

Evaluation of Results of Resection-Reconstruction Using Autologous Non-Vascularized Fibular Graft in Giant Cell Tumour Affecting Distal Radius - A Prospective Study

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ABSTRACT

BACKGROUND

Giant Cell Tumour (GCT) is a locally aggressive benign bone neoplasm characterized by proliferation of mononuclear stromal cells and many osteoclast-like multinucleated large giant cells affecting the epiphyseal segments of long bones mostly in females of 20 - 40 years age group. Distal radius is the third most common site of occurrence of GCT next to distal femur and proximal tibia. Resection or extended curettage remain the main modalities of treatment in Campanacci Grade I and II while en-bloc excision with reconstructive procedures, arthrodesis or amputation are the treatments of choice in Grade III with the latter two procedures leading to loss of joint function. Fibula being a non-weight transmitting bone of the lower limb, can be harvested in its proximal 1 / 3rd and used for the reconstruction of the distal radius. In this study, we evaluate the functional and clinical results of resection and reconstruction using a non-vascularized fibula graft in the distal radius GCT.

METHODS

This is a prospective study of 20 patients diagnosed with GCT of distal radius either treated primarily at our institution or reviewed here after having been treated elsewhere. After confirmation of diagnosis, the patients underwent resection of the tumour and reconstruction of the distal radius using ipsilateral non vascularized fibula graft, fixed with dynamic compression plate. Follow-ups were done at regular intervals and radiological signs of graft healing, recurrence of tumour, wrist range of motion, and revised Musculoskeletal Tumour Rating Scale (MSTS) was used for assessing the functional outcome.

RESULTS

In our study, it was found that mostly females 13 (66.6 %) of the age group 30 - 35 yrs. were affected. The average grip strength achieved was 71 % (42 - 86 %) & average combined movements of 64 % (29 - 78 %) of contralateral normal side. Mean duration of union was 24 weeks (14 - 42 weeks). One case of non-union was seen which eventually achieved union with bone grafting. There was one case of soft tissue recurrence but the patient refused any further procedure. Complications were seen in 8 cases (41.6 %). We achieved excellent results in 15 (75 %), good in 2 (10 %), satisfactory in 2 (10 %) and poor in 1 (5 %) case.

CONCLUSIONS

We found that in GCT resection of the distal radius and reconstruction arthroplasty using autologous non-vascularized proximal fibular graft is useful in preserving the functional status as well as achieving satisfactory range of movement and grip strength with lesser chances of tumour recurrence.

KEYWORDS

Distal Radius, Giant Cell Tumour, Resection Reconstruction, Fibula

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BACKGROUND

Giant Cell Tumour (GCT) constitutes a locally aggressive osteolytic benign bone neoplasm characterized by proliferation of mononuclear stromal cells and many osteoclast-like multinucleated large giant cells which are the hallmark of this disease.¹ It comprises of 5 - 9 % of all primary bone tumours and about 20 % of benign bone lesions. It affects the epiphyseal segments of long bones mostly in young females in the age group of 20 - 40 years with peak incidence in 3rd decade of life.² The distal radius is the third most common site of occurrence of GCT next to distal femur and proximal tibia.³

Campanacci radiological classification serves as a guide to determine the aggressiveness, risk of local recurrence and plan of treatment.⁴ The various options being intralesional curettage, wide local excision followed by cementing, resection reconstruction arthroplasty using either fibular autograft or custom made distal radius prosthesis, arthrodesis and finally amputation.⁵ Surgical resection or extended curettage remain the main modality of treatment in Campanacci Grade I and II while en-bloc excision with reconstructive procedures, joint fusion or amputation are the treatment choice in Grade III with the latter two procedures leading to complete loss of joint function.⁵

The reconstruction of the wrist joint due to its proximity to neurovascular and tendinous structures, constitutes a challenge for the surgeons. The technique employed should provide enough joint stability and mobility to meet the functional demands. Fibula being an almost non weight transmitting bone of the lower limb can be harvested in its proximal 1 / 3 rd and can be used for the reconstruction of the resected distal radius along with conventional internal fixation devices like dynamic compression plate and Kirschner Wires (K-wire) with very less donor site morbidity and good functional outcome with preservation of the wrist joint.⁶

This study aims at evaluating the long term results of this procedure where a non-vascularized proximal fibular autograft has been used for reconstruction of the resected distal radius due to GCT.

METHODS

This prospective, single center, cohort study was conducted from December 2017 to November 2019 in the Department of Orthopaedics, Sri Ram Chandra Bhanja Medical College & Hospital, Cuttack in patients with giant cell tumour of distal radius either treated primarily at our institution or reviewed at our institution after having treatment elsewhere. Before enrolling any patient for the study, informed written consent was obtained.

Sample size was determined using this formula $n = z^2 p (1 - p) / d^2$ [z - Confidence coefficient for level of confidence of 95 % = 1.96, p - prevalence of GCT in distal radius = 1 % (0.01), d - absolute precision = 0.05, n = 15, additional 30 % (4.5) added to cover for loss to follow up. Hence total sample size comes to be 19.5 (20)]. Convenience sampling

was done as per the availability and accessibility of the patient.

A total of 20 patients were included in the study based on the following inclusion and exclusion criteria. The inclusion criteria included patients who gave consent for treatment with 1) Histopathologically confirmed GCT affecting the distal radius, 2) GCT belonging to Campanacci grade III with blown out cortex, 3) Selective cases of GCT belonging to Campanacci Grade II with subcortical bone stock available for curettage, 4) Recurrent GCT previously treated with curettage and bone cement implantation. Patients who didn't give consent for the study were excluded from the study.

After hospitalization, detailed history was obtained with emphasis on any previous treatment or procedures. Then a thorough general and systemic check-up, musculoskeletal examination of both the wrists was done, appropriate radiographs (anteroposterior & lateral views) of the involved wrist, ipsilateral leg, MRI of the involved wrist with tumour profile and contrast and finally confirmation by histopathological study with needle biopsy were done.

After administering general anaesthesia in a supine position either a volar or dorsal approach, was used depending upon anterior or posterior expansion of the tumour in the wrist. The tumour was resected en bloc with five cm of distal radius as safe margin in all the cases. The bone defect was in an average 8 cm after excision of the tumour. Reconstruction arthroplasty of the defect was done using ipsilateral proximal fibular transplant which was dissected out with great care without injuring the common peroneal nerve & fixed with distal radius with a small dynamic compression plate with three cortical screws on each side with the proximal most screw in an eccentric manner to achieve axial compression. The head of the fibula which is the articulating part was transfixed with the carpals using one 1.5 mm K-wires inserted in an oblique manner. Another K-wire was used transversely to stabilize the fibular- ulnar articulation (Figure 1). Post operatively the patients were put in an above elbow posterior slab in neutral position for eight weeks.

Regular follow up was done, the slab and the k wires were removed at 8 weeks to allow elbow mobilization. After 3 months gentle active and assisted wrist exercises were started and gradually increased in intensity depending on the tolerance and comfort of patient. Clinical and radiological follow-up were done at 4 weeks, 8 weeks, 4 months, 6 months, 12 months. A dynamometer was utilized to quantify the grip strength and then compared to opposite normal side. Likewise, a goniometer was used to assess range of movement and comparison with the healthy side. At latest follow up, functional results were described using the revised musculoskeletal tumour society score which gives scores to patients based on factors (pain, functional activities, and emotional acceptance) applicable to patient as a whole and factors specific to either upper limb (positioning of hand, manual dexterity, and lifting ability) or the lower limb. Results were marked as excellent for MSTS score > 90 %, good for 80 - 90 %, satisfactory for 60 - 80 % and poor for ≤ 60 % score intervals. (Figure 2).

Statistical analysis was done using Microsoft Excel 2013. Mean & percentage mean was calculated from the available data.

RESULTS

In our study of 20 patients, females 13 (66.6 %) were found to be involved more than the males 7 (33.3 %). The age distribution of the disease is shown in Table 1. It was mostly found in the age group of 30 - 35 years 10 cases (50 %). Left wrist 15 (75 %) was more commonly involved than the right wrist 5 (25 %). 15 of the cases (75 %) presented in Campanacci Grade III while 5 (25 %) in Grade II. One patient in our study was treated elsewhere with extended curettage and bone cement implantation but had local recurrence. The mean duration of surgery was 90 ± 15 minutes. The average resected length of the distal radius was 8.5 ± 1 (range 8 - 12) cm.

Sl. No.	Age in Years	No. of Cases	Percentage
1	20 - 25	5	25
2	25 - 30	2	10
3	30 - 35	10	50
4	35 - 40	2	10
5	40 - 45	1	5
Total		20	100

Table 1. Age Distribution

The average grip strength achieved was 71 ± 11 % (42 – 86 %) comparing with the normal contralateral wrist. The average range of motion achieved in the involved wrist was 46° ± 5° dorsiflexion, 40° ± 3° palmar flexion, 10° ± 1° radial deviation, 22° ± 3° ulnar deviation, 50° ± 5° supination and 45° ± 2° pronation. The mean combined range of motion was 64 ± 13 % (29 – 78 %) with respect to the healthy opposite wrist. Average time for union at host graft junction was 24 ± 7 weeks (15 – 42 weeks) (Table 2). We achieved excellent result in 15 (75 %), good in 2 (10 %), satisfactory in 2 (10 %) and poor in 1 (5 %) cases as per the Revised MSTS score. There was a mean increase in 39 % between the pre op and post op MSTS score with a mean post op MSTS score of 90.39 %.

Duration	No. of Cases	Percentage
15 - 20 weeks	4	20
20 - 25 weeks	12	60
25 - 30 weeks	2	10
> 30 weeks	2	10
Total	20	100

Table 2. Duration of Fracture Union

Among the various complications, we had one patient with non-union which required a second surgery with bone grafting and eventually led to union, one patient with superficial infection which was treated with 2 weeks course of antibiotics. No donor site common peroneal nerve injury was seen. One patient had recurrence after 6 months but the patient refused for any further procedure and lost to follow up. (Figure 3).

DISCUSSION

Giant cell tumour with its varied treatment options still remains a challenge for the surgeons. The ultimate aim of the treatment is to remove the tumour completely (R0 resection), decrease chances of recurrence and preserve the joint motion. The defect created by the excision of the distal radius can be filled by non-vascularized / vascularized autogenous proximal fibular graft. Vascularized fibular speeds up the union process at host-graft junction hence reduces the period of immobilization.⁷ The long operating time for the procedure (often reaches 12 - 14 hours), lack of sophisticated infrastructure, lack of skill have made its use limited. Hence we used the nonvascularized proximal fibular autograft.

In our study we found a female preponderance (66 %) which is in contrast to study by Cao et al who found a male dominance (52.1 %) which could be due to the population of study being different.⁸ Most of the cases (75 %) encountered in our study was of Campanacci Grade III which is similar to Salunke et al who found 88 % Grade III cases.⁹ The higher number of advanced stage disease could be due to the less awareness regarding the condition, an insidious nature of disease and tendency to get treated by local bone setters.

The mean resected length of radius was 8.5 cm which is similar to Humail et al where the resected bone measured 9 cm in an average.¹⁰ The average grip strength achieved was 71 % and the mean combined range of motion was 64 % of the contralateral normal wrist which is comparable to Saini et al. Average time for union in our study was 24 weeks which is less than that to Saini et al i.e. 33 weeks which may be due to improper surgical technique, not using compression mode in plating and early return to activity in the later.¹¹ We achieved excellent result in 15 (75 %) cases as per the MSTS rating which is more than that of Saini et al (46 %).¹¹

Non-union was seen in only 1 case in our study while Murray et al reported 5 cases of non-union in a study of 18 cases which could be due to inadequate fixation of the graft or improper principles of compression.¹¹ We didn't have delayed union in any of the cases. Saikia et al advised doing routine cancellous bone grafting at the host-graft junction to prevent delayed union but in our study cancellous bone grafting was not done primarily.¹² There were no cases of graft fracture in our study. Similar results were also obtained by Cheng et al.¹³ We didn't find any significant donor site morbidity like pain, weakness, lateral instability and neuropraxia of common peroneal nerve which is in contrary to Murray et al who found it frequently.

The other treatment options like bone grafting or cementing after intralesional curettage of the tumour has a significantly high local recurrence rate.¹⁴ It has been reported that GCT of distal radius is particularly more aggressive and has an even higher rate of local recurrence.¹⁵ Wrist arthrodesis with autologous fibula or ulna produces a painless, stable wrist, at the expense of mobility.



Figure 1. A. Preoperative Radiograph, B. Immediate Post Op, C. Follow up after 6 Months, D. Post Op Dorsiflexion of Wrist, E. Assessment with Dynamometer



Figure 2. A, B. Preoperative Radiograph, C. Immediate Post Op, D. Follow up after 6 Months showing Dorsiflexion, E. Showing Supination of Wrist



Figure 3. A, B. Initial Preoperative Radiograph. C, D. 6 Months Follow up showing Recurrence. E, F. Clinically Evident Recurrence

Many authors report good outcome with arthrodesis in low demand patients.¹⁶ Osteoarticular allografts may be a good option provided there is bone bank which due to its high cost and lack of voluntary body donation is very limited in our country.¹⁷

Ceramic custom made distal radius prosthesis can be used if the bone defect is large (> 8 cm) and it provides a reasonable alternative to autograft but leads to early arthritis.¹⁸ Bipolar hinged mega prosthesis can be used but due to the incompatibility between prostheses and the host bone, prostheses are not suitable for long-term survival. To ensure the long-term survival of the prosthesis, bone union is of paramount importance. Natarajan et al in 16 cases of GCT of distal radius treated with mega prosthesis achieved mean 75 % MSTS rating post operatively.¹⁹ Very rarely Ilizarov mode of reconstruction of the distal radius after resection of GCT has also been published in literature.²⁰

Limitations of our study include less number of patients, limited follow up period and being a non-comparative study, its efficacy could not be matched with any other method. Hence randomized control trial with larger sample size with other available methods of treatment will be helpful in establishing the true potential of this procedure.

CONCLUSIONS

Our method of autologous non-vascularized fibular grafting after en bloc resection of tumour provides good functional outcome and has several advantages like restoring the normal joint movement and preservation of the cartilage over the carpal bones which is well known to be an effective barrier to the spread of tumour, and hence decreases local recurrence. In future, if required, arthrodesis can be done in

a second stage surgery with a relatively simple procedure. It obviates the need of major infrastructural facilities and microvascular anastomosis skills and has an easy learning curve.

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