

# Clinical effects of three surgical approaches for a giant cell tumor of the distal radius and ulna

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**Abstract.** The aim of the present study was to assess the curative effects of three surgical approaches for a giant cell tumor (GCT) of the distal radius and ulna. A total of 27 patients with GCT on distal radius and ulnas (7 and 20, respectively), confirmed by biopsy, were treated with individualized treatment regimens, according to the Campanacci's grade system: i) Curettage plus inactivated tumor bed and allogeneic bone graft/bone cement augmentation for Campanacci's grade I GCT of the distal radius and ulna (Group A); ii) simple *en bloc* resection for Campanacci's grade II and III GCT of the distal ulna (Group B); iii) *en bloc* resection and reconstruction with non-vascularized fibular autograft/allogeneic bone graft for Campanacci's II and III GCT of the distal radius (Group C). Postoperative recurrence and complications were recorded. The Musculoskeletal Tumor Society Score was used to assess functional results. The mean follow-up time was 25 months (range, 9-125 months). A total of 3 patients exhibited tumor recurrence at 9, 11 and 15 months following surgery (1 case succumbed to pulmonary metastasis at 27 months). Overall, the incidence of the postoperative recurrence of the GCT of the distal ulna and radius were 14.3 (1/7) and 10% (2/20), respectively, with a statistical P-value of 0.762. No statistically significant difference was observed regarding the incidence of the postoperative recurrence, postoperative complications and MSTS results among the three surgical approaches for the GCT on distal ulna and radius (all P>0.05). However, statistically significant differences were noted when the incidence of the postoperative recurrence of curettage (Group A) was

compared with that of *en bloc* resection (Groups B and C) (P=0.024). In conclusion, in order to achieve the best clinical effects for patients with GCT on distal radius and ulna, individualized treatment regimens must be designed according to the different Campanacci's grades and tumor locations.

## Introduction

Giant cell tumor (GCT) of the bone represents ~5% of primary bone tumor types and 20% of benign bone tumor types (1). The disease often occurs in adults between the ages of 20- and 40-years-old, with a higher incidence in females (2,3). GCTs are generally composed of mononuclear histiocytic cells, multinucleated giant cells resembling osteoclasts and neoplastic stromal cells that are the predominant proliferating cell population (4,5). The disease is generally recognized as a border or low-grade, with a certain degree of invasive characteristics, demonstrated by biological behavior (6,7). The predominant problem in the management of GCT is local recurrence following surgical treatment: 27-65% following isolated curettage; 12-27% following curettage with adjuvants such as high-speed burr, phenol, liquid nitrogen, or polymethylmethacrylate; and 0-12% after *en bloc* resection (6).

The distal radius and ulna is the fourth most common location for GCT of the bone, after the distal femur, proximal tibia and proximal femur, accounting for ~9% of cases (8,9). Numerous previous studies have identified the distal radius and ulna as being particularly prone to recurrence. To date, the ideal treatment methods for GCTs of the distal ulna and radius remain controversial (10-12). *En bloc* resection of GCT provides lower rates of recurrences, which also sacrifices the joint, results in a major reconstruction, and the functional outcomes are questionable. Intralesional excision (curettage) preserves the joint; however, has a reasonably high risk of local recurrence even if used in combination with surgical adjuvants, including liquid nitrogen, phenol or cement (8,10,13). Therefore, the effect of different surgical modalities on tumor recurrence and postoperative wrist function remains unclear. The aim of the present study was to assess the clinical effects of three surgical approaches for GCT of the distal radius and ulna, including curettage plus inactivated tumor bed plus allogeneic bone graft/bone cement augmentation, simple *en bloc* resection, and *en bloc* resection and reconstruction

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with non-vascularized fibular autograft/allogeneic bone graft segment.

## Materials and methods

**Patients.** The present study was approved by the Ethics Committee of the Tumor Hospital of Yunnan Province and was performed in accordance with the declaration of Helsinki. Informed consent was obtained from all patients. The present study retrospectively collected the clinical data of patients with a GCT of the distal radius and ulna between January 2000 and December 2013. The inclusion criteria were patients who were diagnosed with GCT by biopsy examination in The Third Affiliated Hospital of Kunming Medical University, Tumor Hospital of Yunnan Province and confirmed the location as the distal radius and ulna by X-ray and computed tomography. The exclusion criteria were as follows: i) Patients with a previous history of surgery; ii) patients receiving surgical treatment other than the three surgical methods being assessed; iii) patients who received non-surgical treatment.

**Surgical points.** Individual therapeutic regimens were selected according to the Campanacci's grade (14) and the location of distal ulna and radius (Table I). The key points included: Following curettage, a Stryker drill (Stryker, Kalamazoo, MI, USA) was used to grind lesions along each direction. Then, 95% ethanol was used to inactivate the tumor bed. For *en bloc* resection, the scope of the osteotomy was determined by the preoperative imaging results. It is usually no less than 2 cm distance to the focus, including soft tissue reaction zone or soft tissue focus. The present study used autologous fibular graft or allogeneic bone graft segment (contained distal articular surface) to reconstruct the radiocarpal joint (Fig. 1).

**Functional assessment.** The Musculoskeletal Tumor Society Score (MTSS) was used to assess limb function (15). The system consisted of six items, including pain, overall function, psychological level, gesture, sensitivity and muscle strength. The functional result was assessed as excellent (30-24 scores), good (23-18 scores), fair (17-12 scores) or poor (<12 scores) using the grading scheme.

**Statistical analysis.** The mean follow-up time of the 27 patients was 25 months (range, 9-125 months). All data were analyzed using SPSS 19.0 software (IBM SPSS, Chicago, IL, USA). Continuous variables were expressed in terms of means  $\pm$  standard deviation and were compared using a one-way analysis of variance. Categorical variables were expressed in terms of percentage and frequency, and were compared using the  $\chi^2$  test.  $P < 0.05$  was considered to indicate a statistically significant difference.

## Results

**Preoperative patients' characteristics.** From January 2000 to December 2013, a total of 27 patients with GCT of the distal radius and ulna were included. The patients consisted of 10 male and 17 female. The mean age was 34.8-years-old

Table I. Baseline characteristics of 27 patients with a giant cell tumor on the distal radius and ulna.

Characteristic	No. patients
Mean age, years (range)	34.8 (21-72-years-old)
Gender (male/female)	10/17
Location (distal ulna/distal radius)	7/20
Campanacci's Grade	
Grade I	4
Grade II	16
Grade III	7
MSTS scores (range)	20 (11-28)
Surgical regimens	
Group A	4
Group B	5
Group C	18
Preoperative soft-tissue invasion	7
Preoperative pathological fracture	5
Tumor size	
$\geq 3$ cm	22
<3 cm	5
Follow-up time, months (range)	25 (9-125 months)

Group A, curettage, inactivated tumor bed and allogeneic bone graft/ bone cement augmentation; Group B, simple *en bloc* resection; Group C, *en bloc* resection and reconstruction with non-vascularized fibular autograft/allogeneic bone graft; MSTS, Musculoskeletal Tumor Society Score.

(range, 21-72-years-old). The tumor location was the distal ulna in 10 cases and the distal radius in the remaining 17 cases. The GCT was graded radiologically according to Campanacci *et al* (14). According to Campanacci's grading system, 4 cases were in stage I, 16 cases in stage II and 7 cases in stage III. The clinical data of the patients are shown in Table II.

**Postoperative recurrence.** A total of 3 patients (11.1%) exhibited tumor recurrence at 9, 11 and 15 months after surgery. The case with Campanacci's grade I GCT of the distal radius exhibited tumor recurrence 9 months after curettage plus inactivated tumor bed plus bone cement augmentation. The case with Campanacci's grade I GCT of distal ulna exhibited recurrence 11 months after curettage plus inactivated tumor bed plus bone cement augmentation. The two patients were treated with *en bloc* resection and reconstruction with allogeneic bone graft segment after pathological examination and developed no recurrence after the aforementioned secondary surgery. The remaining case with Campanacci's grade III GCT of distal radius exhibited tumor recurrence 15 months after *en bloc* resection and reconstruction with allogeneic bone graft segment. The patient was further treated with *en bloc* resection and reconstruction with autologous fibular graft. At 6 months postoperatively, the patient developed pulmonary metastasis and succumbed to respiratory failure

Table II. Individualized surgical methods according to Campanacci's grade of giant cell tumor of the distal ulna and radius.

Tumor location	Campanacci's classification		
	Grade I	Grade II	Grade III
Distal ulna	Curettage, inactivated tumor bed and allogeneic bone graft/bone cement augmentation (Group A)	Simple <i>en bloc</i> resection (Group B)	Simple <i>en bloc</i> resection (Group B)
Distal radius	Curettage, inactivated tumor bed and allogeneic bone graft/bone cement augmentation (Group A)	<i>En bloc</i> resection and autologous fibular graft/llogeneic bone graft segment (Group C)	<i>En bloc</i> resection and autologous fibular graft/llogeneic bone graft segment (Group C)

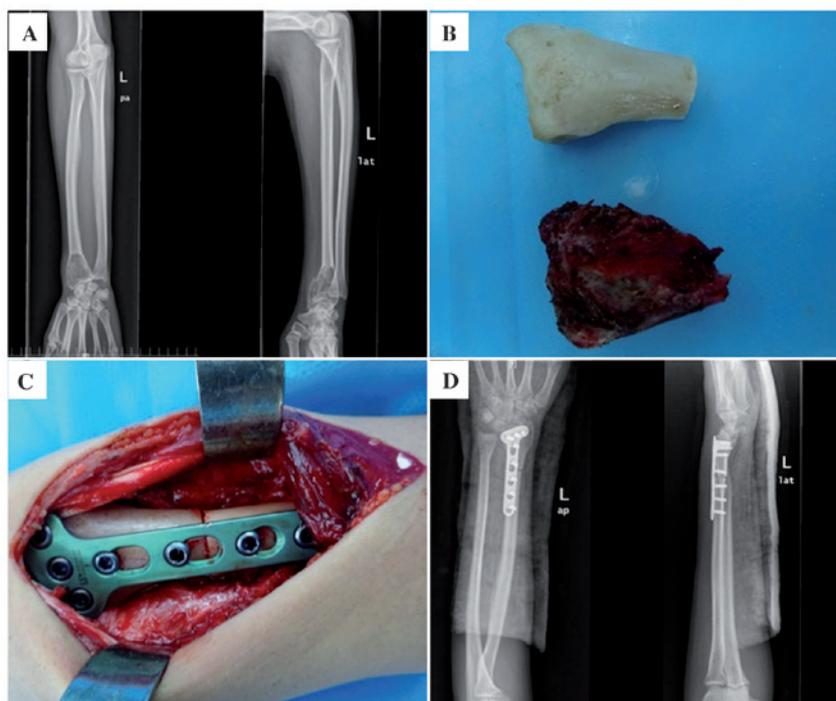


Figure 1. A 21-year-old female with Campanacci's grade III giant cell tumor of the distal radius on the left side and pathological fracture. The patient was treated with distal radial tumor segment resection, allogeneic bone segment graft and plate-screw internal fixation. (A) Preoperative anteroposterior (left) and lateral X-ray (right) examination revealed bone destruction and pathological fracture of the left distal radius. (B) The resected tumor segment of radius and trimmed allogeneic bone segment. (C) Postoperative photo following surgery. (D) Postoperative anteroposterior (left) and lateral (right) radiographs.

after chemotherapy and supportive therapy for 6 months. Overall, the incidence of the postoperative recurrence of the GCT of the distal ulna and radius was 14.3 (1/7) and 10% (2/20), respectively, with a statistical P-value of 0.762. The incidence of the postoperative recurrence were 50% (2/4) in Group A, 0% (0/5) in Group B and 5.6% (1/18) in Group C, with a statistical P-value of 0.069. However, statistical significance was noted when the incidence of the postoperative recurrence of curettage (Group A) was compared with that of *en bloc* resection (Groups B and C) (50 vs. 4.3%;  $P=0.024$ ).

**Postoperative complications.** Of the patients, 4/27 (14.8%) with GCT of the distal radius developed postoperative complications, including 1 case of postoperative infection, 2 cases of implant breakage and postoperative fractures, and 1 case of

nonunion (Table III). No statistically significant difference was observed regarding the incidence of the postoperative complications among the three surgical approaches for the GCT on the distal ulna and radius ( $P>0.05$ ). The patient who developed postoperative infection healed following anti-infection drug therapy. The remaining 3 patients underwent secondary fibulo-scapolunate arthrodesis, and no postoperative infection or nonunion was noted. None of the patients developed neurovascular complications.

**Function outcomes.** The mean follow-up time of the 27 patients was 25 months (range, 9-125 months). Functional MTSS results were excellent in 7 cases (25.9%), good in 12 cases (44.5%), fair in 5 cases (18.5%) and poor in 3 cases (11.1%). The overall excellent and good rate was 70.4% (Table III). No statistically significant difference was

Table III. Postoperative outcomes in the three groups.

Outcome	Group A (n=4)	Group B (n=5)	Group C (n=18)	P-value
Recurrence	2 (50%)	0 (0%)	1 (5.6%)	0.024 <sup>a</sup>
Infection	0 (0%)	0 (0%)	1 (5.6%)	0.660
Internal fixation fracture	0 (0%)	0 (0%)	2 (11.1%)	0.427
Nonunion	0 (0%)	0 (0%)	1 (5.6%)	0.660
Functional assessment				
Excellent	2 (50%)	2 (40%)	3 (16.7%)	0.397
Good	0 (0%)	2 (40%)	10 (55.5%)	
Fair	1 (25%)	1 (20%)	3 (16.7%)	
Poor	1 (25%)	0 (0%)	2 (11.1%)	

<sup>a</sup>Group A vs. Group B and C.

observed regarding the postoperative MTSS results among the three surgical approaches for the GCT on the distal ulna and radius.

## Discussion

Currently, no consensus has been reached regarding the optimal treatment approach for GCTs that occur in the distal radius. Although almost 100% local control can be achieved with *en bloc* resection (16), limb function is usually offset (17). Intralesional excision with curettage is the standard method of treatment; however, it is associated with the rates of local recurrence ranging between 10 and 40% (18-21). As a result, topical adjuvant agents, including hydrogen peroxide, phenol and alcohol, have been used to decrease the recurrence rates (9). Liu *et al* (10) reported that patients in the intralesional excision group exhibited a higher recurrence rate, particularly for Campanacci's III Grade GCT compared with the *en bloc* resection group (10). Pazonis *et al* (11) reported that the odds of local recurrence were three times less in the *en bloc* resection group (n=60) compared with the intralesional excision group (n=81). Considering the high local recurrence risk of curettage, the 23 patients with Campanacci's grade II and III GCT of the distal radius and ulna were all treated with *en bloc* resection, and only one patient (1/23; 4.3%) relapsed. However, 6 months after secondary surgery, the patient developed pulmonary metastasis, which may be associated with the high invasiveness. Considering the limited lesions of Campanacci's grade I GCT, the present study selected the curettage plus inactivated tumor bed and allogeneic bone graft (1 case)/bone cement augmentation (3 cases) for Campanacci's grade I GCT of the distal radius and ulna, which can theoretically guarantee the safety boundary. However, the incidence of the postoperative recurrence of patients was 50% (2/4), which is higher compared with that reported previously, which may be due to limited sample size. It can also partially reflect that the application of bone cement augmentation cannot reduce the risk of the recurrence of GCT (9). A previous report suggested that wrist joint can still reach 75% grasp strength and 80% range of motion following distal ulnar resection (22). Therefore, in

the present study, *en bloc* resection without reconstruction for Campanacci's grade II and III GCT of the distal ulna was selected. Following surgery, no statistically significant difference was revealed regarding the incidence of the postoperative recurrence of the GCT in distal ulna and radius (14.3 vs. 10%). Although no statistically significant difference was found in the present study regarding the incidence of the postoperative recurrence among the three surgical approaches for the GCT on distal ulna and radius, a >10-fold higher difference was revealed regarding the incidence of the postoperative recurrence of curettage when compared with that of *en bloc* resection. Further studies with a larger number of samples are warranted.

Various surgical approaches for GCT of the distal radius and ulna can produce different rates of postoperative complications. Previous reports suggested that *en bloc* resection was associated with a relatively high rate of major complications (range, 29-100%) (23-27). These complications included nonunion at the graft-radius junction (12-38%) (26-28), fracture of graft (13-29%) (26,27), subluxation (12-67%) (23,26), arthritis (13-50%) (23,28) and postsurgical pneumonia (24). Notably, in the present study, 1 case (5.6%) experienced postoperative infection, which may be associated with rich blood supply and rapid tissue healing. Additionally, 2 cases of internal fixation fracture (11.2%) and 1 case of nonunion (5.6%) occurred. These patients received reconstruction with allogeneic bone graft. This may be associated with the slow creeping substitution of allografts and premature functional exercise. These 3 patients underwent with fibulo-scapolunate arthrodesis and thereafter no postoperative infection or nonunion was noted. Overall, the postoperative complications observed in the present study were lower compared with that in the aforementioned reports.

Patients with GCT of the distal radius and ulna can have long-term survival, unless the incidence of pulmonary metastasis occurs; therefore, functional recovery of the wrist is extremely important. In the present study, patients undergoing allogeneic bone graft were all treated with individual customized allografts with the preservation of the articular aspect of the distal radius. The overall excellent and good rate

of *en bloc* resection and reconstruction was 70.4%, which is not statistically different compared with that of curettage. The present study suggested that *en bloc* resection and reconstruction can be used as the standard initial treatment method for Campanacci's grade II and III GCT. Wysocki *et al* (12) suggested that curettage can be considered for the initial treatment for Campanacci's grade II and III GCT of the distal radius, since *en bloc* resection can be performed if tumor recurrence occurred. However, secondary surgery not only increases the expense of the patients, it also increases the risk of postoperative complications. Therefore, the present study suggested that *en bloc* resection can be used as the standard initial treatment method for Campanacci's grade II and III GCT, whereas curettage can be used for Campanacci's I Grade GCT.

In conclusion, in order to achieve the best clinical effects for patients with GCT on distal radius and ulna, individualized treatment regimens must be designed according to the different Campanacci's grades and tumor locations.

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