

Fibular Allograft Osteoplasty and Silicone Arthroplasty following Gunshot Injury of the Metacarpal

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Summary: The complexity of a gunshot wound to the hand with segmental bone loss and adjacent joint disruption presents a unique challenge for the reconstructive surgeon. There are several options for posttraumatic reconstruction of hand joint defects, ranging from arthrodesis, implants, and autologous arthroplasty. Despite the abundance of literature regarding guidelines for isolated osteoplasty and arthroplasty, there are only case reports describing management of bone and joint defects, all within the setting of cancer resection. This case report presents a 24-year-old, right-hand dominant man with a gunshot wound to his left hand involving the fifth metacarpal and metacarpal phalangeal joint. The metacarpal was reconstructed with a fibular bone allograft with simultaneous placement of a silicone arthroplasty implant, allowing preservation of motion at the metacarpal phalangeal joint with satisfactory functional outcomes. This illustrates the feasibility of successfully reconstructing segmental bone loss and adjacent joint defects simultaneously in the traumatic setting of firearm injuries. (*Plast Reconstr Surg Glob Open* 2023; 11:e5369; doi: 10.1097/GOX.0000000000005369; Published online 3 November 2023.)

Gunshot wounds (GSWs) to the hand are common injuries in level 1 trauma hospitals, with roughly one-third of these injuries involving the metacarpals.^{1,2} This presents an etiology of significant morbidity in both adult and pediatric populations.³ Optimal treatment consists of debridement, antibiotics, reconstruction, and rehabilitation.² Among patients requiring surgery, those presenting with simultaneous bone and joint defects provide a unique reconstructive challenge. This case report presents considerations and surgical approaches to segmental bone loss and disruption of adjacent joint anatomy of the fifth metacarpal and metacarpal phalangeal (MCP) joint. In addition, we present the feasibility of utilizing allograft and silicone arthroplasty techniques as an alternative to autologous bone grafting in the traumatic setting.

CASE REPORT

A 24-year-old, right-hand dominant man with no prior medical history presented to the emergency department with a GSW to his left hand. Physical examination revealed a soft tissue defect on the dorsum of the MCP joint of the small finger and ulnar aspect of the fifth metacarpal. All flexor and extensor tendons were intact. Radiographs of the left hand showed an open intraarticular comminuted fracture of the fifth metacarpal shaft and head, although the included image underestimates length lost (Fig. 1). He underwent external fixation of the comminuted fracture to maintain length, and the soft tissue envelope was debrided and allowed to heal secondarily.

One month after external fixation, definitive reconstruction was performed. A dorsal mid-axial longitudinal incision was made over the fifth metacarpal and dissection carried down and through the periosteum that revealed a bony mass containing cartilaginous, cortical, and cancellous fragments. Due to the fibrous structure of this mass, it was removed to provide a more structurally sound base, suitable for reconstruction. This mass comprised the distal two-thirds of the metacarpal and was excised. The defect was reconstructed using fibular allograft (Fig. 2). The allograft was cut to the size of the defect, around 3 cm, ensuring creation of a stair-step osteotomy on the proximal aspect of the native metacarpal bone and on the allograft. The graft was secured using a Medartis screw set. Arthroplasty was performed to create a new MCP joint using a #3 Swanson silicone implant, followed by closure

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Fig. 1. Radiographic imaging of the left hand with an open intraarticular comminuted fracture with shaft shortening of the fifth metacarpal shaft and head.

of the periosteum. The patient tolerated the procedure well and was placed into an ulnar gutter splint.

Three months following reconstruction, the patient exhibited full range of motion (ROM) at the interphalangeal joints of the left small finger and flexion up to 80-degrees at the MCP joint with full extension (Fig. 3). Radiographs at 1 year showed ongoing healing with no evidence of hardware complications (Fig. 4). At this 1-year follow-up, the patient continued to have excellent functional results and maintained ROM.

DISCUSSION

Although isolated osteoplasty^{4,5} and arthroplasty⁶ guidelines are widely discussed separately, they are rarely described in combination outside of locally invasive tumor resection.^{7,8} This presentation greatly differs from reconstructive considerations in blast injuries because of soft tissue distortion and zone of injury present.⁹⁻¹¹

The initial conceptualized reconstructive approach for this patient was to perform a cancellous bone autograft with MCP joint arthrodesis, similar to Jones et al in 2012.⁷ External fixation was used to await defervescence of soft tissue edema and to allow for nonfibrous bony growth to occur. However, the unexpected presence of mixed bony

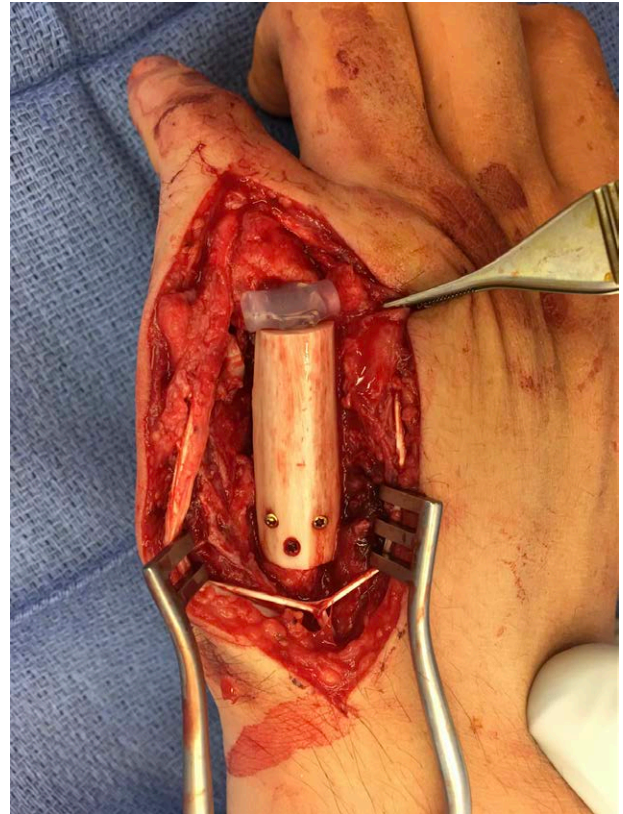


Fig. 2. Intraoperative imaging of bony defects reconstructed using a fibular allograft.



Fig. 3. Patient exhibiting up to 80-degree flexion at the MCP joint.

mass with intraarticular involvement led us to pursue resection of the mass and repair the bone loss with cadaveric fibular allograft and silicone arthroplasty. The presence of cartilaginous, cortical, and cancellous fragments increases the risk of fibrous healing and lack of stability. Jones et al reported good outcomes with autologous fibular grafts 4.5 years postoperatively with MCP joint ROM of 15-85 degrees, which was achieved in our patient with ROM of 80 degrees of the MCP.⁷



Fig. 4. AP radiographic image that displays fibular allograft and silicone arthroplasty 52 weeks postoperatively.

Autologous grafts are regarded as the standard of treatment for bone defects in the hand, primarily iliac crest grafts,^{10,12} parascapular grafts,¹³ and fibular grafts^{7,9}; the case presented here illustrates the usefulness and successful outcome from using readily available cadaveric fibular allograft. Using cadaveric allografts minimizes the risks associated with donor site morbidity following autologous grafts, such as stress fractures and peroneal nerve injury in autologous fibula grafts.⁴ Additionally, bone grafting with allograft reduces operative and hospitalization times, and can be a useful tool among patients refusing autogenous bone grafting options.¹⁴ Although allografts lack the osteogenic and -inductive properties of their autograft counter parts, they retain their osteoconductive properties to allow for bony ingrowth through creeping substitution at lengths of 5 cm maximum.⁴ This modality includes length limitation that can be avoided with the incorporation of the Masquelet technique or a vascularized bone graft.^{15,16} Less frequent use of this modality in the traumatic setting versus the oncologic setting may contribute to variable outcomes in the recovery time period. This case report aimed to provide an example of allograft osteoplasty, making it a viable reconstructive technique in complex traumatic cases.

In addition, silicone implants for arthroplasty have been found to provide reliable pain relief and reproducible functional outcomes, especially of the MCP joint.⁷ With a relatively low complication rate compared

with alternative arthroplasty mediums, silicone arthroplasty also provides an estimated 8- to 10-year longevity, though there is lack of evidence beyond 10 years.¹⁷ Due to age, our patient has a higher functional demand than the older population studied with silicone arthroplasties, which will likely lead to need for a replacement. Incorporation of silicone-based arthroplasty allows for joint reconstruction and provides an avenue to combine both procedures, resulting in successful functional outcomes.

CONCLUSIONS

GSWs of the hand involving concurrent adjacent bone and joint defects can be successfully treated with allograft osteoplasty to reconstruct the segmental bone loss and silicone arthroplasty to restore functional movement. Fibular allograft allows for bypass of donor site morbidities and decreased operating time, while providing adequate treatment of the bone defect.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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