Pre-operative Selective Arterial Embolization as a Neoadjuvant Therapy for Proximal Humerus Giant Cell Tumor of Bone: Radiological and Histological Evaluation

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The management of giant cell tumor of the proximal humerus that extends to the joint is challenging. Here, we report a case of proximal humerus giant cell tumor with cortical bone destruction extending to the shoulder joint. Pre-operative selective arterial embolization induced peripheral tumor ossification. Subsequently, the lesion was removed by intralesional curettage, and the cavity was filled with cement. Macroscopically, the inner wall of the cavity was found to be lined with a thick fibrous membrane. Histologically, massive fibrosis and resultant remodeling of the destroyed cortical bone were induced, which was consistent with the peripheral ossification on the plain radiograph. We believe that selective arterial embolization can be an effective neoadjuvant therapy for giant cell tumors of the extremities, especially for tumors with large cortical defects or joint involvement.

Key words: giant cell tumor – selective arterial embolization – neoadjuvant therapy

INTRODUCTION

Giant cell tumor (GCT) of the bone is generally considered benign, but it can be locally aggressive and can even metastasize. The current standard treatment for GCT of the bone is curettage, if possible, and bone cement can be used to fill the defect. This approach has yielded good functional results, but it has been associated with higher recurrence rates (1). In the case of large cortical defects or joint surface involvement, en bloc resection and endoprosthesis reconstruction are indicated to reduce the risk of local recurrence (2). However, these procedures are associated with poor functional outcomes, especially for tumors of the proximal humerus (3). Endoprosthesis replacement for young patients is also accompanied by the risk of aseptic loosening or breakage of the prosthesis.

Here, we report a case of GCT of the proximal humerus with cortical bone destruction extending to the shoulder joint, which was successfully managed with selective arterial embolization and intralesional curettage. Selective arterial embolization was performed pre-operatively to induce tumor shrinkage and peripheral ossification. Then, we sought to preserve the shoulder joint by performing curettage and cementation. We also provide histological evidence, showing that selective arterial embolization results in lining of the inner wall of the cavity by a thick fibrous membrane.

CASE REPORT

A 21-year-old man visited our hospital with a 2-month history of gradually increasing pain in the left shoulder, but with no...
history of trauma. Physical examination did not reveal any tenderness, but the range of motion of the shoulder was severely restricted because of the pain. Results of plain radiography and computed tomography (CT) were consistent with GCT of the proximal humerus (Fig. 1a and b). A biopsy of the lesion was performed, which confirmed the diagnosis of GCT. Because cortical bone destruction was significant and extended adjacent to the joint surface, we decided that joint preservation was technically impossible. En bloc resection with endoprosthetic reconstruction offers the theoretical advantage of a lower risk of recurrence; however, it is associated with implant failure, including aseptic loosening and breakage. Therefore, we hesitated to perform en bloc resection and endoprosthetic reconstruction for this young patient. As several recent reports demonstrated that selective arterial embolization in GCT of the sacrum induced peripheral ossification and shrinkage of the extraosseous mass (4,5), we first tried selective arterial embolization to induce tumor shrinkage and peripheral reossification.

The embolization technique involved femoral access and selective embolization of the anterior circumflex humeral artery, posterior circumflex humeral artery and deltoid branch of thoracoacromial artery with Gelfoam (Astellas Pharma Inc., Tokyo, Japan). Angiography was performed at the beginning of each session to identify arteries of sufficient caliber to allow embolization. Gelfoam particles were selectively delivered until stasis was achieved. Embolization was conducted every 5 weeks. Typically, embolizations are performed until pain is reduced and radiographic evidence of reossification is observed (4). After the completion of the fifth embolization procedure, the patient’s shoulder pain decreased significantly. A plain radiograph and CT scan demonstrated increased peripheral ossification (Fig. 2a and b).

Figure 1. (a) Pre-operative plain radiograph and (b) computed tomography (CT) scan obtained at initial presentation showing a radiolucent tumor and the destroyed medial aspect of the proximal humerus.

Figure 2. (a) Plain radiograph and (b) CT scan obtained after fifth arterial embolization showing the peripheral remodeling.
The cortical bone defect adjacent to the shoulder joint was also remodeled. To reduce the risk of a pathological fracture, we directed the patient to put his arm in a sling for the treatment period.

We determined that the patient had a positive response to embolization; therefore, intralesional curettage followed by cement packing was performed 18 days after the fifth embolization procedure. A deltopectoral incision was made to expose the proximal humerus. Grossly, the cortical bone defect was remodeled with a thin bony shell. A large window was created in the anterior part of the proximal humerus to facilitate observation and evacuation of the tumor. Curettage was performed to remove the tumor. Macroscopically, the inner wall of the cavity was lined with a whitish fibrous membrane, which made the curettage easy, although the blood loss was 2200 ml (Fig. 3). We did not replace the external cortical bone that was removed to create the window.

Histologically, the peripheral part of the tumor was massively replaced by a scar-like fibrous tissue without viable tumor cells (Fig. 4a and b). In contrast, the central part of the tumor demonstrated residual typical histological findings of GCT, exhibiting proliferation of oval or plump spindle-shaped mononuclear cells uniformly interpersed with osteoclast-like multinucleated giant cells (Fig. 5a and b). The patient uneventfully recovered and returned to normal daily life. No local recurrence or metastasis was observed (Fig. 6), and the Musculoskeletal Tumor Society (MSTS) score was 26/30 (86.6%) at the 21-month follow-up after surgery. The range of motion in the shoulder is slightly restricted, with flexion 110° and abduction 75°.

DISCUSSION

For large tumors with joint involvement, en bloc resection is generally indicated. This offers the theoretical advantage of a lower risk of recurrence because the entire tumor is removed. However, endoprosthetic reconstruction is associated with poor functional outcome and implant failure, including aseptic loosening and breakage. Studies of proximal humerus bone tumors treated with resection and endoprosthetic reconstruction reported MSTS functional scores of 79 and 69%, respectively (6,7). In contrast, mean functional score after conservative treatment with curettage and bone packing was 86% (8), which was approximately the same as that in our patient. Therefore, we hesitated to perform en bloc resection and endoprosthetic reconstruction for this young patient with proximal humerus GCT that involved the
shoulder joint. We tried to preserve the joint by using a combination of selective arterial embolization and intralesional curettage.

Arterial embolization for the treatment of bone tumors including GCT was first introduced in 1975 (9). Since then, several studies have demonstrated its advantages, which include decreased blood loss, pain resolution and tumor shrinkage (4,5,10). Selective arterial embolization was introduced as an alternative, minimally invasive and effective conservative treatment procedure for sacrum GCTs, and it showed good mid-term results. Hosalker et al. (5) reported that seven of nine patients showed no disease progression after an average follow-up period of 8.9 years. We have also reported early clinical results in a patient with sacrum GCT that was successfully managed by selective arterial embolization (10). Because selective arterial embolization of GCTs of bone induces extensive shrinkage of the extraosseous mass and peripheral ossification, we employed this procedure for our patient as a neoadjuvant modality. Peripheral reossification after the embolization enabled us to perform the intralesional curettage as a joint-preservation procedure. Although the follow-up period was short, the good outcomes obtained suggested that selective arterial embolization is an effective neoadjuvant therapy even for GCTs of the extremities.

Selective arterial embolization induced peripheral ossification and shrinkage of the extraosseous mass. However, the effects of embolization have not yet been histologically evaluated. In this study, we histologically evaluated the response to selective arterial embolization. To the best of our knowledge, this is the first report to demonstrate the embolization-related histological response of GCT. On the tumor front, massive fibrosis and resultant remodeling of the destroyed cortical bone were induced, consistent with the peripheral ossification observed on the plain radiograph. The marginal fibrosis seems very unique. In general, the peripheral portion of the GCT is viable and shows typical characteristics, although the central portion tends to be modified by a secondary phenomenon such as aneurysmal bone cyst-like changes. We think that the marginal fibrosis may be the most important histological change caused by arterial embolization. In the central part of the tumor, some necrotic foci were observed; however, it seems unlikely that necrosis would occur due to arterial embolization, because GCT of the bone often shows spontaneous necrosis in the lesion. In fact, incisional biopsy performed before arterial embolization in this case demonstrated necrotic foci (data not shown).

Joint surface incompatibility was observed because the embolization caused reossification to develop in the peripheral rim of the tumor that extended into soft tissue (4). This incompatibility may limit the shoulder’s range of motion.

It is recommended that surgery be performed within 3 days after embolization because flow reconstruction through collaterals increases with time, resulting in increased bleeding during surgery (11). In our case, surgery was performed 18 days after the fifth embolization. This delay might have caused recanalization and collateral development, resulting in 2200 ml blood loss.

Local recurrence after intralesional curettage commonly occurs at the peripheral part of the tumor. In our case,
selective arterial embolization led to the formation of a fibrous rim, which supports the hypothesis that a combination of pre-operative selective arterial embolization, curettage and cement packing may decrease the risk of local recurrence.

We note some limitations. First, our speculations require more detailed evaluation with more patients to address this issue. Second, our follow-up duration was relatively short, although the first recurrence generally is detected within the first 2 years after treatment (12).

In conclusion, selective arterial embolization can be an effective neoadjuvant therapy for GCTs of the extremities, especially for tumors with large cortical defects or joint involvement. We recommend the combination of embolization and curettage as an effective treatment that will not only lower the local recurrence rate, but also provide better functional outcomes.

Conflict of interest statement
None declared.

References