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Case Report

Wrist arthroplasty using an autogenous iliac crest for giant cell tumors of the distal radius: 9 cases of giant cell tumors (Campanacci grade III) of the distal radius

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Abstract: Background: Giant cell tumors (GCT) of the distal radius follow a comparatively aggressive behavior. Wide excision is the management of choice, but this creates a defect at the distal end of the radius. Objectives: To present the functional results of a technique of wrist arthroplasty using autogenous ilium after *en bloc* resection of giant cell tumors (GCTs) of the distal radius. Methods: A total of 9 patients with a mean age of 29 years (range, 21-46 years) with aggressive giant cell tumors (Campanacci grade III) of the distal radius were managed with *en bloc* resections and reconstruction with an autogenous ilium graft. The primary outcomes of the upper limb and wrist joint functions were evaluated using the Musculoskeletal Tumor Society rating score (MSTS) and the Mayo score respectively. Results: The mean follow-up period was 1.8 years (range, 1-3 years). The average bone healing time was 16 weeks (13~18 weeks). One patient had a local recurrence, and two patients developed a radiocarpal dislocation. The mean range of motion of the wrist joint was increased significantly after surgery ($p<0.05$). The mean functional score was 23.5 points (range, 18-29 points) and 53 points (range, 46-62 points) according to the MSTS and Mayo scores. Conclusions: Wrist arthroplasty using autogenous ilium after an *en bloc* resection could be a useful option to treat Campanacci grade III giant cell tumors of the distal radius. This technique provides a stable wrist and partially restored wrist motion.

Keywords: Wrist arthroplasty, autogenous iliac, giant cell tumor, curative effect

Introduction

Giant cell tumors (GCT) of bone are locally-aggressive benign tumors, the distal end of the radius is the site most commonly affected, and the condition carries a definite female preponderance. Treatment options have included intralesional excision and en bloc resection followed by reconstruction or arthrodesis. However, the best treatment approach for GCTs that occur in the distal radius is unclear. In addition to en bloc resection of the GCTs of the distal radius, the defects needed to be filled by some materials to achieve a stable wrist [1]. Several researchers have reported some methods for reconstructing function: allograft bone transplantation, simple fibular graft, vascularized fibular autograft, wrist prosthesis, and so forth. Relative research suggests that intralesional excision is associated with a higher rate of recurrence for Campanacci Grade 3 GCTs [2]. Curettage has been associated with a high rate of recurrence (30% to 50%), On the other hand, en bloc resection is considered to be a more effective method for treating Campanacci Grade 3 GCTs [3]. After en bloc resection, various filling materials have been used; however, the use of bone grafts is considered a more physiological method for reconstruction [4]. Multiple options have been reported for reconstruction of the wrist after en bloc resection. Arthroplasty utilizing a graft from the iliac crest has the advantages of avoiding donor site morbidity and the decreased operating time associated with the harvesting of the grafts. In the present study, we assayed the validity and feasibility of wrist arthroplasty using autogenous iliac crest for Campanacci Grade 3 GCT of the distal radius.

Table 1. The data from the nine patients

Case	Sex	Age at time of diagnosis	Grade of tumor	Extension	Flexion	RD	UD	Pronation	Supination
1	FEMALE	23	III	19.5	18.5	5.8	11.5	19.5	10.8
2	FEMALE	25	II	21.3	16.6	8	8.5	29.9	17.9
3	MALE	26	III	25.5	11.3	7	10	31.5	16.5
4	MALE	46	III	26	13.6	4.1	8	29.5	14.3
5	FEMALE	22	III	15.5	19.9	6	9.5	26	16.8
6	MALE	27	III	18.5	13.9	8.5	7.5	30.3	17.1
7	FEMALE	30	II	21.4	14.6	7	12.1	26.7	13.1
8	MALE	38	III	18.5	13.2	6.8	12.3	26.8	16.5
9	MALE	30	III	19.5	15.2	8.1	8	29.8	17.8

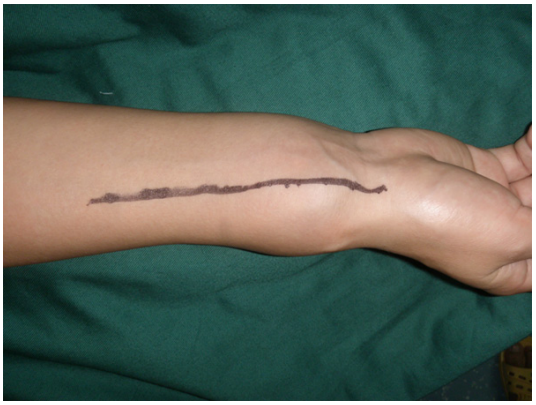

Figure 1. Pictures of surgical procedure. Preoperative shape.

Patients and methods

Subjects

This study included 9 cases of giant cell tumor (Campanacci grade III) of the distal radius at the Department of Orthopedics of No. 91st Hospital of Liberation Army between January 2013 and January 2017. The patients included 4 men and 5 women with a mean age of 29 years (range, 21-46 years). The mean duration was 12.3 months (range, 2-26 months). There were 3 patients whose lesions occurred in the dominant hand, and 6 cases whose lesions occurred in the non-dominant hand. All patients underwent a preoperative plain radiography and MR imaging, and a biopsy was taken when giant cell tumor of the distal radius was indicated. For the dates of the nine patients, see **Table 1**.

Surgical technique

The basics of the operation: general anesthesia, a tourniquet in the upper arm air cell. Elevate extensively and purely in the cut on the volar and back sides according to the amount of MIR before operating. Cut ulna periost horizontal 2 cm away from the tumor on the part of the separating ulna, pull the tumor inside, cut the interosseous membranes up to the wrist, and cut out the wrist capsular ligament to remain as much as possible wrist capsular ligament, the ulnar part of the low radius capsular ligament and TFCC without entering the tumor bump. Cut the radius firm and the tumor outside film, cut out the pulp cavity tissue left in the bone and do a routine fast pathology check to confirm there is no tumor bump left. The injury should be immersed in distilled water. According to the cut length in the radius bone, choose ilium transplant to rebuild the radius wrist joint. Change the suit, gloves and the appliances, cut an arc in the ilium ridge, and take a 2 cm wide ilium, whose length is the same as the cut part of radius. Fix one piece of the ilium to form a radius wrist surface, then put it in the distal radius, and the other in the nearer end. Select the proper fix steel plate to the left end of the radius. When the edges touch discontentedly, apply the ilium to improve the recovery of bone. Use a needle to pin the low ulnar radius and two needles to fix radius wrist joint. Fix one piece of the ilium to form the radius wrist surface, then put it in the distal radius, and the other in the near end. Select the proper fix steel plate to the left end of radius. When the edges touch discontentedly, apply the ilium to improve the recovery of the bone. A needle to pin the low ulnar radius and two needles to fix the radius wrist joint. For pictures of the surgical procedure, see: **Figures 1**-**4**.

Postoperative management

After the operation, the wrist joint was fixed with paste support at a functional position for 8

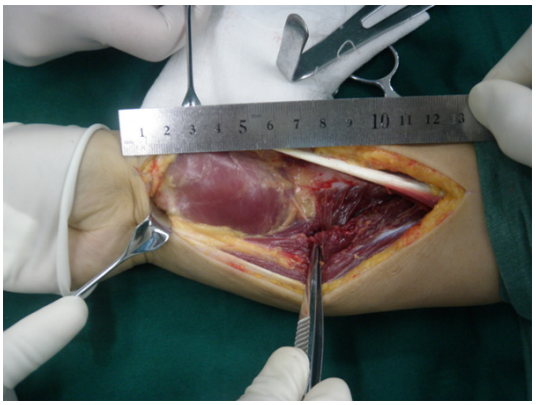

Figure 2. Pictures of surgical procedure. Intraoperative GCT size.

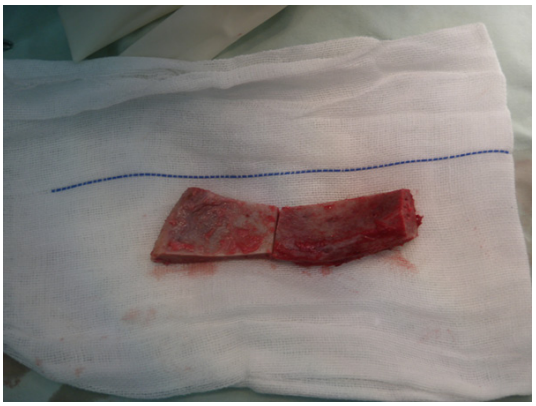

Figure 3. Pictures of surgical procedure. Remove iliac crest.

weeks, and functional training was performed during this period. Active and passive functional training of the wrist joint can be performed when the paste fixator and Kirschner wires of the distal radioulnar joint and radiocarpal joint are removed after 8 weeks. Hyperactivity and lifting something that exceeds 0.5 kg are prohibited before the bone healing is diagnosed by X-ray examination.

Evaluation method

Clinical and imaging evaluations were performed for all the 9 patients. The range of motion of the palmar flexion, extension, ulnar deviation, radial deviation of the wrist joint and the pronation and supination of the forearm was measured before and after the operations. The grip strength was measured using an electronic dynamometer (WCS-100, Shanghai). The primary outcomes of upper limb and wrist joint functions were evaluated by the Musculoskeletal Tumor Society rating score (MSTS) and the Mayo score, respectively.

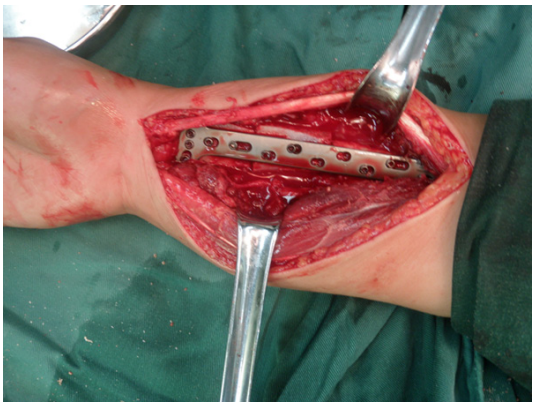

Figure 4. Pictures of surgical procedure. Implant iliac crest.

Statistical analysis

The continuous data were expressed as the mean ± standard deviation. Data was evaluated using a normal distribution (Kolmogorov-Smirnov test) and homogeneity of variances (Levene's test). The Paired *t* test was applied for analysis of the differences pre and post-operation. All data in the study were evaluated using SPSS19.0 software. A *P* value less than 0.05 was considered statistically significant.

Results

Follow-up was completed in all patients. The mean follow-up period was 1.8 years (range, 1~3 years) All the transplanted autogenous ilium survived and the average healing time was 16 weeks (13 to 18 weeks). The results of the operations in this study are shown in **Figures 5**-**7**. One patient had a local soft-tissue recurrence with no bony involvement. The recurrence was excised. Two patients developed radiocarpal dislocations, and they underwent manual repositionings and external fixation by plaster cast which were resolved at 10 weeks. There were significant differences between the preoperative and postoperative range of motion of the wrist joint (all $P<0.05$) (See: **Table 2**). At the final follow up, the mean grip strength was 74% (mean, 33.8 kg and range, 15.6~51.2 kg) on the contralateral side. The mean functional score according to the MSTS was 23.5 points (range, 18-29 points). The mean functional score of the wrist joints

Figure 5. The typical pre- and post-operative X-ray representation of GCT of the distal radius. Preoperative X-ray.

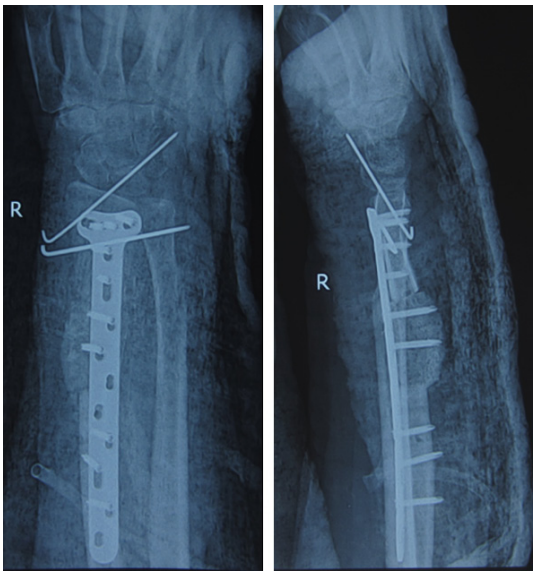

Figure 6. The typical pre- and post-operative X-ray representation of GCT of the distal radius. Immediately post-operative X-ray.

according to the Mayo score was 53 points (range, 46-62 points).

Discussion

Giant cell tumors of bone is a primary invasive tumor which has the risk of regional recurrence. The distal radius is the third most common site

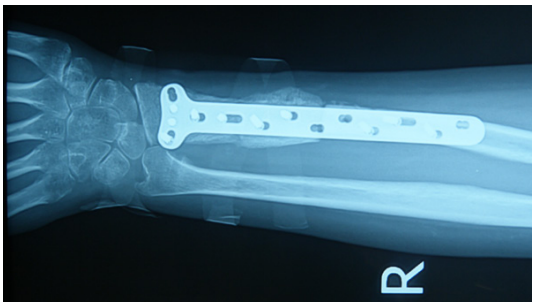

Figure 7. The typical pre- and post-operative X-ray representation of GCT of the distal radius. Post-operative (3 months).

for lesions next to the distal femur and the proximal tibia.

The recurrence of GCTs of the distal radius is mainly on account of the anatomical characteristics [5]. GCTs in the distal end of the radius have been challenging owing to the limited amount of surrounding soft tissue. The best treatment is still controversial because of the special biological behavior of giant cell tumors of bone. The therapeutic goals of GCTs have included resecting the bone tumor, reducing the risk of recurrence and protecting the regional joint function. Treatments for GCTs have included intralesional excision and en bloc resection. The classic treatment of curettage and bone grafting is used to preserve the function of the joint, but it has been associated with a high rate of local recurrence [1]. Although the recurrence rates for en bloc resection are relatively lower, en bloc resection usually requires the sacrifice of the articular surface, and secondary arthritis has occurred in 13% to 50% of patients [6-8]. Based on these considerations, the en bloc method was suggested for Campanacci grade II~III GCTs.

Although it has been suggested that a vascularized bone graft has the advantage of earlier union and wider adaptations, several authors have reported similar functional outcomes for non-vascularized grafts if primary bone grafting is used [9, 10] and similar observations have been made in this series. Clinical studies have indicated [8] that the sheering of tumor excision is related to the possibility of recidivism of some parts of the tumor. On the one hand, giant cell tumors of the bone are apt to break through the cortex of bone to form a flab bump,

Table 2. Comparison of the range of motion of the wrist joint between pre-operation and 3 months after operation

Variable	Extension	Flexion	Radial deviation	Ulnar deviation	Pronation	Supination
Pre-operation	20.6±3.4	15.2±2.7	6.8±1.4	9.7±1.9	27.8±3.6	15.6±2.4
Post-operation	63.7±7.6*	33.8±4.2*	15.6±3.9*	21.5±3.2*	45.8±6.6*	37.6±4.3*

Mean ± SD (n=9), *P<0.05, Compared with the pre-operation.

while the endwise stretch length in the pulp cavity is short [9]. On the other hand, according to the extent in magnetic resonance imaging, the extent of excision includes those healthy bone tissues within 2 cm away from the tumor in case that tumor recurs. The pronator teres offers an effective barrier to hold back the invasion to the palm side [10]. The tumor seldom invades the extensor tendon in the back and arthrodial cartilage [11, 12]. Selecting a large segment defect forming after ilium transplant to recover distal radius giant cell tumors of bone and rebuilding wrist function can lengthen the period of recovery time and enhance its efficiency. There are volar angle ranging from 10-15° and ulnar deviation (20-25°) on large segment defects. The ilium arc should lean the same angle to make the wrist and ulnar measures when the wrist recovers. Our study applied a needle to pin wrist and another needle to fix the low radius. Severe functional disorder is bound to take place on unstable wrists in the long run. The middle wrist and stable radius could improve the front arm spin function. Therefore, this also improves the amount of activities wrist does and is still satisfying. The triangle fiber cartilage complexus left in the distal ulna proximal row wrist is helpful in getting healthy wrist function. During an operation, they also improve the recovery of wrist function.

In conclusion, the present study demonstrates that wrist arthroplasty using autogenous ilium after en bloc resection is a useful option to treat Campanacci grade III giant cell tumors of the distal radius. This technique provided a stable wrist and partially restored wrist motion.

Disclosure of conflict of interest

None.

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References

[1] Cheng CY, Shih HN, Hsu KY, Hsu RW. Treatment of giant cell tumor of the distal radius. Clin Orthop Relat Res 2001; 383: 221-8.

[2] Liu YP, Li KH, Sun BH. Which treatment is the best for giant cell tumors of the distal radius? A meta-analysis. Clin Orthop Relat Res 2012; 470: 2886-94.

[3] Peng-Fei S, Yu-Hua J. Reconstruction of distal radius by fibula following excision of grade III giant cell tumour: follow-up of 18 cases. Int Orthop 2011; 35: 577-80.

[4] Panchwagh Y, Puri A, Agarwal M, Anchan C, Shah M. Giant cell tumor - distal end radius: do we know the answer? Indian J Orthop 2007; 41: 139-45.

[5] Szendröi M. Giant-cell tumour of bone. J Bone Joint Surg Br 2004; 86: 5-12.

[6] Gitelis S, Mallin BA, Piasecki P, Turner F. Intralesional excision compared with en bloc resection for giant-cell tumors of bone. J Bone Joint Surg Am 1993; 75: 1648-55.

[7] Harness NG, Mankin HJ. Giant-cell tumor of the distal forearm. J Hand Surg Am 2004; 29: 188-93.

[8] Cheng CY, Shih HN, Hsu KY, Hsu RW. Treatment of giant cell tumor of the distal radius. Clin Orthop Relat Res 2001; 383: 221-8.

[9] Chadha M, Arora SS, Singh AP, Gulati D, Singh AP. Autogenous non-vascularized fibula for treatment of giant cell tumor of distal end radius. Arch Orthop Trauma Surg 2010; 130: 1467-73.

[10] Humail SM, Ghulam MK, Zaidi IH. Reconstruction of the distal radius with non-vascularised fibular graft after resection of giant cell tumour of bone. JJ Orthop Surg (Hong Kong) 2014; 22: 356-9.

[11] Clark AG, Vignjevic DM. Modes of cancer cell invasion and the role of the microenvironment. Curr Opin Cell Biol 2015; 36: 13-22.

[12] Wu JS, Sheng SR, Liang XH, Tang YL. The role of tumor microenvironment in collective tumor cell invasion. Future Oncol 2017; 13: 991-1002.