Ilizarov Bone Transport with Knee Arthrodesis in the Treatment of Giant Cell Tumor of Proximal Tibia

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Abstract: For almost two decades extremity amputation has not been the only viable option for patients with osteoclastoma in the region of the knee. Remarkable advances in surgical reconstructive technique provide a new option for surgeons who diagnose and treat bone tumors. Ilizarov bone transport has become widely accepted alternative in limb salvage surgery of the extremities. The aim of this study was to present the outcome of the treatment of bone tumors in the knee region by the use of Ilizarov bone transport with knee arthrodesis. In the period from 2001 to 2008 we adopted new clinical practice protocols for management in candidates with osteoclastoma of proximal tibia including: surgical tumor staging, histopathological verification, determinants of anatomical defect, as well as status of soft tissues. The patients were monitored during ≥24 months after the surgery for detecting possible complications. All procedures were performed without complications during and immediately after the surgery. During the follow-up period not less than 24 months we failed to record any significant complications. Ilizarov bone transport with knee arthrodesis is a good treatment option of bone tumors in the knee region.
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Key words: osteoclastoma proximal tibia, ilizarov bone transport, knee arthrodesis.

1. Introduction:

For almost two decades extremity amputation has not been the only viable option for patients with bone cancer in the region of the hip and knee. Remarkable advances in implant technology, surgical reconstructive technique and adoption of new chemotherapy protocols provides a new option for the surgeons who diagnose and treat bone tumors(1). Megaendoprosthesis has become widely accepted alternative in limb salvage surgery of the extremities. They allow restoration of function; improve the control of malignant disease and subjective patient satisfaction (3). A success in limb salvage approach depends upon understanding of tumor biology and assessment of tumor aggressiveness, advances in reconstructive techniques and the development of effective chemotherapy protocols for primary and secondary bone tumors (2). Metal implants fixed with polymethylmethacrylate (PMMA) cement have been recognized for a long time as a successful modality of treatment of pathological bone fractures after metastasis (1). In patients with disseminated metastatic disease, treatment should improve the quality of life in line with prognosis. In these cases the demands and needs for endoprosthesis are temporally and functionally restricted to facilitate the mobilization and health care. On the other hand, patients with newly diagnosed bone tumor, that requires resection, are often young and are expected to live with the prosthesis for many years. A substantial amount of healthy bone may need to be resected to provide a safe margin, leaving a remnant bone segment not enough to secure fixation of a megaendoprosthesis (1). Reconstructive options after resection of tumors in the region of the hip and knee, besides a custom made endoprosthesis, include osteoarticular alografting, alograftprosthesis composites, arthrodesis with intercalary bone graft and rotational plastic procedures. However, only resection with grafting, arthrodesis and rotational plastic procedures such as VanNes rotational plasty has many functional restrictions and can be applied only in exceptional cases. Megaendoprosthesis provides numerous advantages, one of them being the possibility that a patient, soon, returns to daily activities with the full weight bearing. It is very important, because the available data show that approximately 25% of these patients live less than two years after the surgery (1). Other advantages are reliability, availability, and proven favorable cost-effectiveness ratio (2). Nevertheless, possible complications of reconstructive surgery, in general, such as infection, aseptic loosening, dislocation of prosthesis, joint stiffness or contracture, instability of components, and implant mechanical weaknesses may compromise the outcome, and the possibility of a successfull revision, when the only remaining option is amputational surgery (3). In patients with osteoclastoma of the knee, the age of patients is relatively young and life expectancy is prolonged so, in these patients we used tumor resection with ilizarov bone transport and arthrodesis of the knee joint.

2. Patients and Methods

In the period from 2001 to 2008, five patients with osteoclastoma of proximal tibia were treated with wide resection of the tumor and limb reconstruction using Ilizarov bone transport with arthrodesis of the knee joint. Postoperative follow-up of each patient was at least 24 months. All patients were treated with wide resection of the tumor and application of Ilizarov device, two rings connected with rods are applied to the femur and another two rings connected with rods are applied to the tibia, for each ring two K. wires are applied with drop out wire without the need for application of Shanz, then both devices are connected to each other by connecting rods. Double osteotomies are then done, one between the two rings in the femur, and the other one between the two rings in the tibia. After one week bifocal bone transport is started at osteotomy sites by a rate of 0.25mm every 6 hours till distal end of femur meet proximal end of tibia after bridging the bone defect (docking site) verified by x-ray follow up every 3 weeks at start then every week when approaching to bridge the defect completely. Afterward the device is left in place till complete consolidation of regenerate. Before meeting of docking site the patient is mobilized with crutches without weight bearing. After meeting at docking site the patient is allowed touch-down weight bearing which is gradually increased as tolerated till fill weight bearing is achieved. After complete consolidation of regenerate in the femur and tibia and complete union at docking site the device is then removed with or without anesthesia. We adopted a protocol for selection and preoperative preparation of candidates for the treatment of tumors in the knee region with Ilizarov limb reconstruction. The protocol included surgical assessment of tumor aggressiveness, biopsy and histopathological verification, anatomical-mechanical determinants of the defect, the status of soft tissues, to plan the surgery. In order to succeed, we made an exact preoperative evaluation of lesion size, careful preoperative planning of the level and accurate application of the Ilizarov device. In order to ensure the safe margins, resection of significant segments of healthy bone was sometimes required.

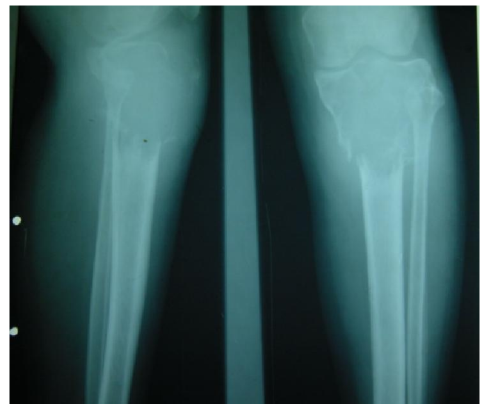

Figure (1): Forty five years old female with osteoclastoma of proximal tibia with pathological fracture and soft tissue mass in the anterior compartment.

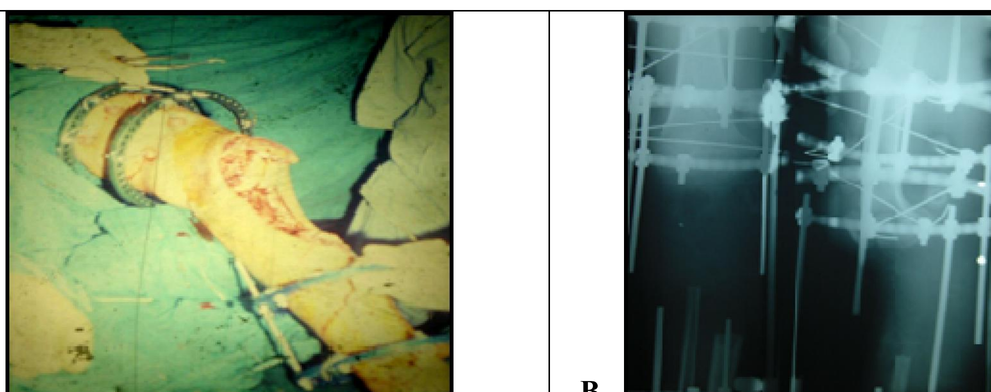

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Figure (2): (a) Intra-operative image after resection of the tumor with safety margin showing the extent of the defect and its soft tissue cover and application of Ilizarov device with two rings in the femur and two rings in the tibia with 2 K. wires and one drop-out wire for each rings and the two rings are connected with rods and both the tibial and femoral components are connected with rods. **(b)** Immediate post-operative x -ray showing the extent of bone defect.

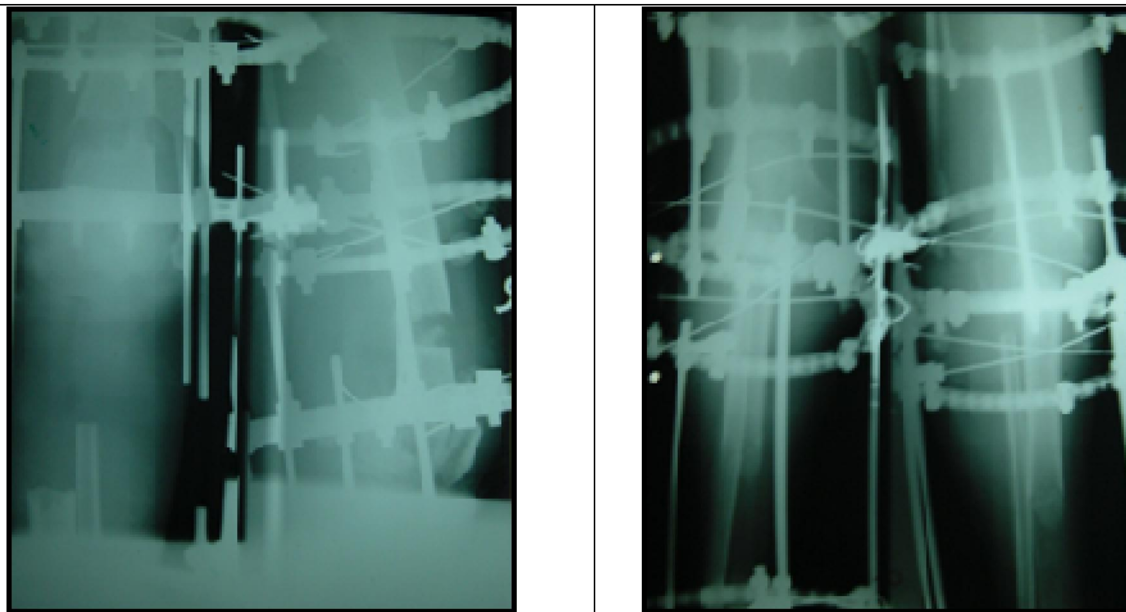

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Figure (3): (a) Follow up x-ray showing femoral osteotomy site with distracion osteogenesis to bridge the defect. **(b)** Follow up x-ray showing tibial osteotomy site and bone transport with good regenerate and meeting at docking site with obliteration of the bone defect.

A B

Figure (4): (a) Anteroposterior and lateral views of the femur and knee after removal of the ilizarov device showing complete consolidation of regenerate of the femur with sound fusion of the knee joint. **(b)** Anteroposterior and lateral views of the tibia after Ilizarov removal with complete consolidation of regenerate.

Figure (5): The patient after removal of ilizarov device with obliteration of bone and soft tissue defect and arthrodesis of the knee joint.

3. Results

There were no intraoperative complications, neither complication in the early postoperative period (a month after the surgery). All the patients were followed up minimally 24 months postoperatively. The Ilizarov frame was placed for transport and until bone was solid for an average of 12 months (range: 10-18 months). External fixator index ranged from 22 to 32 days/cm (average 25.5 days/cm).No patient needed bone graft at the docking site for delayed union. Two patients needed open reduction and removal of interposed soft tissue. No patient had equinus deformity at the time of frame removal. Three patients had pin track infection which responded well to daily dressing and proper antibiotic according to culture and sensitivity. There were no recurrences of tumor in all cases. The overall survival of patients in the follow-up period was 100%In the series. All patients underwent wide resection of tumor and Ilizarov limb reconstruction. All the patients were regularly checked up at the first month postoperatively and after three months. In tumor reconstructive surgery bone resections are usually broad and necessarily affect a good portion of healthy tissue. Although we presented only light patients we are proud to highlight the absence of the most common and certainly the most difficult complications to resolve such as deep infections, nerve and vascular injuries.

4.Discussion:

Surgical treatment of locally aggressive and malignant bone tumours ranges from intralesional excision and packing with bone cement or bone graft to wide resection plus reconstruction with modular prostheses, allografts or vascularised bone grafts. These methods are not without complications, and failure may occur due to local recurrence, loosening, infection or re-fracture (4, 5). Large defects are usually challenging and the soft tissues may be deficient. Infection may further complicate the condition and make reconstruction extremely difficult. Limited options are available for the management of such difficult problems. Ham *et al.* (6) reviewed the oncologic results and survival of the end prostheses in 32patients with primary bone sarcoma of the distal femur and found that end prosthesis-related complications occurred in 41% of the cases. Revision of the end prostheses was required in five cases (16%) and amputation of the involved limb was performed in four patients (13%) because of local recurrence in two of them and infection in the other two patients(6). Distraction osteogenesis has been used extensively in the management of post traumatic bone defects; it has been used with promising results as a primary line of management in reconstruction of bone defects after tumour resection (7-10). In this study we used bone transport in the management of bone defects resulting from tumour resection in 5 cases with aggressive and advanced osteoclastoma of proximal tibia. The knee joint was involved in all the cases, so extraarticular resection and bone transport aiming for knee fusion was done in all cases. The defects created by tumour resection are usually large and the expected time of external fixation is long, so the construct must be stable enough to outstand this duration. We routinely did mild to moderate shortening of the limb to decrease the defect but to a degree that does not affect soft tissue tension. After meeting at the docking site the shortening of limb can be compensated by lengthening alone at osteotomy sites. This procedure can allow bony healing at docking site while lengthening at osteotomy sites is performed to decrease the time of application of the device. Freshening of the bone ends with removal of interposed tissue followed by reduction and compression at docking site was indicated in 3 cases. Infection was eradicated in all the infected cases without the need for prolonged antibiotics and without reactivation throughout the period of follow-up. This is compatible with the observation of Ilizarov that the infection is burnt in the fire of regeneration. He attributed this to the massive increase in blood supply of the limb during distraction (11). One of the advantages of the distraction process is its ability to bridge soft tissue defects without the need for major plastic surgery. During distraction osteogenesis not only the bone but also the soft tissues are lengthened and this helps in spontaneous closure of the soft tissues defects (12). Although most of our cases ended up with knee arthrodesis, they were satisfied with their results as they were able to do their living activities without pain or instability. This is in agreement with Harris *et al.* (13) who compared functional outcome after different modalities for the treatment of bone tumours and found that patients with an arthrodesis of the knee perform the most demanding physical and recreational activities, although they have difficulty with sitting. The major disadvantage of the distraction process is the long external fixation time. In our prospective study on a small sample certainly has some weaknesses together with the relatively short duration of follow-up (24 months postoperatively). Megaendoprosthetic reconstruction as a method for the treatment of bone tumors has numerous advantages. It allows immediate stability, and early rehabilitation with immediate full weight bearing.

Conclusions:

Bone transport is a valid option for the management of bone defects created by wide tumour resection. Bifocal or trifocal osteotomies help in achieving rapid filling of large defects. Trifocal osteotomies appear as a good method to eliminate large defects in the lower limb more than 20 cm. It can simultaneously address the major problems of failed limb reconstruction which include bone defects, infection and soft tissues defects. All procedures, presented in the paper, were performed without complications during and immediately after the surgery. During the follow up period not less than 24 months in all the cases we did not record any significant complications.

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