

A decade Monitoring of Constrained Metacarpophalangeal Joint Arthroplasty Utilizing an RM prosthesis in the Patient having Rheumatic Arthritis

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Received : July 20, 2023 ;

Accepted: July 22, 2023 ;

Published : August 22, 2023 ;

ABSTRACT

A 72-year-old man with demanding daily activities reported having rheumatoid arthritis, primarily affecting the finger joints in his right hand. Radiographically, the metacarpophalangeal joints (MCPJs) II–V were severely destroyed and luxated. Constrained RM prostheses were usually uncementedly inserted into MCPJs II–V. The main cause of complications during the course of the procedure was an intraoperative periprosthetic fracture of the metacarpal IV, which was treated with immobilisation in a plaster splint for six weeks. The rest of the course was straightforward. The patient reported increasing pain and loss of function in his MCPJ IV for six months, eight years after the primary surgery; no clinically significant symptoms were present in the other finger joints. On radiography, every part of the 4 RM prostheses had unique osteolyses with cortical thinning, and the implant's hinge joint in MCPJ IV was fractured. Using the unrestricted MCPJ resurfacing SRTM MCP implant and cementing both components, a total exchange arthroplasty of the MCPJ IV was carried out. All MCPJ implants were still in the correct position at the 10-year follow-up, which includes a 2-year follow-up following MCPJ IV exchange arthroplasty. The patient is still able to carry out his high-demand daily activities despite the three other RM prostheses showing noticeable radiographic loosening and subsidence.

Keywords : *Rheumatoid arthritis; Metacarpophalangeal joint; Constrained arthroplasty; Resurfacing arthroplasty*

INTRODUCTION

Metacarpophalangeal joints (MCPJs) are the most commonly affected hand deformity in patients with Rheumatoid Arthritis (RA). Since the MCPJ is more inherently unstable than the other long finger joints II–V, it is more susceptible to the deforming forces brought on by RA [1]. The deformity is typically brought on by chronic synovitis, which impairs the ligamentous support of the joint and results in palmar (sub) luxation of the proximal phalanges and ulnar drift of the fingers. As a result, the pinch-induced radial stress on the fingers pushes them in the ulnar direction. Individuals who have this condition frequently describe being unable to stretch their fingers. Furthermore, because the index and middle fingers can no longer resist the thumb in a tip-to-tip squeeze, the deformity impedes the capacity to cut the fingers around bigger objects and impedes delicate pinching [2]. According to the classification by Larsen et al., a stable and functional MCP joint is essential for adequate function of the entire finger, especially in RA patients with concurrent mutilating proximal interphalangeal joint (PIPJ) destruction Grade V. [3] in cases where PIPJ and/or distal interphalangeal joint (DIPJ) fusions are the only surgically recommended course of action (Figure 1A–B) [4]. Constrained MCPJ arthroplasty was developed to reduce the possibility of postoperative recurrence of ulnar deviation and palmar (sub) luxation because of the intrinsic lack of ligamentous support observed in up to 31% of RA patients undergoing silicone rubber implant arthroplasty [5]. The role of the piston effect, primarily known from the silicone rubber implant that increases the range of motion of the proximal phalanx, for breakage of prosthesis in cases of loosened non-silicone uncemented MCPJ implants, such as in unconstrained resurfacing pyrocarbon arthroplasty [8, 9] or in constrained arthroplasty, such as in our following case presentation, is not

clearly understood at this time. However, the rates of loosening and mechanical failure of almost all types of constrained prostheses are so high that their use cannot be recommended at this time [6]. One type that is in use is the second generation of the restricted and uncemented MCPJ RM prosthesis (Mathys, Bettlach, Switzerland) [10].

Case Presentation

A 72-year-old man with demanding daily activities who mostly had RA in his right hand's finger joints presented. Radiographically, there was ankylosis with a Z-deformity of the thumb in addition to severe destruction with luxation of MCPJs II-V (Figure 2A). Initially, the deformity of the thumb was restored through the fusion of the MCPJ and IPJ. Subsequently, a second procedure involved inserting the constrained RM prostheses into the MCPJs II-V, usually without cement. Observe that on the radiograph taken one day after surgery, there was a periprosthetic fracture of the metacarpal IV at the tip of the implant stem (Figure 2B). For six weeks, the fracture was immobilised in a plaster splint as part of a conservative treatment plan. The next course was straightforward. The patient reported increasing pain and loss of function in his MCPJ IV eight years after surgery; no clinically significant symptoms were present in any of the other finger joints. Radiographically, all of the 4 RM prostheses' components showed characteristic osteolyses with cortical thinning and subsidences, and the implant's hinge joint in MCPJ IV was broken (Figure 2C). Using the unconstrained MCP joint resurfacing SRTM MCP (formerly Avanta SR, Small Bone Innovations, Morrisville, PA, USA) implant with cementation of both components, a total exchange arthroplasty of the MCPJ IV was carried out. During the procedure, the RM prosthesis breakage was confirmed, and both components were loosened (Figure 3A). The subsequent course was again simple. The patient reported a good outcome regarding his finger functions and is able to perform his high-demand activities of daily living again (Figure 4), even though there was noticeable radiographic loosening and subsidence of the three other RM prostheses. These findings are consistent with the 10-year follow-up, which includes a 2-year follow-up following MCPJ IV exchange arthroplasty. Prior to MCPJ IV exchange arthroplasty, the patient's pain in visual analogue score (0-10) decreased from 7 to 2, and he stated he would undergo the same procedures again if needed.

Discussion

One of the main priorities in the MCPJs II-V is motion preser-

vation. The secret to the finger's overall satisfactory function is a stable and functional MCPJ. For a strong extension and first conclusion, the stable active extrinsic motion-arc synergistically modulates the intrinsic function in the PIPJ. However, in order to maintain the MCPJ in flexion posture during PIPJ motion, the intrinsic muscles must contract. At the MCPJ and PIPJ, functional flexion postures averaged approximately 60°, while at the DIPJ, they were 40° [11, 12]. When all other surgical options have failed, an MCPJ fusion should not be performed as the primary surgical procedure [2, 11-14]. The silicone rubber implants, first introduced by Swanson in 1968 [15], and its more recent development, NeuFlex, introduced in 1998, are still recommended for low-demand patients with RA (Figure 1A-B) [4, 16, 17], despite the well-known high complication rate (wear-related synovitis and osteolysis, implant loosening and/or breakage). Additionally, for these patients, MCPJ resection-interposition arthroplasties using autologous soft tissue structures can be an additional option [11, 18-20].

Stable and functional MCPJ II-V arthroplasties have been recommended for high-demand patients with RA, like the one in our case. Various (semi) constrained prostheses were designed (the Brannon and Klein type was first developed in 1953, and other types followed in 1961: Flatt, Griffith-Nicolle, Schetrumpf, Schultz, Steffe, George-Buchholtz, Minami, Strickland, Walker, Weightman, Link, Weko, Daphne). These prosthetics were made to increase grip strength and reduce the risk of ulnar deviation with or without (sub)luxation after surgery because silicone rubber MCPJ arthroplasties typically have an inherent lack of ligamentous support. Introduced in the 70th century, the first variant of the constrained and uncemented Mathys prosthesis was an all-plastic implant made up of a metal core, a screw, a polyester and polyacetal-resin component. The two implants are made independently, and an expanding mechanism (the rawl plug principle) fixes them intramedullary. To anchor the stems into the medullary spaces, a screw presses a cone-shaped metal piece into the stem.

Afterwards, the two parts are snapped together (hinge joint). The primary issue was prosthesis migration, which resulted in extremely poor Range of Motion (ROM) within a few months postoperatively [21-23], prompting the product to be removed from distribution. Two polyetheretherketone (PEEK) components make up the second design of the constrained Mathys prosthesis (RM prosthesis), with its hinge joint, which was utilised in our case (Figure 2B). The stems are coated with titanium to promote bone ingrowth, and an internal titanium screw is used for initial fixation [24]. It has been demonstrated that PEEK is a biocompatible biomaterial that is strong enough to replace

a joint [25]. A retrospective investigation comparing the results of 22 RM prostheses with 86 silicone implants for MCPJs and PIPJs in a short- to medium-term follow-up showed that the RM prostheses had much superior functioning and stability than the silicone implants [10]. However, the literature does not provide long-term results involving a greater number of patients. Therefore, more research is required to validate the RM prosthesis. The occurrence of intraoperative periprosthetic fractures in MCPJ arthroplasty, like the one we had, is concerning. Research indicates that this fracture occurs 3% of the time and is linked to higher risk factors, including the use of pyrocarbon implants, cementless component fixation, like the one we had, and diabetes mellitus [26]. Ceramic prostheses for the replacement of the hand's small joints are generally and critically discussed in the literature [27–30]. The newest type of MCPJ arthroplasty involves unrestricted surface replacement using prostheses made of pyrocarbon [8, 31, 32] or prostheses with an articulation of metal on polyethylene (PE) [33, 34]. The goal of these prostheses is that they are low profile, anatomically designed implants limit the amount of bone removed [35]. One of the new generation types currently in use is the unconstrained partial cemented MCPJ resurfacing SRTM MCP implant [36]. Its hemispherical metacarpal head, made of the cobalt-chrome (CoCr) alloy, articulates against the Ultra-High Molecular Weight (UHMW) PE phalangeal component (Figure 3A). The metacarpal component, with its titanium-coated stem, was primarily made for uncemented insertion based on the osseointegration concept for endoprosthetic reconstruction of the phalangeal component, which is generally to be inserted with cementation. hand's tiny joints [37, 38]. But in cases like ours where the metacarpal intramedullary space widens as a result of cortical thinning and bone resorption, cementation of the titanium-coated stems—which are also helpful in PIPJ arthroplasty [39]—is unavoidable. The MCPJ is a condylar ball-and-socket joint where the proximal phalanx has an incongruent (greater radius of curvature) concave surface and the metacarpal head has a convex surface. The primary issue with unrestricted resurfacing MCPJ implants is the potential for dislocation in the ulnopalmar direction in the event that there is insufficient collateral ligament and/or palmar plate. Because the dorsal part of the metacarpal component of the SRTM MCP implant has a larger arc of curvature, this danger is reduced. In a biological study, it was possible to assess the implant's greater intrinsic stability in comparison to human cadaver joints that were unaffected [40]. One drawback of this implant is that it is difficult to remove the cement when revision is required, and the effects of heat polymerization are a source of concern [41]. In a prospective study involving 105 SRTM MCP

joint arthroplasties (88 patients with RA, including severe conditions like palmar (sub) luxation preoperatively), Ibsen Sørensen [42] reported that clinical parameters (ROM, pain, pinch grip) had improved, there was only one metacarpal component loosening after three years (0,95%), and early implant dislocation due to collateral ligament insufficiency was found in 74 patients with a minimum of one year's follow-up. seen in 8 cases (7,6%) following surgery. Following surgical repair of the collateral ligaments, all eight dislocated prostheses have survived with no adverse effect on clinical parameters. However, long-term results with the use of the SRTM MCPJ resurfacing arthroplasty could not be found in the literature either, in contrast to the use of constrained MCPJ arthroplasty with the RM prosthesis. Resurfacing pyrocarbon MCPJ arthroplasty is said to have an 81,4% long-term survival rate [8].

Conclusion

As far as we are aware, this is the first case report in the literature that details the MCPJ arthroplasty at a 10-year follow-up using the uncemented constrained RM prosthesis. In a RA patient with demanding daily activities, three implants are functioning well and providing a satisfactory outcome, despite the four implants showing distinct radiographic loosening and subsidences. The use of silicone rubber and pyrocarbon implants has revealed this characteristic (difference between radiographic findings and good subjective results and without necessity of surgical revision in the absence of clinical symptoms) [4, 6, 8, 16, 17, 31]. However, it is not possible to conclude that the RM prosthesis is a truly dependable alternative for treating RA affecting the MCPJs because there are no bigger case series with long-term follow-ups in the literature. Furthermore, our case study shows that, following a failed primary limited MCPJ arthroplasty, an unconstrained distally partial cemented MCPJ resurfacing SRTM MCP arthroplasty can be a motion- and strength-preserving salvage operation. In cases like ours where the metacarpal intra-medullary space has widened as a result of loosening with bone resorption and cortical thinning following a failed primary implantation of another implant, cementation of the metacarpal component of this implant is required.

Acknowledgements

None.

Declarations

The author declares that he has none conflict of interests concerning this article.

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