Silicone Implant Arthroplasty for Severe Bony Ankylosis of the Proximal Interphalangeal Joints in Rheumatoid Arthritis

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Silicone implant arthroplasty for severe bony ankylosis of the proximal interphalangeal joints in rheumatoid arthritis: A case report

Short title: Silicone arthroplasty for severe ankylosis of PIP joints in RA

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Conflicts of interest
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Abstract

Arthrodesis and prosthetic arthroplasty have been used to treat severe proximal interphalangeal (PIP) joint arthritis. Silicone implant arthroplasty has been an established treatment for rheumatoid arthritis (RA) of the fingers. However, few studies have reported the application of silicone implant arthroplasty for the treatment of severe ankylosis of the PIP joint in RA patients. Here, we report, for the first time, a case of a 46-year-old woman who presented with severe bony ankylosis of the right fourth and fifth PIP joints at >90º flexion. PIP silicone arthroplasty in combination with reconstruction of the extensor mechanism was successfully performed in the affected joints. Four years after surgery, active flexion of the fourth and fifth PIP joints was 55º and 75º, respectively, with an extensor lag of only 5º without pain and joint instability. Proper repair of the extensor mechanism with shortening of the central slips and mobilization of the lateral bands dorsally was most important in maintaining the extended position of the PIP joints. PIP silicone arthroplasty with intensive reconstruction of the extensor mechanism could become a potential treatment option to maintain joint mobility even in severe ankylosis of the PIP joints in RA patients.

Keywords: Rheumatoid arthritis, arthroplasty, finger, deformity, contracture, Avanta

Introduction

Silicone implant arthroplasty in the metacarpophalangeal (MP) and proximal interphalangeal (PIP) joints has become an established treatment for rheumatoid arthritis (RA) because of the expected pain relief and joint mobility.[1-3] However, no reports have applied PIP silicone arthroplasty to joints with severe ankylosis at >90º flexion, which are commonly treated with arthrodesis in a more functional extension position. Here, we report the first case of an RA patient with severe bony ankylosis of the fourth and fifth PIP joints who was treated successfully with silicone implant arthroplasty in combination with reconstruction of the extensor mechanism.

Case report

A 46-year-old woman presented with fixed flexion contractures of the right fourth and fifth PIP joints and impaired activities of daily living. The flexion deformity of the fingers had progressed gradually over the past 5 years, although her RA was well-controlled with medication for >3 years (Figure 1). On physical examination, the right fourth and fifth PIP joint was fused at 110º and 95º flexion, respectively, and both the distal interphalangeal (DIP) joints were at 50º flexion. Normal range of motion (ROM) was observed in the other digits without swelling including the fourth and fifth MP joints; however, slight swelling was observed in the right second MP joint due to erosive changes. The RA was well controlled with methotrexate and tocilizumab. Laboratory results revealed the following: white blood cell count, 6500/μL; C-reactive protein, 0.01 mg/dL; rheumatoid factor, 15 IU/mL; and matrix metalloproteinase-3 41 ng/mL. The Disease Activity Score in 28 joints using C-reactive protein (DAS28-CRP) showed a remission value of 2.56. Radiography and computed tomography showed complete bony ankylosis of both fourth and fifth PIP and DIP joints. Since the patient had no pain in the fingers and desired mobility, she opted for silicon

implant arthroplasty.

Straight dorsal midline incisions were made over the PIP joints to expose the extensor apparatus under general anesthesia. The distally based extensor flaps were elevated to protect the insertion of the central slip to the middle phalanges, and the central slips were cut in a V-shape on the proximal phalanges and reflected distally to expose the ankylosed joints (Figure 2). Subsequently, the head of the proximal phalanges and the base of the middle phalanges were resected after confirming the appropriate osteotomy sites using fluoroscopy. The osteotomy sites of the proximal phalanges were proximal of the insertion of the collateral ligaments, resulting in transection of the collateral ligaments. The ankylosed joints were opened, and a new sufficient space for each implant was created by releasing the volar plate and capsule. Subsequently, the PIP joints were placed in extension without extensive flexor tenolysis, the proximal and middle phalanges were reamed, and silicone spacers (Avanta®, Small Bone Innovations, New York, NY, USA) were inserted. To maintain the extended position of the PIP joints, the extensor mechanism was reconstructed by shortening the central slips and mobilizing the lateral bands. The adjustment of their tension was most important as the central slips were shortened by overlapped V-Y advancement proximally; the lateral bands were positioned dorsally, sutured to either of the central slip, and shortened. Lengthening of the volar skin was not necessary as enough elasticity was present in the skin. There was an abundance of dorsal skin, which was trimmed and closed.

Postoperatively, the PIP joints were maintained in full extension using volar splints, and ROM exercises were initiated on postoperative day 5. Volar night splints were applied for 8 weeks. Four years postoperatively, the active flexion of the right fourth and fifth PIP joints was 55º and 75º, respectively, without pain and joint instability. Extension lag of the PIP joints was only 5º in both digits. Radiographs showed good positioning of the implants without breakage or loosening. The DAS28-CRP remained at a remission value of 2.07. The

patient-reported outcomes, measured by the Quick Disability of the Arm, Shoulder, and Hand and the Hand20 questionnaires, were improved from 88.6 and 90.5 preoperatively to 11.4 and 16 postoperatively, respectively.[4] The patient was satisfied with the appearance of the extended digits and improvement in function.

Discussion

Arthrodesis and prosthetic arthroplasty using silicone, metal surface replacements, or pyrolytic carbon implants have been used to treat severe PIP joint arthritis.[5-9] Arthrodesis can provide joint stability for pinch while relieving pain, but sacrifices joint mobility and has a risk of nonunion.[6] Arthroplasty can provide pain relief while maintaining joint mobility, but the procedure is technically demanding and has a greater risk of complications such as implant loosening and breakage.[7-9] In the present case, we selected implant arthroplasty because we agreed that flexion of the PIP joints in the ring and little fingers was important in grasping small objects and their function should be restored with arthroplasty if possible and PIP arthrodesis was indicated for the index finger as flexion was not as crucial, but the ability to form a strong pinch was important.[2, 10, 11] Moreover, in addition to the patient's desire for mobile PIP joints, we thought that acquiring movement of the PIP joints was meaningful because the MP joints were normal and the DIP joints had already been fused. In particular, we chose silicone implant arthroplasty because metal surface replacement was contraindicated in the present case without the preservation of the collateral ligaments, and pyrolytic carbon implants were unfortunately unavailable in Japan.

PIP silicone arthroplasty, which involves replacing the degenerated or destroyed joint with a silicone spacer, is a well-established treatment for RA patients who experience pain, deformity, and functional impairment.[2, 3] However, it has been generally contraindicated for swan-neck deformity, advanced boutonniere deformity, and significant fixed flexion

contracture because of unsuccessful results.[2, 7, 10, 12] In those cases, arthrodesis in a more functional position has been recommended.[10, 11] Silicone implant arthroplasty for ankylosis of the PIP joint in RA patients has only been described once in a case report in the English literature.[13] Awan et al. reported that a 56-year-old woman with RA whose fourth and fifth PIP joints were fused in 15º of flexion was successfully treated with silicone implant arthroplasty, resulting in 60º of active PIP joint flexion with extensor lag of 10º.[13] In contrast, the present case had severe bony ankylosis of the PIP joints at >90º flexion. Nevertheless, PIP silicone arthroplasty was successful and the patient achieved pain-free mobility in the joints with an arc of 50º to 70º. We believe that this was because of the intensive focus on successful reconstruction of the extensor mechanism by shortening the central slip and dorsally positioning the lateral bands under optimal tension (Figure 2). Feldon et al. recommended that extensive reconstruction of the extensor mechanism with prolonged postoperative splinting is necessary for PIP silicone arthroplasty in significant fixed flexion contractures.[3, 10]

Swanson et al. reported on 424 PIP silicone arthroplasty procedures, with complete pain relief achieved in 98% cases with an average of 5 years of follow-up; 208 PIP silicone arthroplasty procedures were performed in RA patients, of whom 66% had an arc of motion >40º.[2, 14] Several authors have reported that PIP silicone arthroplasty in RA cases provides pain relief and reasonable function with an arc of active ROM between 30º and 60º.[7, 12, 15] Even in the present case of severe ankylosed PIP joints, the same functional arc of the PIP joint as reported in previous cases was satisfactorily achieved by PIP silicone arthroplasty in combination with reconstruction of the extensor mechanism; the silicone implant was maintained in a fully extended position by a dorsal hinge axis in cooperation with approximate tension of the extensor tendons. PIP silicone arthroplasty with reconstruction of the extensor mechanism could become a potential treatment option to restore joint mobility in

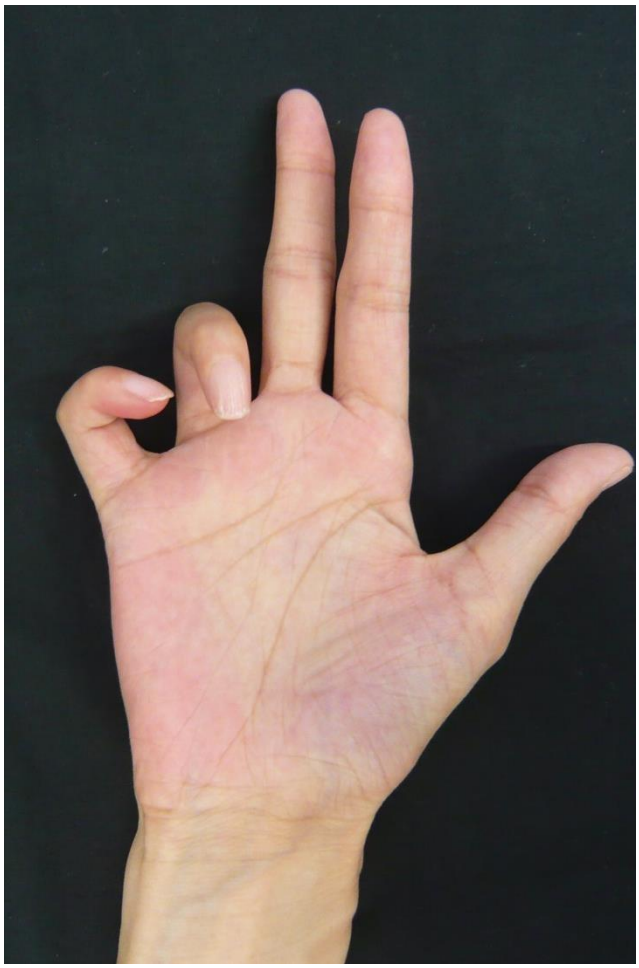
RA patients with severe ankylosis of the PIP joints.

Figure captions

Figure 1: A, B Preoperative palmar (A) and lateral (B) photographs showing fixed flex contracture of the fourth and fifth PIP and DIP joints; **C, D** Preoperative radiograph (C) and CT (D) images showing bony ankylosis of the fourth and fifth PIP and DIP joints.

Figure 1

A



B

C

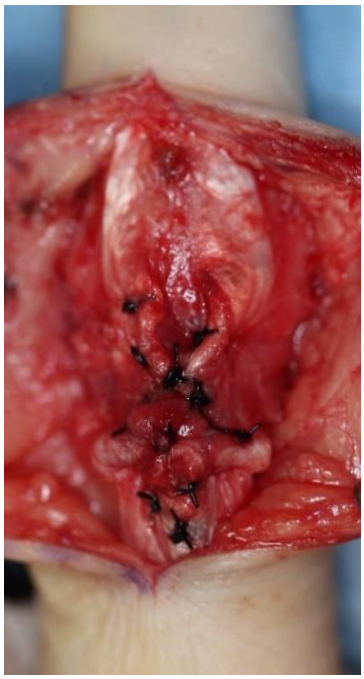
D

Figure 2: A Intraoperative dorsal view of an opened PIP ankylosed joint; **B, C** Reconstruction of the extensor mechanism with shortening of the central slips and mobilized lateral bands; **D, E** Postoperative anteroposterior (D) and lateral (E) views of the radiographs after PIP silicone arthroplasty.

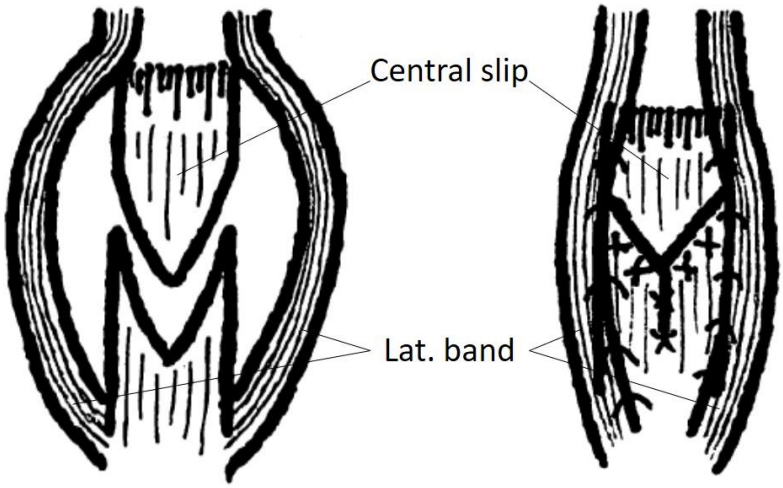
Figure 2

A

B



C



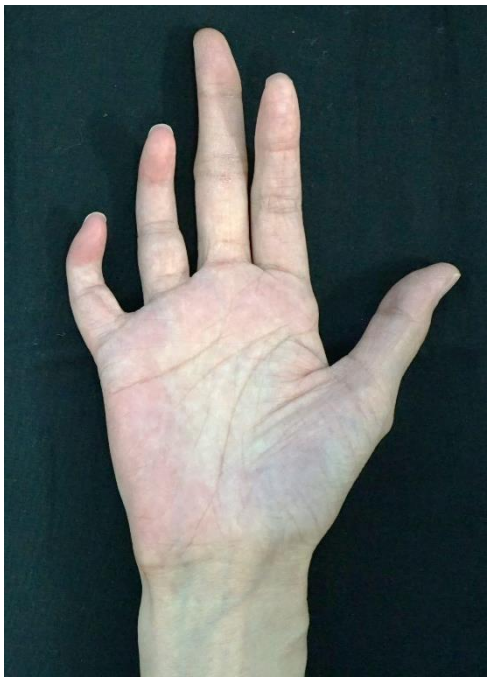
D

E

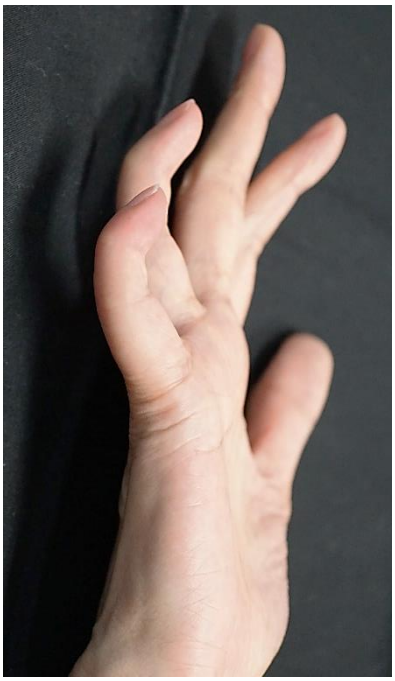
Figure 3: A-C Postoperative palmar (A) and lateral (B) photographs of extended digits and lateral (C) photograph of flexed digits 4 years postoperatively; **D, E** Postoperative anteroposterior (D) and lateral (E) views of the radiographs 4 years postoperatively.

Figure 3

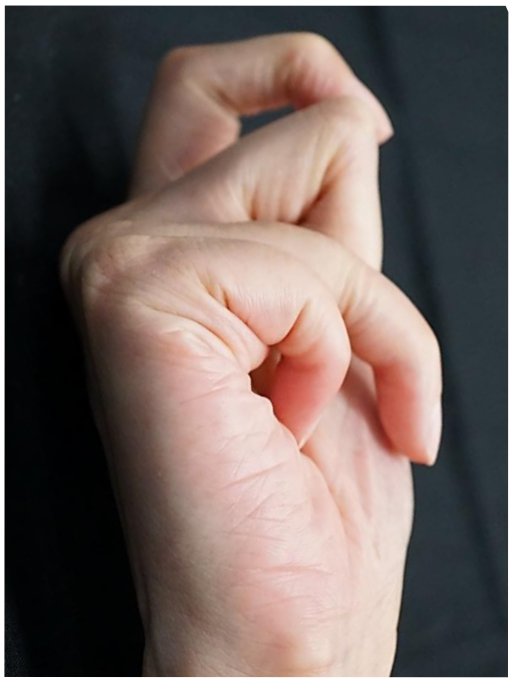
A



B



C



D

E

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Ethical statements

All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions.

Informed consent

Informed consent was obtained from the patient in this study.