

# Reconstruction of Proximal Humerus Using Custom Made Acrylic Prosthesis in Malignant Bone Tumors

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## What to Learn from this Article?

Custom made acrylic prosthesis is an effective alternative to endoprosthesis in the management of malignant proximal humerus tumors.

## Abstract

**Introduction:** Proximal humerus is a common site for malignant bone tumors. The mainstay of treatment involves radical excision and reconstruction. Reconstructing the proximal humerus is quite challenging. The best modality of treatment is a modular endoprosthesis which is expensive. Here, we present two cases where the proximal humerus was reconstructed with acrylic prosthesis.

**Case Report:** A 19-year-old male and 51-year-old lady from India presented with painful swellings of the upper arm with a clinical diagnosis of Ewing's sarcoma arising from the left humerus and secondary metastatic tumor of proximal end of right humerus, respectively. They were treated with radical excision of tumor, and the upper two-third of the humerus were reconstructed using custom made acrylic endoprostheses.

**Conclusion:** Reconstruction of proximal humeral defect with custom made acrylic prosthesis is less expensive and an effective alternative to modular endoprosthesis, which can be used in developing countries.

**Keywords:** Acrylic prosthesis, proximal humerus, malignant tumors.

## Introduction

Proximal humerus is not an uncommon site for malignant bone tumors [1]. Recent trend in the management of malignant bone tumors is in the form of radical excision and reconstruction.

Reconstruction of proximal end of humerus is quite challenging as the outcome is to satisfactorily restore shoulder, elbow, and hand functions. A variety of modalities is available for reconstruction of these defects such as osteoarticular allografts, modular endoprosthesis, resection arthrodesis, and other prosthetic composites [2]. At present, most preferred among these is a modular segmental endoprosthesis. However, in developing

countries, they are quite expensive and difficult to procure. A simpler and less expensive alternative includes a custom made endoprosthesis fabricated out of acrylic material. We present two such cases which provided satisfactory functional results.

## Case Reports

### Prosthesis preparation

For preparation of this prosthesis, an approximate size of the humeral head and its length was calculated from the radiographs of the normal side. An age and sex matched dry humerus specimen of similar size belonging

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## Author's Photo Gallery



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to the same side was procured from the Anatomy Department. The length of the humerus to be resected was determined from pre-operative magnetic resonance imaging (MRI). A negative mold was prepared using the dry humerus specimen. The prosthesis was fabricated out of dental acrylic material using the negative mold. A humeral interlocking nail was incorporated into the acrylic prosthesis. Three holes were drilled into the proximal end of prosthesis for attachment of rotator cuff muscles, and the entire construct was gas sterilized. After resection of tumor, the medullary canal of distal humerus was reamed for introduction of nail. Reamed material was sent for histopathological examination (HPE). Bone cement was packed into the canal, and the nail was locked following insertion. The rotator cuff muscles were anchored to the prosthesis through the pre-made holes.

### Case 1

A young man aged 19 years presented with complains of pain over left arm since 3 months. He had a trivial fall 3 months back for which the limb was immobilized in a cast. Following removal of the cast, he noticed a swelling over left arm. He was afebrile; however, there was a history of loss of weight and appetite. The physical and systemic examination did not reveal any abnormalities. There were no other swellings elsewhere.

On examination, a firm, globular 10 cm × 5 cm × 5 cm was present over the anterolateral aspect of proximal one-third of left arm. The swelling was tender and abnormal mobility was present.

There was no distal neurovascular deficit.

Routine blood investigations were normal. Plain radiographs of left humerus showed a permeative, destructive lesion involving the upper and middle one-third with pathological fracture (Fig. 1a). Chest radiograph was normal. Magnetic resonance imaging revealed altered marrow signal intensity in the diaphysis and proximal metaphysis of the left humerus. There was a large soft tissue component which was hypointense on T1, heterogeneously hyperintense on T2 and Short tau inversion recovery images (Fig. 1b). He underwent an incisional biopsy. The HPE diagnosis was Ewing's sarcoma. Immunohistochemistry showed positivity for CD99 and Bcl-2. Positron emission tomographic scans demonstrated no evidence of pulmonary metastasis. The tumor was staged as IIB according to Musculoskeletal Tumor Society Staging.

He underwent four cycles of neoadjuvant chemotherapy with vincristine, adriamycin, and cyclophosphamide (VAC). Even though clinically and radiologically the tumor showed features of regression, post chemotherapy MRI revealed the presence of residual tumor (Fig. 1c and d).

He underwent radical excision of the tumor (Malawer Type 1 resection) [3]. The defect was reconstructed with custom made acrylic prosthesis (Fig. 2a and b). The entire tumor mass and the margins were sent for biopsy.

The specimen sent for HPE showed features of Ewing's sarcoma; however, margins were free of tumor. Postoperatively, he received 16 cycles of adjuvant chemotherapy with VAC, ifosfamide, and etoposide. At 1 year follow-up he was pain free with shoulder abduction of 20°, external rotation of 40°, and flexion of 30°. He had good elbow, wrist and hand movements with excellent power grip (Fig. 2c and d).



**Figure 1:** Plain radiograph of left humerus of case 1 showing permeative, lytic lesion with pathological fracture (a), T2W magnetic resonance imaging (MRI) showing heterogeneous hyperintense lesion with extracompartmental extension into soft tissue (b), plain radiograph showing sclerosis of tumor following neoadjuvant chemotherapy (c), post neoadjuvant chemo MRI showing presence of residual tumor (d).



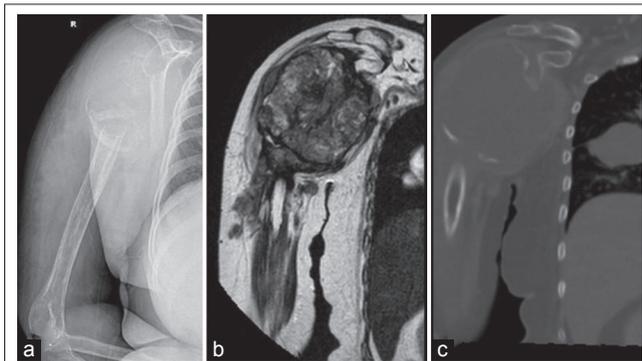
**Figure 2:** Excised tumor with custom made acrylic prosthesis (a), implanted acrylic prosthesis after tumor resection (b), plain radiograph with prosthesis in place at 1 year follow-up (c), clinical photograph showing satisfactory shoulder, elbow, and hand function at 1 year follow-up (d).

### Case 2

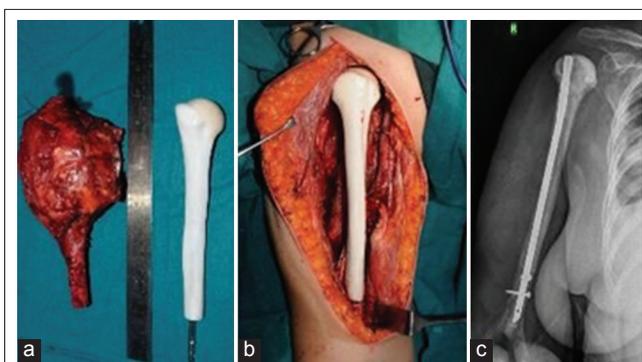
A 51-year-old lady who had undergone total thyroidectomy and received a complete course of I<sup>131</sup> ablation therapy for follicular carcinoma of thyroid 5 years ago presented with painful swelling over her right upper arm for last 3 months. The swelling was gradually increasing in size. At the time of presentation, the pain was severe enough to disturb her sleep and activities of daily living. On examination, there was a diffuse swelling extending from the shoulder to middle one-third of arm. The swelling was tender, firm in consistency with abnormal mobility.

Routine blood investigations and thyroid function tests were within normal limits. Plain radiographs of right humerus showed an expansile lytic lesion causing complete destruction of the head, neck, and proximal half of right humerus (Fig. 3a). MRI revealed a large expansile, lytic lesion which was hyperintense on T2 and iso to hyperintense on T1 image. There was a breach in the cortex circumferentially with infiltration into muscles of proximal arm (Fig. 3b).

Posteriorly, the lesion was seen to abut the radial nerve. Contrast enhanced computerized tomographic scan of chest showed multiple cannon ball type of metastasis (Fig. 3c).



**Figure 3:** Plain radiograph of right humerus showing an expansile lytic lesion, (a) Magnetic resonance imaging showing a large destructive lesion with cortical breach and soft tissue extension, (b) Computerized tomographic scan of humerus and chest showing aggressiveness of tumor and cannonball metastasis (c).



**Figure 4:** Excised tumor with barium sulfate loaded custom made acrylic prosthesis (a), Implanted acrylic prosthesis after tumor resection (b), Plain radiograph showing prosthesis *in situ* (c).

Radical excision of tumor (Malawer Type 1 resection) was done, and the upper end of humerus was reconstructed with a custom made barium sulfate loaded acrylic prosthesis (Fig. 4).

The biopsy was positive for metastatic follicular carcinoma of thyroid. Postoperatively, patient developed transient radial nerve paralysis which slowly recovered. She was completely free of pain and by 4 weeks had satisfactory shoulder, elbow, and hand function.

### Discussion

Proximal humerus is a common site for malignant bone tumors [1]. In the pre-chemotherapy era tumors arising from the proximal humerus were treated with surgical ablation. However, with the advent of radiotherapy and chemotherapy, limb salvage surgeries have become the gold standard. The ultimate goal of surgical treatment is en mass removal of the tumor, preservation of the limb with satisfactory shoulder, elbow, and hand functions [2]. This can be achieved by osteoarticular allografts, acrylic prosthesis, allograft prosthesis composite, modular endoprosthesis, etc. [2].

Allografts and modular endoprosthesis are expensive. They are not easily available in developing countries. The use of acrylic prosthesis for reconstruction following removal of bone tumors dates back to 1964 [4]. However when used for lower limb reconstruction, the failure rate is high. Being a nonweight bearing bone, humerus is subjected to less biomechanical stress [5].

Hence, acrylic prostheses have a role in reconstruction of these defects. These prostheses are simpler, less expensive and hence more suitable in developing countries where most of the patients cannot afford a modular endoprosthesis.

Cement nail prosthesis where a Kuntcher's nail wrapped in bone cement and used as a spacer has been described in the literature [5]. We utilized a similar concept where custom made acrylic prosthesis shaped according to the anatomy of the proximal humerus was used. For the preparation of this prosthesis an approximate size of the humeral head and its length was calculated from the radiographs of the normal side. An age and sex matched dry humerus specimen of similar size belonging to the same side was procured from the Anatomy Department. The length of the humerus to be resected was determined from preoperative MRI. A negative mold was prepared using the dry humerus specimen. The prosthesis was fabricated out of acrylic material using the negative mold. A humeral interlocking nail was incorporated into the acrylic prosthesis. Three holes were drilled into the proximal end of prosthesis for attachment of rotator cuff muscles, and the entire construct was gas sterilized. After resection of tumor, the medullary canal of distal humerus was reamed for introduction of nail. Reamed material was sent for HPE examination.

Bone cement was packed into the canal, and the nail was locked following insertion. The rotator cuff muscles were anchored to the prosthesis through the premade holes. Using this technique a satisfactory range of shoulder movements was obtained. Both cases were pain free following surgery with good upper limb function.

### Conclusion

A recent trend in the management of aggressive and malignant bone tumors is radical excision and reconstruction with modular endoprosthesis. Limb salvage procedures for proximal humeral tumors aim at restoration of satisfactory shoulder, elbow, and hand function. Reconstruction of proximal humeral defect with custom made acrylic prosthesis is a less expensive and an effective alternative to modular endoprosthesis, which can be used in developing countries.

### Clinical Message

Treatment of malignant tumors of proximal end of humerus involves radical excision and reconstruction. Although many treatment modalities are available, custom made acrylic prosthesis is a simple and less expensive alternative providing good shoulder, elbow, and hand function.

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