

Outcomes of short segment distal radius resections and wrist fusion with iliac crest bone grafting for giant cell tumor

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ABSTRACT

Background: Distal radius is third most common site for occurrence of Giant cell tumor (GCT) of bone. Most of Campanacci grade II & III cases require resection. Reconstructions of these defect are challenging. Though fibular arthroplasty provides mobility at wrist but is fraught with complications of donor site morbidity and instability with wrist pain. Wrist arthrodesis with ulna translocation provides stable reconstruction but is cosmetically less appealing. We present a series of 12 cases of GCT of distal radius treated with short segment (6 cm or less) resections and wrist fusion with iliac crest grafting. We evaluated donor site morbidity, functional and oncological outcomes.

Objectives: To assess time to union, donor site morbidity, functional and oncological outcomes after wrist fusion with iliac crest bone grafting for distal radius resection (≤ 6 cm).

Methods: Retrospective analysis was performed from a prospectively maintained database between January 2011 and December 2017, 12 patients (7 male and 5 female; 9 primary and 3 recurrent; all Campanacci grade III) were included. Mean age was 29 years (15–41 years) with mean resection length of 5.1 cm (4.5–6 cm). The dominant hand was involved in 6 patients. Time to union, donor site morbidity, functional and oncological outcomes were evaluated. Functional outcomes were evaluated using Musculo-Skeletal Tumor Society (MSTS) score and Patient Rated Wrist Evaluation (PRWE) score. Grip strength and arc of forearm rotation were also evaluated.

Results: All patients were available for analysis. No symptomatic donor site morbidity was observed. One patient had prominent implant following a fall and delayed union. Mean time to union for 22 osteotomy sites in rest of 11 patients (both proximal and distal) was 6 months (4–11 months). At median follow up of 45 months (18–78 months) 2 patients had soft tissue recurrence, 1 had a stable pulmonary metastasis. Local Recurrence rate was 17%. All patients returned to their pre surgery activity. Mean MSTS score was 25 (19–29) and PRWE score was 12 (6–28). Grip strength and Prono - supination measurements were available in 10 patients. Grip strength was 69% of non operated limb. Mean supination was 53° (0° to 80°) and mean pronation was 73° (40° to 80°). Mean arc of rotation was 126° (80° to 160°).

Conclusion: Reconstruction of distal radius bone defects with Iliac crest bone grafting and wrist arthrodesis retains prono-supination while maintaining wrist girth (cosmesis). The oncologic and functional outcomes make it an acceptable modality in selected cases of distal radius tumours with short resection length (≤ 6 cm).

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1. Introduction

The distal radius is the third most common site for giant cell

tumor of bone affecting 9%–22% of all cases.^{1–3} Giant cell tumours (GCT) are radiologically classified by Campanacci in 3 grades based on cortical expansion and soft tissue extent⁴. Campanacci grade I and most grade II lesions can be managed by intra-lesional curettage. Campanacci grade III are best managed by resection of distal radius as recurrence rates (25%) are high after curettage.^{4,5} Modalities of reconstruction after resection of distal radius tumours vary. There are an equal number of proponents of arthroplasty (with fibula graft or megaprosthesis) as there are for

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arthrodesis.^{6–13}

The iliac crest commonly is used as an autograft for many orthopaedic procedures. It can also be used after short segment distal radius resection for wrist fusion. The use of iliac crest as a reconstruction modality is limited to resection of short segment as it is not feasible to harvest a long segment of linear bone graft from iliac crest. This can avoid the donor site morbidity associated with harvesting a fibula graft and the poor cosmesis associated with using the ulna to create a “one bone” forearm.^{14–16}

The aim of this study was to evaluate the results of wrist fusion with iliac crest grafting after resection of the distal radius (for resections 6 cms or less). We assessed the complications of the technique, donor site morbidity, time taken to union, oncological outcome and functional outcome.

2. Materials and methods

We conducted a retrospective review from a prospectively maintained surgical database. All details pertinent to the patient such as medical records, imaging, complication and oncologic outcomes were retrieved and functional status was reviewed. Between January 2011 and December 2017, 67 distal radius tumours were treated with resection, in 12 of this patients the resection length was ≤ 6 cm. All 12 patients were treated with wrist fusion with iliac crest bone grafting (Table 1) and were Campanacci grade III GCT. There were 7 male and 5 female patients with a mean age of 29 years (15–41). Three patients had recurrent disease at the time of procedure. Dominant extremity was affected in 6 patients and non-dominant in 6.

Pre-operative histopathological diagnosis was confirmed as GCT. Radiographs and magnetic resonance imaging (MRI) of the wrist and a chest radiograph was done. All cases were carefully assessed and decision to perform iliac crest grafting was done in a joint clinic by the senior authors (AP,AG). Cases needed resection more than 6 cms were excluded as they were reconstructed by other modalities. Preoperative an Allen's test was performed in all patients to check for the patency of radial and ulnar vessels. In an attempt to facilitate resection, 2 patients received pre-operative Denosumab 4 patients received pre-operative Zoledronic acid.¹⁷ No patients received post-operative Denosumab or Zoledronic acid.

3. Operative technique

A tourniquet was used in all cases. Wide excision of the distal radius was performed through a dorsal approach with incision centring over 3rd metacarpal. Extensor tendons of thumb and fingers, radial vessels and superficial radial nerve were dissected on

dorsal side and pronator quadrates muscle was kept as a margin over tumor on volar side. Cartilage of scaphoid and lunate was denuded to expose bone for arthrodesis. A tricortical iliac crest graft was harvested with a separate set of instruments after measuring the size of the defect. The auto graft was shaped to create a narrow straight tricortical strut. This graft was used to reconstruct the bone defect between radius and scaphoid. Wrist fusion was done maintaining 10–15° of dorsiflexion in neutral position after ensuring complete supination and pronation. Osteosynthesis was done using appropriately contoured plates and screws Fig. 1.

The mean Resection length was 5.1 cm, (range 4.5 cm –6cm). Mean surgical time was 139 min and mean blood loss was 178 ml. All patients were given a below-elbow splint for 6 weeks. Active shoulder, elbow and finger mobilisation was encouraged in the immediate post-operative period. Supination pronation was encouraged after splint removal.

Patients were followed up every 3 monthly for 2 years, every 6 monthly till 5 years and yearly thereafter. During each visit patients were evaluated clinically to assess function and radiographs of the wrist were evaluated for union. Union was defined as continuity of 3 out of 4 cortices on biplanar radiographs in antero-posterior (AP) and lateral views. A chest radiograph was evaluated every six months for evidence of metastases. Objective functional evaluation was done at the final follow-up using the Musculoskeletal Tumor Society Scoring System (MSTS)²² and Patient Rated Wrist Evaluation score (PRWE)²³. MSTS for the upper limb was based on the analysis of 6 factors i.e. pain, function, emotional acceptance, hand positioning, dexterity and lifting ability. For each of the six factors, values of 0–5 were assigned based on established criteria. The result was expressed as a sum-total with a maximum score of 30. PRWE is a 15-item questionnaire designed to measure wrist pain and disability in activities of daily living. Score is evaluated by measuring sum of pain and function score with less score indicating better outcome. All patients were also evaluated for grip strength using hand dynamometer and supination pronation with goniometer at final follow up.

4. Results

All patients were available for follow up at median follow up of 45 months (18–78 months). One patient had prominent implant distally following fall and had delayed union of both osteotomy sites at 20 months. He refused any further intervention as he is asymptomatic. Mean time to union for 22 osteotomy sites in rest of 11 patients (both proximal and distal) was 6 months (4–11 months). Two patients complained of temporary paraesthesia on outer aspect of iliac crest which subsided without any intervention.

Table 1

S.No	Age	Sex	RL	MU	DU	Follow up	Status	Sup	Pro	GS op	GS non op	MSTS	PRWE
1	30	F	5	4	4	78		20	80	12	18	27	1
2	25	M	5	5	5	59						21	19
3	25	F	6	5	5	63	Lung Metastasis (stable)	0	80	12	32	22	8
4	33	M	6	6	6	59		60	60	23	25	21	11
5	24	M	5.5	10	10	58		80	80	27	35	27	10
6	32	M	6	8	8	43						24	20
7	21	F	5.5	5	5	49	Soft tissue recurrence	40	80	8	16	19	28
8	15	F	4.5	3	3	37		70	80	20	21	27	5
9	41	M	5	20	20	31		65	40	15	24	28	10
10	31	M	4.5	6	6	28	Prominent implant & soft tissue recurrence	80	70	19	30	29	12
11	41	M	4.5	11	11	19		80	80	25	42	27	6
12	30	F	4.5	4	4	18		40	80	24	21	25	11

S.No: Serial No, RL: Resection Length, MU: Metaphyseal osteotomy Union, DU: Diaphyseal osteotomy Union, Stat: Status, Sup: Supination, Pro: Pronation, GS op: Grip Strength of operated limb, GS non op: Grip Strength of non-operated limb MSTS: Musculoskeletal Tumor Society score, PRWE: Patient rated wrist evaluation score.



Fig. 1. Pre-operative radiograph (figure a) of Rt forearm with wrist with radius ulna showing osteolytic expansile lesion in distal end of radius. Biopsy confirmed it to be GCT. Intra-operative pictures (figure b) showing harvested iliac crest bone graft, contoured 3.5 mm dynamic compression plate (DCP) and forearm after reconstruction with iliac crest bone graft and osteosynthesis with 3.5 mm DCP. 58 months follow up radiograph (figure c) showing union of both osteotomy site.

No other donor site morbidity was observed.

Two out of 12 patients had local recurrence at 8 and 28 months. One of this was a recurrent case who developed soft tissue recurrence at 8 months following distal radius resection. This was excised again. Second patient developed bony recurrence with a soft tissue component at 28 months. He also had an asymptomatic prominent implant and is scheduled for surgery. One patient developed unresectable pulmonary metastasis and was treated with serial angio-embolization and Denosumab. The patient has stable pulmonary disease at 63 months follow up post index surgery.

Mean MSTS score was 25 (19–29). Mean PRWE score was 12 (1–28). All patients had returned to their prior occupation. Supination, pronation and grip strength measurements were available in 10 out of 12 patients. Operated hand grip strength was 69% of non-operated hand grip strength. Mean supination was 53° (0° to 80°) and mean pronation was 73° (40° to 80°). Mean arc of rotation was 126° (80° to 160°) (Fig. 2).

5. Discussion

Intralesional procedures are preferred for Campanacci grade I and grade II lesions as they give better functional results compared to reconstruction modalities post resection i.e. arthroplasty and arthrodesis. Management of Campanacci grade III tumours needs to strike a balance between morbidity of resection versus increased chances of local recurrence. Excision may be preferred to reduce the incidence of local recurrence, particularly if the tumor invades the wrist joint, destroys more than 50% of the cortex or break through the cortex with an extra osseous mass in more than one plane.¹⁸

Reconstruction of bone defect after distal radius excision has always been a challenge. Arthroplasty with fibula graft retains wrist movement with better cosmesis but is associated with high rates of wrist subluxation, arthritis and wrist function deteriorates with time.¹⁹ In addition donor site morbidity (common peroneal nerve injury, joint laxity) can occur.^{14,15} Reconstruction with a mega-prosthesis also retains wrist movement with cosmesis but is associated with infection and loosening.⁶ Wrist arthrodesis may be performed using a fibula, iliac crest or ipsilateral ulna (ulna translocation).^{8,11–13,16,20} While arthrodesis using the fibula is associated with increased donor site morbidity^{14,15} ulnar translocation is associated with narrowing of the wrist which may not be cosmetically appealing to patients.

The iliac crest commonly used as an autograft for many

orthopaedic procedures can also be used after distal radius resection to achieve wrist fusion. The limitation is it can be attempted only for short segment resections (≤ 6 cm), as it is not feasible to harvest a long segment of linear bone graft from iliac crest.

Previously we have advocated wrist fusion by ulna translocation. Even though this technique has given us reproducible good results, it is associated with poorer cosmesis (narrowing of wrist due to one bone forearm) and loss of adjacent ulna which may be helpful in salvaging future recurrences.¹⁶ Iliac crest grafting is cosmetically more acceptable than ulnar translocation as it maintains wrist girth with an added advantage of leaving behind the ulna for management of any future local recurrences.

Except for two patients who complained of temporary paraesthesia on outer aspect of iliac crest there was no donor site morbidity. The technique of harvesting the iliac crest graft is quite familiar to orthopaedic surgeons and attention to good technique can minimize complications such as meralgia paresthetica, persistent pain at the harvest site, fracture, hernia and possibility of tumor seeding.²⁰

In our study 2 osteotomy site had a delayed union due to fall rest osteotomy sites united uneventfully. These rates are comparable to our earlier published data of reconstruction of distal radial effects with ulna translocation.¹⁶ Another ulna translocation series by Vyas at al showed a union rate of 70%, with use of only intramedullary k wire for fixation.²⁴ In the series of Wang et al. union rate of wrist fusion with iliac crest bone grafting was 79%.²⁰ They postulated the use of a less rigid 3.5 mm reconstruction plate could have contributed to the 21% non-union or delayed-union rate. This emphasise the need of rigid fixation. We have used 3.5 mm dynamic compression plate in our series which we feel provides more rigid fixation and helped achieving better union rates.

In our study arc of forearm rotation was 126° which is comparable to the study by Wang at al, in which they observed arc of forearm rotation 113°²⁰ and to other published ulna translocation study.²⁴

In our study operated limb hand mean grip strength of 69% of non-operated hand, which is comparable to the study by Saikia at al in which they observed grip strength of operated hand to be 67% of non-operated hand where they used auto non-vascularized fibula for wrist arthrodesis.²¹ Grip strength in our study is also comparable to other published ulna translocation study.²⁴ However in the study by Wang at al,²⁰ they observed that operated hand grip strength was 51% of non-operated limb which is lower than our study.

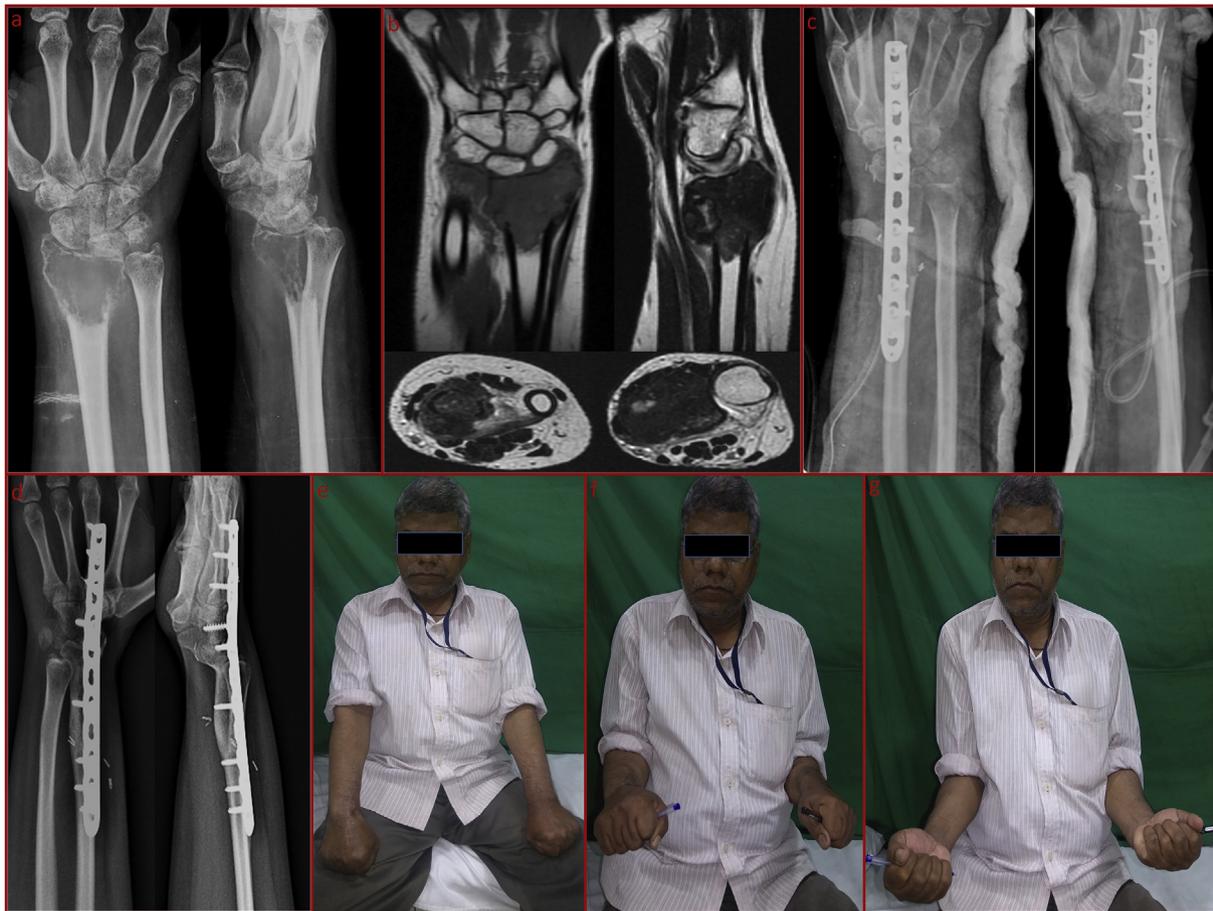


Fig. 2. Pre-operative radiograph (figure a) of Rt forearm with wrist with radius ulna showing osteolytic expansile lesion in distal end of radius. MRI of wrist distal radius showing extraosseous soft tissue mass (figure b) in coronal, sagittal and axial section. Core needle biopsy confirmed GCT. Post-operative radiograph (figure c) showing reconstruction with iliac crest bone grafting and osteosynthesis with 3.5 mm dynamic compression plate. At 18 month follow up radiograph showing (figure d) union of both osteotomy site. Wrist girth is maintained (figure e) and forearm rotation is preserved (figure f and g) after surgery.

6. Conclusion

Wrist fusion with autogenous iliac crest grafting is a simple, reproducible technique with minimal donor side morbidity (compared to fibular autografting and arthrodesis). The technique retains pronosupination and favors in achieving better cosmesis and acceptability compared to ulna translocation. Good oncological and functional outcomes make it an acceptable modality of reconstruction in short segment (≤ 6 cm) resection of distal radius. Though limited by the availability of linear tricortical iliac crest bone graft, it is a feasible alternative to other reconstruction modalities required for reconstruction of bone defects after distal radius excision.

Declaration of competing interest

We don't have any conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jcot.2019.09.024>.

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