Retrospective Analysis of Giant Cell Tumor Lower End Radius Treated with *En bloc* Excision and Translocation of Ulna

Abstract

Background: Distal end of radius is third most common site for GCT of long bones and 1% of these metastasize mostly to lungs. Reconstruction methods commonly used are fibula (vascularized and nonvascularized), centralization of ulna, translocation of ulna, and endoprosthetic replacement. We report the outcome of series of twenty cases where we did *en bloc* excision of tumor with translocation of ulna. **Materials and Methods:** Twenty cases of giant cell tumor (GCT) of lower end of radius were included in this retrospective study. The mean age of patients was 33.15 years (range 21-55 years). We had 14 of Campanacci Grade III and 6 of Grade II. Preoperative radiographs and magnetic resonance imaging of the involved wrist and forearm were done. **Results:** Of all twenty patients, 14 were males and 6 were females. Mean followup duration was 3.9 years (range 1.5–17 years). Mean grip strength of involved side as a percentage of normal side was 71% (range 42%–86%) and the actual mean value for operated side was 29 kg as compared to 40 kg for normal side. The average range of forearm movement was supination 80.25° (60°–90°) and pronation 77.5° (70°–90°). No patient was dissatisfied as far as cosmesis was concerned. **Discussion:** In our opinion considering the propensity to recur with more aggressiveness after recurrence, *en bloc* excision with translocation of ulna has become a standard treatment option for GCT of lower end of radius, with advantages of better functional outcomes, retained vascularity, and elimination of risk of donor site morbidity.

Keywords: *Centralization, giant cell tumor, lower end radius, translocation ulna, vascularized*

MeSH terms: *Giant cell tumors, radius, fibula, prosthesis*

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Introduction

Giant cell tumors (GCT) are uncommon primary neoplasm of bone accounting for only 4%–5% of all primary bone tumors in the United States of America and 20% of all primary bone tumors in Southeast Asian regions.[1] Traditionally, this tumor was classified as benign bone lesion along with nonossifying fibroma, osteitis fibrosa cystica, chondromyxoid fibroma, aneurysmal bone cyst, and chondroblastoma.

GCT is characterized histologically by a vascularized network of plumpish or ovoid stromal cells heavily interspersed with multinucleated giant cells. Since the microscopic appearance and classification system appear as benign in nature, a false impression arose of the harmlessness of the true GCTs, and it was treated accordingly. However, long ago, GCTs were recognized to run a malignant course. Coley and Higinbotham[2] stated that about 15% of GCTs become malignant[2] and believed that they could present with pulmonary metastasis. In 1953, Jaffe[3] stated that GCT of bone was a treacherous lesion that was difficult to assess with respect to its clinical behavior. The pulmonary metastasis of GCT have been reported in only 1%–2% of patients, with good prognosis although up to 25% of patients die from the disease.[1] According to Siebenrock *et al*.[4] distal end of radius is most common primary site responsible for metastasis. Distal end of radius is the third most common site of affection and 1% of which metastasis.[1]

The aim of the treatment is elimination of disease and preservation of the function simultaneously. Curettage and bone grafting is the modality of treatment which can preserve maximum function, but there is high recurrence rate (27%–54%).[5] Lesions in the distal end of radius, especially when aggressive are preferably treated with *en bloc* excision, which has a recurrence rate of 0%–32%.[5] After excision of tumor, reconstruction methods commonly used are reconstruction by fibula (both vascularized and nonvascularized),[6-10] reconstruction

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by centralization of ulna,[11] translocation of ulna,[12,13] and endoprosthetic replacement.[14]

In this series we did *en bloc* excision of tumor followed by translocation of vascularized ulna with all its soft tissue attachments and functional outcome was studied.

Materials and Methods

Twenty cases of GCT of lower end of radius treated by en bloc resection and translocation of ulna between July 1996 and February 2011 were included in this retrospective study. All preoperative data were collected from medical records of the hospital.

The mean age was 33.15 years (range 21–55 years). There were 14 males and 6 females in the group. The patients were classified according to Campanacci radiological grading method[15] consisting of three grades [Table 1]. We had 14 patients of Campanacci Grade III and 6 of Grade II.

The diagnosis of all 16 patients was confirmed by preoperative biopsy. We had four cases where GCT recurred, among which three cases were treated by curettage and bone grafting, and one by *en bloc* excision and reconstruction with nonvascularied fibula. All recurrent cases were initially operated at other centres.

All patients were evaluated preoperatively with plain radiographs and magnetic resonance imaging of the involved wrist and forearm to see the extent of tumor and with a plain radiograph of the chest. In cases where we dealt with recurrence, high resolution computed tomography of the chest was also performed to rule out any metastasis. Local findings on MRI showing a confined lesion and a clear chest radiograph grossly ruled out pulmonary metastasis and hence precluded computed tomography.

Operative procedure

Patients were operated under supraclavicular brachial block anesthesia, in supine position, under pneumatic tourniquet with affected arm resting on side table. [Figure 1A (a)] Surgical approach chosen for distal radius was based on the site of radiographic thinning or breach of cortical bone [Figure 1A (b and c)]. Twelve cases were operated from dorsal exposure and eight from additional volar approach as in these cases, we were not able to excise tumor completely from dorsal approach and there was a danger of spillage of tumor. In two cases, incision was shifted dorsoradially as tumor was about to permeate from dorsoradial skin in one case and in another case the previous surgeon used this approach for excision and reconstruction with fibula. In both cases, the skin which was supposed to be involved was excised, and later on, the skin defect was covered with groin flap. Biopsy tract, if present, was taken in the initial incision. Bone was resected at a level determined preoperatively based on the extent of bone involvement on skiagram with a safe margin of about 3 cm. On an average, 10.5 cm (range 8–13 cm) of bone was resected. Dissection remained extraperiosteal at all time to avoid spillage of tumor tissue, and a soft tissue cuff was excised along with the tumor taking care not to damage neurovascular structures. During *en bloc* excision [Figure 1A (d)], the extensor compartment muscles, especially the wrist extensors (extensor carpi radialis longus/extensor carpi radialis brevis) and extensor pollicis longus (EPL), if found adherent, were sacrificed. Wrist extensors were not reconstructed, but EPL was reconstructed in five cases by tendon transfer using palmaris longus as donor. After excision, tumor bed was routinely treated with 3% hydrogen peroxide to take care of the inadvertent spillage, if any. At this time, ligamentous attachments on cartilaginous part of ulnar head was removed and slot of appropriate size was formed in carpus. An osteotomy was planned for ulna. In initial five cases, step-cut osteotomy [Figure 1A (e)] was planned, but later, transverse osteotomy with few millimeter excess ulna was divided to achieve snug fit as well as rotational stability at translocation site. Fixation was performed with an intramedullary thick K-wire extending from third metacarpal, ulna to radius [Figure 1e], which preserves the soft tissue attachments of ulna throughout the procedure, thus maintaining the vascularity. A K-wire is first passed in a retrograde manner from carpus and exiting near third metacarpal head. Under fluoroscopy guidance, the K-wire is then advanced in an antegrade pattern in predrilled ulna to prevent spin of ulna. Ulna is then transected at desired level and brought close to proximal radius. The wire is then advanced further in the radius proximally. Postoperatively, all patients were immobilized in above elbow slab which was converted to above elbow cast for 3 months which contributed to rotational stability. Polypropylene brace was provided until radiological union was attained [Figure 1A (f)].

At final followup range of motion [Figure 1B], grip strength and patient satisfaction were noted, and yearly followup is advised to see recurrence up to 3 years and then as needed.

Table 1: Campanacci grading of giant cell tumors

Grade	Radiological finding
I	Well-defined border of a thin rim of mature bone
	Bony cortex is intact
II	Well-defined margins
	Radiopaque cortical rim absent
III	Fuzzy borders

Results

Results were based on mean grip strength and average range of forearm/wrist movements. Sixteen cases were confirmed on biopsy preoperativelyat our centre, however four cases of recurrence were initially treated elsewhere. None of the cases had a pathological fracture or metastatic disease at presentation. Metastasis was ruled out based on

Figure 1A: (a) Clinical photograph of the forearm, wrist and hand showing swelling (5 cm × 3 cm) volar aspect left wrist. (b) X-ray of the forearm and wrist anteroposterior and lateral views showing typical expansile lytic lesion lower end left radius with destruction of cortex over lateral surface (Companacci grade III) (c) Clinical photograph of forearm, wrist and hand showing curvilinear incision dorsum of forearm and wrist. (d) Clinical photograph showing tumor excised en bloc. (e) X-ray of forearm, wrist and hand anteroposterior view showing excision of distal radius and step-cut osteotomy and centralization of ulna and fixation with intramedullary K-wire. (f) Clinical photograph of forearm, wrist and hand showing union with callus formation at osteotomy site and removal of K-wire

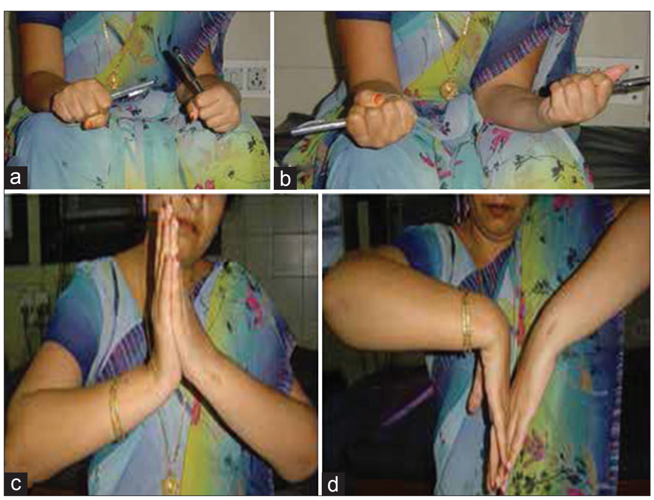

Figure 1B: Clinical photographs showing functional outcomes (a) pronation (b) supination. (c) dorsiflexion. (d) palmar flexion

local findings on MRI and chest radiograph. No case of radioulnar synostosis was noticed.

Mean grip strength (as measured with spring dynamometer) of the involved side as a percentage of normal side was 71% (range 42%–86%) and the actual mean value for operated side was 29 kg as compared to 40 kg for contralateral normal side. The average range of forearm movement was supination 80.25° (range 60°–90°) and pronation 77.5° (range 70°–90°). No patient was dissatisfied as far as shape of the wrist and cosmesis was concerned.

There were no major complications related to the procedure. Two patients developed superficial infection at operative site which settled after drainage and a prolonged course of antibiotics for 4 weeks. One patient had hematoma which subsided with suture removal, and resultant raw area was covered with split skin thickness graft. There was one case of soft tissue recurrence of GCT [Figure 2] after 5 months which was treated with excision of mass followed by no further signs of recurrence after a followup of 1 year. Another case had a recurrence at local site, but on investigation, there was large metastasis in one lung and diffuse foci in another lung after 20 months post *en bloc* excision which was lost to followup. Rest of 23 cases had not shown any sign of recurrence at the last followup. Six patients had nonunion at radioulnar junction for which iliac crest bone grafting and plate fixation performed with union achieved at 4–6 months postoperatively. All cases had shown union at carpoulnar site. Excluding these six cases, average time for union at radioulnar junction was 4.9 months (range 3–8 months).

Figure 2: (a) Clinical photographs showing soft tissue recurrence of giant cell tumor. (b) X-ray of forearm, wrist and hand anteroposterior and lateral views showing excision of distal radius and transverse osteotomy and centralization of ulna and fixation with intramedullary K-wire. (c) X-ray of forearm, wrist and hand anteroposterior view showing union at osteotomy site and with K-wire *in situ*

Discussion

"A bone tumor confronts with two problems - the cure of the disease and preservation of maximum function in affected part. The cure of disease should almost invariably take precedence and decision to treat a lesion by segmental resection must be based on exact information about its nature and prognosis.[16]" GCTs of the bone have a propensity to recur with more aggressiveness after recurrence. It is for this reason *en bloc* excision has become a standard treatment option for curing GCTs of lower end of radius[9,17,18] except Grade I lesions. *En bloc* excision is a reliable procedure for curing the disease, but it creates a defect. For reconstruction of defect, fibular graft (vascularized or nonvascularized) and centralization of ulna are the treatment options.

Fibular graft has been used by many surgeons, but most of them used nonvascularized fibula[9,10,19] although some have advocated for the use of vascularized fibula as it has been suggested that a vascularized fibula has advantage of earlier union, several authors have reported similar union time (about 33 weeks) for nonvascularized fibular graft if rigid fixation and primary bone grafting is used[19-22] Site of entry of nutrient artery to fibula is variable among general population which sometimes necessitates harvesting of a longer graft than required,[21] and it has been further suggested that the use of rigid fixation with plate and screws, which is a norm these days may jeopardize the vascularity of fibular graft forcing it to act essentially as a nonvascular graft[23] Moreover, long surgical time and unavailability of required expertise of a microvascular surgeon are further drawbacks which preclude the use of vascularized fibular grafting at many centers. Whenever fibula is used in Grade III lesions, partial arthrodesis, and for Grade II lesion, arthroplasty is preferred.[24] Even comparative study performed by Minami *et al*.[24] has shown that arthrodesis is better than arthroplasty because carpal subluxation, degenerative changes are common in later.

It is clear by above discussion that the commonly reported complication of using fibula, i.e., volar subluxation of carpus is cosmetically unacceptable. There is usually the development of secondary arthritic changes in the wrist and secondary fusion of wrist.

The average range of motion after fibular reconstruction in previous series[23,25] was 52° forearm supination, 37° forearm pronation[23] and pronation of 15°–50° (mean 28.7°), and supination 10°–25° (mean 16.5°).[25]

If ulna is translocated[12] and single bone forearm is created to reconstruct the gap after excision of GCT of radius, it also produces a fused wrist and translocated ulna acts as a local graft without any extra donor site morbidity. In addition, as it is attached with muscles, so it retains its vascularity, so graft union time with radius is also less. Patients are able to achieve supination and pronation by superior radioulnar joint in range of 60°–90° and 70°–90°, respectively. This is better than another reported series.[18,19]

Studies by Kruft (1997) have shown that 20° of flexion and extension at wrist is adequate for daily activities.[17] Based on this fact, we tried to retain some movements at midcarpal joint. However, we were only able to achieve jog of movements in 13 cases which seems to be at midcarpal joint.[26] The ideal position of wrist fusion is 10° dorsiflexion and 5°–10° ulnar deviation; however, in our cases, we could not achieve it because of rigid and straight K-wire. We, therefore, suggest that ulnar deviation could have been achieved by transfixing with second metacarpal.

We had nonunion in six cases at radioulnar junction which were treated with iliac crest bone grafting, and additional stability was provided with plate fixation which later achieved union. This is different from our initial strategy of avoiding plate and using intramedullary fixation with K-wire as it has advantage of avoiding periosteal stripping. To achieve, we used step-cut osteotomy in initial five cases as it provided more contact area, but it proved to be cumbersome, so in later cases, transverse osteotomy was used with few extra millimeter of ulna to gain snug fitting. The methodology involving plate fixation mainly at radioulnar junction can be used to overcome this complication. The single forearm created by this method was cosmetically accepted to most of the patients. The tapering of the distal forearm can be easily hidden by wearing bangles in women and wearing long sleeve shirts in men. We believe that although results of reconstruction by translocated ulna of distal radius show substantial loss of function as compared to normal wrist, it still gives subjective results acceptable to most of the patients and comparable to other available methods of such reconstruction. The technique also carries the advantage of not requiring the facilities of bone bank or microvascular surgery. The complication rates associated with such reconstruction of distal radius are universally high but do not preclude satisfactory results.

Conclusion

The wide excision and reconstruction of distal radius by translocation of ulna can be considered as a reasonable option after *en bloc* excision of campanacci Grade II/III GCT.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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