Failure of Artelon Interposition Arthroplasty After Partial Trapeziectomy: A Case Report With Histologic and Immunohistochemical Analysis

Yi-Chao Huang, MD, Leila Jazayeri, MD, Wei Le, MD, and Jeffrey Yao, MD

Abstract

Artelon is a degradable biomaterial used for the treatment of osteoarthritis in the carpometacarpal joint of the thumb. The device reportedly works through 2 modes of action—stabilization of the carpometacarpal joint by augmentation of the joint capsule and by formation of a new articular surface at the trapeziometacarpal interface. We present a patient with late failure of arthroscopic hemitrapeziectomy and Artelon interposition that required surgical excision of the Artelon implant and trapeziectomy 4 years postoperatively. Gross and histologic evaluation of the explanted Artelon implant and remaining trapezium revealed lack of articular resurfacing by hyaline ingrowth.

Osteoarthritis (OA) of the first carpometacarpal (CMC) joint is a common disabling condition that mostly affects women over 45 years of age.[1] Surgical intervention is usually indicated in advanced stage OA of the first CMC joint that has failed conservative treatment. Several surgical techniques have been described, including partial or total trapeziectomy, interposition arthroplasty with or without ligament reconstruction,[2,3] metacarpal osteotomy,[4] hematoma and distraction arthroplasty,[5] total joint arthroplasty, arthrodesis, and suspensionplasty.[6] However, no single surgical procedure has proved to be superior.[7]

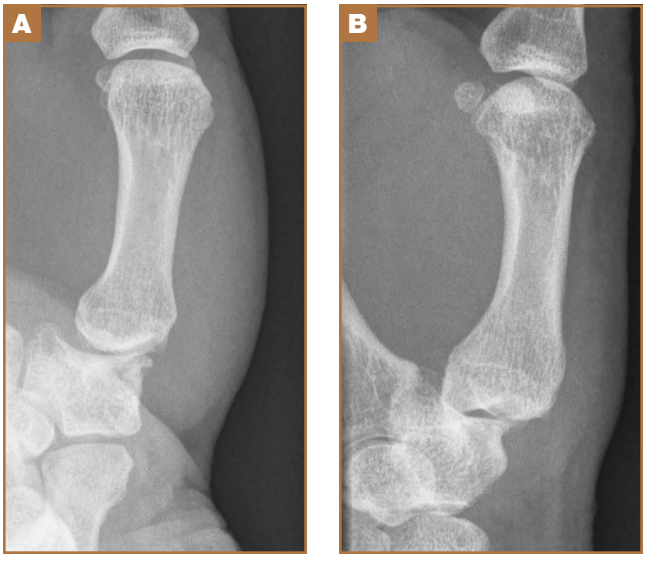
The Artelon implant (Artelon, Nashville, Tennessee) is a T-shaped spacer composed of a biocompatible and biodegradable polycaprolactone-based polyurethane urea polymer. The developers of the implant first presented its use in CMC OA in 2005.[8] The device, an endoprosthetic replacement for the CMC joint, was designed to work through 2 modes of action: stabilization of the CMC joint by augmentation of the joint capsule and by formation of a new articular surface at the trapeziometacarpal interface. The interposed biomaterial has been described as preventing bony impingement and allowing time for replacement with a newly formed articular surface as it undergoes slow and controlled degradation.[8]

We present a patient with recurrent CMC pain and disability 4 years after arthroscopic hemitrapeziectomy and Artelon interposition and discuss the associated histologic findings. The patient provided written informed consent for print and electronic publication of this case report.

Case Report

A 53-year-old man presented with painful disability of right thumb of several months' duration. Clinical and radiographic evaluation supported the diagnosis of right thumb CMC joint Eaton stage III arthritis (**Figures 1A, 1B**). Surgical intervention was indicated after a failed course of conservative treatment, including splinting, nonsteroidal anti-inflammatory medica-

Figure 1. Preoperative radiographs show Eaton stage III thumb carpometacarpal osteoarthritis. (A) Betz view; (B) anteroposterior view.



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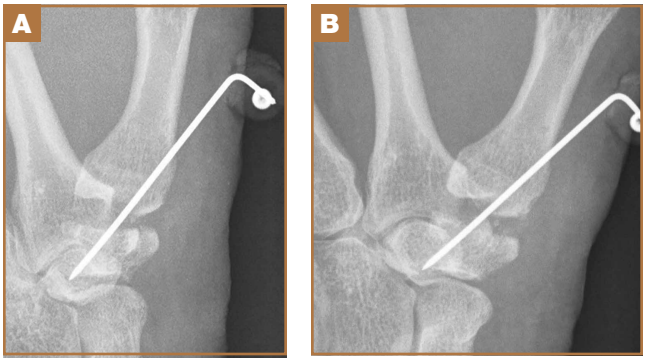

Figure 2. Postarthroscopic partial trapeziectomy and Artelon interposition. The distal 3 mm of the trapezium was resected parallel to scaphotrapezial joint line. A 0.045-inch Kirschner wire was placed for 4 weeks to maintain the partial trapeziectomy space. (A) Betz view; (B) anteroposterior view.

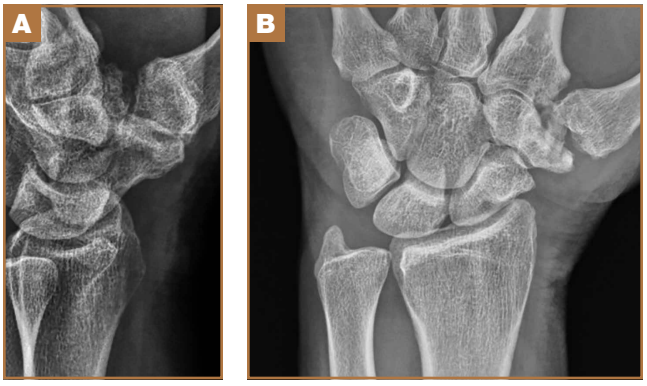

Figure 3. Four years after postarthroscopic partial trapeziectomy and Artelon interposition, radiographs show evidence of advancing arthritis, central trapezial destruction, and rim osteophyte formation. (A) Betz view; (B) anteroposterior view.

tions, activity modification, and corticosteroid injection. Preoperatively, the patient reported a visual analog scale (VAS) score of 8 with activity and 5 at rest, and a Disabilities of the Arm, Shoulder, and Hand (DASH) score of 72.5.

Arthroscopic débridement, hemitrapeziectomy, and interposition arthroplasty with the Artelon spacer were performed. Using standard thumb arthroscopy, 3 mm of the distal trapezium was excised and shaped parallel to scaphotrapezial joint. The wings of the standard-sized Artelon spacer were removed, and the central (articulating) portion was rolled into a tube and inserted through the 1R portal (directly radial to the abductor pollicis longus tendon) into the trapezial space. The Artelon spacer was unrolled within the joint to cover the remaining trapezium and was stabilized with the placement of a 0.045-inch Kirschner wire through the metacarpal, the spacer, and the remaining trapezium. The patient used a thumb spica splint for 4 weeks.

The postoperative radiographs showed a smooth and adequate hemitrapeziectomy with good alignment and implant position (**Figures 2A, 2B**). Four weeks after surgery, the Kirschner wire and cast were removed and physical therapy was initiated. The patient's CMC pain gradually subsided. At the 3-month postoperative visit, the patient's VAS score was 3 with activity and 1 at rest, with a DASH score of 28. His key pinch strength was 12 lb, compared with 20 lb on the contralateral side. At 6 months, the patient's VAS score was 1 with activity and 0 at rest, with a DASH score of 12. His key pinch strength was 18 lb, compared with 22 lb on the contralateral side. At his 2-year postoperative visit, the patient was doing well with the exception of some mild residual pain when he opened tight jars. His VAS score was 1 with activity and 0 at rest, with a DASH score of 3. His key pinch strength was 20 lb, compared with 23 lb on the contralateral side. Radiographs showed good maintenance of the CMC space.

Four years postoperatively, the patient presented with worsening right CMC pain with decrease in pinch strength that interfered with his activities of daily living. His VAS score was 9 with activity and 6 at rest, with a DASH score of 70.

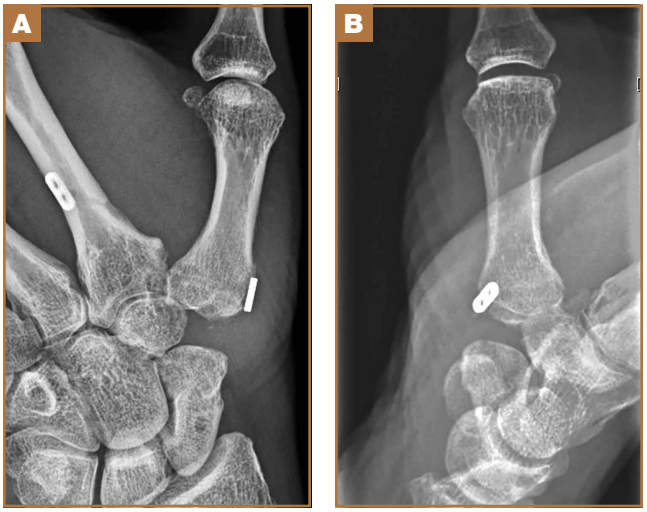

Figure 4. Four months after Artelon explantation, total trapeziectomy, and suture-button suspensionplasty, radiographs show good maintenance of the carpometacarpal joint space. (A) Betz view; (B) anteroposterior view.

On examination, pinch strength was 16 lb, compared with 22 lb on the contralateral side. Radiographs showed advancing arthritis with new osteophyte formation and irregular contour of distal trapezium (**Figures 3A, 3B**). The symptoms were refractory to conservative measures and continued to interfere with his activities of daily living. Revision surgical intervention was indicated and pursued in the form of an open CMC arthroplasty.

The intraoperative findings revealed degradation and disorganization of the Artelon implant within the central portion of the remaining distal trapezium. Rim osteophytes, especially along the ulnar aspect, were noted. Total trapeziectomy and débridement within the CMC space and suture-button suspensionplasty were performed.[8] Slight degenerative changes of the distal scaphoid were also noted. The incision was irrigated, closed, and stabilized

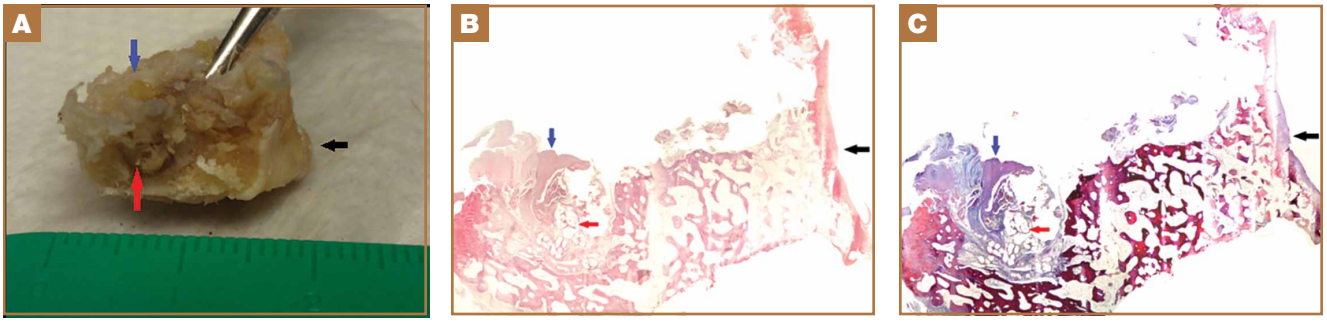

Figure 5. (A) Gross appearance of the trapezium, (B) safranin O stain, and (C) trichrome stain. Red arrows show the Artelon spacer fibers; black arrows show remaining good hyaline cartilage of trapezio-trapezoid joint. Blue arrows show both gross and histologic evidence of central destruction of the distal trapezium without any smooth articular surface formation. There were significant differences in morphology between the normal cartilage and soft tissue surrounding the Artelon spacer.

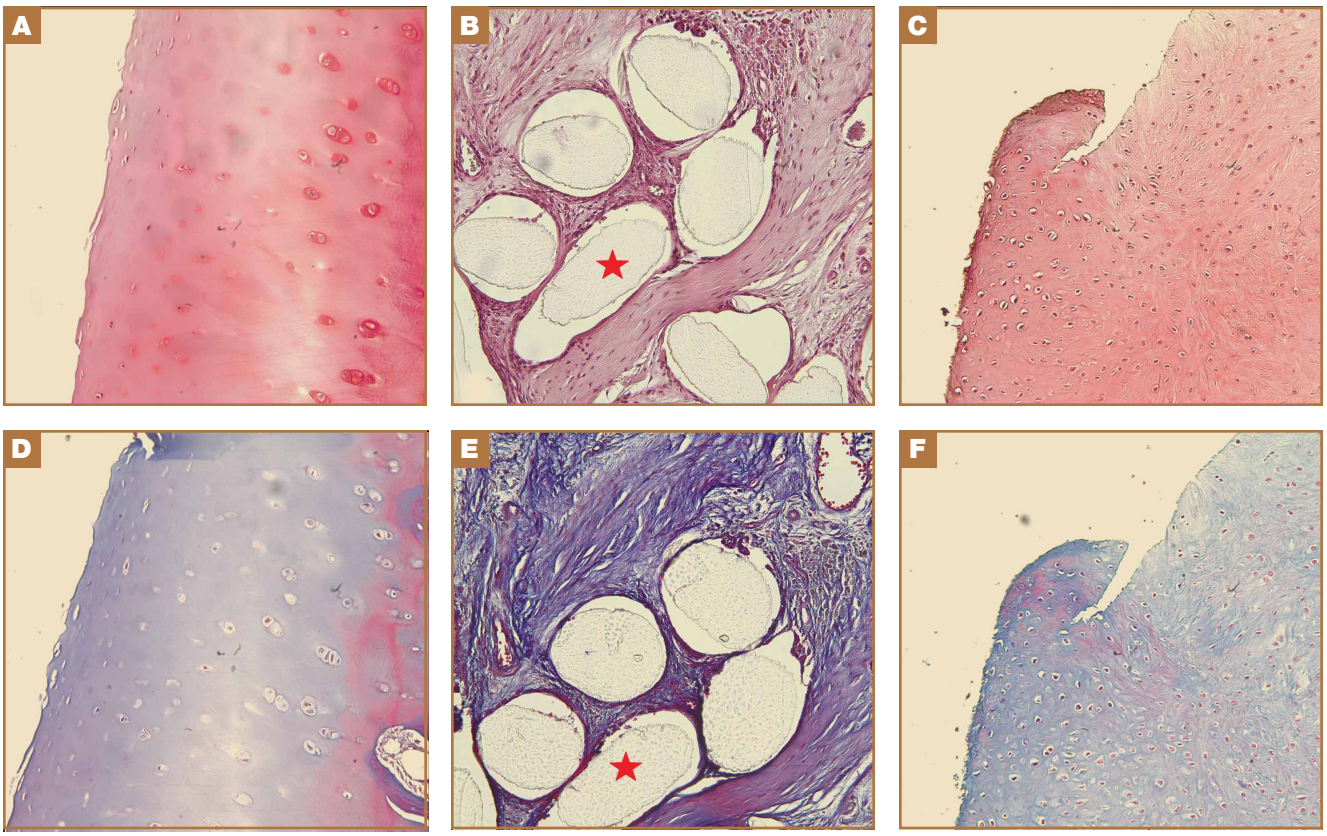

Figure 6. Safranin O stain (original magnification ×200), with (A) normal cartilage, (B) interposed soft tissue with embedded Artelon fibers, and (C) control fibrocartilage. Trichrome stain (original magnification ×200) with (D) normal cartilage, (E) interposed soft tissue with embedded Artelon fibers, and (F) control fibrocartilage. The asterisks indicate Artelon fibers. This morphology of the soft tissue over the distal trapezium was significantly different from the smooth hyaline cartilage and was similar to fibrocartilage.

in a thumb spica splint (**Figures 4A, 4B**).

The harvested trapezium was immediately immersed in buffered formalin. The bone tissue was decalcified, dehydrated, embedded in paraffin, and sectioned in the coronal plane. The sections were stained with safranin O and trichrome, and light microscopic analysis was performed. Central erosion of distal trapezium without smooth resurfacing soft-tissue formation was noted grossly (**Figure 5A**) and microscopically (**Figures 5B, 5C**). The histologic morphology of the soft tissue over the distal trapezium was significantly different when compared with the smooth hyaline cartilage at the preserved trapezio-trapezoidal joint (**Figures 6A-6F**). Microscopic analysis also showed multinucleated giant cells within the soft tissue surrounding the degraded Artelon B (**Figure 7**).

Immunohistochemical analysis was performed to identify type I and type II collagen using the Histostain-Plus,3rd

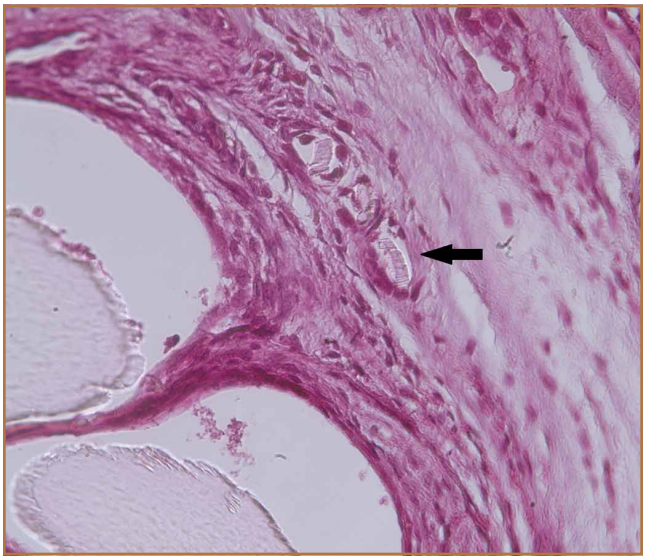

Figure 7. Microscopic analysis also showed multinucleated giant cells within the soft tissue surrounding the degraded Artelon B (safranin O stain, original magnification ×400). Note the arrow is pointing to a multinucleated giant cell.

Gen IHC Detection Kit (Invitrogen Corporation, Camarillo, California) (**Figures 8A-8F**).[9] The immunohistochemical stain was used to identify new hyaline cartilage formation that may have been induced by the Artelon as the resurfacing articulation. Hyaline cartilage contains mainly type II collagen, and collagen types VI, IX, X, XI, XII, and XIV all contribute to the mature matrix.[10] Little type I collagen is found in hyaline cartilage. The results showed that the soft tissue over the distal trapezium with embedded Artelon fiber contained both type I and type II collagen. There was no visible hyaline cartilage formation induced by the Artelon. Both morphologic analysis and immunohistochemical staining revealed that the soft-tissue growth into the Artelon spacer on the distal trapezium consisted primarily of fibrocartilaginous tissue, which is composed mainly of type I collagen with some type II collagen.

Two weeks after total surgical excision of the Artelon implant, total trapeziectomy and suture-button suspensionplasty, the sutures were removed and physical therapy was initiated. Radiographs showed good alignment and position of thumb metacarpal with good maintenance of the implant and CMC space. Four months postoperatively, the patient

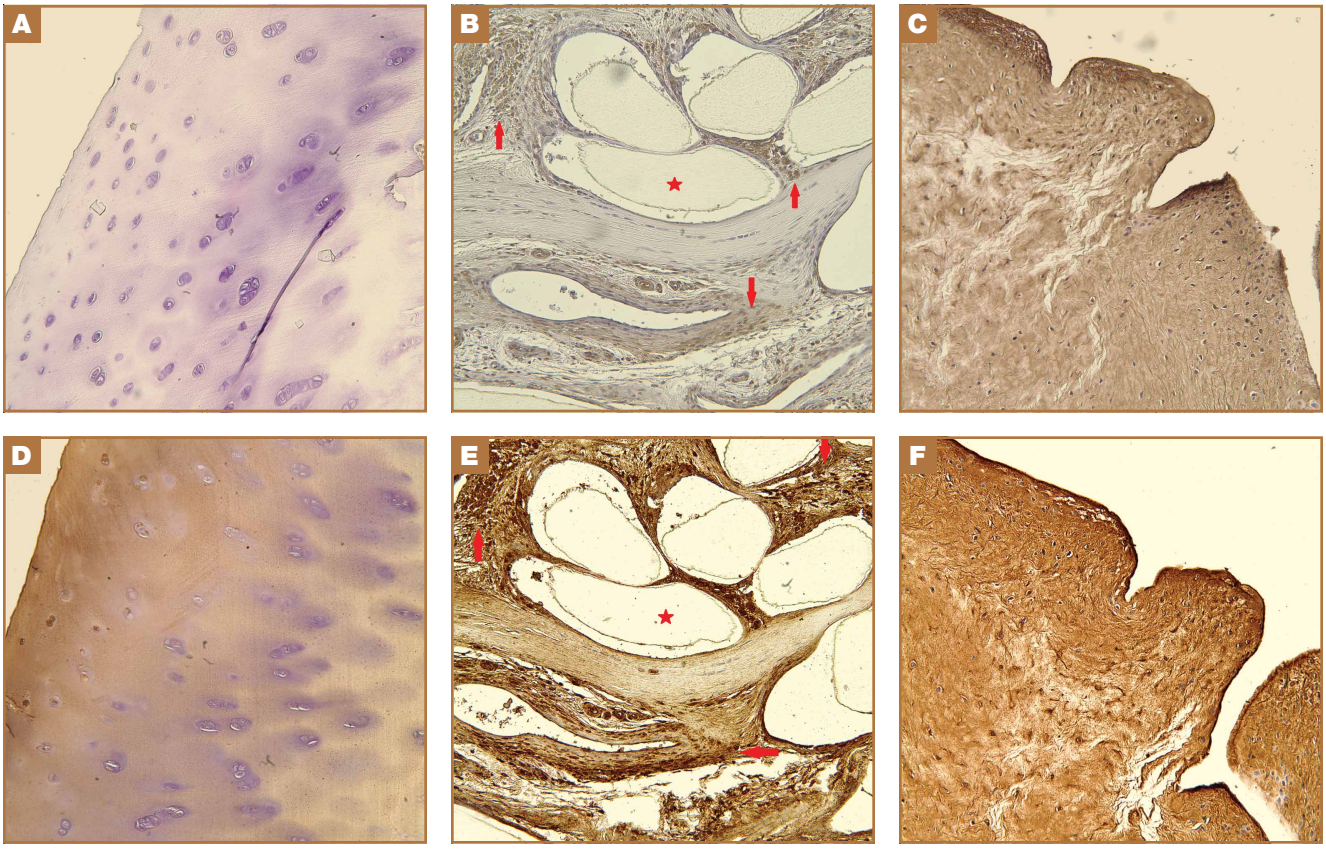

Figure 8. Immunohistochemical stain (original magnification ×200) for type I collagen of normal cartilage. (A) Negative stain; (B) positive stain (arrows) of soft tissue surrounding the Artelon fibers; (C) positive stain of control fibrocartilage. Immunohistochemical stain (original magnification ×200) for type II collagen showed (D) positive stain for control normal cartilage; (E) positive stain (arrows) for soft tissue around the Artelon fibers; and (F) positive stain of control fibrocartilage. The asterisks indicate the Artelon fibers. The immunohistochemical stain results show the soft tissue around the Artelon fibers contained both type I and type II collagen, indicating fibrocartilage formation rather than hyaline cartilage.

reported that he was doing well without pain and without interference in his activities of daily living. On examination, the patient exhibited no pain with the CMC grind maneuver. Radial abduction of the right thumb was 85° and palmar abduction was 90° (compared with 100° and 90° of the left thumb), obtained by measuring the angle between thumb and index finger, respectively. Opposition was to the small finger metacarpophalangeal joint. Grip strength was 72 lb and pinch strength was 20 lb (compared with 70 lb and 24 lb, respectively, on the contralateral side).

Discussion

The use of Artelon as an endoprosthetic spacer to treat osteoarthritis in the CMC joint of the thumb appears to stabilize and resurface the joint while avoiding total trapeziectomy.[8] Nilsson and colleagues[8] presented a prospective study concluding that the Artelon CMC spacer provided better pinch strength when compared with a traditional abductor pollicis longus suspensionplasty procedure. This study also suggested incorporation of the device in the surface of the adjacent bone with no signs of foreign-body reaction. The synthetic material was shown to be safe and biocompatible in vitro and in animal studies.[11-13]

This case report describes the gross and histologic findings after continued pain led to explantation 4 years after arthroscopic partial trapeziectomy and insertion of the spacer. Intraoperative findings at this stage showed lack of incorporation of the Artelon material, central destruction of distal trapezium, and no evidence of smooth articular surface formation. Our histologic analysis showed only poorly organized fibrocartilage within the CMC space rather than a smooth articular surface. These histologic findings may correlate more with Jörheim and colleagues'[14] matched cohort study, which showed that short-term outcomes after treatment with the Artelon implant were not clinically superior to those of tendon suspension-interposition arthroplasties. Multinucleated giant cells were also seen in our specimens. Choung and Tan[15] presented a case report of foreign-body reaction to the Artelon spacer with histologic findings. The foreign body–type reactions associated with Artelon resulted in multinucleated giant cells in their specimens. Recently, several case reports have described similar foreign-body reactions.[16] Nilsson and coauthors[17] presented a randomized, controlled, multicenter study of 109 patients. They reported the Artelon CMC spacer did not result in superior results compared with tendon interposition arthroplasty. In a study by Gretzer and colleagues,[18] the authors suggested that chronic inflammation may result from unstable Artelon fixation instead of the foreign-body reaction.

It is possible that the central erosion of the distal trapezium seen in our case may have resulted from chronic inflammation caused by foreign-body reaction and/or an unstably fixed spacer. The spacer was transfixed to the remaining trapezium in the CMC joint with a Kirschner wire followed by immobilization for 4 weeks. Poor soft-tissue integration of the Artelon spacer may have led to unintended motion and chronic inflammation, which may have also resulted in erosion between the Artelon spacer and the trapezium, leading to central destruction of the distal trapezium. Lastly, the byproducts formed by the degradation of the spacer may have resulted in erosion of the remaining trapezium.

Conclusion

The Artelon CMC spacer used in this patient provided comparable, but not superior, clinical results to other procedures. Histologically, the new articular surface in our patient was formed with rugged fibrocartilage instead of the expected smooth cartilaginous surface. The chronic inflammatory reaction may have resulted from foreign-body reaction, unstable implant fixation, or poor soft-tissue integration. This inflammatory reaction may have contributed to the patient's recurrence of symptoms. These findings support recent clinical data that suggest the use of the Artelon spacer may not provide superior results to other surgical options for the treatment of CMC joint arthritis.

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