

Case Report

Novel femoral head allograft reconstruction technique of giant cell tumor of the bone in the mid-foot: a case report

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ABSTRACT

An 83-year-old female presented with seven months of right medial foot swelling. Imaging revealed a lesion of the medial and middle cuneiforms with extension into the 1st and 2nd metatarsals. Biopsy suggested giant cell tumor of bone. She underwent wide excision, argon beam adjuvant, and reconstruction with a custom-molded femoral head allograft and midfoot arthrodesis. At one-year follow-up, she was pain-free, weight-bearing, and demonstrated fusion without recurrence. This case highlights a novel cement-mold technique to optimize graft fit, introducing a reconstructive strategy that maintains midfoot function despite extensive resection.

Keywords: Giant cell tumor of bone, Midfoot reconstruction, Femoral head allograft, Cement mold technique, Foot and ankle oncology

INTRODUCTION

Giant cell tumors of bone (GCTBs) are uncommon in foot and ankle, are exceedingly rare in midfoot.^{1,2} Radiographically, GCTBs typically present as expansile radiolucent lesions with adjacent cortical thinning, while histologic examination characteristically reveals multinucleated giant cells.³ Although multiple treatment strategies have been described for GCTBs, management of midfoot lesions remains challenging, largely due to risk of significant functional compromise associated with resection in this weight-bearing region.⁴ We report a case of GCTB involving medial cuneiform with extension into middle cuneiform and the bases of 1st and 2nd metatarsals, managed with bony resection followed by femoral head allograft reconstruction and midfoot arthrodesis.

CASE REPORT

An 83-year-old female presented with a 7-month history of discomfort and swelling over her medial right foot. She

was originally evaluated by a podiatrist treating her for plantar fasciitis. A second opinion was obtained due to concern for significant swelling. Radiographs revealed an expansile radiolucent lesion at the medial cuneiform extending into the middle cuneiform and 1st-2nd metatarsals, with an intermediate zone of transition and no aggressive periosteal reaction (Figure 1). Magnetic resonance imaging similarly demonstrated the lesion with fluid-fluid levels and possible extra-osseous expansion (Figure 2). Subsequent biopsy revealed sheets of monomorphic tumor cells with admixed multinucleated giant cells and background hemorrhage and focal cystic degenerative changes favoring benign giant cell tumor. The patient was thus indicated for tumor excision with allograft reconstruction and midfoot arthrodesis.

We began by utilizing the anteromedial approach to the foot, starting just distal to the first tarsometatarsal (TMT) joint, extending proximally to the talonavicular (TN) joint, taking care to stay between the dorsomedial and dorsoplantar hallucal nerves. Careful dissection was

performed through the skin, subcutaneous tissue, and fascia, ensuring preservation of neurovascular structures. We elevated our skin flap dorsally to identify the medial cuneiform, the navicular-cuneiform joint, and the first TMT joint. Kirschner wires (K-wires) were placed in the 1st metatarsal at the level of the desired resection and in the navicular-cuneiform articulation to mark the extent of our resection proximally. A Hintermann distractor was placed over the two K-wires to maintain length (Figure 3). We used a pencil tip burr to begin our cut in the 1st metatarsal, which was completed with a flexible osteotome. The flexible osteotome was subsequently used to disarticulate the medial and middle cuneiform from the navicular. The remaining soft tissue attachments were carefully removed by electrocautery, and the lesion was removed (Figure 4). The specimen was sent to pathology for analysis. The remaining shell of bone was removed using a rongeur. We soaked the wound bed with hydrogen peroxide and performed curettage of the 1st-2nd metatarsal canal using a curette. Next, we removed all cartilage on the navicular using a rongeur and smoothed the surface with a burr. We subsequently used the argon beam on the entire wound bed for further adjuvant therapy.

A sheet of Xeroform was placed in the resection bed and filled with cement to create a mold of the defect. The frozen femoral head allograft was shaped to match the previously created mold using a sagittal saw and was noted to have a good fit in the resection bed (Figure 5). We secured it in place provisionally using K-wires. We then placed a medially based 3.5 mm plate provisionally with two screws in the navicular and two screws in the 1st metatarsal.

Subsequently, a small incision was made distally over the 1st metatarsal head. The TMT joint was plantarflexed to access the articular surface of the 1st metatarsal head. A K-wire was placed through the metatarsal to the level of the navicular. We then placed a 105 mm cannulated 7.5 mm fully threaded Salvation screw through the 1st metatarsal, the allograft, and into the navicular, which was noted to be in appropriate position on fluoroscopy. A 4.0 mm cannulated screw was placed through the 2nd metatarsal allograft and navicular using the same technique. Prior to insertion, there was noted to be increased widening between the 1st and 2nd metatarsal (Figure 6). To correct this widening, we placed a Weber reduction clamp between the 1st and 2nd metatarsal bases prior to Salvation screw insertion through the 2nd metatarsal, allograft, and navicular. Finally, we finished securing our plate with an additional locking screw in the navicular and two more screws into the allograft.

Appropriate positioning of the hardware was confirmed using orthogonal fluoroscopic views (Figures 7). At this point, the capsule was closed over our metatarsal-phalangeal joints of the first and second digits, where we had placed our screws. The case was then turned over to our plastic surgery colleagues for closure via vastus lateralis free flap and full-thickness skin graft.

At our patient's 8-week visit, she was doing well, with no significant pain. The medial foot flap was healing well, with no signs of necrosis or infection. Radiographs demonstrate hardware in maintained position with early callus formation at the lateral border of the 2nd metatarsal base, without signs of tumor recurrence. Imaging for pulmonary metastases was not performed. We opted to continue her non-weight-bearing status for 12 weeks to allow sufficient time for fusion to occur. The patient continued to remain stable and presented one year postoperatively with no pain. The graft incorporated well, and radiographs demonstrated evidence of fusion (Figures 8). She is weight-bearing as tolerated without assistive devices. We plan to continue monitoring for tumor recurrence with annual radiographs, which is a known risk even with optimal surgical management.



Figure 1 (A-C): Anteroposterior, oblique, and lateral radiographs of right foot.

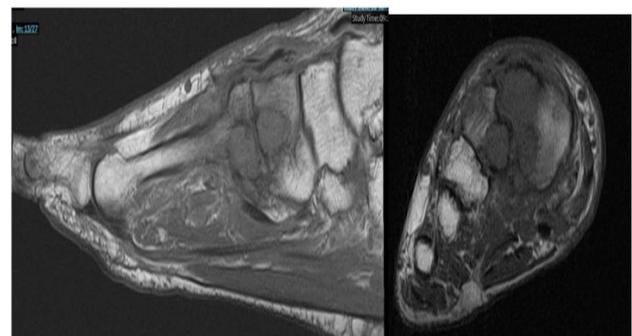


Figure 2: T1 magnetic resonance imaging of right foot.

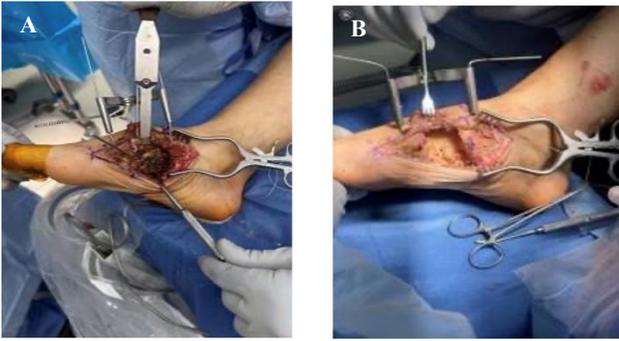


Figure 3 (A and B): Visualization of lesion.



Figures 7: Final fixation.



Figure 4: Resection of lesion.

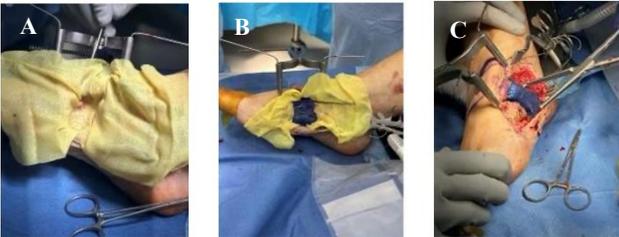


Figure 5 (A-C): Creation and assessment of mold.



Figure 6: Plate and screw fixation with reduction clamp in place.



Figures 8 (A-C): One year post-operation imaging.

DISCUSSION

GCTBs are locally aggressive tumors that are rare in the midfoot. Management options include en bloc resection, curettage, cement, adjuvant therapy, and grafting. Midfoot lesions pose unique challenges due to complex anatomy and the need to preserve mobility.³ Literature on the management of midfoot GCTBs is sparse, with few reported cases. This report highlights the successful management of a GCTB extending from the medial cuneiform to the middle cuneiform and 1st-2nd metatarsals with resection, allograft reconstruction, and midfoot arthrodesis.

Reconstruction strategy

Midfoot reconstruction strategies are variable and case-dependent. Common autograft considerations include vascularized and non-vascularized iliac crest and fibular grafts. Iliac crest grafts have demonstrated efficacy in foot and ankle procedures, with low donor-site pain and reportedly higher osteoprogenitor concentrations

compared to lower extremity grafts.⁵ Szendrői et al successfully utilized a non-vascularized iliac crest graft for forefoot-to-hindfoot fusion after resection of GCTB involving the navicular, cuboid, and cuneiforms.⁶ In contrast, fibular autografts notably assist with larger defects involving the metatarsals, given similarities in structure.⁷⁻⁹ Vascularized fibular bone grafts have been utilized for lateral foot arch reconstruction, with medial arch stability achieved with arthrodesis. Vascularization of the graft improves bony union rates and time to weight bearing.¹⁰ However, autografts often require a second operative site and substantial graft size to ensure structural integrity and successful integration, leading to high complication rates in foot and ankle procedures-including donor site pain, infection, hematoma, and fracture.¹¹

Allografts-particularly frozen femoral allografts-provide an alternative consideration in the management of midfoot GCTBs.¹² Compared to iliac crest autografts, frozen femoral allografts offer decreased morbidity, shorter operation time, and lower costs, though they may delay healing and carry a risk of immune reaction.^{13,14} Importantly, femoral allografts have achieved successful functional outcomes comparable to alternative autograft options, while providing excellent mechanical strength and a spherical shape, allowing individual customizability.^{14,15} In this case, a femoral head allograft was selected over an iliac crest or vascularized fibular graft due to its mechanical properties and ease of customization, which were essential for maintaining midfoot structural integrity and functional mobility.

When considering graft optimization, this case introduces a novel technique involving mold creation of the tumor resection bed. Utilization of the Xeroform sheet and cement ensured an accurate mold of the defect, allowing for precise shaping and sizing of the allograft. The optimized allograft provides improvement to the structural integrity and functionality of the reconstructed area. This technique has not been previously described in the literature, underscoring its potential application in similar cases requiring custom-fit allografts.

Challenges and limitations

A predominant challenge when managing midfoot GCTBs is ensuring adequate exposure and resection while preventing fractures and instability in areas of thin bone.¹⁶ The increased injury risk was highlighted in this case by the intraoperative lateral subluxation of the 2nd metatarsal. The instability was appropriately addressed; however, it emphasized the delicate balance between aggressive tumor resection and preservation of structural integrity.

A significant limitation of this report is the lack of long-term follow-up to monitor for tumor recurrence-a known risk even with optimal surgical management. Postoperative follow-up with imaging assessment will be crucial in identifying recurrence earlier in its course.

CONCLUSION

This case report contributes to the limited literature on the management of midfoot GCTBs, demonstrating the efficacy of resection, femoral head allograft reconstruction, and midfoot arthrodesis in maintaining functional mobility despite extensive midfoot resection. The use of adjuvant therapies and comprehensive surgical planning were essential in achieving a favorable outcome, highlighting the importance of individualized care when managing complex midfoot reconstructions.

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