Rhizarthrosis: treatment approaches in modern orthopedics

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Abstract

Rhizarthrosis is an osteoarthritis of the trapezium-metacarpal joint, a common condition mainly affecting postmenopausal women, which has a significant impact on the quality of life and functionality of the hand. The thumb is critical for grasping and strength of the entire hand, and functional impairment of the thumb mobility in rhizarthrosis reduces hand function significantly. Despite its high prevalence and risk of disability, therapeutic options for rhizarthrosis remain limited. Treatment usually requires a multidisciplinary approach using a combination of non-pharmacological, pharmacological and surgical strategies. The literature review observes various surgical treatment options for rhizarthrosis, such as ligament reconstruction, tendon interposition, resection arthroplasty and joint replacement or arthrodesis.

Keywords: rhizarthrosis, orthopedics, trapezium-metacarpal joint, surgical treatment, hand joints, biomechanics, joint replacement.

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Ризартроз: особенности лечения в современной ортопедии

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Аннотация

Ризартроз, или остеоартроз трапециевидно-пястного сустава, – распространенное заболевание, в основном поражающее женщин в постменопаузе и оказывающее значительное влияние на качество жизни человека. Первый (большой) палец определяет силу хвата всей руки, поэтому нарушение его подвижности при ризартрозе значительно снижает функционал кисти. Несмотря на высокую распространенность и риск развития инвалидности, терапевтические возможности лечения ризартроза по-прежнему ограничены. Лечение обычно требует междисциплинарного подхода с использованием комбинации нефармакологических, фармакологических и хирургических методик.

Литературный обзор посвящен анализу таких хирургических методов лечения ризартроза, как реконструкция связок, интерпозиция сухожилий, резекционная артропластика, эндопротезирование или артродезирование сустава.

Ключевые слова: ризартроз, ортопедия, трапециевидно-пястный сустав, хирургическое лечение, суставы кисти, биомеханика, протезирование сустава.

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РзА – ризартроз, CMCJ – пястно-запястный сустав (carpometacarpal joint).

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INTRODUCTION

Rhizarthrosis (RzA), or trapeziometacarpal osteoarthritis, is an arthritic degenerative process that affects the first joint of the thumb [1]. The thumb having the leading function in the biomechanics of the hand, the loss of that function results in 40 to 50 per cent deterioration of the function of the hand [2]. RzA manifests as pain in the base of the thumb, restricting the force of the grip and making performance of daily tasks complicated. The pain sets on in certain movements and can progress to permanent sense of discomfort over time. Chronic RzA leads co joint contractures, visual deformations (Z-shaped thumb), and muscular atrophy [3].

Functional disorder of the thumb that determines the grip and the force of the hand decreases a person's capability of performing everyday activities, such as writing, opening of jars, turning keys or handling small objects [4]. The anatomic configuration of the joint surfaces of the carpometacarpal joint (CMCJ) of the thumb is complex. The base of the metacarpal bone is concave dorsovolarly and convex radioulnarly. Conversely, the trapezoid concave arc is radioulnar, and the convex arc is dorsovolar. The trapezoid and the metacarpal joint surfaces have incommensurable curvature radii that match only in the extreme positions of the movement. The concave-convex saddle-shaped structure of the CMCJ is involved in the flexion/extension and abduction/adduction. Pronation and supination is a complex rotation and translation of the joint. The concavity of each articular surface is shallow, and the bone and cartilage component ensures minor internal stability of the CMCJ. The ligaments and muscles play an important role in the stability of this complex joint [5].

The biomechanics of CMCJ is characterized with multidimensional mobility [6]. The high mobility of the human CMCJ has developed in the course of evolution. The evolutionary requirements for gripping and manipulative activity of the upper limbs developed simultaneously with upright posture [7, 8]. The functional paradox of the CMCJ is in the combination of stability and high mobility. The thumb needs a wide range of motion to perform tasks only characteristic of humans, from a strong grip to a fine pinch [5].

WP 3rd Cooney and EY Chao (1977) used the method of biomechanical analysis to calculate the internal forces in the joints and soft tissues of the thumb during the pinch and the grip. It was found that the tendons of the intrinsic and extrinsic of the thumb withstand from 10 to 30 kg during the pinch exerting a force of 5 kg on the tip of the thumb, and up to 50 kg during the grip. The force of contraction (contact) of the joint on average is 3 kg in the phalangeal joints, 5.4 in the metacarpophalangeal joints and 12.0 kg in the carpometacarpal joint (CMCJ) in the simple pinch (applied force of one kg). Gripping forces up to 120 kg may develop in the CMCJ in a strong grip [9]. Since the skeletal architecture of CMCJ provides rather mild internal bone stability, the ligaments are critically important to withstand the natural tendency for incomplete dislocation in the compression and gripping [5]. CMCJ copes with extreme forces created by such movements since it is stabilized with a complex system of ligaments and muscles. Without that stability, the incomplete dislocation of the thumb could occur under loads of grip and compression, and the gripping would be incomplete. The understanding of the character of such interaction occurring in the CMCJ is important for the adequate treatment of pathology of this joint [10].

H. Hafiz et al. (2024) developed a biomechanical model of CMCJ to study the contribution of tendons, ligaments and other soft tissues in the passive forces during distraction. Five fresh autopsied specimens were tested with a distractor in order to measure the applied forces during gradual distraction of the non-damaged joint. The next step included positioning of a sensor into the articular capsule through a minor incision for a precise measurement of the main intra-articular forces while maintaining integrity of tendons and ligaments. Prior to the separation of the bones the forces exerted by the tendons and ligaments were relatively low in comparison to the force of the capsule that was approx. 92% from the total applied force. The contribution from the tendons and ligaments increased with further distraction. The passive contribution of the tendon force in distraction for 2 mm was less than 11% while that of the tendons it was 74%. Thus, the 'ligament-capsule' complex plays a significant role in the passive forces of the CMCJ during distraction [11]. The thumb is responsible for over 40% of the hand functions for its gripping and compressing capacity is inefficient without its opposition and gripping capability [12]. Therefore, degeneration of the CMCJ may lead to disability [3].

Traditionally, RzA is seen as an endemic women's disease in the post-menopausal period. Demographic radiographic studies show that incidence ratio of CMCJ in women and men is 6:1; however, the ratio decreases over age, and the incidence rate in women and men at the age of 75 is 40% and 25%, respectively [5]. The clinical prevalence of RzA is

twice as high in women than in men (affecting 25% women in the post-menopause), while its radiographic prevalence is even higher, from 45% to 60% [13, 14]. In women aged 70 and above the risk of the disease is double than that in women after the menopause [15]. The high susceptibility of women towards RzA is related to the lower congruence of the articular surfaces: the concavity of the metacarpal surface and the convexity of the trapezoid surface in women are less pronounced than in men [16].

The diagnosis of RzA is basd on a clinical examination. The major symptoms are pain localized in the basis of the thumb, stiffness, loss of range of motion and significant impairment of the function of the hand. The pain is often diffuse, originates in the anatomical snuffbox, and follows a waxing-and-waning pattern [4]. Radiographic findings are commonly used to stage the disease, even in the absence of a clear correlation between clinical symptoms and the severity of imaging changes [17].

In 1973, Richard Eaton and William Littler described four progressive radiographic stages of RzA, which were later modified to include scaphotrapezial arthritis. The modified Eaton-Littler classification is currently the most widely used radiographic staging system for basal arthrosis of the first digit of the hand.

Stage I: minor expansion of the CMC joint gap. Stage II: minor narrowing of the CMC joint gap, sclerosis and cystic alterations with osteophytes or loose bodies < 2 mm. Stage III: considerable narrowing of the CMC joint gap, sclerosis and cystic alterations with osteophytes or loose bodies > 2 мм. Stage IV стадия: arthritic alterations in the CMCJ similar to Stage III with scaphotrapezial arthritis [18, 19].

Despite the advanced developments in the therapy of the hand, conservative options of RzA treatment are still limited. Usually, treatment required a multidisciplinary approach utilizing a combination of non-pharmacological, pharmacological and surgical methods [20]. Non-pharmacological measures include rest, changes in the physical activity, immobilization with braces or controls, exercise and physiotherapy [21]. Pharmacological treatment includes analgesics, local or oral non-steroid anti-inflammatory drugs, and injections of gluco-corticosteroids or hyaluronic acid [4, 22]. Intra-articular injections may be administered with ultrasonic control [23]. Intra-articular injection therapy is usually applied to alleviate the symptoms of the disease since it may circumvent the systemic effect and potential side effects of oral drugs [14, 24]. Other injections may include corticosteroids, platelet-rich plasma, and stem cells; there were trial methods of treatment with Infliximab, □-interferon, botulinum toxin [25] and oxygen and nitrogen mixture [26].

Conservative methods of RzA may ensure symptomatic relief in early stages, while later stages require surgical treatment [27].

The aim of this review is to describe and analyze the surgical methods of RzA treatment. The topic of surgical treatment of RzA being in development for a considerable time, we used the sources from the 1940s describing the classic methods, to the present time. The analysis of literature data was performed using scientifica databases: Pubmed, Healio Orthopedics, Medline, Scirus. The literary sources were selected using the following keywords: ризартроз, ортопедия, трапециевидно-пястный сустав, хирургическое лечение, суставы кисти, биомеханика, протезирование сустава, rhizarthrosis, orthopedics, trapezium-metacarpal joint, surgical treatment, hand joints, biomechanics, joint replacement.

■ SURGICAL METHODS OF RHIZARTHROSIS TREATMENT

Resection of the trapezoid bone

Resection of the trapezoid bone, or trapeziectomy, was first described by W.H. Gervis in 1940s as an option of surgical treatment of RzA. The surgeon performed a simple resection of the trapezoid bone to remove the source of the 'bone-to-bone' pain originating from the metacarpal bone articulating with the trapezoid bone. The author reported good initial results in the series of 18 resections of the trapezoid bone [28]. To date, simple trapeziectomy remains the most popular method of surgical treatment of RzA. The method provides mitigation of the pain syndrome and relatively high mobility of the thumb [29].

Later, many technical modifications stemmed from trapeziectomy: these were aimed at prevention of shortening of the thumb than caused recurrent pain and loss of strength in mid-term perspective [30].

T.F.M. Yeoman et al. (2019) demonstrated significant and stable improvement of thumb function after the simple trapeziectomy. 205 patients filled the quick questionnaire on disablement of arm, shoulder and hand (QuickDASH) and five-dimensional EuroQoL questionnaire (EQ-5D), on average 8.2 (3.5…17.0) years after the simple trapeziectomy. The average QuickDASH score of the post-surgery group was 37±17, and the average EQ-5D score was 0.56±0.31. The average QuickDASH score in the pre-surgery group was 54.0±17.0. The mean difference in the QuickDASH score between the pre- and post-surgery groups was 17 points (95% CI 8–26, p = 0.0003) [31].

N. Janakiramanan et al. (2021) saw that trapeziectomy could restore the functions of the thumb with positive mid-term and long-term results, yet the defect in the area of resected bone caused pain, especially in the first two or three months [32]. The simple trapeziectomy could also bring about some complications such as shortening of the thumb, decrease of grip strength, cramping of the distal part of the scaphoid bone [30]. In 1960, A.H. Murley analyzed outcomes of 39 trapeziectomies and concluded that the grip strength and the range of motion in abduction decrease, which is important for men performing hard work [33]. The study of A. Weilby showed that 5 out of 17 patients after trapeziectomy experienced weakness of the hand, painful spasms and difficulties in holding objects [34].

Such results of simple trapeziectomies fostered development of methods of stabilization and restoration of CMCJ surface to ensure a physiological reconstruction [5].

K. Van Royen et al. (2021) studied the possibility of arthrodesis of the scaphoid-metacarpal joint (SMC) with a structural bone graft for multiply operated patients. All patients demonstrated symptomatic instability of the basis of the thumb, and they had undergone three to four surgeries including arthrodesis. Three patients underwent SMC

arthrodesis using structural bone graft from the iliac crest. All patients were satisfied with the results. The average grip strength increased from 3.5 to 10.5 kg, and the average pinch strength, from 1.5 to 2.5 kg. The arthrodesis was confirmed in all patients. We believe that the SMC arthrodesis with structural bone autograft is the operation of choice that significantly preserves the thumb opposition and restores stability [35].

Tendon and Ligament Reconstruction

Researchers emphasized importance of reconstruction of ligament reconstruction tendon interposition (LRTI), or tendon suspension technique of the *abductor pollicis longus* (APL), allograft and other methods of interposition, implantation arthroplasty, unloading osteotomy and arthrodesis [36]. A.I. Froimson (1970) identified the problem of metacarpal subsidence and weakness following trapeziectomy and recommended the interposition of a tendon spacer between the metacarpal and scaphoid bones [37].

Other researchers maintained the approach of stabilizing the metacarpal bone by reconstructing the ligaments that would bind the basis of the first metacarpal bone with the neighboring metacarpal bone of the second finger. The aim of the intervention was to prevent development of incomplete dislocation and sinking of the metacarpal bone with the absence of the entire trapezoid bone or part thereof and to secure the ratio of the first metacarpal bone to the second [5].

R.G. Eaton, J.W. Littler (1973) reported that after the simple trapeziectomy the hypermobility of the thumb caused pain and predisposed the joint to progressive degeneration. They developed a method of reconstruction of the palmar carpal ligament using a half of the distal tendon of the radial flexor of the wrist (*flexor carpi radialis*, FCR), that would be passed through the palmar dorsal aperture at the base of the metacarpal bone of the thumb. The tendon is tensioned and sutured to the adjacent periosteum. After fixation, the graft is passed through the abductor tendon of the first digit and re-sutured to the proximal portion of the FCR. It was supposed that the reconstruction restores the function of the weak palmar ligament and strengthens the thin radial capsule. This reconstruction supports the joint in two planes making it more stable that a single-plane reconstruction [38].

In 1973, R.G. Eaton and J.W. Littler used the reconstruction of the palmar ligament to treat patients with all four stages of disease of basal joints. The authors reported good or excellent results in 16 out of 18 patients and two satisfactory results in patients with stage IV of basal joint disease [38]. In 1984, results of a long-term follow-up were published: of the 38 patients who were followed up for 7 years, 32 (84%) had good or excellent results, and 6 (16%) patients had satisfactory results [39].

Today LRTI is the most frequent method of RzA treatment. The LRTI technique involves interposition of the tendon not used for reconstruction to a space created after the trapezoid excision. Alternative LRTI procedures use different redirection paths for the FCR tendon (with or without bone tunnels) or use various tendons to suspend the first metacarpal to the second metacarpal [5].

R.I. Burton and V.D. Jr. Pellegrini (1986) performed LRTI by expanding the reconstruction of the palmar ligaments to combine it with partial and total trapeziectomy. The concept is similar to the reconstruction of palmar ligaments with the exception that the tendon is directed diagonally via the base of the metacarpal bone of the thumb and exits dorsally approx. 1 cm distally to the joint surface, perpendicularly to the plane of the thumb. The remaining tissue is folded and inserted into the space created after the trapezoid excision. The reconstruction is stabilized with the Kirschner wire [40]. Initially, a split FCR tendon was used for reconstruction, but recent practice employs the entire tendon, thereby providing more tissue for interposition. A two-year postoperative follow-up by D.M. Freedman *et al.* (2000) of 25 patients after LRTI showed that the first metacarpal subsided proximally by 11% of the arthroplasty space, and subluxation was limited to 7%. Pain relief was observed in 92% of patients, who were satisfied with the outcomes [41]. In a 9-year study of 24 patients, M.M. Tomaino *et al.* (1995) reported a minor change in the subsidence of the metacarpal (13%) and subluxation (11%), as well as pain relief (95%). The strength improved as did the grip by 93%, the key pinch improved by 34%, and the pinch grip by 65% [42].

Suspensionplasty utilizes a portion of the *abductor pollicis longus* (APL) tendon to stabilize the first metacarpal. The method was proposed by J.S. Thompson (1989) as reoperative treatment after unsatisfactory arthroplasty of the CMCJ osteoarthritis. Considering its marked positive outcome, the indications were extended to include primary treatment of Stage II-IV of CMCJ disease. During the procedure, a portion of the APL tendon is split distal to the myotendinous junction, mobilized from proximal to distal, and left attached to the dorsal base of the first metacarpal. An oblique tunnel is created at the base of the first metacarpal, similar to the one used in LRTI. The tunnel originates dorsally, approximately 1 cm distal to the articular surface, and exits proximally, slightly volar to the center of the metacarpal base. A second tunnel is drilled in a dorsal-to-volar direction, 1 cm distal to the base of the second metacarpal. Using suture materials or a tendon passer, the APL graft is passed through the base of the first metacarpal and then in a volar-to-dorsal direction through the base of the second metacarpal. After appropriate tension is set, the APL graft is secured dorsally by suturing it to the adjacent tendon of the *extensor carpi radialis longus* (ECRL) [43].

O. Soejima et al. (2006) reported on 18 patients (21 cases) after suspensionplasty who were followed up for on average of 33 months. No pain was registered in 13 cases; 5 patients experienced mild pain under vigorous physical activity, and 3 patients reported minor pain under mild activity. The subsistence of the metacarpal was 15% from the arthroplasty space. Radial and volar abduction were 56 degrees [44]. These findings match with results of LRTI reported by R.I. Burton and V.D. Jr. Pellegrini (1986) [40].

The systematic review by M. Saab and G. Chick (2021) described long-term outcomes and complications of trapeziectomy after a five-year follow-up. It included 22 studies involving 728 patients. All studies reported good outcomes with respect to pain and range of motion in the follow-up of patients for 8.3 years (from 5 to 22 years); the average level of satisfaction with treatment was 91% (from 84% to 100%). The force of the key pinch returned

to pre-operative level, whereas the pinch grip had a slight improvement (+14%), the grip force increasing by 25%. The complications were related to tendons or nerves involved in the course of additional procedures for the stabilization of the joint (11.6%; n = 56). Mechanical complications included symptomatic impingement of the scaphoid M1 (3.1%; n = 15/580), which led to nine surgical revisions of 581 trapeziectomies [30].

Interpositional Implants

The construction of interpositional implants provides for filling of the empty space remaining after trapeziectomy thereby preserving the length of the thumb, the grip strength and preventing the joint of the first metacarpal and the scaphoid bones. Implants of the first generation appeared in 1970s and were silicone liners stabilized with a pin inserted in the first metacarpal [29]. Some retrospective studies showed positive long-term outcomes with high patient satisfaction in a 10-25 years follow-up.

H.P. Bezwada et al. (2002) analyzed long-term outcomes of silicone arthroplasty of CMCJ. From 1975 to 1990, 85 patients with RzA received 90 silicone implants. 62 implants in 58 patients were available for subsequent analysis for an average of 16.4 years (10–25 years). In 84% cases satisfactory results with positive outcomes were achieved that were characterized with reduced pain and preserved function of the thumb. Strength in power grip, key pinch and tip pinch increased. The ability to touch the base of the fifth finger with the tip of the first finger improved. Subluxation was observed in 19% of patients but was not clinically significant. Implant failure occurred in 6% of patients, requiring revision surgery. Out of 62 cases reviewed, none developed silicone synovitis [45].

At the same time, other authors reported high numbers of remote complications with silicone synovitis, failure of the implant and subluxation [46, 47]. Thus, A. Minami et al. (2005) published a review of 12 surgeries on 10 patients who underwent partial trapeziectomy and interpositional arthroplasty using silicone implants. The follow-up period was 15 years, on average. The surgery provided patients with early pain relief, however, subsequent follow-ups registered its strengthening. The dislocation of the implant was observed in two cases, and its failure, in five. Periprosthetic osteolysis was found in four patients [46]. The study of J.C. MacDermid et al. (2003) showed that out of the 26 operated patients, periprosthetic and wrist osteolysis was seen in 90% patients. Six patients (20%) required revision surgeries (three in the early and three in the later stages), including one patient with a pathological fracture of the scaphoid bone [47].

In order to prevent failure of the silicone implant and development of synovitis, the implants began to be manufactured from solid materials. An example of these is the titanium basal implant CMJ Swanson (Wright Medical) for cement-free fixation. Data published on its application are not abundant but literary sources report about 20% revisions 2 years after the surgery [48]. A similar structure was developed by BioPro: it uses a Cobalt-chromium prosthetic with modular head sizes. The pin is covered with a layer of titanium to promote osseointegration [29]. Pin-free interpositional implants are also manufactured from ceramics

and pyrolytic carbon. The analysis of their use revealed such problems as instability, subsistence, fracture of the trapezoid bone, and revision surgeries were quite frequent [49–51].

Porous materials, such as polyurethane-urea mesh graft (Artelon), were also used for implantation following partial trapezium resection; however, a significant number of complications in the early postoperative period was reported [52].

Pyrocardan, the pyrolytic carbon disk, is used in interpositional arthroplasty. S. Russo *et al.* (2016) reported that its use required revision surgeries in 6% of the cases over three years [53]. The Pyrocardan implant for trapeziometacarpal interposition is a free-floating intra-articular spacer composed of pyrocarbon. This biconcave resurfacing implant, which preserves both ligaments and bone stock, is indicated for use in early and moderate stages of RzA. Post-surgery findings after implantation with Pyrocardan are comparable with those after surgeries for ligament reconstruction and tendon interposition (LRTI), the robustness being higher than in LRTI [54]. J. Logan *et al.* (2020) published a prospective cohort study of mid-term outcomes of the use of the Pyrocardan implant. 40 Pyrocardan implants were implanted in 37 patients. The median age of patients was 58 (46–71) years. The patients were examined before the surgery and 3 months, 6 months, 1 year and 2 years after the surgery. There were no significant complications or revision surgeries after the implantation. The average follow-up period was 29 months (from 12 months to 7 years). The average grip strength after 2 years was 30 kg vs. 19.6 kg in the group of patients of the same age after trapeziectomy [54].

The PyroDisk implant has a central aperture enabling stabilization of soft tissues. F. Smeraglia *et al.* (2020) conducted a retrospective study to evaluate 8-year outcomes of surgical treatment of 46 patients who underwent arthroplasty using the PyroDisk implant. The average follow-up interval was 9.5 years (median of 113 months with the range of 97–144 months). The study showed that interpositional arthroplasty with PyroDisk provided considerable relief of pain and high satisfaction of patients. All patients demonstrated lowering of the DASH score by an average of 30 points. PyroDisk demonstrated good longevity and stability after the surgery; however, the functional results achieved with its use were not above the results of trapeziectomy with or without ligamentoplasty. The authors concluded that implantation with PyroDisk is a reliable operation without any additional advantages over the simpler methods of surgery [55].

Thus, the outcomes of interposition arthroplasty vary. Convincing evidence that interposition is superior to trapeziectomy was not established.

Arthroplasty of CMCJ

Arthroplasty of CMCJ aims to provide pain-free movement of the thumb while preserving its stability. The normal anatomical saddle joint is replaced by a spherical prosthesis. Designs that preserved the anatomical features inherent to the joint were used in clinical practice [29], but without positive outcomes, which was associated with the required capsular release and subsequent instability of the components due to anatomical constraints [56]. Some authors also reported impaired osseointegration and subsequent instability of the prosthetic components [57].

Currently, the spherical prosthesis is the most common design for CMCJ arthroplasty. The first trapeziometacarpal joint prosthesis was developed in the early 1970s by J.Y. de la Caffiniere.

In 1979, JY de la Caffiniere and P.C. Aucouturier published a scientific article on the use of the developed prosthesis. The authors implanted a total of 34 full trapeziometacarpal joint prostheses. 28 were followed up for over 6 months (max. 5 years) allowing for a reliable evaluation of results. Two thirds of cases demonstrated positive outcomes. In 5 cases, weakening of the trapezoid cup was observed due to intraoperative errors [58]. E.T. Skyttä et al. (2005) analyzed the outcomes of implantation with the de la Caffiniere implants in patients with inflammatory arthropathy affecting the CMCJ. A total of 57 procedures were performed for rheumatoid arthritis (41 cases), juvenile chronic arthritis (10 cases), psoriatic arthritis (4 cases), and other inflammatory joint diseases (2 cases). During follow-up, 5 cases of prosthetic component instability and 2 cases of recurrent prosthetic component dislocation requiring reoperation were observed. The survival rate of the prosthesis based on revision surgeries was 87% (95% CI 73–94) over 10 years, and the total rate of component instability as per radiographic data was 15% (95% CI 7–29) over 10 years [59]. P. Johnston et al. (2012) analyzed long-term outcomes in 71 patients (93 procedures) who had the de la Caffiniere prosthesis implanted from 1980 to 1989. 26 patients were followed up for an average of 19 years (from 16 to 26 years). The patients reported satisfactory strength and mobility of the thumb [60].

Despite predominantly positive outcomes, isolated cases of cup instability were reported [61]. To address this problem, a cementless fixation method was developed. However, due to the constrained anatomical space and the biomechanical characteristics of the joint, a metal-on-metal bearing couple was utilized [29]. P.J. Regnard (2006) analyzed results of implantation of 100 cementless fixation "Elektra" prostheses made from titanium and chrome-cobalt steel. The key advantage of the prosthesis was its 9 mm cup diameter, which could be accommodated within the small trapezial bone. The mean follow-up period was 54 (36 to 78) months. Studies assessing pain intensity, range of motion, and dynamometry were conducted, with positive results reported in 83 cases. The most prevalent complication was lack of osseointegration of the trapezoid component of the prosthesis (15 cases). In two cases, sinking of the distal pin into the metacarpal bone was reported. Other complications were observed, too: metal allergy (one case), fracture after direct injury of the thumb (one case) and osteoarthritis of the scapho-trapezoid joint with an acute pain syndrome (one case) [62]. Negative aspects of the intervention are the consequences of using the chosen metal-on-metal bearing couple, which were complicated by metallosis. [63, 64]. According to C. Frølich and T.B. Hansen (2015), abnormal reactions to prostheses with metal-on-metal construction are well known from replacement arthroplasty: elevated level of chromium or cobalt in the blood, pain and formation of a pseudo-tumor [63]. Increased concentration of chromium and cobalt ions after such surgeries was reported by other researchers [64, 65]. At present, metal-on-metal bearing prostheses are used much less frequently [29].

Cementless Prostheses with a Metal-on-polyethylene Bearing Couple

Arthroplasty of the CMCJ may restore the length of the thumb and the metacarpal arch. Correction of adduction of the thumb and the compensatory hyperextension of the metacarpophalangeal joint may be achieved in most patients [66–68]. Based on the studies of prior designs, a new line of CMCJ prostheses was developed. Cementless fixation reduces the risk of instability of the cup component, and the bearing surface minimizes wear and causes no adverse reactions seen in the metal-on-metal designs [65].

What causes problems from the perspective of stability of the system is the cup of the prosthesis. The load exerted on the trapezial cup during pinching and gripping is a combination of both shear and axial forces, resulting in an oblique vector that can predispose the cup to instability. Therefore, the trapezoid component is vulnerable in terms of instability, especially in the early postoperative phase before the osseointegration occurs. To minimize the possible instability of the component the manufacturers use two principal geometric shapes of the cup, the conical and the hemispherical [29]. The cup shapes differ in distribution of the potential force, but there are no clinical or empirical proof that one design is superior towards the other. Both demonstrate promising results in the stability of components in the follow-up for over 5 years [66, 69–71] or even ten years [72, 73].

Another issue with spherical joint designs is dislocation. Consequently, a dual-mobility system was developed, well-known since the early 1980s and based on the principles of total hip arthroplasty [74]. In the standard design, the metallic head of the metacarpal component articulates with a polyethylene liner that is rigidly fixed within the metallic shell of the trapezoid cup, creating an articulation between the metallic head and the polyethylene liner. In the dual-mobility design, the metallic head is housed within a larger polyethylene head, which in turn articulates with a smooth metallic cup fixed within the trapezium. Thus, there are two articulations: one between the metallic head and the polyethylene head, and another between the polyethylene head and the cup. The polyethylene head acts as a mobile liner constrained by the metallic head. The larger head reduces the risk of dislocation by increasing the range of motion arc and enlarging the "jump distance" required for dislocation to occur [29].

Considering the range of motion of the thumb, the "jump distance" is clinically more important than the increased motion arc before the impact. The double mobility design decreased the incidence rate of dislocations and replaced the prostheses of the second generation. The early short-term results of implantation of this kind of prostheses showed some good dynamics [66, 69, 75, 76]. The double mobility design is used in the following products: Maia (Groupe Lepine, France), Moovis (Stryker, Pusignan, France) and Touch (Keri Medical, Switzerland). Although this design is intended to reduce the likelihood of dislocations, there is a risk of intraprosthetic dislocation (between the metallic head and the mobile polyethylene liner) and polyethylene liner wear due to increased loads.

J. Glaser et al. (2025) studied the scapho-metacarpal joint prosthesis with double-mobility design for patients with

persisting pain symptom and functional disorder after the surgery. The study involved 11 patients (with 13 surgeries), who demonstrated no positive dynamics after previous surgeries. They underwent underwent bilateral arthroplasty of the scapho-metacarpal joint. All patients demonstrated considerable improvement of the thumb function. Dynamometry results showed average restoration of up to 80–90% of the force of the contralateral side. Radiography showed good osseointegration of implants with no signs of instability or dislocation. The complications included one case of persistent mild hypesthesia of the superficial branch of the radial nerve, which did not impair the function, and one case of fracture of the scaphoid bone 4 weeks after the arthroplasty, during immobilization [77]. The characteristics of the double-mobility prosthesis clearly depend on the type of polyethylene used. The wear of polyethylene largely depends on its molecular composition, shape, vendor and technological process [29].

◼ CONCLUSION

Trapeziectomy usually yields positive outcomes in RzA, relieving the pain and restoring the mobility of the thumb. At the same time the shortening of the thumb may result in a decreased grip and compression strength. Scientists focus on developing alternative methods of treatment. One of surgical methods of treatment is arthroplasty. However, it will take additional studies before it can be viewed as the "golden standard", like the trapeziectomy. The same applies to cementless total CMCJ prostheses that are instrumental in achieving fast rehabilitation, pain relief and restoration of grip force and movement freedom. Over time, these factors will render total CMCJ arthroplasty a full-fledged alternative to trapeziectomy. ◿

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