

Resection-Arthrodesis of Knee Joint for Aggressive Giant Cell Tumor of Bone by Intramedullary Nailing with Bone Grafting and Ilizarov Technique for Treatment of Complications Like Post-Operative Infection

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Abstract:

Introduction: A benign aggressive tumor of the bone is known as Giant cell tumor (GCT) which occurs in patients aged around 20 to 40 years with slight preponderance in females. Most commonly it occurs at distal femur, proximal tibia and distal radius. Therefore, in this study outcomes of the patients with aggressive GCTs of the bone surrounding the knee joint along with patients having deep post-operative infection who were treated with ilizarov technique are reported.

Method: An observational retrospective study involving database that was scanned from 1993 to 2021 to identify the patients who underwent resection arthrodesis in aggressive giant cell tumor was done. Twenty six patients were found who were treated with resection and arthrodesis involving 17 female patients and 9 male patients.

Results: 21 out of 26 patients had proximal union, or AD, and were able to bear full weight within 6 to 10 months. After removal of the implant and infected bone grafts with the IT, five patients with profound infection were treated as patients of infectious non-union with bone defect. Four out five such patients united completely achieving bony AD at knee joint. One patient had non-union and shortening of more than 2.5 cm. The functional assessment performed using a modified version of the Musculoskeletal Tumor Society (MTS) system, demonstrated range of functional score between 20 to 26 out of 30. The five patients treated with IT were evaluated with Association for the study and application of methods of ilizarov (ASAMI) scoring system and also with modified system of MTS.

Conclusion: The present study concludes that healing rate was better in patients who underwent knee joint resection and AD. Additionally, the post-operative infection rate was very less as compared to other studies.

Keywords: Resection Arthrodesis, Giant Cell Tumor, Benign Tumor, Knee Joint, Ilizarov Technique, Bone Grafting.

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Introduction

A benign aggressive tumor of the bone is Giant cell tumor (GCT) which occurs in patients aged around 20 to 40 years with slight preponderance in females. Most commonly it occurs at distal femur, proximal tibia and distal radius. These tumors are frequently aggressive.[1]

Surgical removal of tumors is the primary method of treating benign tumors that are locally aggressive whereas, radiotherapy is used only to treat tumors that are inoperable.[2] Surgical excision of this tumor has long been a controversy, with the ideal procedure establishing a balance

between appropriate excision and limb function. In the past, the only form of treatment was simple curettage, which had a recurrence rate of more than 50%. This rate has decreased to 5 to 15% with extended curettage using burrs, liquid nitrogen, phenol, bone cement, electrocautery, or argon beam coagulation, which theoretically helps to kill any tumor cells.[1] GCTs that are well-contained have responded well to extended curettage, but those that have cortical breach and significant soft tissue masses have not.

Therefore, wide resection is only performed on patients who have more advanced (Campanacci Grade III) or recurrent tumors and aggressive tumors biologically. The best reconstructive method to fill up the gap left by a tumor block resection is still up for debate. The expense of treatment goes up with endoprosthesis replacement, which also necessitates multiple surgeries and effective motor reconstruction. Large quantity of allograft required for such reconstructions may not be available at many centers.

A stable limb is provided by an arthrodesis (AD), and the probability of the patient requiring revision surgery is reduced. Even getting adequate autografts for resection, autografts in big defects may be difficult. Hence, AD by Ilizarov technique (IT) i.e. corticotomy and bone transport may be good option to fill the bone defect. We report the outcomes of the patients with aggressive GCTs of the bone surrounding the knee joint who had treatment with intramedullary nailing and bone grafting and outcomes of patients with deep post-operative infection who were treated with IT in this retrospective case study.

Materials and Methods

This was an observational retrospective study that was performed in a tertiary care medical teaching institute in central India. The database was scanned from 1993 to 2021 to identify the patients who underwent resection arthrodesis in aggressive giant cell tumor. Twenty six patients were found who were treated with resection and arthrodesis. 24 patients belonged to Campanacci Grade III and two patients were with recurrent Grade II Campanacci tumors who were treated earlier with curettage and bone grafting. Two patients presented with pathological fracture.

There were 17 females and 9 male patients. Patient Ages ranged from 20 to 45 years. Average follow up period ranged from 24 - 84 months (2-7 years). Preoperatively the patients were investigated with AP and Lateral radiography of the knee joint, and radiograph of chest to detect metastasis. Additionally, open biopsy or Fine Needle Aspiration Cytology (FNAC) was used to confirm the diagnosis. The patients who came back with recurrence and had previous report of histopathology with them were taken as previous cases of GCT and were treated accordingly.

The operative technique involved investigation of the tumor mass in the tibia with well-defined healthy bone borders using an anterior midline incision. In instances with GCT of the lower end of the femur, a long medial incision commenced from the middle of the thigh crossing the knee joint along the medial parapatellar section and distally to the tibial tuberosity was used. Neurovascular bundle was exposed and protected and tumor excised along with normal bone margin was done. The defect was around 10 to 15 cms long. The condyle that was unaffected had its articular cartilage removed. The tumor that was excised was sent for histopathological evaluation. The resected bone was autoclaved and the shell of bone remaining after excision of the tumor was used as bone graft along with other cancellous bone graft from iliac crest. Fixation was done using a long intramedullary nail / K nail. Intramedullary nail was introduced in femur in retrograde fashion and then pushed into tibia and locked proximally in femur and distally in tibia. Other grafts were fixed with two rush nails.

The wound over the site of the drain which was removed after 48 hours was sutured and the limb was immobilized in a slab above the knee. Until union, protected partial weight bearing was performed and after clinical / radiological union full weight bearing was performed. For a year, patients were followed up every three months, and subsequently once a year. Five patients had deep infection post operatively and hence they were treated as infected non-union with bone defect with IT. All the infected bone and granulation tissue was excised and docking done at defect site and stabilized by IT of ring fixator.

Length was achieved by corticotomy and distraction over the fixator. The fixator was removed after confirmation of union at docking site and consolidation of regenerate clinically and radiologically. The pre-operative and post-operative follow-up after 2 years in case of giant cell tumor of upper end of tibia is demonstrated in Figure 1 and Figure 2 respectively. Whereas, pre-operative and post-operative follow-up after 5 years in case of giant cell tumor of lower end of femur is demonstrated in Figure 3 and Figure 4 respectively.



Figure 1: Pre-operative giant cell tumor of upper end of tibia



Figure 2: Post-operative follow-up after two years in giant cell tumor of upper end of tibia



Figure 3: Pre-operative giant cell tumor of lower end of femur with pathological fracture



Figure 4: Post-operative follow-up after five years in giant cell tumor of lower end of femur

Results

There were total 26 patients of GCT around knee. 18 patients had GCT of lower end of femur and 08 patients had GCT of proximal tibia. There were 9 male and 17 female patients and their ages ranged from 20-45 years. There were 25 patients of Campanacci grade III and Two patients of grade II with recurrence. Two patients had pathological fracture at the time of reporting. The average follow-up for all the patients was 4.3 years (2 to 7 years) and the average size of the tumor defect was 11.73 cm (10 to 16cm).

There was no instance of a systemic or local recurrence. There were two cases of peroneal nerve palsy which recovered later. There were 4 cases of Rush nail back out and one case of ender's nail breakage. Rush nail backout was treated by pushing the rush nail back to its position under short GA.

With a mean score of 8.09 months, 21 out of 26 patients had proximal union, or AD, and were able to bear full weight within 6 to 10 months. Seven patients had shortening of 1 to 2 cm.

Three patients had superficial infection which was treated with appropriate antibiotics, cleaning and dressing. There was one case of skin loss which was treated with myocutaneous flap.

After removal of the implant and infected bone grafts with the IT, five patients with profound infection were treated as patients of infectious non-union with bone defect. Four out five such patients united completely achieving bony AD at knee joint. One patient had non-union and shortening of more than 2.5 cm. using a modified version of the Musculoskeletal Tumor Society (MTS) system, the functional assessment was carried out as described in Table 1.

Table 1: Musculoskeletal tumor society score involved in this retrospective study

Patient No.	Age/Sex	Campanacci grade	Site of tumor	Length of defect	Time to heal	Musculoskeletal tumor society score	Follow up period	Complications	Treatment of complication
01	45 F	III	LEF	10 cm	9 m	20	84 m	superficial infection	Cleaning and dressing and antibiotics
02	36 F	III	LEF	12 cm	9 m	24	81 m	shortening	
03	30 M	III with pathological fracture	LEF	12 cm	10 m	20	75 m	superficial infection	Cleaning and dressing and antibiotics
04	32 M	III	LEF	13 cm	7 m	24	72 m	Shortening	
05	25 F	III	LEF	10 cm	7 m	20	66 m	superficial infection	Cleaning and dressing and antibiotics
06	28 F	III	LEF	12 cm	8 m	24	60 m	Shortening	
07	34 M	III	UET	11 cm	9 m	22	60 m	Shortening	
08	36 F	III	LEF	10 cm	6 m	24	58 m		
09	38 M	III	UET	12 cm	8 m	24	54 m	Rush nail backout	
10	29 F	III with pathological fracture	LEF	10 cm	6 m	20	54 m		
11	31 M	III	LEF	11 cm	8 m	20	51 m	Skin loss	Myocutaneous flap
12	34 F	III	LEF	12 cm	9 m	24	48 m	Shortening	
13	29 F	II with recurrence	UET	14 cm	10 m	24	45 m	Rush nail backout	
14	26 F	III	UET	11 cm	9 m	26	42 m		
15	48 M	II with recurrence	LEF	14 cm	8 m	24	39 m	Shortening	
16	26 F	III	LEF	10 cm	8 m	24	36 m		
17	29 F	III	UET	11 cm	8 m	24	36 m		
18	30 F	III	UET	12 cm	8 m	24	28 m	Rush nail backout	
19	28 F	III	LEF	12 cm	8 m	24	28 m		
20	20 F	III	LEF	10 cm	7 m	24	24 m		
21	25 M	III	LEF	12 cm	8 m	26	24 m	Shortening	

M=Male, F=Female, LEF=Lower End of Femur, UET=Upper End of Tibia.

The range of functional score was from 20 to 26 out of 30. The five patients treated with IT were evaluated with Association for the study and application of methods of ilizarov (ASAMI) scoring system and also with modified system of MTS as described in Table 2.

Table 2: ASAMI grading of patients involving bone and functional outcomes

Case	Age/ Sex	Diagnosis	Length of defect	Duration of distraction	Duration of illizarov fixation	Transport ration	ASAMI Grading Bone outcome(B) Functional outcome(F)		Follow Up	Complications
1	22 /F	Resection arthrodesis in Grade III GCT lower end femur, treatment done with intramedullary nailing and bone grafting with severe post-operative infection	12	150	540	45 days	(B) E	(F) G	84 weeks	Nil
2	45/F	Resection arthrodesis in Grade III GCT lower end of femur, treatment done with intramedullary nailing and bone grafting with severe post-operative infection	16	150	600	42.8 days	(B) F	(F) F	72 weeks	Enders nail breakage with nonunion
3	23/M	Resection arthrodesis in Grade III GCT upper end of tibia, treatment done with intramedullary nailing and bone grafting with severe post-operative infection	12	120	412	41.2 days	(B) E	(F) G	60 weeks	Nil
4	36/F	Resection arthrodesis in Grade III GCT lower end femur, treatment done with intramedullary nailing and bone grafting with severe post-operative infection	12	140	500	41.6 days	(B) E	(F) G	65 weeks	Nil
5	40/M	Resection arthrodesis in Grade III GCT lower end femur, treatment done with intramedullary nailing and bone grafting with severe post-operative infection	10	110	410	41 days	(B)	(F)	60 weeks	Nil

ASAMI=Association for the study and application of methods of ilizarov

Discussion

GCTs are aggressive tumors that are difficult to treat. Only limited group of patients with biologically more resistant, recurring, and widespread tumors are eligible for resection and AD. [3]

Aggressive GCTs surrounding the knee joint are best managed with wide resection and mobile joint reconstruction.[3] The selection of a treatment depends on the patient's lifestyle, the surgeon's

preferences, and financial capabilities of the patients.[4] Due to limited healthcare resources, high cost, low availability, patients' high functional expectations, and young patients' non-compliances that result in prosthesis loss, personalised arthroplasty is less common in developing nations. [5] When given an option, patients and orthopaedic surgeons favour limb salvage treatments that allow for knee moment. However, a functional mobile knee reconstruction necessitates active knee extension; as a result, AD is required when the

quadriceps muscle is removed because of a tumor. [4] There are several resection and AD techniques mentioned. After enblock resection, Yadav et al employed twin fibular grafts to bridge the intercalary defect.[6] Callus distraction technique for limb reconstruction was described by Kapukaya et al.[5] After an en block resection, Tsuchiya et al. described how to treat defects using the IT.[7]

In our study, 26 patients underwent knee joint resection and AD using an autogenous cancellous bone transplant from iliac crest, fibular graft along with bone shell which it remains after removal of tumor mass and autoclaving. Stabilization of bone grafts was done with intramedullary nailing and 2 Rush nails. 21 patients out of 26 healed with resection and AD using intramedullary nail, Rush nails and autogenous bone graft from iliac crest, fibula and excised shell of bone after removal of tumor mass and autoclaving. The main healing rate in our study was 80.76% which is in contrast to studies given by Kapoor and Tiwari, who conducted resection and AD using plating and free fibular graft, IM nail with free fibular graft, and IM nail combined with ring fixator employing bone transfer. Fusion after first surgery in the above study was achieved in 77.7%, 75% and 90% respectively.[8]

Out of these 26 patients 5 got infected (19%) and were then treated with IT for control of infection and management of bone defect. The infection rate in our study was same as Campancci study done in 1979 i.e. 19%. [9] In a subsequent study by Agrawal and A K Jain (2007), patients who had resection and AD using intercalary allograft (decalcified and ethanol preserved) experienced a significant difficulty with infection. [10] All the 26 patients treated with both techniques were free from local or systemic recurrence. Local recurrence was found in few studies done in 2007 by Sudhir Kapoor and Akshay Tiwari who described 2 recurrences in 36 patients.[8] In another study in 2010 by K C Saikia they had 1 recurrence out of 32 patients.[4]

The union rate was 96.5% (25 out of 26) with using both the techniques. Most series report infection as the cause of failure (5 to 12 %).[4] Whereas, 19 percent infection rate was reported in a previous study.[9] In our series also five patients got infected out of 26 which is around 19 percent but they were later treated with IT to eradicate the infection and filling of bone defect or to manage the shorting caused by docking at bone defect site. In our study four patients treated with IT healed completely with restoration of limb length. But one patient failed to unite at defect site which resulted into shortening more than 2.5 cm.[4,9]

Functional scores in our study varied from 20 to 26 out of 30 for which the MTS modified grading

method was employed. The modified MTS system and the ASAMI scoring system were used to evaluate five patients who underwent the IT of treatment. As the post-operative infection rate was found less with better healing rate, knee joint resection and arthrodesis should be more encouraged in order to provide effective and safe management along with functional recovery of the patient.

Conclusion

The present study concludes that healing rate was better when treatment was performed using an autogenous cancellous bone transplant from iliac crest, fibular graft along with bone shell which remains after removal of tumor mass and then autoclaving it in patients who underwent knee joint resection and AD. Additionally, the post-operative infection rate was very less as compared to other studies.

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AG analyzed and interpreted the patient data. SM and AA drafted the manuscript. All authors read and approved the final manuscript.

Author's Contribution

SM analyzed and interpreted the patient data. AA and RS drafted the manuscript. All authors read and approved the final manuscript.

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