Case Report

Reconstruction of the Distal Tibia with Porous Tantalum Spacer after Resection for Giant Cell Tumor

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Abstract Treatment options for giant cell tumors of the distal tibia include curettage and cement packing, curettage and bone grafting, or resection and reconstruction for aggressive tumors. Curettage of aggressive tumors often leads to severe bone loss requiring reconstruction. Allograft and autograft may be effective options for reconstruction, but each is associated with drawbacks including the possibility of infection and collapse. We present a case of giant cell tumor of the distal tibia treated with curettage and arthrodesis using a porous tantalum spacer. Complete removal of the tumor and successful arthrodesis of the ankle were accomplished using the spacer. The patient returned to pain-free walking along with eradication of the giant cell tumor. We believe porous tantalum spacers are a reasonable option for reconstructing

the distal tibia after curettage of a giant cell tumor with extensive bone loss.

Introduction

Giant cell tumors are a common intraosseous bone tumor found in the epiphysis and metaphyseal region of long bones. The tumor is typically benign but can be locally aggressive. Nearly 6% of giant cell tumors occur in the foot and ankle region, with the distal tibia being the most common location [3]. Surgical options include curettage and cement packing, curettage and bone grafting, or resection and reconstruction. In the setting of an aggressive giant cell tumor, we believe curettage is the most appropriate treatment. Curettage of a giant cell tumor of the distal tibia often leads to large bone loss requiring complicated reconstruction. Ankle arthrodesis has been shown to restore ankle function after curettage of distal tibial giant cell tumors [21]. The current standard structural graft used for arthrodesis is either autograft or allograft. Autografts and allografts are associated with high rates of healing when used for arthrodesis [11, 19]; however, each has drawbacks including collapse and infection [4]. Conti and Wong reported a 20% rate of osteolysis and collapse of structural grafts after calcaneocuboid arthrodesis [7]. The deep infection rate is reportedly 3% to 12.5% after ankle arthrodesis [5, 19]. These complications have led surgeons to search for better options for arthrodesis.

Porous tantalum is a trabecular metal that has been used extensively in revision THA and TKA. Tantalum is a biocompatible material with mechanical properties similar to bone [17, 22]. These properties make tantalum a potential substitute for other graft materials in the setting of arthrodesis. We present a case of giant cell tumor curettage

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Each author certifies that his or her institution waived approval for the reporting of this case report, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained. This work was performed at Mayo Clinic Arizona.

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of the distal tibia reconstructed by arthrodesis using a tantalum spacer.

Case Report

A 43-year-old woman presented to our clinic with a 4-month history of right ankle pain and swelling. She stated she had no previous trauma to the ankle. The pain had increased slowly during the previous 4 months to the point that she was limited to a few blocks of walking. She also noticed decreased ROM and substantial swelling of the ankle. A radiograph of the patient's right ankle ordered by her primary care physician revealed a lytic lesion of the distal tibia. On examination, the patient had marked swelling of the right ankle especially along the lateral aspect of the joint. She had tenderness to palpation diffusely around the ankle. Extension and flexion of the right ankle were limited. Her left ankle was nontender and had a normal ROM. Repeat radiographs of the right ankle confirmed the presence of a lytic lesion spanning the epiphysis and metaphysis of the right ankle (Fig. 1). MRI of the right ankle revealed a lesion consistent with a giant cell tumor (Fig. 2). Using an anteromedial approach, a CT-guided biopsy of the lesion confirmed the diagnosis of giant cell tumor. We discussed treatment options with the patient including nonoperative and operative treatment; among the operative alternatives we included curettage with

reconstruction using allograft, autograft, or custom spacer, joint arthroplasty, and amputation. With the patient we elected to proceed with curettage and reconstruction. The size and location of the tumor made it evident curettage and reconstruction would be difficult. To assist in the reconstruction, we planned to use a tantalum spacer. We used a CT scan to determine the approximate dimensions of the tumor and to establish the height and width of the tumor. A truncated conical custom porous tantalum spacer measuring 20 mm in length was fabricated by Zimmer, Inc (Warsaw, IN). The spacer had a centrally open core 6 mm in diameter for allograft. No clinically apparent bone loss occurred from the date of spacer measurement to the time of surgery.

Through an anterolateral incision, the right distal tibia was exposed. Once the extensor retinaculum was incised, a soft tissue mass was encountered overlying the distal tibia. An incisional biopsy was performed and sent to pathology for evaluation. Next, the extensor musculature and tendons were elevated anteriorly and the lesion was entered. The tumor extended diffusely through the distal tibia and into the tibial plafond. A thorough débridement using a high-speed drill with a burr was performed to remove the tumor in its entirety from the distal tibia. Curettage of the entire tumor required removal of the anterolateral tibial cortex, the posterior cortex, and the tibial plafond, exposing the articular surface of the talus, leaving only a rim of anterior and medial cortex.

The reconstruction began with a proximal oblique fibular osteotomy to improve exposure of the lateral talus, allowing removal of the lateral articular cartilage. A

Fig. 1 A preoperative AP radiograph of the patient's right ankle shows an aggressive-appearing lytic lesion of the distal tibia extending to the articular surface. The superior margins are relatively well defined, but no sclerosis is seen. Cortical breakthrough posteriorly is seen along with a large soft tissue mass.

Fig. 2 A sagittal T2-weighted MR image with contrast of the right ankle shows an expansile cystic lesion with substantial bone remodeling involving the metaphysis and epiphysis of the distal tibia. There is considerable thinning of the articular tibial plafond and posterior cortex of the tibia.

longitudinal osteotomy of the fibula was performed to remove the distal fibular articular cartilage. An anteromedial incision was used to resect the contiguous articular surfaces of the talus and medial malleolus. An oscillating saw was used to remove the talar articular surface to provide a flat surface to oppose the tantalum spacer.

The central core of the spacer was packed with allograft mixed with marrow aspirated from the proximal tibia. A good compression fit was obtained with the spacer. Additional allograft was placed between the spacer and the medial tibia to fill the medial dead space not filled by the spacer. An anteromedial screw was placed through the medial malleolus to the talus, bringing the two structures into close apposition. An anterolateral tension band plate was secured in tension to the tibia proximally and the talus distally compressing the spacer to the talus. The fibula was secured with one screw in the tibia and one in the spacer, acting as a biologic plate. The wounds were closed in layers over a drain. A bulky dressing was applied to the right leg. Postoperative radiographs were obtained in the postanesthesia care unit (Fig. 3).

A cast was applied and the patient was nonweightbearing on the right leg using a Roll-A-Bout walker (Roll-A-

Bout Corp, Frederica, DE) for 6 weeks. After 6 weeks, the Roll-A-Bout walker was discontinued and she was allowed to begin weightbearing wearing a removable cast. After 6 weeks walking while wearing the removable cast, a custom ankle foot orthosis (AFO) was applied. She was walking well and was pain free wearing the AFO for the next several months. Six months postoperatively, she fractured her ipsilateral fifth metatarsal after striking her foot on a table. Radiographs of the foot showed a non-displaced midshaft metatarsal fracture; however, the arthrodesis remained intact. She was treated nonoperatively with a removable cast and nonweightbearing using a Roll-A-Bout for 6 weeks. Repeat radiographs at 6 weeks showed a healing metatarsal fracture. Again, no fracture was seen in or around the arthrodesis. After this 6-week period, she was transitioned to weightbearing as tolerated wearing her removable cast. Once she was able to ambulate pain-free wearing her cast, she was allowed to ambulate wearing the AFO.

Followup radiographs of the arthrodesis (Fig. 4) taken nearly 4 years postoperatively showed areas of lucency at

Fig. 3 A postoperative AP radiograph of the ankle taken 6 weeks after surgery shows the spacer interpositioned between the distal tibia and the talus. The plate and screws stabilizing the arthrodesis are in good position.

Fig. 4 A postoperative AP radiograph taken nearly 4 years after surgery shows no sign of giant cell recurrence. The tantalum spacer shows no subsidence and the arthrodesis of the ankle with screw and plate fixation appears well healed and stable. The lobulated radiolucencies of the medial aspect of the metal-bone interface in the distal tibia metaphysis have become less distinct. No evidence of hardware loosening is seen.

the bone-metal interface. To further evaluate the area of lucency, a CT scan was obtained. The radiographic appearance of the lucencies was not consistent with recurrent giant cell tumor. These lucencies have been followed with several serial radiographs during the past year and are less apparent on the most recent radiographs. At her latest followup 5 years postreconstruction, she had painless and unlimited ambulation and had weaned from wearing the AFO. Her subtalar and midtarsal motion measured 5° extension and 10° flexion.

Discussion

Curettage and arthrodesis are the primary treatment of aggressive benign tumors of the distal tibia invading the ankle. The method of arthrodesis and the graft choice differ throughout in published studies. Saglik et al. [21] described two cases of aggressive giant cell tumors of the distal tibia treated with fibular autograft and ankle arthrodesis. At long-term followup, the patients had no pain and no limitation in daily or low-impact recreational activities. Campanacci et al. [5] described the use of resection and reconstruction with nonvascularized autografts and allografts for treatment of distal tibial tumors. In their eight patients, there was only one recurrence. The mean functional Musculoskeletal Tumor Society (MSTS) score was 80.4%. Vascularized fibular autografts for arthrodesis of the ankle after distal tibial resection for tumors reportedly provide high rates of arthrodesis and MSTS scores in the 80th percentile [8, 14]. Moore et al. [18] described the use of retrograde intramedullary fixation and allograft for treatment of distal intraarticular tibial tumors with eight of nine patients accomplishing independent ambulation and MSTS scores greater than 73%. Other treatment options include resection of the tumor followed by placement of an external fixator for segmental bone transport and prosthetic reconstruction using custom-made hinged prostheses [1, 10]. Although reasonable options, autograft and allograft have disadvantages. Autograft is associated with donor site morbidity and concerns with the quality and quantity of the bone available. Allografts raise the possibility of infection and immune response, which would be detrimental to the arthrodesis [9, 16]. A concern with using allografts for reconstructing the lower extremity includes collapse or fracture, which is of particular concern in the distal tibia, a major weightbearing joint. Rodl et al. [20] described 17 patients with high-grade malignant tumors of the extremity treated with resection and use of allograft for reconstruction. Of 14 surviving patients at 5 years, seven patients required removal of the allograft owing to fracture. Given these disadvantages, tantalum provides a possible substitute for autografts and allografts.

Structural porous tantalum has many uses in adult orthopaedic reconstruction, including primary and revision arthroplasties, treatment of osteonecrosis of the femoral head, and reconstructive surgery after tumor resection [2, 15]. Bouchard et al. [4] first described the use of tantalum for structural bone graft procedures such as arthrodesis. Holt et al. [13] described the use of tantalum endoprostheses after resection of skeletal sarcomas around the distal femur and proximal tibia. They reported no infections or hardware failures and concluded tantalum was a useful tool in the reconstruction of patients with large bone loss after tumor resection. Porous tantalum has a modulus of elasticity similar to that of subchondral bone, a structure and porosity similar to cancellous bone, and a high surface friction against bone [6, 22]. Zardiackas et al. [22] found the yield and ultimate strength of porous tantalum are greater than subchondral bone. Porous tantalum is stronger than cancellous bone with cantilever bending. Its fatigue properties and endurance limit also were greater than those of cancellous bone, freeze-dried bone chips, ceramic granules, or composite calcium salt pastes. Acting as a bone graft substitute, porous tantalum affords sufficient support for physiologic loads while bone ingrowth occurs, and is superior to cancellous or cortical bone in this regard [22]. In addition, tantalum is a biocompatible material [1]. These properties make tantalum an alternative to allograft or autograft for arthrodesis.

The cost of the tantalum spacer must be taken into account when considering its use for arthrodesis. Frigg et al. [12] compared the cost of tantalum versus autograft and allograft. The group reported the cost of a tantalum block was \$1000 in the US compared with \$850 for allograft. The cost of autograft was estimated to be approximately \$600 to \$700 owing to operating room time, suture, sponges, and dressing. We used allograft and bone marrow aspirate to fill the hollow tantalum. In our opinion, allograft and bone marrow aspirate are better biologic fillers than cement. Although the use of allograft increases the overall cost of the procedure, we believed the expected longevity of the arthrodesis would decrease the overall cost by reducing the need for revision surgery.

We used a preoperative CT scan to estimate the necessary size of the prefabricated spacer. Measurements were taken proximally and distally for width and length. The quality of the proximal medial bone was difficult to ascertain before surgery, and the spacer was measured as if the bone would be deficient. The bone was in fact not deficient and we chose to preserve that bone rather than resecting good bone. The fit of the spacer therefore was adjusted to accommodate for this quality bone without compromising the position of the arthrodesis. The tantalum spacer does appear to be slightly oversized in postoperative radiographs; however, appropriate curettage and salvage of

good bone were the priorities of the procedure, not spacer fit. The tantalum spacer fit is appropriate for it to function in the arthrodesis.

We describe the case of a patient in whom we used porous tantalum as a structural substrate for reconstruction and arthrodesis after curettage of a giant cell tumor of the distal tibia. The reconstruction is stable and the patient is pain free. Tantalum has many advantages that make it a desirable substitute for autograft or allograft, and it is comparable in cost to other types of bone substitutes. Development of specific foot and ankle tantalum spacers is underway. Increased availability of these structural substitutes would decrease the cost and make them a more desirable alternative for reconstruction. Tantalum adds to the armamentarium the orthopaedic surgeon has available for reconstruction and arthrodesis after curettage of distal tibial tumors.

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