

Original Research Article

Functional outcome of wide resection and autologous avascular proximal fibular graft arthroplasty in distal radius GCT

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Received: 15 October 2018

Revised: 13 December 2018

Accepted: 18 December 2018

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ABSTRACT

Background: Giant cell tumor (GCT) of distal radius usually presents in late stages with aggressive progression. Extended curettage alone is usually inadequate and wide resection is the most common surgery performed. Reconstruction of the resulting defect poses significant challenges.

Methods: 11 patients with distal radius GCT treated with wide resection and autologous avascular proximal fibular graft arthroplasty were studied retrospectively. One patient was Campanacci grade II and the rest 10 were Campanacci grade III. All patients underwent a standard preoperative workup and underwent a standard procedure. Patients were followed up for a mean period of 33 months (range: 1 year–7 years). Wrist movements were documented and functional outcome was scored using revised musculoskeletal tumor society scoring (MSTS).

Results: Of the 11 patients, eight had excellent outcome, two had good outcome and one had satisfactory outcome according to MSTS scoring. Mean dorsiflexion, palmar flexion, supination and pronation was 44 degrees (range 10-80), 34 degrees (range 10-70), 60 degrees (range 20-80), 54 degrees (range 15-70) respectively. The complications encountered were fibulo-ulnar diastasis in 3 patients, fibulo-carpal subluxation in 2 patients, soft tissue recurrence in 1 patient and graft site non-union in 1 patient. Despite fibula-ulnar and fibula-carpal instability functional outcomes were seen to be excellent (4 patients) or good (1 patient).

Conclusions: Avascular autologous proximal fibular arthroplasty provides for excellent to good functional outcomes after wide resection in distal radius GCT even if radiological appearances are suboptimal.

Keywords: Distal radius GCT, Autologous fibular arthroplasty, Wide resection

INTRODUCTION

Giant cell tumor (osteoclastoma) is a benign, locally aggressive tumor occurring in the 2nd to 4th decades of life.¹ This challenging tumor of the epiphysis, described by WHO as “aggressive, potentially malignant” contributes to about 5% of all bone neoplasms; moreover it has been found to account for 20% of all bone neoplasms in India and China.^{2,3} Distal radius is the third

most common site of occurrence, after distal femur and proximal tibia. Tumors arising from this site are particularly troublesome as they follow a more aggressive course, have higher recurrence rates and higher rates of lung metastasis.^{2,4,5-10}

Curettage is the preferred modality of treatment for most cases of GCT, but lesions in distal radius are usually not ideal candidates for curettage owing to the relatively

advanced stage at presentation and higher rates of recurrence following curettage.¹¹ Hence wide resection is very commonly performed for distal radius GCT, the common indications being extensive bone and soft tissue involvement, pathological fracture, articular cartilage collapse, recurrence and malignant transformation.^{12,13} Reconstruction of the resulting defect is a demanding task for the surgeon and involves choosing from a variety of options, namely arthroplasty or arthrodesis using vascularized or non-vascularized fibular autograft, ulnar translocation, osteoarticular allograft and endoprosthesis. Providing the best possible functional outcome is of paramount importance as the affected demographic is in the prime of life.

METHODS

Our study series included 11 patients treated at our institute between 2005 and 2012. Only patients with distal radius GCT treated by wide resection and fibular autograft arthroplasty were included in the study retrospectively. All patients underwent plain radiograph and MRI evaluation of the tumor pre operatively. Campanacci grading was used to grade the tumors radiologically.¹⁴ Chest radiograph and CT were done in all patients to rule out metastasis. Preoperative biopsy to exclude malignant transformation was done in two patients with particularly aggressive radiological picture. Preoperative counseling was given to all patients and expected functional results, complications and other treatment options were explained. All patients chose fibular autograft arthroplasty. One patient underwent wide resection and arthroplasty following a recurrence after curettage and packing with bone graft and artificial bone substitute. In the remaining 10 patients, arthroplasty was the primary procedure. Mean follow up period was 33 months (Range: 1 year to 7 years).

Procedure

All patients were operated upon in supine position, with the affected upper limb placed on a side board and a pillow placed under the ipsilateral knee, and parts were painted and draped. Pneumatic tourniquet was used routinely. Nine patients were operated upon using volar approach to distal radius, mainly due to familiarity with the approach by the surgeon. Remaining two patients had preexisting dorsal incisions, and they underwent dorsal exposure.

After elevating free soft tissue, radius was resected with a margin of 3-4 cm from tumor edge using extraperiosteal dissection. Soft tissue enveloping the tumor was resected as a cuff all around (Figure 1). A length of radiocarpal ligaments were preserved whenever possible. Tumor bed was treated with hydrogen peroxide solution (3%) and was packed after securing hemostasis.

Next step was to harvest ipsilateral proximal fibular graft using lateral approach. Special care was taken to avoid

injuring common peroneal nerve, the nerve being traced well into distal thigh. Length of fibula resected depended on length of radial defect, with an additional 1-2 cm to allow for fine adjustments during fixation. Lateral collateral ligaments were divided cleanly at the center and the stump of ligaments and biceps femoris were attached to proximal tibia using drill holes. Care was taken not to damage the articular surface of fibula. Leg wound was closed by an assistant after securing hemostasis. Suction drain was used in all cases.



Figure 1: Intra operative picture showing the wide margin of resection in distal radius. Soft tissue envelope of the tumor has not been violated.

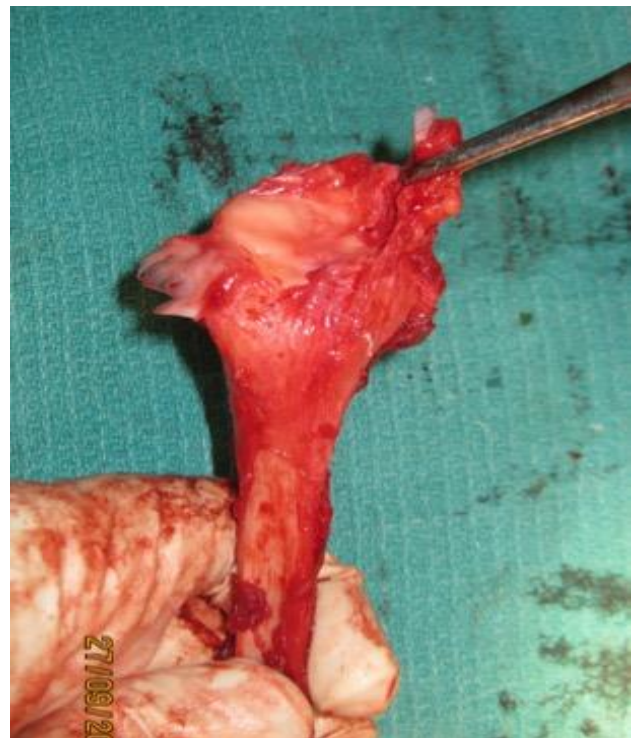


Figure 2: Intra operative picture of ipsilateral proximal fibular graft with attached lateral collateral ligament stump (held by forceps). This was sutured to radiocarpal ligament stump.



Figure 3: Final picture after graft fixation with 3.5 mm DCP and fibula-ulnar and fibula-carpal K wire fixation.

Fibular graft was placed in the forearm and the lateral collateral ligament stump was sutured to the radiocarpal ligament stump (Figure 2). Graft was reduced onto the radius such that the apex of the fibular head came to rest 5 mm distal to the ulnar styloid, thus substituting for radial styloid. Length of graft was trimmed as necessary and fixation to radius was performed with asian DCP (3.5 mm). Fibulo ulnar articulation was stabilized with a K wire passed from lateral side (Figure 3). Fibulo carpal K wire was used in some patients. Thus, the articular surface of fibula came to rest with that of the scaphoid. Graft-bone junction was augmented with autologous iliac crest graft in all cases. Wound was closed with suction drain. Long arm splint was applied with elbow in 90 degree flexion.

Postoperative protocol

Drain was removed in 2nd postoperative day. Lower limb weight bearing was allowed as tolerated; no braces were used. Finger mobilization was encouraged. Long arm splint was removed after 6 weeks along with stabilizing K wires. Passive wrist and forearm mobilization was started along with rest BE splint; gradual progression to active movements was done as tolerated by the patient. Splint was fully discontinued after 4 weeks. Lifting

weights, weight bearing on upper limb and other such strenuous activities were withheld for 8-12 months based on consolidation.

Repeat radiographs were performed at 3 monthly intervals for first 2 years, 6 monthly from years 3 to 5 and yearly thereafter. Chest radiographs were performed at 6 months to rule out metastasis. Grip strength was evaluated using dynamometer and movements were measured using goniometer. Patient outcomes were evaluated using the revised musculoskeletal tumor society (MSTS) score which scores the following factors: pain, functional activities, emotional acceptance, positioning of hand, manual dexterity and lifting ability.¹⁵ Results were reported as excellent for >90%, good for 80-90%, satisfactory for 60-80% and poor for <60%.

RESULTS

The mean age of the patients was 25.2 years (range: 16-38). There were 6 female and 5 male patients. Disease was graded using Campanacci radiological grading; all except one patient fell under grade III, the remaining patient was grade II (Table 1).

Table 1: Demographic data of 11 patients with Campanacci disease grade and follow up.

S. No	Age/ sex	Campanacci grade	Follow up (years)
1	24/M	III	3
2	25/F	III	2
3	16/F	III	3
4	26/F	III	1
5	27/M	III	4
6	38/F	III	3
7	17/F	III (recurrent)	1
8	29/M	III	2
9	30/M	III	7
10	28/F	II	2
11	24/M	III	3

Table 2. Functional outcome of 11 patients with distal radius GCT that were treated with wide resection and autologous avascular proximal fibular graft arthroplasty.

Patient No.	Supination	Pronation	Dorsi flexion	Palmar flexion	MSTS Score	Complication
1	60	50	50	45	96.67	None
2	80	60	80	70	96.67	Fibulo ulnar diastasis
3	20	70	40	30	90	Soft tissue recurrence
4	60	45	40	20	93.33	None
5	60	40	30	20	93.33	None
6	80	70	40	30	90	Fibulo ulnar diastasis
7	70	60	20	10	76.67	Non union
8	30	15	10	20	83.33	Fibulo carpal subluxation
9	75	60	80	60	96.67	None
10	65	60	45	30	93.33	Fibulo carpal subluxation
11	70	65	50	40	93.33	Fibulo ulnar diastasis
Mean	61	54	44	34	91.21	---

Of the 11 patients, eight had excellent outcome, two had good outcome and one had satisfactory outcome according to MSTS scoring (Table 2). Mean dorsiflexion

in our series was 44 degrees (range 10-80), mean palmar flexion was 34 degrees (range 10-70), mean supination was 60 degrees (range 20-80), and mean pronation was 54 degrees (range 15-70).



Figure 4: Patient no.2: 25/F, (A) Campanacci grade III disease, (B and C) 2 years follow up shows fibula-ulnar diastasis; (D-G) but patient has well preserved wrist ROM. MSTS score–96.67.

The complications encountered were fibulo-ulnar diastasis in 3 patients, fibulo-carpal subluxation in 2 patients, soft tissue recurrence in 1 patient and graft site non-union in 1 patient. It was seen that all 3 patients with fibulo-ulnar diastasis had a good range of motion and had excellent outcome on scoring (Figures 4 and 5). Of the fibulo-carpal subluxations, one had excellent score and one had good score. Hence, it is seen that despite a poor radiographic picture patients maintain good to excellent functional outcome.

The patient with soft tissue recurrence underwent excision of the lesion at one year follow up (Figure 6). She has a good functional outcome at three years follow up. The patient who had secondary wide excision and arthroplasty for recurrent tumor developed graft non-union at 8 months follow up. She was not willing for further treatment for non-union. She had a satisfactory outcome on scoring at 1 year.



Figure 5: Patient no.6: 38/F, (A) Campanacci grade III disease, immediate postop radiograph, (B) 3 years follow up radiograph shows fibula-ulnar diastasis; (C-F) but patient has well preserved rotatory movements with restriction in dorsi and palmar flexion, MSTS score- 90.

DISCUSSION

Johnson and Dahlin in 1959 wrote that “The treatment of giant-cell tumors leaves much to be desired, and the analyses of several large series of cases that have appeared in the literature serve only to add to the confusion of the reader when he attempts to determine the proper course of treatment for any given giant-cell tumor of bone”.¹⁶ More than 5 decades hence, this statement still holds true in many instances of GCT. Furthermore, distal radius GCTs are further challenging as they present with lesions in advanced stage that make salvage of the bone difficult.

Campanacci grade I tumors can be uniformly treated with extended curettage and bone grafting/cementing. Management of grade II tumors is to be considered on a case to case basis. Those with intact articular cartilage and minimal soft tissue involvement do well with extended curettage. Grade III tumors are seldom satisfactorily treated by modalities other than en bloc resection.²

None of the available grading systems have been truly established to be predictive of prognosis.^{5,17-20} Also, it is near impossible to predict the course of disease based on histological appearance.^{21,22} Chromosomal abnormalities, excessive metalloproteinase expression, overexpression

of c-myc and p53 have been linked with highly malignant behavior and metastasis.²³⁻²⁷ McDonald et al, in an analysis of 221 patients, concluded that the most significant factor governing recurrence of GCT is the surgical procedure used— 34% recurrence in curettage

with adjuvant therapy versus 7% in resection.¹¹ This has been supported by other authors also.^{19,28-30} It is also a concern that an aggressive recurrence after curettage may be more difficult to manage and might very adversely affect the functional outcome for the patient.³¹



Figure 6: Patient no.3: 16/F, (A) Campanacci grade III disease, (B and C) 3 years follow up with graft union, patient has restricted supination (D and E). (F) She presented at 3 years with soft tissue swelling in dorsum of wrist (G) which on excision proved to recurrence in extensor tendon sheath. MSTs score– 90.

Whenever wide resection is performed, reconstruction of the defect left behind after resection presents a bigger challenge than obtaining full tumor clearance. The several options available for reconstruction are non-vascularized fibular autograft, vascularized fibular autograft, ulnar translocation, osteoarticular allograft, custom prosthesis and arthrodesis.

Vascularized fibular graft has the advantage of earlier graft incorporation, but this is easily superseded by the high rates of union achieved using non vascularized graft with rigid fixation and bone grafting.^{12,32-34} Use of vascularized fibular graft is further compounded by the

need for technical expertise, vascular surgery assistance, prolonged surgical duration, extensive radiographic studies of vascular patterns of limbs, need for sacrifice of two major vessels and the high probability of jeopardizing the vascular supply while performing rigid fixation of the graft.^{12,32} In contrast, routine avascular fibular graft is technically simple to harvest and does not require any special investigations. In our series, non-union was seen only in one patient and it was not hindering function at latest follow up.

Ulnar translocation is a promising alternative, but it involves a primary ulnocarpal arthrodesis sacrificing all

wrist motion and a poorer cosmetic outcome (hourglass appearance).^{31,35} In our series, cosmesis of the involved upper limb was well maintained and wrist movements were also preserved to allow for good to excellent functional outcome.

Osteoarticular allografts have been studied by a few authors, but has disadvantages like increased risk of disease transmission and higher rate of graft fracture due to irradiation. The necessity of bone bank facilities is another prohibitive factor.³⁶⁻³⁸ Custom prostheses for distal radius have not been studied extensively and their costs are an hindrance in developing nations in public sector institutions.³⁹⁻⁴¹ Availability of allografts prohibited us from employing this methodology.

In summary, wide resection yields good success in disease control and reconstruction with autologous avascular proximal fibular graft provides for resumption of normal wrist and DRUJ functions postoperatively. Complications such as fibulocarpal or fibuloulnar subluxations do not appear to hamper good functional outcome.

CONCLUSION

Avascular autologous proximal fibular arthroplasty provides for excellent to good functional outcomes after wide resection in distal radius GCT even if radiological appearances are suboptimal. The surgical procedure is relatively simple and does not necessitate any costly imaging like CT angiogram and preserves good range of movements at the wrist.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

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Cite this article as: Murugan Y, Shanmugasundaram B, Dulasi K, Vaidyanathan S. Functional outcome of wide resection and autologous avascular proximal fibular graft arthroplasty in distal radius GCT. *Int J Res Orthop* 2019;5:42-9.