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# The Biologic Reconstruction Of The Childhood Osteosarcoma With Irradiated Femur And Vascularized Fibula Graft

Percin Karakol MD[1], Serhat Dündar MD[1]
[1] *HealthScienceUniversity Bağcılar Educationand Training Hospital, Department of Plastic, ReconstructiveandAestheticSurgery, Istanbul, Turkey.*
*Corresponding Author: Percin KARAKOL, MD*
*HealthScienceUniversity Bağcılar Educationand Training Hospital, Department of Plastic, ReconstructiveandAestheticSurgery, Istanbul, Turkey*

***Abstract:***
***Introduction:*** *Osteosarcoma is the most common malignant bone tumor of the childhood. Over the last 30 years, survival rates in osteosarcoma increased dramatically. Surgery is still the mainstone of treatment. Although amputation and limb salvage surgery are main surgical techniques, limb salvage surgery is the treatment of choice , especially in preference to young adolescants and children. Among the reconstructive options after a segmental resection of a sarcoma, selection of the most appropriate method is still challenging. Combining an allograft with a bone flap provides the early strenght of an allograft and the biological activity of a flap.* ***Clinical findings:*** *A 16-years-old female was presented to outpatient orthopedics clinics with a complaint of swelling and pain for 2 months in left thigh. On examination, approxiametly a 10*5 cm sensible mass was found, suspecting a bone tumor. On x-ray examination, the lesion was seen on left distal femur demonstrating irregular distrubiton of osteolytic and sclerotic lesions with a Codman triangle. Magnetic resonance imaging and computed tomography showed soft tissue extension. Finally a tru-cut biopsy was taken and histologic diagnosis was osteoblastic osteosarcoma.* ***Material-Methods:*** *The patient underwent neoadjuvan chemotheraphy and responded. We performed segmental bone resection and intercalary reconstruciton with combining devitalized bone and vaskularized free fibular graft. After 18-month follow, she has almost returned to her normal life.* ***Discussion-Conclusion:*** *The aim of this presentation is to emphasize the importance of performing biological reconstruction after limb salvage surgery though recovery takes a long time and technique has difficulties.*

***Key Words:*** *Osteosarcoma, Vascularized fibula graft, Biological Reconstruction.*

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## I. Introduction

The most common primary malignant bone tumor in childhood is osteosarcoma, most commonly originating from the metaphyseal region and the most common locations are the distal femur, proximal tibia and proximal humerus, respectively[1]. Patients often present with pain, palpable mass or rarely decreased joint motion, and sometimes pathological fracture may be the first symptom[2]. Standard therapy is chemotherapy and external rescue surgery[3]. In the last 30 years, the success of surgical treatment in young adolescents and children has increased dramatically, and long-term survival has increased from 20% to 80%[1]. Although amputation and limb salvage surgery are the main surgical techniques, it has been observed that the 5-year survival in patients who received neoadjuvant chemotherapy was higher than those who received amputation[4-6]. Thanks to advances in preoperative imaging techniques, neoadjuvant and adjuvant chemotherapy, metaphysio-diaphyseal bone tumors in long bones can be excised while protecting the joint[7]. Limb-sparing surgery has become the rule rather than an option, with advances in chemotherapy and reconstructive surgery [8]. Despite this paradigm shift, finding the most appropriate reconstruction method is still a challenging step to be overcome, and it is necessary to know the options and evaluate them individually[8,9]. Options for reconstruction of intercalarial bone defects are allograft, vascularized fibular graft, combination of fibular graft and allograft, segmental transport, extracorporeal devitalized autografts, segmental prostheses, and bone cement-induced membrane technique[6-8,10]. Among all these techniques, the advantages of biological reconstruction with fibula flap come to the fore, especially in young patients with high life expectancy[3,9]. According to the studies in recent years, multifunctional bone grafts that can be controlled photothermally by taking advantage of the temperature sensitivity of tumor cells have been studied in vitro, with the advancement of tissue engineering [11].

Vascularized fibula graft is a gold standard reconstruction method, which is frequently used for the reconstruction of intercalarial defects after excision, especially in child patients with long bone osteosarcoma in

today's osteosarcoma surgery treatment, where limb-sparing surgery has become a necessity. In our case, the tumor of a child patient with osteosarcoma in the femur distal metaphysis was excised while protecting the joint, and reconstruction was performed by combining irradiated bone graft and fibula flap.

## II. Findings

A 16-year-old female patient was admitted to the outpatient orthopedics clinic with the complaint of swelling and pain in the left thigh. There was no feature in the patient's history and medical history. On physical examination, there was a delicate mass with approximately 10*5 cm size in the distal 1/3 lateral of the left femur. On direct radiography, hyperintense tissue was observed in the left femur distal diaphysis, involving the medullary bone, causing irregularity in the cortex, periosteal new bone formation and Codman triangle. Lactate Dehydrogenase and Alkaline Phosphatase assays were within normal limits. The patient, whose non-contrast thorax tomography performed for tumor staging was within normal limits, presented an irregularity in the lateral bone contour of the left femur 1/3 distal diaphysis, hyperemia in the blood pool stage and increased activity in the soft tissue. Tru-cut biopsy result came as Osteoblastic type Osteosarcoma. Considering the pathology and radiology results, the musculoskeletal tumors were evaluated as stage 2B according to the surgical staging[12], and E4 according to the anatomical spread[13] of stage 2B tumors.

## III. Material-Methods

The patient received neoadjuvant 10 weeks Methotrexate, Doxorubicin and Cisplatin chemotherapy. After chemotherapy, local swelling and sensitivity decreased, clinical response was obtained[14,15]. The patient was operated in two ways, which are tumor excision in the left femur in the supine position and removal of the flap in the right fibula. The orthopedic team made an elliptoic incision to include the biopsy tract, and distal and proximal osteotomies were performed, respectively, at the 3.5 cm and 23 cm proximal of the physis line, the tumor was excised, the soft tissues on it were cleaned and the medulla was emptied with the help of a drill. The patient was then sent to radiation oncology for extracorporeal irradiation. Frozen biopsies were sent from the surrounding tissues, and the surgical margins were reported as clear. After excision, an intercalarial bone defect of 20 cm length has occurred. The plastic team prepared the right vascularized free fibula as 21.5 cm, leaving 6 cm from the lateral malleolus to the proximal (Figure 1). After 30 minutes, a right vascularized fibula graft was placed into the bone tissue, which was taken back to the surgical site, which was considered as acellular (Figure 2). Anastomosis, 1 from the artery and 2 from the veins, was performed to the descending branch of the left lateral femoral circumflex artery and the accompanying veins through the L-shaped window opening medial to the devitalized femur (Figure 3). The long parts of the vascularized fibula flap within the devitalized bone contact the medulla of the proximal and distal femur (Figure 4). The combination of autograft and fibula flap was fixed with a 30 cm plate and 4 screw in the proximal, 4 screws in the medial and distal 5 screw. A syndesmosis screw was applied to prevent valgus in the right ankle. A long splint from cast was applied to the left lower extremity. The duration of surgery was recorded as approximately 150 minutes. The patient was followed up in the intensive care unit on the first postoperative day, and was taken to the orthopedic service on the second day (Figure 5). There were no complications observed. Cefoxime was administered as postoperative antibiotherapy. The patient received the same adjuvant chemotherapy as the neoadjuvant regimen. Osteoblastic osteosarcoma and 70% necrosis were seen in the excised tumor material. Chemotherapy response was Huvos grade 2 in histological staging.

**Figure 1**:Designingthefibularflap in therightleg.

The hospitalization period of the patient was 7 days. No load was allowed on the left lower extremity for about 3 months. At the end of the 3rd month, as a result of callus formation and periost reaction, partial load was allowed on the affected extremity and the splint was removed. In the follow-up of the patient, chest x-ray, right tibia and left femur direct grays, bone sintigraphy every 6 months and thorax CT were performed every 2-3 months. Union in the osteotomy lines of the vascularized fibula graft was seen at the end of the 12th month and full weight bearing was allowed (Figure 6). Grading performed at the end of 18 months 20% hypertrophy according to both the fibular graft hypertrophy index defined by DeBoor and Wood[16] and the bone hypertrophy index[17].

**Figure 2**:View of the irradiated left femur.

**Figure 3:**Fibula flap with artery and vein ready for anastomosis.

At the end of 18 months, the patient received 24 points out of 30 in the evaluation made according to the musculoskeletal tumor group evaluation system[18].

## IV. Discussion-Conclusion

In the last 30 years, as limb-sparing surgery has become the standard in osteosarcoma surgical treatment, the use of free fibula flap alone or in combination with allograft in long bone reconstruction has come to the fore as a reliable method, predictable in bone healing, functionally good resulting and low complication rate[8,9,19,20]. In lower extremity reconstructions, complication rates, especially bleeding, fracture and late union, and hospital stay are higher than those in the upper extremity[3,20,21]. In the late 1980s, Capanna et al. defined the combined use of allograft and vascularized fibula graft[22]. The mechanical strength of the allograft and the biological activity of the vascularized tissue are obtained together with the use of these methods, both of which have their own complications when used alone[8]. For these reasons, we preferred this combined method in our patient. Another advantage of vascularized fibular graft is its ability to become hypertrophied over time. This hypertrophy does not depend on the length of the graft and the lower extremity is more pronounced with it[16,17]. While the rate of hypertrophy is the least in intramedullar fixations, it is highest in external use[16,23].

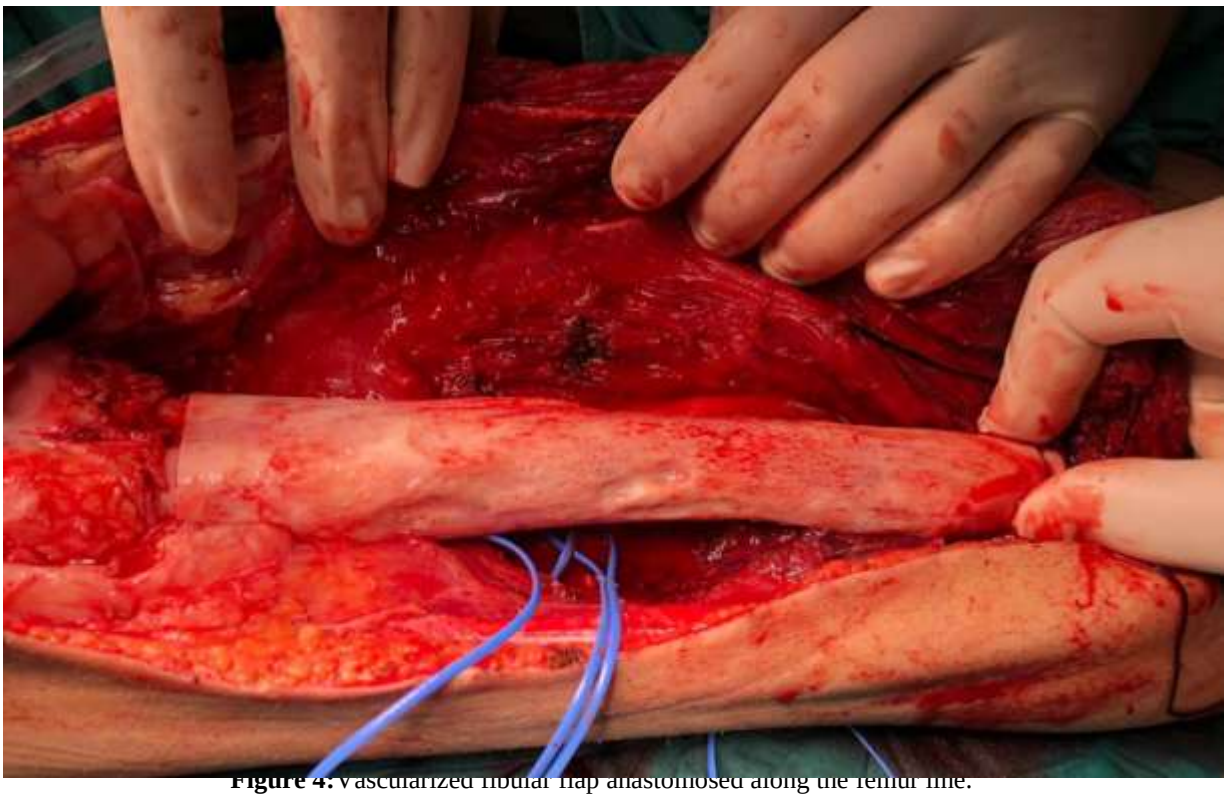

**Figure 4:** Vascularized fibular flap anastomosed along the femur line.

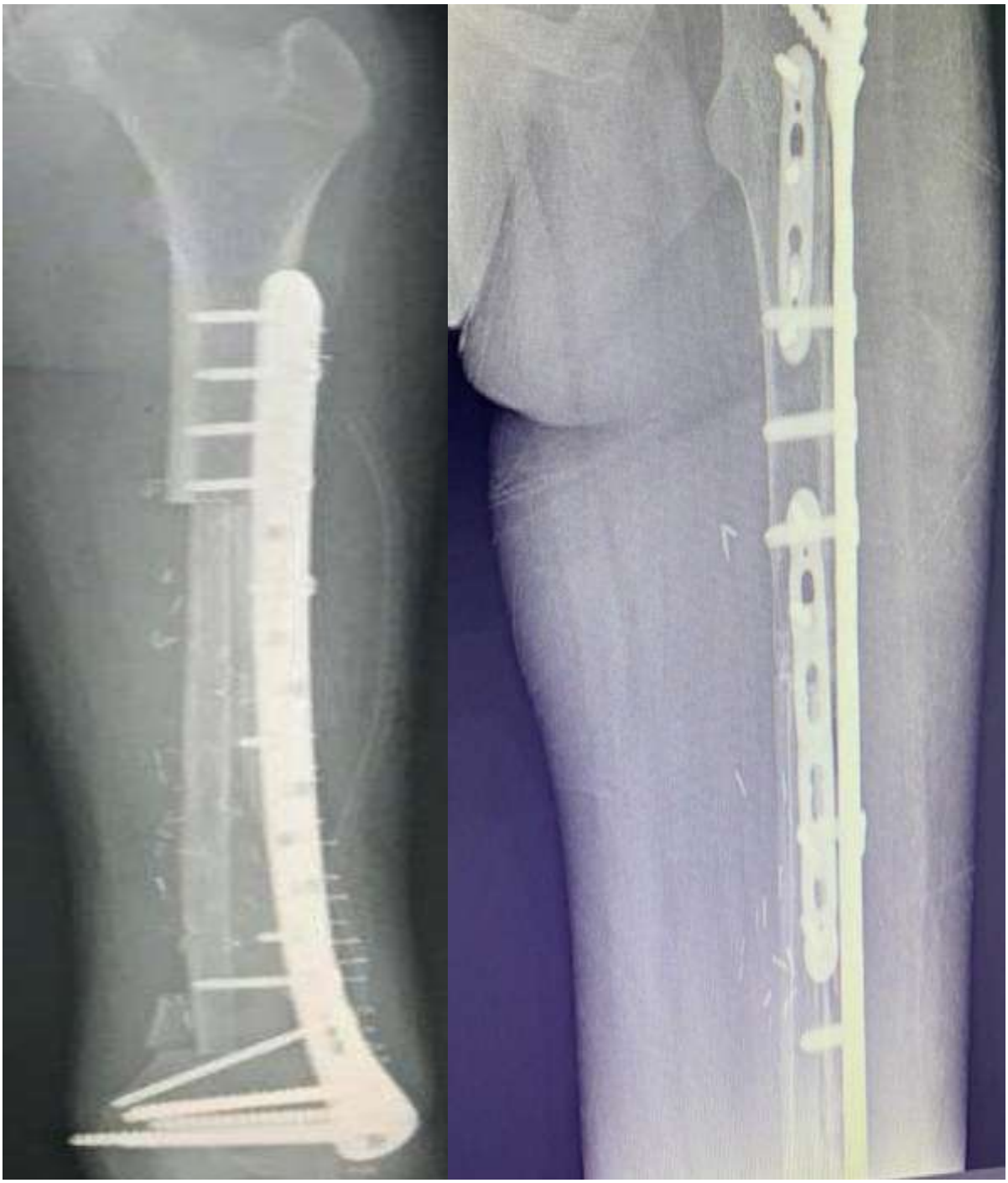

**Figure 5**:Radiological image of the patient in the early postoperative period.
**Figure 6:** Radiological image of the patient in thepostoperative 12 months.

Much faster development of hypertrophy compared to conventional allografts has been preferred for free fibular flap[23]. Although the exact mechanism of this hypertrophy is unknown, it is thought to be due to mechanical loading[24]. Hypertrophy mostly occurs endosteally and is more pronounced at the distal end of the femur. For this reason, instead of the hypertrophy index defined by De Boer and Wood, the graft comparing the thickness of the thinnest place with the thickness on the day of operation is more valuable[15,17]. In our case, we used the graft index because of the heterogeneity in hypertrophy formation when evaluating hypertrophy.

Leilei et al. observed the average bone healing time as 4.9 months and the healing rate as 94.4% in their own study[20]. Chang et al, on the other hand, determined this period to be approximately 8.6 months (3-24 months)[25]. In our patient, this period was seen as 12 months. This may be due to adjuvant chemotherapy. The use of unsupported and unrestricted extremities was observed as approximately 24 months in these two studies while it was 18 months in our study.

The patient's functional outcome was 24 according to the Musculoskeletal Tumor Society evaluation system[18,26]. In the study conducted by Leilei et al., the mean score of the patients was 27.0, but the scores of the lower extremity patients were significantly lower[20].

The most common complication in vascularized fibula grafts is fractures that occur due to low mechanical strength. In order to avoid this, it is important to follow up closely and not to remove the splint in time, to exercise the patient gradually and to put weight on that extremity[21]. The combination of allografts and vascularized fibular graft also increases the mechanical durability of the reconstruction. Another disadvantage of the fibula flap is the length of surgery time and technical difficulty. However, depending on the experience, the operation time is low and the success is high.

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