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Case Report

Patient-Specific 3D Printed Metacarpophalangeal Joint Prosthesis for Post-Septic Arthritis: A Case Report

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Abstract

Background: Septic arthritis of the metacarpophalangeal (MCP) joint remains a challenging condition that often results in joint destruction and long-term functional impairment. In recent years, three-dimensional (3D) printing has emerged as an innovative option for reconstructing small joints, particularly in cases where standard implants are unavailable.

Case Presentation: We present the case of a 41-year-old male who developed septic arthritis of the left middle finger MCP joint following a penetrating injury. Despite initial treatment with antibiotics and surgical debridement, he evolved to persistent pain, swelling, and severe motion limitation. A patient-specific 3D printed MCP joint prosthesis was designed and implanted one year after the initial injury. Postoperative rehabilitation was initiated early, and at 6-month follow-up the patient reported absence of pain, functional range of motion, and minimal limitations in daily activities.

Conclusion: Patient-specific 3D printed prostheses can provide a valuable reconstructive option in cases of MCP joint destruction after infection when conventional implants are unavailable. Although short-term outcomes are promising, long-term follow-up and larger case series are needed to validate safety and durability.

Keywords: Septic Arthritis; MCP Joint; 3D Printing; Patient-Specific Implant; Hand Surgery

Introduction

Septic arthritis of the hand is relatively frequent, particularly involving the metacarpophalangeal (MCP) and proximal interphalangeal (PIP) joints. It often follows penetrating injuries such as clenched-fist trauma, which introduces oral cavity pathogens and can damage tendons, capsules, and bone [1,2]. When not diagnosed and managed promptly, septic arthritis may result in permanent joint destruction and functional disability.

Reconstructive options for MCP joint destruction are limited. The most commonly available implant in many countries is the Swanson silicone prosthesis; however, outcomes may be unsatisfactory in young or active patients. Recent advances in 3D printing have enabled the design of customized implants and surgical guides, showing encouraging results in bone tumor reconstruction and selected hand cases [3-5].

This report describes the design, implantation, and short-term outcome of a patient-specific 3D printed MCP prosthesis in a patient with septic arthritis sequelae.

Case Presentation

A 41-year-old male with no significant past medical history sustained a penetrating injury to the left middle finger MCP joint. Initial management in a community hospital consisted of wound closure and unspecified treatment.

Two weeks later, the patient presented with swelling and erythema on the dorsum of the hand. He was diagnosed with soft tissue infection and treated with broad-spectrum antibiotics. At three weeks, he was evaluated in our clinic with severe swelling, intense pain, and marked motion limitation. Septic arthritis was suspected, and he was hospitalized for urgent debridement. Intraoperative findings included partial extensor tendon injury, effusion, fibrotic tissue within the joint, and a bone defect of the metacarpal head (Figure 1). Cultures were negative, likely due to prior antibiotics.

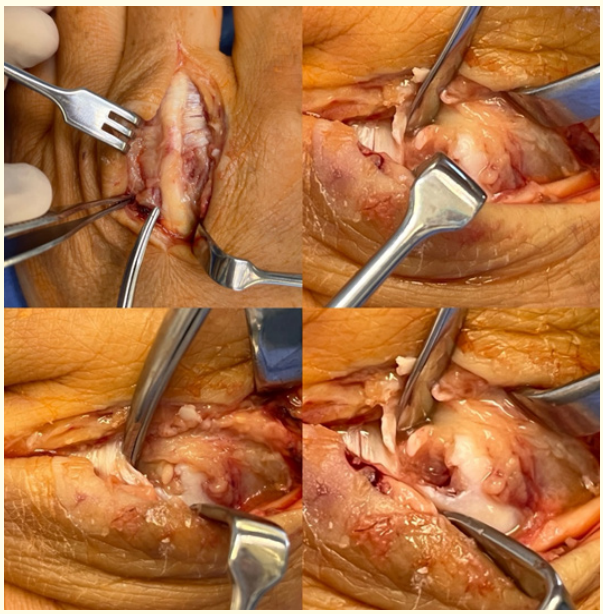

Figure 1

The patient received intravenous ertapenem and was discharged after 5 days. Over 6 months of follow-up, no recurrence of infection was observed; however, he remained with restricted motion (extension 30°, flexion 55°). CT scan revealed significant joint space narrowing and metacarpal head defects. Total joint replacement was proposed.

Prosthesis design and surgical technique

A CT scan of the affected hand was obtained with specifications required by the manufacturer (Techfit Digital Surgery, Inc., Florida, USA). Customized components for the metacarpal and proximal phalanx, as well as patient-specific cutting guides and intramedullary awls, were designed and produced.

One year after the initial debridement, surgery was performed through a dorsal approach. The extensor tendon was mobilized, the capsule opened, and bone resections guided by patient-specific instruments were carried out. Trial implants confirmed proper fit and soft tissue balance. Final titanium components were implanted, and the capsule and extensor tendon were repaired. Postoperative radiographs confirmed adequate alignment.

The patient underwent early mobilization, starting passive motion after 1 week and physical therapy at 2 weeks. At 6 months postoperatively, he achieved extension of 10° and flexion of 75°, reported no pain, and returned to most daily activities.

Discussion

Only a few cases of patient-specific 3D printed small joint prostheses have been reported in the literature, most for bone defects after tumor resection [3-5]. In Mexico, this represents one of the first reported uses of a 3D printed MCP prosthesis. Compared with standard implants such as the Swanson prosthesis or arthrodesis, 3D printed implants offer the advantages of anatomical fit, bone-preserving fixation, and restoration of motion.

This case also highlights the versatility of 3D printing, not only for definitive implants but also for creating surgical instruments and guides, which improve accuracy and reproducibility [6-10].

Nevertheless, limitations remain. Short follow-up precludes conclusions about long-term outcomes, as loosening and subluxation are commonly reported complications at 5–10 years [5,11]. Another drawback is the high cost and lack of certified local manufacturers, which restricts widespread use in developing countries.

Conclusions

Patient-specific 3D printed MCP prostheses represent a feasible alternative in cases of septic arthritis sequelae with joint destruction, especially when conventional implants are unavailable. This case demonstrates satisfactory short-term outcomes in terms of pain relief and motion recovery. Further studies with larger cohorts and long-term evaluation are essential to validate their clinical utility.

Key Learning Points

- Septic arthritis of the MCP joint may result in severe destruction and functional impairment if not promptly treated.
- 3D printing technology enables the design of patient-specific prostheses and instruments for small joint reconstruction.
- Customized MCP prosthesis implantation is feasible and can restore motion with good short-term results.
- Long-term follow-up and multicenter studies are needed before widespread adoption.

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