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Functional Outcome in management of distal radius Giant Cell Tumour through En-Bloc Resection and Reconstruction with Ipsilateral Non-Vascularized Fibular Graft

D A.K.Prabhakaran [1], Dr.Yeshwanth Subash[2*]

[1]Department of Orthopaedics Saveetha Medical College and Hospital Saveetha university , Thandalam, Chennai – 602105,Tamilnadu, India
[2]Department of Orthopaedics Saveetha Medical College and Hospital Saveetha university , Thandalam, Chennai – 602105, Tamilnadu, India
*Corresponding Author

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ABSTRACT

Introduction: Giant cell tumors (GCT) of the distal radius pose a significant challenge in management due to their unique clinical characteristics and the complexity of the distal radius region. This study addresses the multifaceted challenges by exploring the outcomes of en bloc resection and reconstruction with ipsilateral non-vascularized fibular graft. The distal radius's impact on wrist joint functionality, the late presentation of cases, and the imperative goals of complete excision and functional restoration necessitate innovative surgical approaches.

Materials and Methods: A retrospective and prospective analysis of 16 patients who underwent wide resection of distal radius GCT and reconstruction with non-vascularized fibular graft from Feb 2016 to Feb 2024 was conducted. Patients were selected based on specific criteria, excluding recurrent cases. Ethical approval and informed consent were obtained, and standardized protocols were followed for evaluations, surgeries, and postoperative care. Functional outcomes, radiological assessments, and statistical analysis were performed using established tools and IBM SPSS Version 22.0.

Results: The study included 16 patients (mean age: 40.9 years, 67% females), predominantly with Campanacci grade II tumors. The ipsilateral fibula was harvested in 66.7% of cases. The union rate was 93.3%, and the average time to union was 12.5 weeks. Functional outcomes showed preserved global range of motion (64%) and an average MSTS score of 78.4%. Complications included infected non-union, graft collapse, graft fracture, and iatrogenic common peroneal nerve injury. Recurrence rate was 18.75%, associated significantly with patient age.

Conclusion: Reconstruction with ipsilateral non-vascularized fibular graft after en bloc resection emerges as a promising approach for distal radius GCT, offering favorable functional outcomes and an acceptable recurrence rate. The study emphasizes the importance of tumor grading, margin positivity, and fibuloulnar distance in predicting outcomes. The negative correlation between MSTS score and fibuloulnar distance calls for further investigation. The study encourages further exploration of statistical associations and reinforces the importance of surgical meticulousness in achieving optimal outcomes for patients with distal radius GCT.

Keywords: Giant cell tumour, reconstruction; non-vascularised fibular graft; functional outcome; recurrence ; management

INTRODUCTION

The management of giant cell tumours of the bone (GCT), particularly those occurring in the distal radius, presents a multifaceted challenge due to the intricacies in clinical presentation, treatment complexities, and the unique issues associated with the distal radius location [1]. This benign mesenchymal tumour primarily affects the extremities of long bones, with a significant occurrence in the epiphyseal region [2]. Globally, GCT represents around 5% of primary benign bone tumours, exhibiting a higher prevalence in Asian populations [3]. With a slight predilection for females and occurrences typically in individuals aged 20-45, the tumour's manifestation in the distal radius adds an extra layer of complexity [4]. Notably, GCT may exhibit aggressive behaviour, with documented cases of malignant transformation and distant metastasis [5]. Local recurrence rates after tumour removal range from 20-50%, underscoring the importance of effective management strategies [6].

The distal radius, a critical site due to its impact on wrist joint functionality, poses specific challenges in surgical intervention. Late presentation of cases in certain settings further complicates the surgical landscape. The

imperative goals of GCT treatment involve complete excision, prevention of recurrence, and restoration of functional abilities, especially in the wrist joint. The distal radius, being prone to higher recurrence rates compared to other sites, necessitates innovative approaches.

One such promising approach involves en bloc resection and reconstruction with an ipsilateral non-vascularized fibular graft. This technique has demonstrated a significant reduction in recurrence rates to less than 5%, making it a well-tested option [7,8]. However, its functional impact and recurrence rates in an Asian context warrant further investigation. Parameters such as the postoperative distance between the ulna and fibular graft in X-rays play a crucial role in determining the functional capacity of the reconstructed wrist joint.

In our study aims to assess clinicoradiological parameters related to complications and recurrence rates in distal radius giant cell tumours. Additionally, we aim to evaluate the functional outcomes of the hand and forearm in patients treated with en bloc excision and reconstruction using an ipsilateral non-vascularized fibular graft.

MATERIALS AND METHODS

This is a retrospective and prospective analysis of patients who underwent wide resection of the GCT of distal radius and reconstruction with non-vascularized fibula graft from Feb 2016 to Feb 2024. Patients were chosen from admissions to the trauma ward in the Department of Orthopaedics at Saveetha Medical College, Chennai, based on specific criteria with a minimum follow-up period of three years. Only patients with primary tumors at their initial presentation were included, while those with recurrent disease were excluded. Ethical approval and informed consent were obtained from all participants. Patients underwent initial evaluations, detailed medical history, and physical examinations upon admission, following a standardized management protocol. Subsequent radiological evaluations, blood investigations, and surgery were conducted after obtaining informed consent and ensuring anaesthesia fitness patient was taken up for surgery.

The surgical procedure involved the same operating team for every case, with a pneumatic tourniquet applied to both the operated limb and the donor's leg. The ipsilateral fibula was harvested in most cases, although the contralateral fibula was used in some cases based on surgeon preference. The approach for the distal radius depended on tumor extension, with careful dissection to preserve surrounding tissue integrity. The proximal fibula graft was harvested, and rotational alignment was marked for plating. The fibula was plated to the radius using a Dynamic Compression Plate, and periosteal sleeve and ligament repairs were performed.

Postoperatively, ulnar gutter splint was applied for six weeks, with sutures removed at two weeks and Kirschner wires at six weeks. Night splints and physiotherapy were continued for another six weeks, with gradual arm usage, wrist ROM permitted after 6 weeks while avoiding heavy lifting and strenuous activities.

Parameters including range of motion, grip strength, and functional scores were evaluated using standardized tools during clinic visits, and radiological assessments were conducted to monitor union and progress. Statistical analysis of collected data was performed using IBM SPSS Version 22.0, with a P-value of less than 0.05 considered statistically significant.

RESULTS

This prospective study of 16 patients who underwent wide resection of the distal radius with non-vascularized fibular graft in the study. The mean age was 40.9 years (range: 24–56) [table 2], with a predominance of female patients (67%) [fig 1]. The dominant hand was involved in 60% of cases. Campanacci grade II tumors constituted 73.3%, while grade III tumors comprised 27%, with no cases of Grade I tumors. The average follow-up duration was six years (3.25–9.92 years). The fibular graft was harvested ipsilaterally in 66.7% and contralaterally in 33.3% of patients [table 1]

The mean resection length of the distal radius was 7.89 cm (range: 5–12 cm). The study employed the volar approach solely in nine cases, while a combined volar and dorsal approach was used in seven patients. The mean blood loss of about 146.3 ml during the surgery. Fibula carpal joint reduction was observed in 27% of subjects, with 53% experiencing less than 0.5 cm subluxation and 20% having ≥0.5 cm subluxation of the joint. Dislocations of the joint were not reported, and the fibula ulna joint remained intact in all 15 cases. Additionally, 60% displayed <2 mm joint space narrowing of the fibula carpal joint.

The union rate was 93.3% (n = 14), with an average time to union at 12.5 weeks (range: 5.6–27.9). Grip strength averaged 48.07% (range: 9–99%) compared to the opposite hand. The average range of movements included 67° (0°–100°) for forearm supination, 45° (0°–90°) for forearm pronation, 47° (0°–90°) for wrist flexion, and 27° (0°–80°) for wrist extension, with combined movements of 162° (80°–200°). Overall, 64% (29–78%) of the global range of motion was preserved.

The mean MSTS score was 78.4% (range: 30–93), DASH score was 25.2 (range: 9–59), and TESS score was 83.98% (range: 57.9–95.2%). The use of an ipsilateral fibula significantly correlated with better TESS ($p = 0.029$) and DASH ($p = 0.033$) scores, but not MSTS ($p = 0.067$) score, and had no significant impact on grip strength ($p = 0.505$) [fig 2]

Complications included one case of infected non-union treated with debridement and external fixation, another case of graft collapse addressed with a vascularized fibula graft, and a subsequent case of graft fracture

requiring plate removal and splinting. Additionally, one case of iatrogenic common peroneal nerve injury resulted in persistent symptoms. These complications did not significantly impact MSTS (p = 0.102) and DASH (p = 0.115) scores and grip strength (p = 0.551), but notably affected TESS scores (p = 0.002).

This study examined recurrence patterns in 3 patients, revealing an overall recurrence rate of 18.75%, encompassing soft tissue (2 cases) and bony (1 case) instances. Notably, all recurrences were observed in patients below 30 years. Age demonstrated a significant association with recurrence (p=0.037). Other factors, including tumor grade, margin positivity, redo surgery, and tumor size, did not exhibit statistically significant associations with recurrence.

DISCUSSION

The treatment landscape for giant cell tumors (GCT) of the distal radius has evolved, with various surgical techniques demonstrating both advantages and disadvantages. Enbloc excision has been shown to have a lower recurrence rate compared to intralesional extended curettage [3]. Our study contributes to this body of knowledge by focusing on reconstruction with an ipsilateral proximal fibular non-vascularized graft, which has been reported in the literature to offer good functional outcomes and low recurrence rates.

In support of our study, Aithal and Bhaskaranand et al. reported a local recurrence rate of nearly 60%, with 13.3% of patients requiring amputation [9]. The use of ipsilateral proximal fibular grafts in our study may account for the favourable functional outcomes observed, as we report a recurrence rate of 18.75%, which is deemed acceptable considering the late presentation of most cases in our centre. Our average MSTS score of 20.36 +/- 3 aligns with the outcomes reported by Saraf and Goel's et al., which included 42 patients treated with resection and a non-vascularized fibular graft [10]. Ten out of 24 patients (41.6%) in the study by Saikia et al. had carpal subluxation compared to 4 out of 13 patients (30.7%) in the series reported by Maruthainar et al. [11]. The overall complication rate was 42.3%, with wound infection found in 15.3% of patients. Other reported complications included fibulocarpal arthritis, graft failure, and non-union of the graft.

Comparisons with other studies reveal similar grip strength and range of motion (ROM) values. Lackman et al. reported a mean grip strength of 49%, while Maruthainar et al. observed 57% [12]. Our study showed an average ROM and grip strength compared to the opposite side of 44.27% and 50.36%, respectively. Although limited by a smaller sample size, our functional outcomes are comparable to or even more favourable than those reported by Saini et al., Maruthainar et al., and Saraf and Goel.

Interestingly, our statistical analysis showed a significant association between the Musculoskeletal Tumour Society (MSTS) score and the grade of the tumour. Grade 3 tumours exhibited a higher MSTS score compared to Grade 2 tumours, emphasizing the importance of tumour grading in predicting functional outcomes [13]. However, caution is warranted in interpreting this finding due to the absence of Grade 1 tumours for comparison and the small sample size.

Additionally, we explored the correlation between the MSTS score and fibuloulnar distance, revealing a negative correlation, though not statistically significant. This novel insight into the functional implication of fibuloulnar distance calls for further investigation with a larger sample size. Our study also noted a statistically significant association between MSTS score and margin positivity, suggesting the importance of surgical meticulousness in achieving complete tumour removal and careful follow-up [14,15].

Our study has limitations, including a small number of recruited patients due to the low prevalence rate of the condition. The use of non-vascularized grafts, especially at longer lengths, is associated with higher complications.

CONCLUSION

In our study advocates for the use of ipsilateral proximal fibular non-vascularized grafts in the reconstruction of GCT of the distal radius in 16 patients, showcasing promising functional outcomes and an acceptable recurrence rate. The statistical associations between MSTS score and tumour grade, margin positivity, and fibuloulnar distance warrant further exploration with larger cohorts. Reconstructing with a non-vascularized fibular graft following en bloc resection emerges as a favourable treatment approach for giant cell tumours in the distal radius. This method exhibits notable advantages, including minimal recurrence rates, low infection occurrences, and favorable functional outcomes in comparison to international studies. In addressing Campanacci grade 3 tumours, the treatment decision often involves a choice between amputation and wrist arthrodesis. Close postoperative monitoring proves effective in identifying and managing recurrence, particularly in soft tissues. Timely intervention with intravenous antibiotics and debridement effectively controls wound infections. A noteworthy statistical correlation exists between recurrence rates and the patient's age. Additionally, the fibuloulnar distance, as assessed through postoperative X-rays, demonstrates a significant correlation with functional outcomes, as reflected in the Musculoskeletal Tumour Society (MSTS) score.

Declaration
Funding
None

Conflict of interest
None declared

Ethical approval
None required

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Table 1: demographics data

Patient no	Age	Gender	Follow up (months)	Campanacci	Fibula graft	Length, cm	Union (days)	Subluxation	MSTS SCORE
1	51	Male	61	3	Ipsilateral	7.5	43	<0.5 cm	70
2	32	Female	97	2	Ipsilateral	5	120	nil	80
3	34	Female	61	2	Ipsilateral	7	132	<0.5 cm	80
4	54	Female	61	2	Ipsilateral	12	40	nil	87
5	38	Female	99	2	Contralateral	8	64	<0.5 cm	93
6	29	Female	62	2	Contralateral	7.5	92	nil	90
7	38	Female	119	2	Ipsilateral	6	46	>1 cm	67
8	29	Female	58	2	Ipsilateral	11	56	nil	83

9	24	Female	82	3	Contralateral	6.3	70	<0.5 cm	87
10	34	Male	30	2	Ipsilateral	9.5	39	<0.5 cm	83
11	46	Male	60	2	Ipsilateral	8	Infected non-union	<0.5 cm	30
12	56	Male	112	3	Contralateral	7	168	<0.5 cm	93
13	38	Female	106	3	Contralateral	10	195	<0.5 cm	80
14	56	Female	39	2	Ipsilateral	7	68	>1 cm	76.7
15	55	Male	39	2	Ipsilateral	6.5	46	>1 cm	76.7
16	34	male	92	2	Ipsilateral	7	48	nil	83

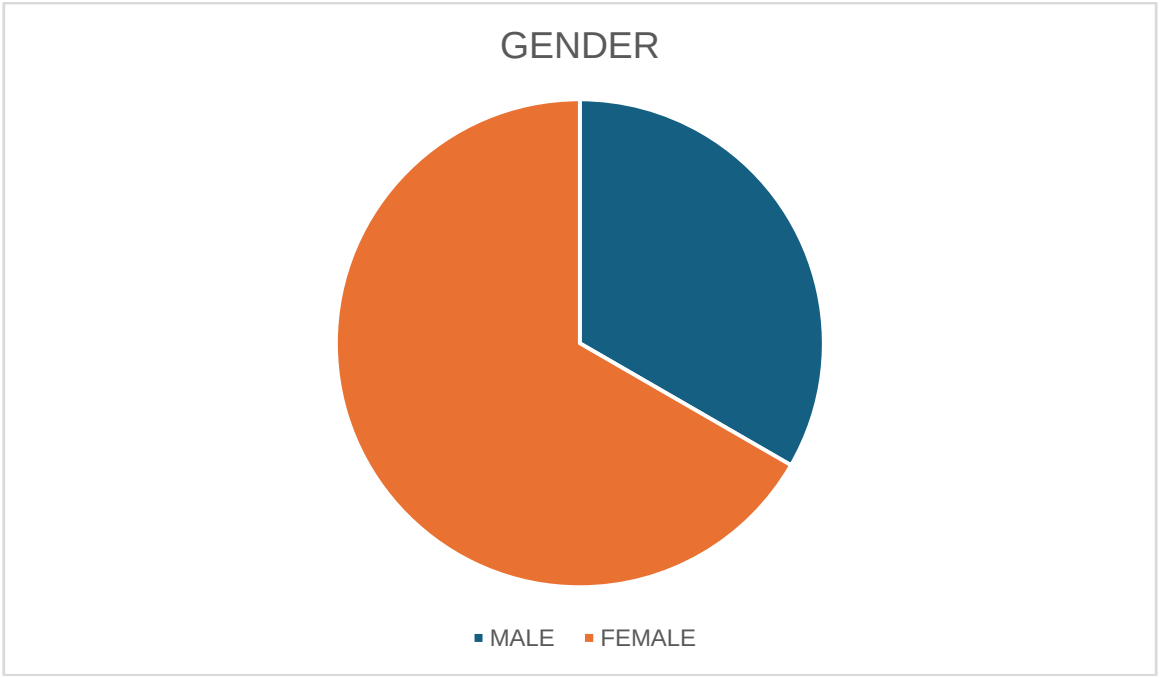

Fig 1: gender distributiom

Table 2: age distribution

Patient Age Group(Years)	Number Of Patients
10-20	0
20-30	3
30-40	4
40 TO 50	3
50 TO 60	5

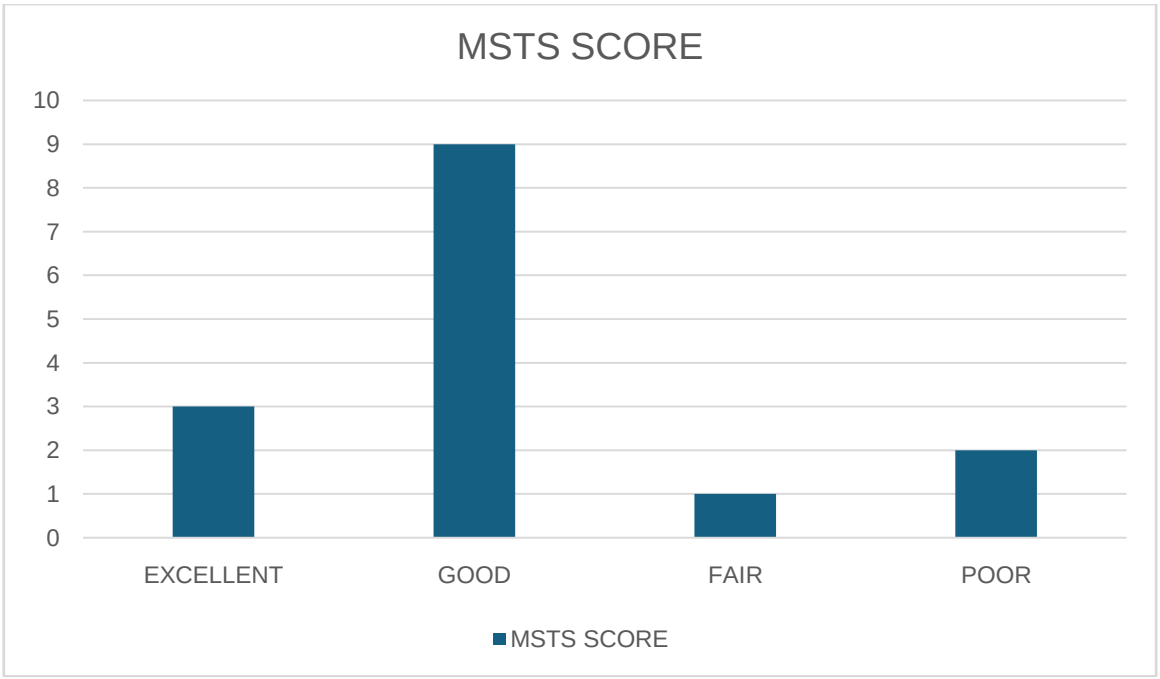

Fig 2: functional outcome score