BIOMECHANICAL ASPECTS OF RECONSTRUCTION OF THE LOWER END OF RADIUS AFTER EXCISION OF OSTEOCLASTOMA

Dasari Venkateswara Rao[1], Ragidi Ramesh Babu[2], Manukonda Kishore Kumar[3], Gadde Venkatesh[4]

[1]Associate Professor, Department of Orthopaedics, Siddhartha Medical College/Government General Hospital, Vijayawada.
[2]Assistant Professor, Department of Radiotherapy, Siddhartha Medical College/Government General Hospital, Vijayawada.
[3]Assistant Professor, Department of Orthopaedics, Siddhartha Medical College/Government General Hospital, Vijayawada.
[4]Postgraduate Student, Siddhartha Medical College/Government General Hospital, Vijayawada.

ABSTRACT

BACKGROUND

Osteoclastoma is associated with high morbidity and functional impairment. It can lead to complications of pathological fractures, recurrence and pulmonary metastasis. They typically occur in patients 20 to 40 years old and there is a slight female predominance. The most common location for this tumour is the distal femur followed closely by the proximal tibia. In the distal radius (the third most common location), these tumours frequently are more aggressive. This necessitates early intervention and restoration of biomechanical aspects of lower end of radius.

MATERIALS AND METHODS

30 cases whose case histories, roentgenograms, histopathological reports, treatment modalities and their outcome were taken up, were treated with excision and reconstruction, fixation with Z cut and screws - 3 cases, 1 case with rush nail, 5 cases with plate and screws, 18 cases with plate, screws and K-wires, 3 cases with acrylic prosthesis. Radiological grading done with Campanacci[1,2,3] grading.

RESULTS

The average duration of symptoms in this study was 2.36 months. Out of 30 patients 16 cases followup was done for more than 2 years, 14 patients were followed up for less than 2 years. Of the 27 cases of reconstruction with the fibular graft, we had 10 patients with recurrence. In the remaining 17 cases treated by reconstruction with fibular graft had no recurrence were separately looked for success of their biomechanical aspect of fixation. On evaluation of wrist movements 7 patients had fair range of movements, 6 patients with good range, 2 patients developed stiffness and 2 cases underwent arthrodesis. Of 17 cases hand function evaluation, 10 cases had good function, 6 cases had fair function and 1 case had poor function. Radiation treatment is advised in recurrent cases.

CONCLUSION

In this study we concluded that in various surgical procedures out of these plate, screws and K-wires had better functional outcomes compared to other procedures.

KEYWORDS

Osteoclastoma, Excision, Reconstruction, Fixation, Radiation Treatment.

HOW TO CITE THIS ARTICLE: Rao DV, Babu RR, Kumar MK, et al. Biomechanical aspects of reconstruction of the lower end of radius after excision of osteoclastoma. J. Evolution Med. Dent. Sci. 2017;6(12):967-971, DOI: 10.14260/Jemds/2017/207

BACKGROUND

Giant-cell tumours of the bone, which are recognised for variable clinical behaviour that is unrelated to their radiographic or histological appearance occur commonly in the distal end of radius in middle aged people. Osteoclastoma is associated with high morbidity and functional impairment. It can lead to complications of pathological fractures, recurrence and pulmonary metastasis. This necessitates early intervention and restoration of biomechanical aspects of lower end of radius by wide excision and reconstruction by plate, screws and bone grafting. It is shown to give one of the best results in terms of the recovery, return to work and functional outcome.

Financial or Other, Competing Interest: None.
Submission 31-12-2016, Peer Review 25-01-2017,
Acceptance 31-01-2017, Published 09-02-2017.
Corresponding Author:
Dr. Dasari Venkateswara Rao,
Department of Orthopaedics,
Siddhartha Medical College,
Government General Hospital,
Gunadala, Vijayawada-520008,
Andhra Pradesh.
E-mail: d_yenkee@yahoo.com
DOI: 10.14260/jemds/2017/207

In this location, they afford the surgeon the opportunity to do marginal or wide local excision and still preserve excellent function of wrist and hand while accomplishing an aggressive surgical treatment of this locally aggressive tumour of bone.

Historically, giant cell tumours of lower end of radius are excised and replaced with upper end of fibula, a corticocancellous graft from tibia, iliac bone graft and acrylic prosthesis.

Although good functional results have been obtained by these different methods, they all have the distinct disadvantages that a large piece of avascular bone is used to reconstruct the defect in the distal end of radius in the forearm, which is itself a relatively avascular area. Problems encountered with this are delayed union, non-union, graft absorption, fracture of graft and recurrence.[4]

Robert W. H. Pho[5] claims that by using a vascularised fibular graft, these complications can be overcome.

We had total of 30 cases of giant cell tumour of lower end of the radius treated at our Institution. We thought it fit to analyse them critically as to see how best we can improve in our approach for better patient care in future.

MATERIALS AND METHODS

30 cases whose case histories, roentgenograms, histopathological reports, treatment modalities and their outcome were taken up by Dr. D. Venkateswara Rao since 1992 to 2014, as a Postgraduate Student at Department of Orthopaedics, Kasturba Medical College, Manipal, and subsequently as Assistant and Associate Professor in Department of Orthopaedics, Siddhartha Medical College/Government General Hospital, Vijayawada and as a consultant at Royal Hospital, Vijayawada. Patients suffering from giant cell tumour of lower end of radius were diagnosed clinically and roentgenographically, biomechanical aspects of reconstruction of lower end of radius evaluated.

In the study, 30 patients evaluated in biomechanical aspects of lower end of radius by various methods of reconstructive procedures in our Institutes. The duration of followup is ranged from 4 months to 24 months. All cases were confirmed histopathologically and histological grading was recorded following excisional biopsy.

The data was recorded in the pattern of proforma which includes patient general details, chief complaints, biopsy details, general health, surgery procedure details, source of bone graft, post-operative immobilisation, functional capacity of hand and wrist, radiological findings and complications.

Methods of Surgical Treatment

1. Wide excision and reconstruction with fibular graft.[6,7]
2. Excision and reconstruction with acrylic prosthesis.
3. Arthrodesis of wrist.
4. Translocation of ulna and ulnocarpal fusion.
5. Amputation.

Aftermath

All these patients were treated with above elbow plaster cast for 12 - 16 weeks followed by below elbow moulded alkathene splint for another 3 - 4 months as a mean of protection. The K-wires when used were removed between 6 - 12 weeks, postoperatively.

The following wrist movements were recorded with the help of goniometer: dorsiflexion, palmar flexion, supination, pronation, radial deviation and ulnar deviation.

The Functional Evaluation of Hand was done by using

a. Jamar hand dynamometer to know the grip strength.
b. Pinch meter to know the key pinch, pulp to pulp pinch and palmar pinch.
c. Pick up objects of various shapes to evaluate the grasp function.
d. Hook also assessed.

For each wrist Movement a Scoring was given in the following way

1. The movement mentioned was compared with that of the opposite side and then the range of movement on the affected side was full, it was given 4 points.
2. When it was less than full, but more than 75%, the score was 3 points.
3. Less than 75%, but more than 50% was given 2 points.
4. Less than 50%, but more than 25% was given 1 point.
5. Less than 25% - 0 point.

For each of the 6 movements the scoring was done as above and these were added together and once again another percentage was achieved by comparing it with that of total score of normal side.

Scoring of the Wrist Movements was considered to be

a. Good > 50%.
b. Fair > 30% - 50%.
c. Poor < 30%.

At the time of review, x-rays of the operated area both antero-posterior and lateral views were taken. The following points on x-ray were noted -

1. Any recurrence.
2. Whether the graft has taken up or not.
3. Graft absorption.
4. Graft osteoporosis.
5. Fracture of the graft.

RESULTS

In this study 30 patients with lower end of radius osteoclastoma who had been treated by various surgical methods, the biomechanical aspects of the cases evaluated in our Institutes.

In the total group of 30 patients there were 15 males and 15 females, affected patients were mainly in middle age, youngest patient was aged 21 years and oldest was 48 years.

Out of 30 cases, 13 cases had the affection on the right side and 17 had it on left side. The average duration of symptoms in our cases was 2.36 months. Pathological fracture was evident on the first radiographic examination in 5 patients (16.65%).

76.86% of the cases could be graded as Grade 2. Excision and reconstruction with fibular graft transplantation was done in 27 cases (90%). Excision and primary reconstruction with acrylic prosthesis was done in 3 patients (9.99%). We have not done amputation as a primary procedure in any case. Fixation in the reconstruction of the lower end of the radius with the proximal fibula were as follows.

Type of Fixation	No. of Cases
1. Z-Cut and cortical screws	3
2. Intramedullary rush nail	1
3. Plate and screws	5
4. Plate, screws and K-wires	18
5. Acrylic prosthesis	3

Table 1

Of the total 30 cases, 10 cases (33.33%) had recurrence requiring subsequent surgeries. Of these only 3 cases were radiologically Grade 3, 6 cases were Grade 2, 1 case was Grade 1.

However, 2 cases though radiologically Grade 3 and another 2 cases though histologically Grade 3 had no recurrence.

Type of Fixation	No. of Cases	Recurrence	Arthrodesis	Amputation	Refused to Surgery
1. Z-Cut and cortical screws	3	1	1	-	-
2. Intramedullary rush nail	1	1	-	1	-
3. Plate and screws	5	3	2	1	-
4. Plate, screws and K-wires	18	5	2	2	1
5. Acrylic prosthesis	3	-	-	-	-

Table 1.1

After the primary grafting and fixation, 3 cases with non-union at the graft and host junction were noted. Of these 3 cases, one was from the group where we have used a Z-cut and screws. The other two cases were from the group of plate, screws and K-wire fixation. Later these two were also treated with arthrodesis and further bone grafting.

At the end of treatment their clinical and radiological evaluation was done concerning the bony union, movements of the wrist and functional evaluation of hand.

On evaluation of movements of the wrist in 17 cases of fibular grafting, there has been no patient who gained the normal range of movements. We have 2 cases of stiffness of wrist. About 7 patients had fair range of movements with no pain and 6 patients had movements with good range.

Figure 1. Distal End of Radius Treated with Z-Cut and Screws and Acrylic Prosthesis

Figure 2. Recurrence of Tumour after Treatment

On evaluation of hand function of 17 cases 10 cases have good hand function, 6 cases had fair and 1 case had poor hand function. We had 6 cases of radioulnar subluxation. All 6 were in cases where the fixation of graft was not reinforced by distal K-wire stabilisation. There were the cases of reconstruction with acrylic prosthesis. Those cases treated by fixation with plate screws and reinforcement with K-wires through the 3rd metacarpal had no inferior radioulnar joint subluxation.

DISCUSSION

Campannaci et al[8] claim that the radiological grading is of help in knowing the malignant behaviour of the tumour.

Of the total 30 cases in our series, 10 cases had recurrence, of which 3 cases were radiologically Grade 3. One case of recurrence occurred in a patient with radiological Grade 1. Campanacci et al view of using radiological grading alone may not be of help in knowing the malignant behaviour of the tumour.

All 10 cases of recurrence had a histological grading of Grade 2. Two cases of histologically Grade 3 did not have any recurrence. We are in agreement with Campannaci et al, Nicola Baldini and Stefano Boriani that histological grading alone also may not help us in the malignant grading of osteoclastoma.

Though various modalities of treatment of giant cell tumour have been described,[9,10,11,12,13,3,14] we had no opportunity to do curettage and bone grafting as none of our patients had adequate thick cortex. This may be because of peculiarity of the site involved being the small area at the lower end of the radius.

One of the safer ways of treating giant cell tumour is by excision and reconstruction. Goldenberg[15] et al in his series of excision and grafting by proximal fibula reported a recurrence rate of 50%. We had only 10 (33.33%) cases of recurrence, which means that only 1/3 of the cases had recurrence.

Though we had done replacement with proximal fibula as a part of treatment in 27 of 30 cases since 10 had recurrence requiring further surgeries, we could take only 17 cases for evaluating the biomechanical aspect of reconstruction.

Of the 17 cases, 3 had non-union. One of the two cases where Z-cut and screws were used resulted in non-union focusing our point that it is a poor kind of fixation. On the contrary, out of the 15 cases where plate and screw was used we had only 2 cases of non-union (6.66%).

Of the 17 cases, there was inferior radioulnar joint subluxation in 3 patients and all these were cases where the wrist and inferior radioulnar joints were not stabilised by K wires. This strengthens our view that good stability of the wrist can be achieved when it is stabilised by K wires in addition to a rigid fixation of the graft to the host bone by plate and screws. The K wires probably help in allowing the healing of soft tissues and development of some fibrous connection between the lower end of the graft and the wrist.

On evaluation of the movements following the resection arthroplasty by fibular graft, no patient had gained the full range of movements of the wrist. Probably, this is of no surprise as the observation of Goldenberg et al also have been the same; 2 patients had total restriction of movement as subsequent need for arthrodesis of wrist joint. In the remaining 15 patients, 2 patients had stiffness of the wrist joint. On close analysis of these 2 patients, we observed that they required subsequent reinforcement in the form of bone grafting requiring prolonged immobilisation in plaster cast.

Functional evaluation of the hand gave us a fair amount of idea about better outcome of hand function in cases where good stabilisation procedures were used. On the contrary when we depended more on a Z cut and screws, the results were poor. To achieve good hand function in spite of limited wrist movements, a good stabilisation in the form of plate screws and K wires is necessary.

Robert W. H. Pho has strongly recommended the usage of vascularised fibula for the reconstruction of gap following resection of giant cell tumour at the lower end of radius.

Since, we had only 3 (9.99%) cases of non-union and no patient had any degenerative changes around the wrist joint. We feel the cumbersome specialised procedure of vascularised fibula may not be mandatory.

We have used acrylic prosthesis shaped in the form of lower end of radius in those cases in whom malignant behaviour of the tumour was in question. Patients have been using it for the past 2 years and results are almost comparable with that of fibular grafting. However, the wrist subluxation is a constant feature in spite of distal K wire stabilisation. This may be because of inability of soft tissues to grow into the acrylic prosthesis. Proximally the host, prosthetic junction shows splaying of the bone which is an index of movement at the site. In one of the cases where we have removed prosthesis and reconstructed the gap with the upper end of the fibula, we could make out that the prosthesis and bone junction was very loose and we could remove the prosthesis with ease. The greatest advantage of the usage of the prosthesis was its usage as a temporary procedure without embarking on major bone grafting procedures, which may become futile if there are repeated recurrences. The acrylic prosthesis acts as temporary spacer in these cases. Radiation treatment is advocated in inoperable or not radically operated cases and recurrences.

CONCLUSION

1. Biomechanically, it is safer to fix the graft with plate, screws with reinforcement by K-wires at the inferior ulno-graft junction and centralisation of 3rd metacarpal.
2. In this study, we concluded that in various surgical procedures out of these plate, screws and K-wires had better functional outcomes compared to other procedures.
3. Only 3 cases had non-union; there is no play for the technically demanding vascularised fibular graft after resection of the lower end of radius.
4. Usage of the acrylic prosthesis is a temporary measure of at least a period of 1 year is worth considering in cases where there is high degree of suspicion of fracture recurrence.
5. Radiation therapy with modern equipment and standards is effective.

REFERENCES

[1] Crawford CJ, Akrbarnia BA. Giant cell tumor of the radius treated by massive resection and tibial bone graft. J Bone and joint surg 1973;57(7):982-6.
[2] Pho RW. Malignant giant cell tumor of distal end of radius treated by free vascularised fibular transplant. The Journal Of Bone and Joint surg 1981;63(6):877-84.
[3] Harris WR, Lehmann EC. Recurrent giant-cell tumour after en bloc excision of the distal radius and fibular autograft replacement. J Bone and Joint Surg 1983;65(5):618-20.
[4] Cheng DD, Hu T, Zhang HZ, et al. Factors affecting the recurrence of giant cell tumor of bone after surgery: a clinicopathological study of 80 cases from a single center. Cell Physiol Biochem 2015;36(5):1961-70.
[5] Sevadge H. Distal ulnar translocation in treatment of giant-cell tumors of the distal end of the radius. J Bone Joint Surg 1982;64(1):67-73.
[6] Murphy KJ, Mcphee I. Follow-up notes on articles previously published in the journal. Elastosis in chronic acidosis: extensive calcification in tendons and soft tissues. J Bone Joint Surg Am 1967;49(6):1227-31.
[7] Leung PC, Chan T. Giant cell tumor of the distal end of the radius treated by the resection and free vascularized iliac crest graft. Clinical Orthopaedics 1986.
[8] Campanacci M, Baldini N, Boriani S, et al. Giant-cell tumour of bone. J bone and joint surg 1987;69(1):106-14.
[9] Amanatullah DF, Clark TR, Lopez MJ, et al. Giant cell tumor of bone. Orthopedics 2014;37(2):112-20.

[10] Lundström B, Lorentzon R, Larsson SE, et al. Angiography in giant-cell tumours of bone. Acta Radiol 1977;18(5):541-53.
[11] Smith RJ, Mankin HJ. Allograft replacement of distal radius for giant cell tumor. J Hand Surg AM 1977;2(4):299-308.
[12] Gaston CL, Bhumbra R, Watanuki M, et al. Does the addition of cement improve the rate of local recurrence after curettage of giant cell tumours in bone? J Bone Joint Surg Br 2011;93(12):1665-9.
[13] Schajowicz F. Giant cell tumor of bone (Osteoclastoma). J Bone and Joint Surg 1961;43(1):1-29.
[14] Murray JA, Schlafly B. Giant cell tumors in the distal end of radius. Treatment by resection and fibular autograft interpositional arthrodesis. J Bone Joint Surg 1986;68(5):687-94.
[15] Goldenberg RR, Campbell CJ, Bonfiglio M. Giant-cell tumor of bone. An analysis of two hundred and eighteen cases. J Bone Joint Surg Am 1970;52(4):619-64.