.

Conclusions: The use of a TOUCH® dual-mobility prosthesis for treating TMJ OA improved postoperative clinical, functional, and radiological outcomes with a lower rate of complications in a short-term follow-up.

Level of evidence: IV.

1. Introduction

Osteoarthritis (OA) of the trapeziometacarpal joint (TMJ), also known as rhizarthrosis, is a progressive and disabling condition that affects the carpometacarpal joint. It is the second most prevalent degenerative disease of the hand, following OA of the distal interphalangeal joint.¹

The TMJ, which connects the first metacarpal of the thumb to the trapezium bone, features a biconcave-convex saddle morphology and enables various movements, including flexion, extension, abduction, adduction, opposition, repositioning, and circumduction.¹ Degeneration of this joint initially causes pain and reduced mobility, progressing to joint dysfunction with restricted movement, weakened pinch strength, and, in severe cases, complete dislocation of the base of the first

metacarpal.^{1–3}

Although the exact etiology of rhizarthrosis remains unclear, genetic predisposition, prior fractures or dislocations, repetitive use, and generalized joint laxity are recognized as potential risk factors. TMJ OA is most observed in elderly individuals, with a higher prevalence in postmenopausal women aged 50–60 years, ranging from 17 % to 33 %. Men exhibit a lower incidence, varying between 5 % and 11 %. This disparity may be attributed to greater ligamentous laxity in the TMJ among women.^{4,5}

The diagnosis of rhizarthrosis involves a comprehensive physical examination, including the grind test and Lever Test. Additionally, assessing the location, duration, onset, frequency, and intensity of pain is crucial. Patients frequently report that activities requiring opposition or pinching exacerbate pain at the base of the thumb. To confirm the

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diagnosis, the Eaton-Littler classification system, a widely used radiographic tool for basal thumb arthritis, is often employed.⁴

Several operative techniques have been described for treating rhizoarthrosis.¹⁻³ Specifically, surgical procedures may be considered when conservative treatments fail.³ Excision of the trapezium alone, ligament reconstruction, or tendon interposition represent the most used procedures, although they may cause loss of thumb length, pinch strength, and slow postoperative recovery.⁴⁻⁷ Many classifications of rhizoarthrosis were reported in the literature.⁸⁻¹⁰ The most widely used is that of Dell et al.⁹. Trapeziometacarpal arthroplasty has been designed for stages III and IV of Dell classification to restore standard thumb length and good mobility, grip strength, and stability.^{9,10} Many prosthetic designs have been developed since the first description of the carpometacarpal joint (CMC) replacement of the thumb in 1973 by De la Caffenièrre.¹¹ Currently, prosthetic replacement of the TMJ may be divided into three major groups: arthroplasties involving resurfacing of only the trapezium alone or the metacarpal base; trapezium replacement arthroplasties for patients with pan-trapezoid OA; and total joint replacement.¹⁰ A dual-mobility TMJ prosthesis was examined in the current study. It is a cementless modular prosthesis with anatomical stems designed to achieve the best results for all joints and a polyethylene insert, as in hip and knee arthroplasty.¹²⁻¹⁵ Although many studies have shown the good results of using single-mobility prostheses for TMJ, only a few have analyzed the outcomes and potential complications of dual-mobility prostheses.^{16,17}

This study aimed to analyze the clinical, functional, and radiological outcomes and complications of a specific dual-mobility prosthesis for TMJ OA to support the hand surgeon in properly managing it in clinical practice.

2. Methods

2.1. Search strategy

A retrospective study was conducted on a consecutive series of 14 patients affected by TMJ OA and treated with the implantation of TOUCH® dual mobility TMJ prosthesis (KeriMedical Switzerland-HQ, Geneva, Switzerland). These prostheses design was implanted by the same orthopedic surgeon in a single center between January 2019 and January 2022. All patients were evaluated for a follow-up period of 12–36 months.

2.2. Inclusion and exclusion criteria

Inclusion criteria for TMJ prosthetic replacement were stages III or IV according to Det et al.'s classification⁹; age between 40 and 75 years; subjects who performed work activities with repetitive pincer movements but with little strength; isolated trapeziometacarpal OA with scaphotrapeziotrapezoid (STT) joint integrity. Moreover, all the patients included had rhizoarthrosis of the contralateral joint or had undergone contralateral hand surgery.

Exclusion criteria were the presence of STT OA; previous thumb surgery that did not allow prosthesis implantation (e.g., fractures, osteotomies, Z-shaped deformity, tendon injuries); hand workers with high functional demands; marked deformity of the thumb column; post-traumatic events or rheumatoid arthritis.

2.3. Data collection

Demographic informations were gathered for all patients included in the study. Hospital records were analyzed to document the presence of osteoarthritis, along with intraoperative and perioperative data. Any local or systemic complications related to the surgical procedures were also noted. All patients evaluated at a single hospital center underwent standard diagnostic imaging, including anteroposterior and lateral X-rays, as well as computed tomography (CT) scans with both 2D and 3D

multiplanar reconstructions. The 3D imaging provided valuable insights into bone quality.

2.4. Surgical technique

The surgical procedure used was the standard dorsal approach between the extensor pollicis brevis (EPB) tendons and abductor pollicis longus (APL). This was followed by stem placement in the diaphysis of the first metacarpal and cup implantation in the trapezium. In most cases, the cup was placed in the trapezium with a slight anteversion to give proper implant stability. For all included patients, preservation of the anterior oblique ligament of the thumb, also known as the beak ligament, and reinforcement of the capsule were adopted to provide additional implant stability. After the surgical procedure was completed, patients wore a short splint for three weeks to limit hand mobilization. Then a standard rehabilitation protocol was followed.

2.5. Data extraction

All patients underwent preoperative and postoperative radiographic investigations. The trapeziometacarpal axis was obtained by measuring the distance between the trapezium's base and the metacarpal's head in a posteroanterior view (Fig. 1).

The pain severity in each hand activity was assessed using a 10-point Visual Analogue Scale (VAS), where 0 corresponds to no pain and 10 to the worst perceived pain¹⁸.

Pulp-to-pulp modified pinch test was used to measure the maximum isometric thumb force. The patient was positioned with the shoulder in the zero position, and the elbow flexed 90° with the forearm and wrist in the neutral position. The patient was instructed to apply maximum pressure between the pads of the thumb and the index finger while keeping the middle, ring, and little finger flexed in the palm. The examiner applied a slight pulling force with three, two or one finger, and the circle was opened. The score ranged from 3 (three fingers to open the circle) to 0 (no finger to open the circle).¹⁹

Kapandji score assessed the thumb's opposition with the other fingers. A score of 0 indicated the absence of opposition, while a score of 10 indicated maximal opposition.²⁰

These previous evaluations were calculated preoperatively and postoperatively at the last follow-up.

The postoperative Michigan Hand Outcomes Questionnaire (MHQ) expressed overall function and ability to perform daily activities.²¹

2.6. Ethical approval

All procedures involving human participants' studies followed the institutional and national research committee's ethical standards and the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

2.7. Statistical analysis

Statistical analysis was performed using R software, version 4.0.5 (2020, R Core Team, Vienna, Austria). Continuous data were assessed through the Student's t-test and Mann-Whitney U test, with results expressed as mean values along with their variability range (minimum to maximum). For categorical data, both absolute counts and percentage distributions were calculated. The p-value <0.05 was considered statistically significant.

3. Results

The mean follow-up of all 14 patients included in the present study was 24 (12–18) months. The mean age was 62 (48–75) years. The male/female ratio reported was 3:4 (8 females and 6 males). All eight female patients were housewives; two male patients were manual workers



Fig. 1. The length of the interval a1/a2 obtained from the posteroanterior view represents the pre and postoperative trapeziometacarpal axis.

(confectioner and ecological worker), and four were former manual workers.

The mean trapeziometacarpal axis was 54.2 ± 4.3 mm in the preoperative and 57.9 ± 3.7 mm in the postoperative. An average increase of 3.7 mm was recorded for the trapeziometacarpal axis, which was statistically significant ($p < 0.05$) (Table 1). The VAS in the preoperative evaluation was 7.9 ± 1.7 . At the same time, in the postoperative, there was a statistically significant ($p < 0.05$) decrease of 5.29 points, with a mean VAS value of 2.6 ± 2.2 (Table 2). A statistically significant decrease ($p < 0.05$) in the pulp-to-pulp modified pinch test of 1.4 points was observed, with a mean value in the preoperative of 1.6 ± 0.8 and in the postoperative of 0.2 ± 0.4 (Table 3). The mean Kapandji score was 8.2 ± 1.7 in the preoperative and 8.93 ± 1.44 in the postoperative. The increment observed from preoperative to postoperative was not statistically significant ($p > 0.05$) (Table 4).

The overall postoperative MHQ score was 83.8 ± 10.7 . The subgroups of work, pain, appearance and final MHQ score were 70.4 ± 21.6 , 76.4 ± 19.7 , 92.8 ± 12.2 , 89.0 ± 9.3 , respectively. Only one complication at the final follow-up was found: a lesion of the extensor pollicis longus (EPL). There were no cases of infection or prosthesis dislocation during the entire follow-up.

Table 1

Preoperative and postoperative trapeziometacarpal axis. N: number of evaluation cases; SD: standard deviation; SE: standard error; mm: millimeter; df: degrees of freedom; p: p-value.

Trapeziometacarpal axis (mm)				
Group	N	Mean	SD	SE
Preoperatively	14	54.171	4.288	1.146
Postoperatively	14	57.871	3.693	0.987
Independent Samples T-Test				
Test	Statistic	df	P	
Student	-2.446	26	0.022	
Mann-Whitney	46.500		0.019	

Table 2

Preoperative and postoperative VAS. VAS: Visual Analogue Scale; N: number of evaluation cases; SD: standard deviation; SE: standard error; df: degrees of freedom; p: p-value.

VAS				
Group	N	Mean	SD	SE
Preoperatively	14	7.857	1.703	0.455
Postoperatively	14	2.571	2.138	0.571
Independent Samples T-Test				
Test	Statistic	df	p	
Student	7.235	26	< .001	
Mann-Whitney	186.500		< .001	

Table 3

Preoperative and postoperative Pulp-to-pulp modified pinch test. N: number of evaluation cases; SD: standard deviation; SE: standard error; df: degrees of freedom; p: p-value.

Pulp-to-pulp modified pinch				
Group	N	Mean	SD	SE
Preoperatively	14	1.643	0.842	0.225
Postoperatively	14	0.214	0.426	0.114
Independent Samples T-Test				
Test	Statistic	df	p	
Student	5.666	26	< .001	
Mann-Whitney	180.000		< .001	

4. Discussion

The study's main finding was that using a TOUCH® dual-mobility prosthesis for treating TMJ OA resulted in improvements in postoperative clinical, functional, and radiological outcomes. Specifically, the postoperative improvement in VAS and pulp-to-pulp modified pinch test were statistically significant. A non-statistically significant

Table 4

Preoperative and postoperative Kapandji score. N: number of evaluation cases; SD: standard deviation; SE: standard error; df: degrees of freedom; p: p-value.

Kapandji score				
Group	N	Mean	SD	SE
Preoperatively	14	8.214	1.718	0.459
Postoperatively	14	8.929	1.439	0.385
Independent Samples T-Test				
Test	Statistic	df	p	
Student	-1.193	26	0.244	
Mann-Whitney	72.000		0.224	

postoperative improvement was also found in the Kapandji score. Regarding complications, only one EPL injury was found, but no infection or prosthetic dislocation.

The main treatment of TMJ OA is a trapeziectomy with or without ligament reconstruction and tendon interposition.^{6,7,19,22} However, it has been found in the literature that arthroplasty has a shorter recovery time than trapeziectomy.^{23,24} Analysis of the overall MHQ score of the included patients enrolled in this study confirmed good results regarding aesthetics, pain, satisfaction, and function in the last postoperative follow-up. A statistically significant increase in the postoperative trapeziometacarpal axis was observed. This finding aligns with that reported by Toffoli et al., who attended an average lengthening of the I osteoarticular column of 3.4 mm in the postoperative.²⁵ The increase in the trapeziometacarpal axis in the postoperative period is thought to be due to the restoration of the trapeziometacarpal anatomic space, as osteoarthritis causes cartilage erosion and thus its destruction results in a decreased distance between the two affected bony structures. Parry et al., 2015, reported a 33 % reduction in trapezoidal space after suspension arthroplasty with Mini TightRope®, with a decrease in the distance between the scaphoid and the metacarpal base and a reduction in the distance between the trapezium and the proximal phalanx, and consequently a reduction in the trapeziometacarpal axis.²⁶ In addition, Lins et al., in 1996, observed up to 51 % reduction in the distance between the trapezium and proximal phalanx, although, according to the authors, there was no correlation with clinical outcomes.²² Therefore, restoring the trapeziometacarpal anatomical axis could promote muscle action, improve function, and provide more outstanding aesthetic thumb quality.

In the present study, a 7.1 % incidence of complications was reported after 12–36 months of follow-up. Specifically, this was a case of EPL injury. The patient complained of an inability to extend the thumb interphalangeal joint 14 days after surgery. An ultrasound revealed an EPL injury, which was successfully reconstructed with a transposition of the extensor indicis proprius (EIP), while the prosthetic implant components were not revised. Lastly, one patient complained of severe chronic pain in the operated hand. After investigating hypotheses, a computed tomography (CT) scan of the cervical spine revealed severe cervical osteoarthritis. The patient reported significant brachialgia and chronic neuropathic pain, then treated with Gabapentin during the follow-up.

There were no cases of hypersensitivity, aseptic mobilization, trapezoidal fractures or infections during the entire follow-up. Moreover, the most remarkable finding is no cases of prosthesis dislocation, as many studies in the literature point out.^{4,26,27}

The absence of a cup and stem loosening, which could cause dislocation, may be due to the frusto-conical shape of the TOUCH® dual-mobility cup. This design better distributes mechanical loads as in a total hip arthroplasty (THA).^{13,28} The cup position and fixation in the trapezium are very similar to that of the cup in the acetabulum, with the positioning in slight anteversion. The authors strongly believe that preservation of the beak ligament and the capsule's reinforcement could also protect against prosthesis dislocation. Moreover, this implant does

not represent an irreversible treatment for TMJ OA. In case of failure, it could be converted with other surgical treatments such as an arthrodesis or trapeziectomy with or without tendon interposition.^{6,7} This paper represents one of the few studies examining the results and potential complications of a specific dual-mobility prosthesis for treating TMJ OA. Two other recent articles with large cohorts of patients, recommend implant arthroplasty as the standard procedure for patients with isolated trapeziometacarpal joint OA because of the high survival rate and promising outcomes at follow-up.^{29,30}

A significant strength of this study lies in the fact that all surgeries were conducted by an experienced senior hand surgeon, following a consistent and reproducible surgical protocol. Additionally, a standardized rehabilitation regimen was implemented for all patients, ensuring consistent follow-up care to closely monitor their progress.

However, the study is not without limitations. Firstly, being a retrospective analysis, it lacks the advantage of patient randomization. Employing a randomized clinical trial (RCT) design could mitigate bias and other confounding factors. Secondly, the follow-up period ranged from 12 to 36 months, which aligns with other studies on dual-mobility prostheses but falls short of the decade-long evaluations seen elsewhere, with an average follow-up duration of approximately four years. Thirdly, all procedures were performed at a single hospital, potentially introducing a center-specific bias. Multicenter research would be beneficial for developing standardized treatment protocols. Fourthly, the longevity of this prosthetic design remains under investigation, requiring further data to draw definitive conclusions. Fifthly, the high cost associated with this implant may pose a challenge, particularly for hospitals with limited financial resources. Lastly, the study's short follow-up period and relatively small patient cohort may not provide sufficient data to identify potential failure mechanisms. Future research involving longer follow-up durations and larger patient populations could help validate these findings.

Further studies are essential to establish clear, standardized protocols for managing trapeziometacarpal joint OA using dual-mobility prostheses. Patient selection also plays a pivotal role in achieving optimal outcomes. Identifying patients who stand to benefit most from this treatment requires considering factors such as the severity of osteoarthritis, age, and comorbid conditions. Although a specific dual-mobility prosthesis design shows promise as a therapeutic option for trapeziometacarpal joint OA, its efficacy varies depending on patient characteristics and the extent of joint degeneration. Ongoing research is critical to fully understand its potential, as this design may represent a valuable addition to the treatment arsenal for this condition.

5. Conclusion

Although this is a preliminary study with a limited number of patients and a short follow-up, we think that the dual-mobility prosthesis may be a viable treatment for TMJ OA. The Touch® prosthesis offers excellent short-to medium-term results in patients with stage III-IV Dell RA. Dual mobility restores strength and mobility of the trapeziometacarpal joint and reduces pain rather quickly, as demonstrated by improved VAS, modified pulp-to-pulp pinch, Kapandji score, and postoperative MHQ score.

CRedit authorship contribution statement

Giuseppe Rovere: Conceptualization, Writing – original draft, Methodology. **Francesco Bosco:** Investigation, Visualization, Supervision. **Alessio Cioffi:** Writing – original draft. **Fortunato Giustra:** Investigation, Visualization. **Francesco Liuzza:** Investigation, Visualization. **Lawrence Camarda:** Supervision.

Guardian/patient's consent

Not Applicable.

Ethical statement

The study was conducted following the ethical standards of the Declaration of Helsinki (1964).

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Declaration of competing interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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References

- Bonetti MA, Rovere G, Fulchignoni C, et al. Autologous fat transplantation for the treatment of trapeziometacarpal joint osteoarthritis. *Orthop Rev.* 2020;12(Suppl 1): 8666.
- Falkner F, Tümkaya AM, Thomas B, Panzram B, Bickert B, Harhaus L. Dual mobility prosthesis for trapeziometacarpal osteoarthritis: results from a prospective study of 55 prostheses. *J Hand Surg Eur Vol.* 2023. <https://doi.org/10.1177/17531934231156280>.
- Cohen-Shohet R, Morgan A. Surgical treatment of advanced carpometacarpal joint arthritis: trapeziectomy with hematoma arthroplasty. *Hand Clin.* 2022;38(2): 199–205.
- Tchurukdichian A, Gerenton B, Moris V, See LA, Stivala A, Guillier D. Outcomes of double-mobility prosthesis in trapeziometacarpal joint arthritis with a minimal 3 Years of follow-up: an advantage for implant stability. *Hand (N Y).* 2021;16(3): 368–374.
- Gay AM, Cerlier A, Iniesta A, Legré R. Surgery for trapeziometacarpal osteoarthritis. *Hand Surg Rehabil.* 2016;35(4):238–249.
- Parry JA, Kakar S. Dual mini TightRope suspensionplasty for thumb basilar joint arthritis: a case series. *J Hand Surg Am.* 2015;40(2):297–302.
- Robles-Molina MJ, López-Caba F, Gómez-Sánchez RC, Cárdenas-Grande E, Pajares-López M, Hernández-Cortés P. Trapeziectomy with ligament reconstruction and tendon interposition versus a trapeziometacarpal prosthesis for the treatment of thumb basal joint osteoarthritis. *Orthopedics.* 2017;40(4):e681–e686.
- Taccardo G, DE Vitis R, Parrone G, Milano G, Fanfani F. Surgical treatment of trapeziometacarpal joint osteoarthritis. *Joints.* 2014;1(3):138–144.
- Dell PC, Brushart TM, Smith RJ. Treatment of trapeziometacarpal arthritis: results of resection arthroplasty. *J Hand Surg Am.* 1978;3(3):243–249.
- Vandenberghe L, Degreef I, Didden K, Fiewes S, De Smet L. Long term outcome of trapeziectomy with ligament reconstruction/tendon interposition versus thumb basal joint prosthesis. *J Hand Surg Eur Vol.* 2013;38(8):839–843.
- De la Caffenièrre JY. Total trapetiometacarpal prosthèses. *Rev Chir Orthop.* 1973;59: 299–308.
- Christiansen T. A new hip prosthesis with trunion-bearing. *Acta Chir Scand.* 1969; 135(1):43–46.
- Bistolfi A, Giustra F, Bosco F, et al. Ultra-high molecular weight polyethylene (UHMWPE) for hip and knee arthroplasty: the present and the future. *J Orthop.* 2021;25:98–106.
- Giustra F, Bistolfi A, Bosco F, et al. Highly cross-linked polyethylene versus conventional polyethylene in primary total knee arthroplasty: comparable clinical and radiological results at a 10-year follow-up. *Knee Surg Sports Traumatol Arthrosc.* 2023;31(3):1082–1088.
- Duerinckx J, Caekebeke P, Van Melkebeke L. Polyethylene liner fracture in dual mobility trapeziometacarpal total joint replacement: how to make a timely diagnosis? *J Hand Surg Eur Vol.* 2024;49(8):1034–1035.
- Duché R, Trabelsi A. The concept of first metacarpal M1-M2 arch. New interest in trapeziometacarpal prostheses. *Hand Surg Rehabil.* 2022;41(2):163–170.
- Gonzalez-Espino P, Pottier M, Detrembleur C, Goffin D. Touch® double mobility arthroplasty for trapeziometacarpal osteoarthritis: outcomes for 92 prostheses. *Hand Surg Rehabil.* 2021;40(6):760–764.
- Jensen MP, Chen C, Brugger AM. Interpretation of visual analog scale ratings and change scores: a reanalysis of two clinical trials of postoperative pain. *J Pain.* 2003;4(7):407–414.
- Komine S, Morizaki Y, Uehara K, Miura T, Ohe T, Tanaka S. Risk factors for residual pain after ligament reconstruction and tendon interposition on osteoarthritis of the first carpometacarpal joint. *J Orthop Surg (Hong Kong).* 2022. <https://doi.org/10.1177/10225536221103301>.
- Kapandji A. Cotation clinique de l'opposition et de la contre-opposition du pouce [Clinical test of apposition and counter-apposition of the thumb]. *Ann Chir Main.* 1986;5(1):67–73.
- Chung KC, Pillsbury MS, Walters MR, Hayward RA. Reliability and validity testing of the Michigan hand outcomes Questionnaire. *J Hand Surg Am.* 1998;23(4):575–587.
- Yuan F, Aliu O, Chung KC, Mahmoudi E. Evidence-based practice in the surgical treatment of thumb carpometacarpal joint arthritis. *J Hand Surg Am.* 2017;42(2): 104–112.e1.
- Lins RE, Gelberman RH, McKeown L, Katz JN, Kadiyala RK. Basal joint arthritis: trapeziectomy with ligament reconstruction and tendon interposition arthroplasty. *J Hand Surg Am.* 1996;21(2):202–209.
- Ulrich-Vinther M, Puggaard H, Lange B. Prospective 1-year follow-up study comparing joint prosthesis with tendon interposition arthroplasty in treatment of trapeziometacarpal osteoarthritis. *J Hand Surg Am.* 2008;33(8):1369–1377.
- Toffoli A, Teissier J. MAIA trapeziometacarpal joint arthroplasty: clinical and radiological outcomes of 80 patients with more than 6 Years of follow-up. *J Hand Surg Am.* 2017;42(10):838.e1–838.e8.
- Dreant N, Poumellec MA. Total thumb carpometacarpal joint arthroplasty: a retrospective functional study of 28 moovis prostheses. *Hand (N Y).* 2019;14(1): 59–65.
- Martins A, Charbonnel S, Lecomte F, Athlani L. The Moovis® implant for trapeziometacarpal osteoarthritis: results after 2 to 6 years. *J Hand Surg Eur Vol.* 2020;45(5):477–482.
- Froschauer SM, Holzbauer M, Mihalic JA, Kwasny O. TOUCH prosthesis for thumb carpometacarpal joint osteoarthritis: a prospective case series. *J Clin Med.* 2021;10(18):4090.
- Herren DB, Marks M, Neumeister S, Schindele S. Low complication rate and high implant survival at 2 years after Touch® trapeziometacarpal joint arthroplasty. *J Hand Surg Eur Vol.* 2023;48(9):877–883.
- Herren DB, Marks M, Neumeister S, Schindele S. Short-term recovery after implant versus resection arthroplasty in trapeziometacarpal joint osteoarthritis. *J Hand Surg Eur Vol.* 2023;48(10):1048.