

Resection and Arthrodesis of the Knee Joint by Different Modalities for Aggressive Giant Cell Tumors of Bone

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Abstract

Purpose: The aim is to evaluate the functional outcomes in Campanacci Grade 3 giant cell tumor (GCT) of distal femur and proximal tibia treated with wide resection and arthrodesis with different implants used such as long intramedullary interlocking nail (n=11), long Kuntscher nail (n=2), and DCP plate (n=3) and to compare the outcomes and functional results of arthrodesis with arthroplasty which were done elsewhere. GCT is a aggressive benign bone tumor [1] seen in young patients with a normal life expectancy. Campanacci Grade 3 tumors and recurrent tumors require wide resection [1,2]. Arthrodesis is an alternative options for reconstruction in Campanacci Grade 3, though Arthroplasty is ideal option for campannci Grade 3 tumors.

Methods: Criteria included 16 patients of Campanacci Grade 3 GCT in which 14 male and 2 female around aged between 20 and 60 years with a mean age of 30 years underwent resection and arthrodesis of the knee for GCTs of bone involving the distal femur (n=7) or proximal tibia (n=9). After wide resection, 2 struts were fashioned from the harvested fibula of the same side and inserted into medullary canal at the resected ends of the tibia and femur. Cancellous bone grafts were taken from the same side of the iliac crest. Hemicylindrical graft was taken from anterior part of either distal femur or proximal tibia. A long intramedullary interlocking nail was inserted in retrograde fashion through piriformis fossa to distal tibia. Cancellous bone grafts [2,3] were placed transversely along the struts and circumferentially over the host-graft junctions. For other patients, long Kuntscher nail and DCP plate with K-wire were used. Results of arthrodesis were evaluated those in which long intramedullary interlocking nail (n=11), long Kuntscher nail (n=2), and DCP (n=3). Outcomes and complications were evaluated and compared with those of endoprosthetic arthroplasty reported elsewhere.

Results: Patients were followed up for a mean of 12 years. All patients were of Campanacci Grade 3. The mean size of tumors was 12-10-7 cm. All patients achieved arthrodesis with intramedullary interlocking nail, Kuntscher nail, and plating. A total number of patient (n=16). The mean bone union time was 12-14 weeks. There was no loss of alignment, loosening, and no implant breakage. The mean musculoskeletal tumor society [5] score was 27 (87% of full score). The complications were evaluated in which patients were having skin necrosis (n=3), skin infection (n=2), and peroneal nerve injury (n=1).

Conclusions: In aggressive Campanacci Grade 3 GCT around the knee joint, arthrodesis [6,7] with long intramedullary interlocking nail provides good results. Long intramedullary interlocking nailing in arthrodesis provides high fusion rates, minimal shortening, and rotational stability as compared to plate fixation. Arthrodesis is a cost-effective method as compared to arthroplasty in economically constrained population of developing nations and shows good functional outcomes with acceptable morbidity.

Keywords: Giant cell tumor, arthrodesis, intramedullary interlocking nail, hemicylindrical graft, fibula transposition, bone transplantation.

Introduction

Giant cell tumor (GCT) of bone is a benign aggressive tumor of bone [1]. Prediction of recurrence [2, 3, 4, 5, 6] and metastasis are difficult for tumor. Surgical treatment of this tumor has always been controversial with

the desired treatment being a balance between adequate removal and retention of function [7]. Various surgical options include curettage with bone grafting, extended curettage using chemical cauterization/cryosurgery with bone

grafting. Arthrodesis using autogenous bone grafts with or without vascularized fibular grafts. Arthroplasty with a customized prosthesis provides immediate mobility and stability with excellent cosmesis [10] but is costly and of limited longevity. In India,

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patients who cannot afford arthroplasty want low-cost alternatives. Arthrodesis of the knee is the treatment of choice when the extent of bone and soft tissue resection makes

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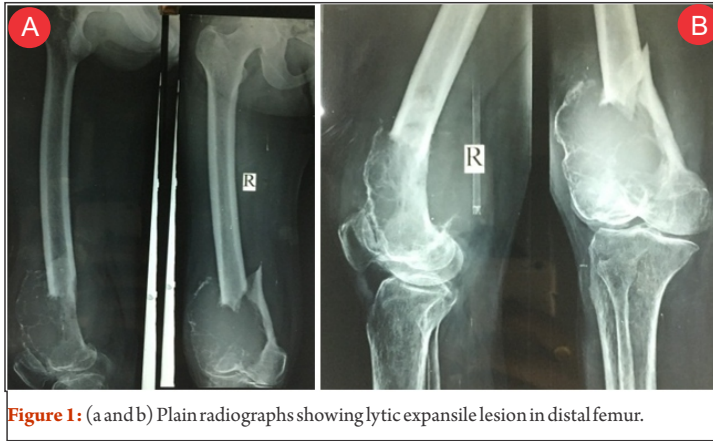


Figure 1: (a and b) Plain radiographs showing lytic expansile lesion in distal femur.

arthroplasty difficult when patients engage in heavy manual labor. They provide practical, low-cost options for reconstruction, despite at the expenses of knee mobility. We had retrospectively evaluated the functional outcomes and complications following resection and arthrodesis of the knee for Campanacci Grade 3 GCT of lower end femur or upper end of tibia as comparisons with different implants used such as long intramedullary interlocking nail (n=3), long Kuntscher nail (n=2), and plating (n=3) treated with wide resection and arthrodesis over a period of follow-up period of since 14 years.

Materials and Methods

The study included the retro-prospective case of a patient who were operated in our hospital for aggressive GCT as defined by Campanacci of distal femur or proximal tibia between February 1995 and January 2016. Male (n=14) and female (n=2) aged between 20 and 60 years underwent resection and arthrodesis of the knee GCT [15, 16, 17] of bone involving the distal

femur (n= 7) and proximal tibia (n= 9). Campanacci classification grade I-tumors involve a margined border of a thin cortical rim of mature bone, and the cortex is intact or slightly thin but not deformed. Grade 2-well-defined margin but no radiopaque rim and Grade 3-tumors involve a fuzzy border. The medical records and plain roentgenograph and magnetic resonance imaging (MRI) were carefully studied. According to the Campanacci Grade 3 tumors at presentation, none of tumors has neurovascular deficient, the radiological findings were typical in all the cases; an eccentric or widely destructive geographic lesions with sclerotic margin, location involved is epiphyseal-metaphyseal in location with destruction of one more cortices, and a large soft tissue mass of the tumor was around 12-10-7cm. Pre-operative planning was done with full-length X-rays, MRI could be obtained in all patients, and studies show that the extent of soft tissue component shows neurovascular bundle, breach of the articular surface, and the intramedullary extent of the disease. MRI was helpful in determining the feasibility of limb salvage. All the cases were confirmed under Biopsies using the core needle (n=12) and some open

biopsies (n=4). The bone which was resected at the time of definitive surgery was also sent for histopathological evaluation. Patients were given epidural anesthesia. Tourniquet was applied in form of Esmarch bandage (n=10) and pneumatic tourniquet (n=6). A wide resection was performed in all the patients using anterior incision, medial parapatellar, and subvastus incisions for lower femoral GCT, and the same incision extended distally for the upper tibial tumors were marked as per pre-operative planning. The whole tumor resected with 4-5 cm of healthy bone margins, the unaffected condyles were denied off articular cartilages simultaneously, fibular and iliac cancellous grafts were harvested from the ipsilateral side, and two struts were fashioned from the harvested fibula. Hemicylindrical bone graft was taken either from the distal femur or proximal tibia and inserted into the medullary canal at the resected ends of the tibia and femur. Fibula was used in the patients with defect more than 10cm, fibula was preserved distally to maintain stability of the ankle mortise, the corresponding ends of the struts were inserted peg holes made in the unaffected condyles in a retrograde fashion from long intramedullary interlocking nail was inserted in retrograde fashion, and now, knee arthrodesis is performed in full extension and neutral rotation. Cancellous bone grafts were placed transversely along the struts of hemicylindrical, and fibular graft circumferentially closure was done in layers of the wound over a drain kept over host-graft junction patient was follow-up for every 2 months for 1 year the patient was followed up to bony union and minimum



Figure 2: (a-c) Follow-up photographs treated with intramedullary interlocking nail.

Table 1: Patient characteristics and outcomes

Patient Number	Sex/age	Campanacci grade	Tumor site	Length of bone defect	Time to heal (months)	Follow-up months/year	Implant used	Shortening	Complications	Musculoskeletal tumor society function score
1	45/m	Grade 3 recurrence	Proximal tibia	12 cm	5	6 months	Intramedullary interlocking nail	0.5 cm	Foot drop	26
2	42/m	Grade 3	Distal femur	11 cm	8	9 months	Interlocking nail	1 cm	Skin necrosis	25
3	55/m	Grade 3	Distal femur	9 cm	10	14 years	Interlocking nail	1 cm	Skin necrosis	26
4	65/m	Grade 3	Proximal tibia	8 cm	8	18 years	Plating	1 cm	Infection	24
5	27/f	Grade 3	Proximal tibia	9 cm	10	20 years	Kuntscher nail	No	No	25
6	30/m	Grade 3	Distal femur	12 cm	9	18 years	Plating	2 cm	Varus deformity	24
7	60/m	Grade 3 recurrence	Distal femur	10 cm	10	16 years	Kuntscher nail	1.5 cm	No	26
8	42/m	Grade 3	Proximal tibia	6 cm	7	10 years	Interlocking nail	No	No	27
9	40/m	Grade 3	Proximal tibia	7 cm	8	8 years	Interlocking nail	No	No	27
10	32/f	Grade 3	Distal femur	5 cm	10	12 years	Kuntscher nail	1 cm	Infection	23
11	37/m	Grade 3	Proximal tibia	9 cm	6	10 years	Interlocking nail	No	No	26
12	26/m	Grade 3	Proximal tibia	10 cm	7	8 years	Interlocking nail	No	No	26
13	28/m	Grade 3	Distal femur	8 cm	8	8 years	Interlocking nail	No	No	26
14	30/m	Grade 3	Proximal tibia	9 cm	6	10 years	Interlocking nail	No	Skin necrosis	26
15	37/m	Grade 3	Proximal tibia	12 cm	7	6 years	Interlocking nail	No	No	27
16	34/m	Grade 3	Distal femur	10 cm	9	8 years	Interlocking nail	No	No	27

follow-up was 1 year a full-length Rontgen graph was taken and it shows good radiological union with 12-14 weeks. The clinical observations were made regarding recurrence of tumor and functional status. Radiological criteria of assessment were local recurrence, status of bone union, and stability at host-graft junction. The patient's musculoskeletal tumor society (MSTS) was calculated at every follow-up. Protected partial weight bearing was allowed at 10-14 weeks. Full weight bearing was allowed at 26-28 weeks depending on radiological evidence of union and absence of pain.

Results

16 patients were analyzed with Campanacci Grade 3 with mean age 30 years in which 14 were male and 2 were female with 7 distal femur and 9 proximal tibia were involved at an average follow-up of 14 years and none of patients showed metastasis or malignant transformation. All patients achieved arthrodesis and full weight bearing without pain within 6-8 months. No further shortening or loss of alignment was observed, apart from the intended shortening of 1 cm. No donor-site morbidity, loosening, implant breakage, metastasis, or death ensued. There were 2 cases of recurrent GCT treated with extended curettage detected 20 and 24 months. The mean size of bone defect was

10 cm. As from Table 1, Case no. 4 and 10 developed infection which was treated with debridement and third-generation cephalosporins. Later, infections subsided in 1 month. Bone union was achieved at 10 months. All the fractures were united with corticocancellous bone grafting patients were free of disease. Case no. 1 had foot drop, and it was confirmed clinically which was treated conservatively by proper positioning of static splint which recovered after 26 weeks. In Case no. 2 and 3, 14 had developed superficial suture line skin necrosis which was disappeared after 3 weeks. No patient had an early or late fracture of the graft. We had also compared the functional outcomes of various treatment modalities. The mean functional score was 27 (89% of the full score). The mean (range) sub-scores for pain, function, emotion, walking ability, and gait were 5(4-5), 4(4-5), 5(4-5), 4(2-5), 4(4-5), and 4(5), respectively. 16 patients had satisfactory functional outcomes; 2 patients were using cane intermittently.

Discussions

Treatment of GCT has been restricted mostly to extended curettage or bone grafting. Local recurrence and loss of joint function are challenging tasks to control. The choice of reconstruction after wide resection is based on the extent of the tumor and soft tissue involvement.

Endoprosthesis, osteoarticular allografting, and arthrodesis are the most commonly used options. Resection arthrodesis of the knee has been found to be a useful procedure for tumors around knee while reconstruction with prostheses and allografts provides better function to the limb in short term by restoring the joint motion they may not be an ideal choice for young vigorous adults with normal life expectancy and low socioeconomic status. In developing countries, most patients can afford only the low-cost limb salvage options such as arthrodesis, extracorporeal irradiation/autoclaving, and reimplantation. An endoprosthesis provides immediate stability and mobility to the knee joint but is costly and limited longevity. Knee [12, 13, 14, 15, 16] arthrodesis provide better stability and in long term give good results with various techniques evolved over time, and high function outcomes were achieved. The requirement of microvascular training and risk of vascular damage with its complication are avoided. In developing countries, customized arthroplasty is less popular because of limited health care resource, high functional demands, and noncompliance of young patients leading to loosening. In some cases, extensive resection leaves few muscles to power an arthroplasty. Young patients with normal life expectancy are likely to outlive the prosthesis even after several revisions. In

Table 2: Comparison study of two groups nailing and plating

Study	I.M group	Plating group	Endoprosthetic
Shortening	<0.5cm	More than 0.5cm	<0.5cm
Stability	More	Less	More
External support(post-operative)	Not required	Required(cylindrical caste)	Not required
Weight bearing	Early(3-5 months)	Late(6 months)	Early(48-72 h after post-operative)
Pain	No pain	Intermediate	No pain
MSTS score	27	24	27

Table 3: Resection arthrodesis versus endoprosthetic arthroplasty of knee joint

Study	Number of patients	Aseptic loosening (%)	Prosthetic survival (%)		Infections (%)	Stem/graft fracture (%)	Musculoskeletal tumor society functional score
			5 year	10 year			
Knee arthroplasty							
Myers et al.	192	35	83	67	47.8	3.7	
Maruthinar et al.	25	33	100	100		0	Good
Sharma et al.	77		84	79	7.8	3.9	30%
Ahlmann et al.	108	2.4	76.9	56.3	5.2	0.5	75.60%
Morgan et al.	80	15	75		2.5		
Gitelis et al.	8		100				Good
Flint et al.	44	0	72.7		15.9	4.5	75%
Natarajan et al.	143	4.2	92.3		6.9	8.3	62% excellent, 27% good
Our study knee arthrodesis	16	0	0	0	0.06	0	85%

some patients, the long stem of the prosthesis becomes unstable under considerable stress and after extensive soft tissue excision. As reference of Table 1 [14, 15, 16, 18, 20], we had evaluated results and outcomes of different implants which were used such as long IMIL nail (n=11), long Kuntscher nail (n=2), and plating (n=3). In our case series of 16 patients. Of Campanacci Grade 3 of GCT, patients who underwent with wide resection and arthrodesis were compared in two groups. Patients who underwent with intramedullary nail and those with plating group were summarized in Table 2 [11, 12, 16, 17, 18]. The criteria were shortening, pain, weight bearing, scoring of MSTS and their complications were evaluated. In nailing group, 11 of 16 patients who undergone long IMIL nail with fibular allograft have been used with success for a long time. It is one-time method and technically easy, and coverage of implant is never a problem with early weight bearing, rotational stability, and no need of immediate post-operative external support of cylindrical caste with minimum pain, shortening, no loosening, and breakage of implant. This is a promising technique that the rate of non-union was low with this technique and was found to be much less cumbersome deformities of the ankle and foot (mostly equinovarus; knee deformities are avoided because of the intramedullary nail). There are minimum complications which were evaluated such as suture line necrosis which was disappeared after 3 weeks. Other patients who underwent with plating (n=3) were studied and evaluated in which there were impinging and loosening of implant. The patient needs external support with cylindrical caste, long hinge braces after immediate post-

operation. Weight bearing is delayed due to intermediate pain. There was infection occurred which later subsided by debridement. In our study, superior fixation was achieved by a long intramedullary interlocking nail contributed to early union at the host-graft junction with minimum complications; the mean functional score long nail was 27 (90% of the full score) patients. Long IMIL nail contributed to early union at the host-graft junction, with rotational stability and long-term promising effect with no external support with long cylindrical caste as compared to others. The functional scores for endoprosthetic knee arthroplasty range from 66% to 85% [15, 16, 28, 29, 30]. Aseptic loosening is a major threat to endoprosthetic replacement [11, 12, 14, 15, 16]. Its incidence ranges from 8% to 56% over 5-10 years of follow-up [14, 16]. Most series report infections (5-12%) as the most common cause of failure. Fixed-hinged implant shows increased wearing. The time of bushing revision was reported to be about 11 years. As compared with megaprosthesis, the 5-year survival is reported to be 73-83%, whereas the 10-year survival is 59-67%. Our results of knee resection arthrodesis were compared with the results of endoprosthetic arthroplasty which was done elsewhere (Table 3) [15, 16]. In our study, most complications were surgery related and occurred at an early stage, whereas the short-term results of endoprosthetic arthroplasty are encouraging. In the long term, resection and arthrodesis result in hypertrophy of fibular struts, in contrast to aseptic loosening secondary to stress shielding in endoprosthetic arthroplasty. The long-term painless stability provided by resection and arthrodesis of the knee joint by long

intramedullary interlocking nail was well accepted by our patients. This limb-salvage procedure produced predictable long-term results and enabled a strong, durable, and stable limb and a satisfactory lifestyle, with limited disability due to loss of knee motion. This form of surgery may be indicated as a salvage procedure following failed prosthetic replacement. Appropriate counselling for emotional issues associated with loss of knee function is vital. Arthrodesis is a viable alternative to customized arthroplasty and provides a long-lasting and cost-effective reconstruction for average patients in developing countries.

Conclusions

In aggressive Campanacci grade 3 giant cell tumor around knee joint. Arthrodesis 6,7 with long intramedullary interlocking nail provides good results. Long Intramedullary interlocking nailing in arthrodesis provides high fusion rates, minimal shortening & rotational stability as compared to plate fixation. Arthrodesis is a cost effective method as compared to arthroplasty in economically constrained population of developing nations and shows good functional outcomes with acceptable morbidity.

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