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ORIGINAL ARTICLE

Resection Arthrodesis of Sarcomas around the Knee: Five Year Survival Outcome from a Cancer Dedicated Institute

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ABSTRACT

Objectives: The surgical removal of malignant bone tumors around the knee requires generous removal of soft tissue along with segments of the femur and tibia without having adequate tissue for reconstruction, however different reconstruction options are proposed after wide local excision of sarcoma around the knee joint the objective of our study is to evaluate the outcomes of reconstruction with knee arthrodesis.

Methodology: Retrospective reviews of all of the patients who received tumor removal and knee arthrodesis in our facility from January 2005 to December 2015 were conducted. The primary outcome was measured by using musculoskeletal tumor society score (MSTS) and Lower Extremity Functional Score (LEFS). The secondary outcome was measured in terms of postoperative complications, Limb length discrepancy, and time to union, metastasis, and recurrence.

Results: A total of 22 patients underwent resection arthrodesis of the knee sarcoma during the mentioned period, performed by using an ipsilateral fibula and contralateral anteromedial cortex of the tibia using dynamic compression plate in 20, and in two patient's Ilizarov apparatus was used. Bone union occurred in 17 (77.2%) patients while 12 (54%) patients had spontaneous union and in 05 (22.7%) patients bone grafting was required. 05 patients had nonunion and all of them had wound infections and ended up in amputation. The mean MSTS score was 67.8+/-4.3% while the mean Lower Extremity Functional Score (LEFS) is 61.2+/-3.7%. Male patients have a low MSTS score of 55.4+/-3.7% as compared to the female population with a score of 74.6+/-4.9%. ($p<0.05$).

Conclusion: We strongly advocate resection arthrodesis a valid reconstructive option for tumors around the knee.

Keywords: Resection Arthrodesis, Sarcoma, Limb Salvage, Knee Joint

This article may be cited as:

INTRODUCTION

Primary soft tissue and bone Sarcomas are uncommon tumors of the musculoskeletal system of mesenchymal origin and are frequently seen in the adolescent population. It accounts for 0.2% of all malignancies with histological-specific bimodal age distribution and commonly affects the young bones in the second decade of life the second peak occurring in the late sixties[1,2]. Growing skeleton and psychosocial factors in the young age group make treatment more challenging, however, With the advancement of surgical techniques, imaging modalities, and modern chemotherapy, limb salvage

surgery is feasible with better functional and aesthetic outcomes[3].

The surgical removal of malignant bone tumors near the knee requires generous removal of soft tissue along with segments of the femur and tibia without having adequate tissue for reconstruction, however different reconstruction options are proposed after wide local excision of sarcoma including mega prosthesis, extracorporeal radiation, and resection arthrodesis and it mainly depends on available resources and surgeons expertise[4]. In the children and adolescent age group, the mega prosthesis is not a valid option and the high cost and unavailability of growing mega prosthesis especially from the low socioeconomic countries make resection arthrodesis of the knee method of choice to reconstruct the large defects[5]. Kamal AF et al compare the different limb salvage surgical options for malignancy around the knee and concluded that mega prosthesis has excellent functional outcome but a knee arthrodesis is still a valid option for the locally advanced stage of disease[6].

Overall the 5-year survival of sarcoma is less than 70%, however, it has been rising recently due to the development of a multi-disciplinary approach[7]. On the other hand, few publications are showing good functional outcomes after resection arthrodesis of the knee in benign aggressive tumors[8], and with extra-articular resection arthrodesis of tumor invading knee but some studies have shown increased complication & decreased survival with resection arthrodesis[9].

To the best of our knowledge, the young age group has limited data especially from developing countries like Pakistan, in the present study we are sharing our comprehensive experience of oncological management of sarcomas near the knee and the purpose of this study is to determine the long-term functional and survival outcome of patients with Sarcoma around the knee treated with Resection-Arthrodesis.

METHODS

Retrospective reviews of all of the patients who received tumor removal and knee arthrodesis in our facility from January 2005 to December 2015 were conducted following Institutional Review Board (IRB) approval. Variables including age, gender, site of the tumor, details of the surgery, reconstruction, histopathology, and complications were assessed. Patients were evaluated pre-operatively for the local disease stage by regional X-rays and MRI of the affected limb while distant metastasis was ruled out by using bone scan and CT scan of the Chest. After the complete workup each patient was discussed in the weekly Multi-disciplinary Tumor board and treatment was devised for all patients, neoadjuvant chemotherapy was given to all the patients with Ewing's Sarcoma and Osteosarcoma. Patients whose tumors involved knee joint or extensor apparatus, those in which mega prosthesis was not suitable or patients who were heavy laborers offered resection arthrodesis of the knee. The primary outcome was measured by using the Musculoskeletal Tumor Society Score (MSTS) and Lower Extremity Functional Score (LEFS). The secondary outcome was measured in terms of postoperative complications, Limb length discrepancy, and time to union, metastasis, and recurrence.

Data were collected by using the Hospital Information System (HIS), patients were reviewed in the clinics, or by calling patients. All the findings were entered into a pre-designed proforma. Quantitative data was described using frequencies and proportions, and categorical data was described using means and standard deviations. To examine the variables linked to morbidity and mortality, a univariate analysis was conducted. To find risk factors for all variables that were significant in univariate analysis, a logistic regression model was used in a multivariate analysis. Overall survival (OS) and event-free survival (EFS) were used as the metrics for the survival analysis. Overall survival (OS) was measured from the date of the initial diagnosis to the date of the last follow-up or death from any cause. Event-free survival (EFS) was measured from the date of treatment completion to the date of the illness recurrence, progression, or death. The Kaplan-Meier technique was used to analyze EFS and OS. A p-value of 0.05 or lower was regarded as significant for all statistical analyses, which were carried out using SPSS 22.

SURGICAL TECHNIQUE & IMPLANT

All the oncological resections were performed by an experienced tumor surgeon. Resection arthrodesis was performed by using a dynamic compression plate. After resection, the autograft was taken from the ipsilateral fibula along with the anteromedial cortex of the contralateral fibula after preserving the common peroneal nerve. Non-vascularized autograft was placed in the medullary canal of the femur proximally & distally into the medullary canal of the tibia which was supported by using a long dynamic compression (DCP) plate with minimum 08 cortices purchase proximally & distally. The patient remained

in a complete cast for 6 weeks & kept non-weight bearing after which partial weight bearing was started

In patients with the minimum bone loss after resection, arthrodesis was performed by using the Illazarov apparatus after preparing the proximal tibia and distal femur. The Proximal Tibia & distal femur were prepared by using knee replacement jigs and held in the final position by using Ilizarov apparatus.

After the procedure, patients were initially followed in clinics after two weeks for suture removal & then referred to an oncologist for adjuvant chemotherapy after satisfactory wound healing. The patient remains in orthopedic follow-up after every 06 weeks initially. All the patients were assessed on a CT scan of the operated limb with MARS protocol for bone union or recurrence 04 monthly for 2 years, then 06 monthly for one year, then yearly afterward. Chest x-ray was advised on every visit followed by a CT scan chest if any suspicious metastasis was present.

RESULTS

A total of twenty-two patients underwent resection arthrodesis of the knee sarcoma during the mentioned period. The median age of the patients who underwent resection arthrodesis was 19.4+/-5.93 years. The median follow-up of the patient was 8.4+/-0.7 years (Range 6-12 years) at the time of the study. Out of twenty-two patients, eleven (50 %) were male and eleven (50%) were female. The most common tumor was osteosarcoma in eighteen (81.8%) followed by two (9.1%) patients of Ewing's sarcoma and two (9.1%) patients of synovial sarcoma. Sarcoma was located in the distal femur in eighteen (81.8%) patients while four (18.2%) patients had sarcoma on the proximal tibia. In twenty patients, arthrodesis was performed by using an ipsilateral fibula and contralateral anteromedial cortex of the tibia using a dynamic compression plate while in two patient's Ilizarov apparatus was used.

Bone union occurred in seventeen (77.2%) patients with an average time of union is 6.7 +/-0.5 months while twelve (54%) patients had spontaneous union and in five (22.7%) patients bone grafting was required. Five patients had nonunion and all of them had wound infections and ended up in amputation.

Overall complication after resection arthrodesis was 68.2% (15 patients). In eight patients deep wound infection was the most common complication and seven patients ended up with above-knee amputation due to infection ($p<0.05$). One patient had a superficial infection, which was managed conservatively.

A total of eight patients ended up with amputation, out of which seven patients had an amputation due to infection while one patient had an amputation due to recurrence. Out of the total, two patients had a stress fracture of the contralateral tibia (donor site), which was managed by the complete above-knee cast for 6 weeks both patients had a union at the end of the eighth week.

Overall two patients had recurrence after resection arthrodesis. Both patients who had a recurrence had osteosarcoma as their primary diagnosis. One patient developed recurrence after 8 months of surgery, which was managed by using above-knee amputation while another patient developed recurrence after 12 months along with visceral metastasis so the patient remained on palliative care and died 17 months after surgery. Both of these recurrences were detected by using a CT scan with MARS protocol.

Table 1: Demographics of patients with knee sarcomas

Characteristics	Number (%)
Gender	
Male Female	11 (50%) 11 (50%)
Age	Mean
Mae Female	85 (73.9%) 30 (26.1%)
Site of Tumor	
Distal femur Proximal tibia	18(81 %) 04 (45 %)
Histological Type	
Osteosarcoma Ewing sarcoma Synovial sarcoma	18(81.8 %) 02 (9.1 %) 02 (9.1%)
Enneking stage at diagnosis	
Stage IA Stage IB Stage IIA Stage IIB	01(81.8 %) 02 (9.1 %) 05 (9.1%) 14 (81.8 %)
Type of Arthrodesis	
Dynamic compression plate Ilizarov apparatus	20() 02()
MSTS score	67.8+/-4.3%
Male Female	55.4+/-3.7% 74.6+/-4.9%.
LEFS Score	61.2+/-3.7%

Twelve patients developed metastasis after resection arthrodesis with an average time of metastasis is 1.2 +/- 0.7 years from the date of surgery. Out of twelve patients who developed metastasis, ten had osteosarcoma while a single patient of Ewing and Synovial sarcoma had metastases. The lung is the most common site of metastasis in nine (40%) patients while two patients had metastasis to the spine (9%) and one (4.5%) patient had visceral metastasis. Out of 12 patients, 07 patients who had single lung metastasis underwent wedge excision of the lung by the thoracic surgeon after patient evaluation and 05 died from metastasis.

The mean MSTS score was 67.8+/-4.3% while the mean Lower Extremity Functional Score (LEFS) was 61.2+/-3.7%. Male patients have a low MSTS score of 55.4+/-3.7% as compared to the female population with a score of 74.6+/-4.9%. ($p<0.05$).

Out of twenty-two patients, six (27.3%) patients were dead at the time of the study. All of these patients died within 3 years of the operation with the metastatic disease being the most common cause of death (83.3%). Five-year overall survival of patients after resection arthrodesis of knee sarcoma was 80%.

DISCUSSION

Bone sarcomas are rare malignancies with age-specific bimodal distribution and first peak is seen in the second decade and the second peak occurs at more than sixty years of age with different histological subtypes. The prognosis of sarcomas is poor due to its high invasiveness and metastasis. Resection of the primary tumor and Restoration of the affected extremity function while optimizing the patient's quality of life are the important goals of treatment.

In the present study, a total of twenty-two patients were included and osteosarcoma around the knee was the most common pathology managed. A higher prevalence of tumors was seen in the second decade of life and male to female ratio of 1:1 which is comparable to the other similar studies[6,10].

In this study, most of the patients came in Enneking stage IIB 14 (%), which is comparable with other studies that have an even higher number of patients with this stage[6,11].

Limb salvage surgery with mega prosthesis is the preferable treatment option for tumors around the knee to maintain joint mobility, allow early weight-bearing, and optimal patient satisfaction[6,12] however, due to the high cost and unavailability of modular mega prosthesis decades back in developing countries makes the arthrodesis a choice of reconstruction after tumor resection with potential advantages of being a stable, durable reconstruction at the expense of lack of motion of the knee with unrestricted activity.

The proposed techniques for resection arthrodesis are multiple and differ according to the nature of the material used for bone reconstruction; in this series, most of the patients[20] had arthrodesis with dynamic compression plate, and in 02 patients with Ilizarov apparatus which is comparable with other techniques like Vascular fibular graft, cortical Autograft, Autoclave bone graft, Allograft with different rate of complications and overall outcome[4,6,17].

Deep wound Infection occurred in eight (36%) patients and seven patients ended up with above-knee amputation due to non-settling infection, Nouri H et al reported an infection rate of 53% in limb arthrodesis using a vascularized fibular rotatory graft while Kamal AF and Shih et al. reported the infection rate 40% and 8.3% in there series repetitively[6,17,20]. Campanacci et al found infection was the only major complication that occurred in 5 of 26 patients (19.2%)[25]. Local recurrence was seen in 02 (09%) patients which is equally comparable with other series who reported recurrence rates of 11%, 20%, and 05 % respectively[4,6,20].

Bone union occurred in seventeen (77.2%) patients while Five (22.7%) patients in this study had nonunion and all of them had wound infection & ended up in amputation which is also comparable to other studies. Luyet et al also showed a high rate of the union after resection arthrodesis but they used an intramedullary rod for arthrodesis contrary to our study[21]. Ballato et al in their study also showed a union rate of 83 % after resection arthrodesis which is comparable to our study[22] Wisanuyotin T et al described a high percentage of union (85.2%) among patients who had nonvascularized autogenous bone graft repair, with a structural failure rate of 18.5% and an infection rate of 3.7%.[23]

Enneking et al examined the outcomes of resection arthrodesis in patients with benign and primary malignant bone tumors at the knee. Massive autogenous bone graft problems included nonunion in four (20%) of the twenty patients and structural failure in five of the twenty patients[24]. We do not observe any structural failure in any of the patient

Osteosarcomas mainly metastasizes to the lungs and metastatic disease has a significant impact on the prognosis of osteosarcoma patients[26], Chen et al.

reported that the 5-year survival rate of osteosarcoma patients with lung metastasis treated by pulmonary metastasectomy was 31 %[27], while Metastasis documented in different groups of treatment by Kamal AF was 18.18%, 25% and 40% in ECI, mega prostheses, and MAMC group respectively[6]. In our study, twelve patients developed metastasis after resection arthrodesis which is higher than in previous studies and commonly seen in osteosarcoma patients while the most common site of metastasis was lungs 09 (75%), Out of twelve patients, seven patients had single lung metastasis underwent wedge excision of the lung nodules suggested that aggressive surgical treatment for metastatic disease results in a favorable outcome.

Kamal AF et al reported the average MSTS score of 68.4 % in the arthrodesis group & 78.7 % in the Mega prosthesis group & the average MSTS score for all groups was 72.1[6]. Wisanuyotin T et al also showed a low MSTS group in arthrodesis patients (72%).

The mean MSTS score was 67.8+/-4.3% while the mean Lower Extremity Functional Score (LEFS) was 61.2+/-3.7% in this study which is low & comparable to other studies. Loss of motion at the knee joint results in difficulty in daily activities and leads to emotional disturbance & low functional score

A multidisciplinary approach, advances in chemo-radiotherapy and surgical treatments for bone sarcoma have improved the survival rates as compared to the previous and the recently reported 5-year survival rate for bone sarcomas is approximately 65%-70%, although a survival rate of up to 90% has also been reported in different series (28, 29). In this study with a median follow-up of 8.4+/-0.7 years the reported overall survival of patients after resection arthrodesis of knee sarcoma was 80 % which is higher and comparable with similar studies & different reconstructive modalities

The limitation of this study is the small sample size and retrospective in nature however this is one of the comprehensive series from developing countries on bone sarcoma treated with resection arthrodesis having a detailed analysis of variables and prognostic factors with type and anatomical distribution, showing an overall survival rate of 80%. Recently Various reconstruction options have been available following tumor excision of the distal femur and proximal tibia including mega prosthesis, however, for patients in developing countries who may not afford and where the availability of mega prosthesis is an issue, we strongly advocate resection arthrodesis a valid reconstructive option for tumors around the knee. The use of allograft bone resulted in a stable, functional reconstruction in most patients. The patient's acceptance of the reconstruction was high, despite the loss of motion of the knee. Future collaborative studies will be valuable in comparison with other reconstructive options to aid more knowledge and outcome data for the betterment of patient management and family counseling.

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