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FUNCTIONAL OUTCOME OF TREATING GIANT CELL TUMOUR OF DISTAL ULNA WITH WIDE EXCISION AND WRIST RECONSTRUCTION WITH ILIAC CREST BONE GRAFT

Orthopaedics

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ABSTRACT

Background: Giant cell tumours of bone are aggressive, potentially malignant lesions. Juxta articular giant cell tumours of lower end ulna are rare and present a special problem of reconstruction after tumour excision. Out of the various treatment procedures described, use of iliac crest bone graft for wrist reconstruction after wide resection of the tumour is done with satisfactory functional results.
Methods: Six patients with a mean age of 21 years, with proven giant cell tumours of distal end ulna were treated with wide excision and reconstruction with tricortical iliac crest graft. Wrist reconstruction and fixation of graft was done with 4.o mm cancellous screws and K wire. The distal stump of resected ulna was stabilised by Extensor carpi ulnaris tendon slip. **Results:** The follow up ranges from 3 years (mean 30 months). At last, follow up, the mean MSTS was 71 and mean grip strength improved from 28 kg. to 37 kg. with an attainment of mean grip strength of 80% as compared with the contra lateral hand and a fair range of movements. There was no incidence of recurrence, any malignant transformation, loss of function, neurovascular deficit. There were no cases with any infection or wound dehiscence.
Conclusions: Distal ulna can be replaced with fixation iliac crest bone graft provided it is attached to the triangular fibro cartilage and ulnar collateral ligament which results in restoration of the anatomy and stability of distal radioulnar joint respectively. The distal resected stump of the ulna should be stabilised with ECU by tenodesis to prevent impingement which gave a good result in our cases.

KEYWORDS

Giant cell tumour; distal end ulna; tricortical iliac crest graft, Extensor carpi ulnaris

INTRODUCTION

There are many diseases affecting the wrist joint. Diseases that compromise the wrist joint function are arthritis (RA, posttraumatic), triangular fibrocartilage injury, tumour of the distal radius or ulna and carpel instability or AVN of lunate. These conditions are treated surgically and might need a reconstructive procedure.

Among the conditions affecting the wrist, giant cell tumour (GCT) is one of the common tumours that necessitates excision of the involved part of the bone to minimise recurrence. GCT is a locally aggressive benign lesion accounting for 3 to 5 per cent of all bone tumours,[1] affecting the age group of 20–40 years. Distal femur, proximal tibia and distal radius are the three most common locations of GCT. On the other hand, GCT of distal ulna occurs rarely, accounting for only 0.5 to 2.9 per cent of all GCT.[2]

Power grip, maintaining the anatomical relationship of carpus and distal radius and supination and pronation primarily occur due to articulation of distal ulna with the radius in sigmoid notch. Hence, the stability of this joint is of utmost importance for activities.

The triangular fibrocartilage complex (TFCC) is located between the ulnar head and the corresponding carpal bones, made up of palmar and dorsal radioulnar ligaments, articular disk, carpel ligaments and a sheath floor of the ECU. TFCC, even though collectively form a single structure, perform different functions—main function being as the stabilizer of both ulnoradial and ulnocarpal joint.[4]

Instability of the distal ulnar stump and radius might be due to partial resection of ulna.[5]The loss of 'cam' effect and distal ulnar support for radius rotation will cause distal radioulnar impingement, resulting in decreased strength, restriction of motion and pain.[6]

Reconstruction of the distal radius with fibula is a well-known procedure that had given good results, but treatment of distal ulna GCT is less frequently reported in the literature as are its treatment options because of its fewer occurrences.[3] Treatment of the GCT of distal ulna is challenging due to its proximity to the distal radioulnar joint, triangular fibrocartilage and carpal bones.

In this study, we will discuss the functional outcome of treating GCT of distal end ulna with a wide resection and maintaining the DURJ function by iliac crest grafting.

MATERIALS AND METHODS

After taking formal approval from the institutional ethical committee, 6 patients (2 males and 4 females) 18 and26 years old (mean age 21 years), were included in the study conducted between March 2013 and October 2019 at our tertiary care centre. Informed written consent was taken from all patients included in the study. All patients were evaluated clinically and radiologically (Table 1), including taking out wrist series X-rays (Figure 1), chest X-rays and haematological survey. After a thorough evaluation, MRI was done to find out the extent of soft tissue involvement and epiphyseal thinning. Cases of GCT were graded according to Campanacci grading,

Grade 1 = well-defined margins and intact cortex.
Grade II = relatively well-defined margin with no radio opaque rim and thinned out cortex, moderately expanded cortex.
Grade III = indistinct borders and cortical destruction.[7]

All cases of GCT of distal ulna with Campanacci grade II and III were included in our study, excluding grade I tumours as well as cases with surrounding soft tissue involvement (mainly TFCC). After diagnosing GCT by imaging studies and incisional biopsy, the patients were ready for surgery after their pre-operative range of motion, grip strength of hand and Campanacci grade was noted.

Under general anaesthesia and using the standard ulnar approach, the tumour of distal ulna—including 2-cm margin of normal bone—was resected proximally (Figure 2). Due caution was taken in order to avoid any injury to the origin of triangular fibrocartilage at the ulnar fovea of the triangular fibrocartilage with ulnar collateral ligament.

Contralateral iliac crest was utilized for harvesting the iliac bone (tricortical). The harvested tissue was grafted to the radius along the ulnar side of the sigmoid notch, after curetting the articulating surface of distal ulna. Fixation of the tricortical graft was done using a 4.0 mm cannulated cortical screw and a K Wire. The ulnar variance was kept

neutral. The preserved triangular fibrocartilage along with the ulnar collateral ligament were attached to the radial aspect of the grafted iliac bone distally using a polyglactin suture. This was done in order to reconstruct the ulnar support.[13–15]

To stabilize the distal ulnar stump, firstly, we split the ECU tendon in the central sulcus, followed by releasing the radial half at ulnocarpal level. After reflecting it proximally, only half of it was stripped longitudinally to stabilize the distal ulnar stump and the part attached to the musculotendinous junction was left alone(Figure 3). The radial half of the ECU was passed through a pre-drilled cortical hole in the distal ulnar stump and sutured back on itself (Figure 4).[15]The wound was closed in layers and the limb was immobilized postoperatively above elbow for 4 weeks in supination and later was supported with a below-elbow splint for 2 weeks. Physiotherapy was started at 6 weeks postoperatively after removing the K wire and weight bearing was allowed at 10 weeks.

Follow-up was scheduled at 1 month and 3 months followed by each3monthsfor a year, then each 6monthsfor a year and, finally, once in the third year. Serial radiographs of the wrist joint (Figure 5) and chest X-rays were taken. Goniometer was used to evaluate the range of motion, dynamometer for grip strength, and revised Musculoskeletal Tumours Society Score (MSTS)were noted during every follow-up, and included 6 parameters of pain, functional outcome, emotional acceptance, hand positioning, manual dexterity and lifting ability (Table 2).

RESULTS

The average duration of the follow-up was 30months (ranging 24–36 months). According to Campanacci grading, 3 cases were classified as grade II and 3 as grade III. No cases were associated with pathological fracture. The mean MSTS was 71 while mean dorsiflexion was 69 degrees, palmar flexion was 68 degrees, supination was 70 degrees, pronation was 70 degrees, ulnar deviation was 23 degrees and radial deviation was 17 degrees (Figure 5). The mean grip strength improved from 28 kgf to 37 kgf with mean grip strength 80 percent of the contralateral hand. There was no incidence of recurrence and radiological lysis at the end of follow-up in any case, any malignant transformation, loss of function or neurovascular deficit. There were no cases with any infection or wound dehiscence.

Figure 1: Pre operative X Ray image of the wrist (a) Anteroposte rior view

Figure 2: Intra operative image of the resected ulna and splitting of the ECU tendon after reflecting from its insertion from triquetral. (a)schematic, (b) intraoperative

Figure 3:Resected bone having GCT

Figure 4Post operative X ray Image of the wrist Anteroposterior view

Figure 5: Post operative X ray Image of the wrist Lateral View

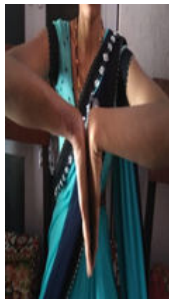

Figure 6 Palmar flexion

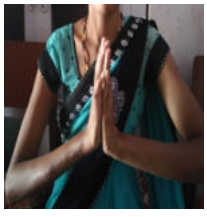

Figure 7 Dorsiflexion

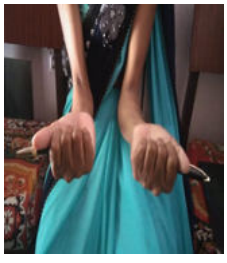

Figure 8 Supination

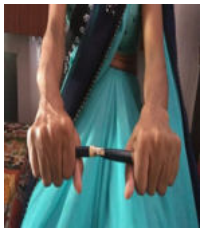

Figure 9 Pronation

Table 1: pre operative parameters of the patient

Sl no	Age/ sex	Campanacci Grade	DF	PF	UD	RD	Supination	Pronation	Grip strength
1	20/M	3	50	65	15	18	60	70	27
2	23/M	3	55	60	12	20	55	60	25
3	18/M	2	60	63	20	20	65	65	32
4	19/M	2	58	58	20	20	70	65	31
5	22/F	2	65	68	18	18	65	60	29
6	24/F	3	65	68	17	10	60	65	27

Table 2: Post operative parameters of the patient

Sl no	Age/sex	DF	PF	UD	RD	Supination	Pronation	Grip strength	MSTS
1	20/M	70	68	26	18	75	70	35	71
2	23/M	68	65	20	15	70	70	37	70
3	18/M	75	70	25	18	70	75	39	76
4	19/M	70	72	25	18	60	70	42	75
5	22/F	65	65	18	15	70	65	33	70
6	24/F	65	68	25	15	65	70	34	68

Table 3: - table describing comparative data with other surgical techniques for the treatment of GCT in distal ulna.

Sl no	Study/ Report	Number of cases	Scores	Range of motion compared with contra lateral wrist	Recurrence	Complications
1	Manjeet singh et al[28]	2	1st case- 16/18 2nd case- 18/18(Ferracini)	Pronation supination 15 degrees restricted comparable	Nil in both after 3 years of follow up	Nil
2	Daniele Vanni et al[29]	1	-	Comparable	Nil	Nil
3	Minami et al (2010)[26]	1	-	Comparable	Nil	Nil
4	Katrina et al[20]	1	Dash score 12.5	Comparable	Nil	Nil
5	Mujaddid et al[30]	2	1st case- 25/30 2nd case- 24/30 (MSTS)		Nil	Nil
6	Mariappan et al[19]	1	-	Comparable	Nil	Nil
7	Jamshedi et al [31]	5+4	5 cases – 87.3±4.3 4 cases- 93.3±2.7(MSTS)	Comparable Decreased	Nil Grade II –Nil Grade III- 100%	Nil
8	Kaiya's et al [9]	1	18/18 (Ferracini)	Comparable	Nil	Nil

DISCUSSION

GCT is a locally aggressiveyet benign tumour encountered most commonly in a relatively young population. Although benign, this tumour may behave unexpectedly irrespective of radiological or histological examinations results.

There are various modalities of treatment for GCT, like intralesional curettage, with or without addition of adjuvant therapy with phenol, hydrogen peroxide, cementing using methyl methacrylate, liquid nitrogen or by excision of the involved bone and soft tissue, and reconstructing the defect by using bone graft or its substitutes. These options are used depending on the grade of the tumour. Wide excision of tumour should be the preferred treatment when we have an option of reconstructing the excised part functionally.

The Darrach's approach of resection of distal end of ulna without any reconstruction of the wrist joint and free lying of the distal stump of ulna caused a number of degenerative changes in the wrist joint as well as pain in the distal stump of ulna during movements of forearm,[3]like high stress manual labour,[7,8]most likely due to abnormal distribution of stress after resection of the distal ulna. However, some authors have suggested only wide resection without reconstruction or stabilization of the ulnar stump. Although some orthopedicians believe that this loss of ulnar support leads to wrist and distal radioulnar joint (DRUJ) instability, which causes weakness, loss of grip strength and pain.[6]Cooney et al. even advised the same procedure as Darrach and concluded that reconstruction of wrist joint was not routinely indicated. High failure rates without stabilization of the ulnar stump have been observed by Kayias et et al.[9]as secondary to the dorsal translation of the stump at the resection site—which tends to converge towards the radius. Nevertheless, the long-term results of the Darrach's procedure are not foreseeable.[10]It has been stated that ulnar instability may lead to ulnar carpal translation, snapping of the distal ulnar end and rupture of the finger extensor tendon.[8]These possible shortcomings of the procedure must be considered in young people with high functional demands.

Goldner and Hayes were the first to describe the procedure of stabilization using the ECU tendon after ulnar resection.[11]Although, it was Kayias et al. who first describedthe application of this technique for ulnar GCT. The patient they treated had an excellent oncological and functional outcome.[9]Kleinman and Greenberg obtained satisfactory results using 50 per centof ECU as longitudinal tenodesis and pronator quadratus interposition to retard impingement and winging.[12]

The procedures used for reconstruction with prevention of ulnar translation of the entire carpus include the Sauve–Kapandji procedure[13,14,15,16] and radiolunate fusion.[17]However,this procedure requires a healthy distal end of the ulna. Such surgeries may also lead to an unacceptable decrease in the range of motionof the affected wrist. The term 'ulnar buttress arthroplasty' was popularized after Hashizume et et al.[18]used a longer iliac bone graft to achieve thisbuttress effect against axial stress loading. In the current study, we fused the distal radio graft joint but it did nothinder the rotation of forearm because we constituted the graft as a part of distal radius rather than a replacement for the distal ulna.

Mariappan et al. used the proximal part of fibula as a free graft for reconstruction of DRUJ by stabilizing it with Palmaris longus graft using extensor carpiulnaris sling.[19]Starcevi et al.[20]did a wide resection and reconstruction of the distal radioulnar joint using autologous free fibular and Palmaris longus tendon graft. This was a staged procedure. Various series using such reconstruction techniques utilizing fibula havebeen reportedto give good functional outcomes for GCT of the lower end of radius. Although there is still a dearth of larger series with longer follow-ups,[21,22,23,24] this procedure has various limitations ranging from stress fractures, delayed or no union, bone resorption, degeneration and deformities to donor site morbidity and ulnar impingement.[21,22,23,24] Very often, prolonged immobilization is required before healing is complete,but a major problem is non-union at the host–graft junction (5 casesreported by Kayias et al.) which required secondary bone grafting. Lackman reported 2 non-unions (n=12), while Murray reported 5 (n=18)—all of which required secondary procedures.

Toavoid the complications reported by other authors, we have used tricortical iliac crest graft in this study to reconstruct the distal ulna. In order to provide the best possible range of motion and functioning at the wrist joint, care was taken to ensure stabilization of DRUJ. We made an arthrodesis at the distal radioulnar joint and stabilized the distal free end of ulna with half of the ECU tendon. A spacer for distal ulna was created this way along with the TFCC which preserved tension of the remaining ligaments and capsule and a 'cushion' between the carpus and the free bone graft.

There were no cases with recurrences in our study as the native bone with the tumour was not in contact with the graft. Minami et al.[25] and Phadke et al.[26]reported a similar case study with resection and ulnar support reconstruction with iliac crest graft and distal ulna stabilization by ECU tendon.We had excellent postoperative results.

CONCLUSION

Good outcome of the GCT distal ulna is dependent on (1) the wide resection of the tumour which minimized the chances of recurrence;(2) stabilization of the ulnar stump to yield a good functional result and;(3) reconstruction of the distal ulna in order to achieve maximal possible grip strength. Distal ulna can be replaced with fixation of iliac crest bone graft provided it is attached to the triangular fibrocartilage fibrocartilage and ulnar collateral ligament, which results in the anatomical restoration and stabilization of distal radioulnar joint respectively. The distal resected stump of the ulna should be stabilized with ECU by tenodesis to prevent impingement asthis gave good results in our cases. Good functional outcome along with no recurrence was obtained in our study. However, a longer follow-up and large

series is required to reproduce the effects in majority of patients.

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