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CASE REPORT
Reconstructive

Function-preserving Surgery for Femoral Sarcoma by "In Situ Preparation" Technique with a Free Flap

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Summary: Resection of soft-tissue sarcomas near important tissues (major blood vessels, nerves, bones) is challenging. "In situ preparation" (ISP) technique enables the function of the affected limb to be maintained by preserving the tissue as much as possible. The technique is based on evaluation of the margin of resection of important tissues near the tumor during surgery. Postoperative fractures are known to frequently occur, however, in cases where bones were preserved and periosteum has been resected by the ISP. We present the case of a 51-year-old woman who required treatment for soft-tissue sarcoma close to the femur. During surgery, femoral periosteum was included in the tumor side and the femur was preserved by the ISP. We covered the femur using a vascularized latissimus dorsi free flap instead of periosteum. The flap survived completely, and 5 years after surgery, there has been no recurrence or postoperative complications and the lower limb is functional. This is the first reported case of successful combined use of the bone ISP and the vascularized latissimus dorsi free flap to preserve the function of the limb affected by femoral sarcoma suspected of bone infiltration. *(Plast Reconstr Surg Glob Open 2021;9:e3398; doi: 10.1097/GOX.0000000000003398; Published online 15 February 2021.)*

Soft-tissue sarcomas can arise near important tissues (major blood vessels, nerves, bones), as shown in preoperative images. In such cases, if important tissues are resected, reconstruction is needed, but this sometimes results in poor function. On the other hand, preservation of such structures can result in an inappropriate resection margin. To solve the problem, the in situ preparation (ISP) technique was developed as a new surgical method of evaluating the margin of resection of important tissues near the tumor during surgery.[1] However, fractures frequently occur in cases where bones are preserved and where the periosteum is resected by the ISP technique.[2] The periosteum has good blood flow and is essential for bone formation and resorption, thus essential in remodeling. To maintain the bone, blood flow is necessary for remodeling; so, if the periosteum is resected, it is necessary to instead cover the bone with tissue that has good blood flow. The vascularized latissimus dorsi free flap is a good candidate tissue for covering the long bones.

Our patient with femoral sarcoma was suspected to have bone infiltration. The femur was preserved, and the periosteum was resected by the ISP. We then covered it with a vascularized latissimus dorsi free flap. This combination seems to be an effective method and, to the best of our knowledge, has not been previously reported.

CASE REPORT

A 51-year-old woman was referred to our hospital with a 3-year history of a tumor in her right thigh. An elastic hard mass was confirmed by physical examination. On T1-weighted MRI (T1W1), the lesion had mainly low intensity. The lesion had high intensity on T2-weighted MRI (T2W1) and f short-τ inversion-recovery. (**See figure, Supplemental Digital Content 1,** which displays the preoperative magnetic resonance image. Axial T2-weighted MRI (T2W1) shows the anterior thigh lesion is high-grade sarcoma. The possibility of bone infiltration could not be ruled out. http://links.lww.com/PRSGO/B570.)

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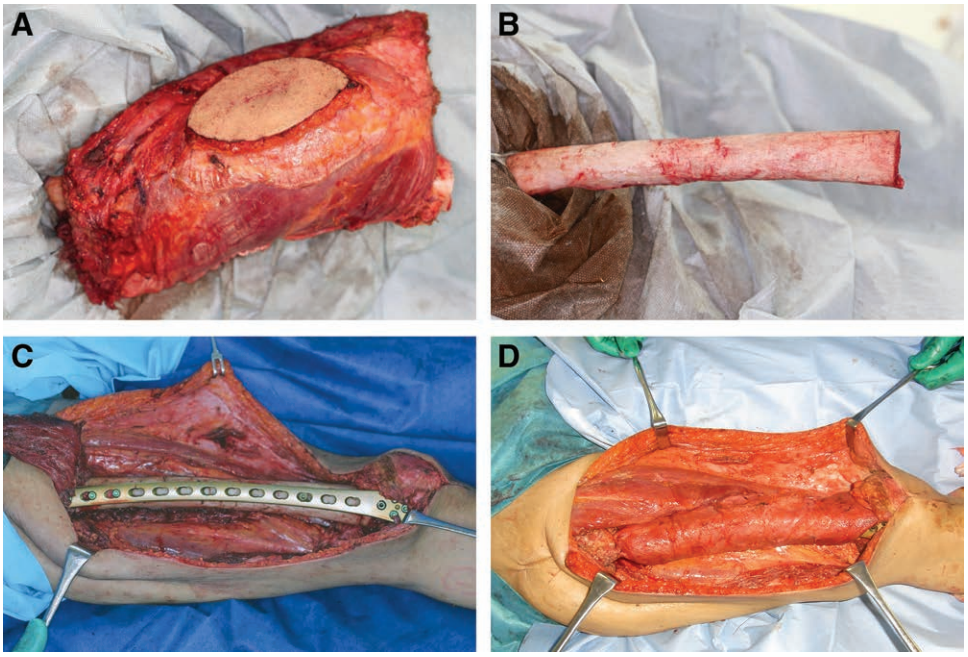

Fig. 1. Intraoperative photographs showing the ISP procedure. A, The block that contains the tumor and femur. B, The femur is completely isolated. C, The femur was internally fixed using locking plate. D, The flap sufficiently covered the femur and the plate.

Diagnosis following pathologic examination of biopsy tissue was of high-grade sarcoma. The possibility of bone infiltration could not be ruled out by MRI findings. The patient was relatively young, so we attempted to preserve the lower limb by ISP. The operation was performed under general anesthesia. We resected the fascia of the rectus femoris, the vastus medialis, vastus intermedius, and vastus lateralis. Part of the femoral periosteum was included in the tumor side, and separated from normal tissue with a margin aiming at wide resection. We cut the femur into an L-shaped bone, laid it on a vinyl sheet, and isolated it from the surgical bed (Fig. 1A). We partially excised the cortex of the femur from the attachment site of the vastus medialis to the tumor side. Some white degeneration of the vastus medialis was observed in the central part of the tumor, but the resection was completed by a wide margin without obvious tumor exposure or erosion of the femur (Fig. 1B). The femur was internally fixed using locking plate (LCP Distal Femur Plate 13 holes, DePuy Synthes) (Fig. 1C). We harvested the vascularized right latissimus dorsi free flap and used it to cover the femur. The descending branch of the lateral femoral circumflex artery and the thoracodorsal artery were anastomosed in end-to-end fashion, as were the thoracodorsal vein and the superficial vein of the vastus intermedius muscle. The flap and preserved rectus femoris sufficiently covered the femur and the plate (Fig. 1D). Macroscopic examination revealed a nodular lesion (size: 85 × 60 × 55 mm) in the skeletal muscle. HE-stained histological image showed necrosis within the tumor, and irregularly-shaped nuclei in the tumor cells. Immunostaining revealed no disease-specific findings, and we diagnosed unclassified sarcoma. Two months after the operation, we began ifosfamide/doxorubicin chemotherapy. The postoperative course was uneventful. At the 5-year follow-up, the patient can walk outdoors and can drive a car using knee joint orthosis. (**See Video [online],** which displays that 5 years after surgery, the patient can walk without orthosis.)

DISCUSSION

In cases of bone defect caused by resection of soft-tissue sarcoma, reconstruction is performed by autologous bone graft, artificial bone replacement, and vascularized autologous bone graft. Autologous bone graft alone has a low rate of bone union, and artificial bones have been reported to have limited durability and unreliable long-term stability.[3] Peroneal bone grafts are mainly used for vascularized bone grafts, but are limited on their own due to the load-bearing.[4] However, when the bone is preserved by the ISP, issues such as long-term stability and insufficient strength can be resolved by the bone union at the site of the osteotomy.

Ae and colleagues reported late postoperative pathological fractures occurred in 7 of the 31 cases in which bones were preserved by the ISP (22.5%).[2] Fractures occurred in cases where the periosteum was completely removed, and the reason was suspected to be decrease in bone blood flow due to a periosteal defect, which resulted in bone union failure.

The periosteum consists of 2 distinct layers: the outer fibrous layer composed of strong fibrous connective tissue, and the inner layer containing cellular components, blood vessels, and nerves.[5] The outer third of the cortical bone receives its blood supply from the periosteum, and the remaining two-thirds and the cancellous bone receive their blood supply from the nutrient

artery. Blood flow in periosteum and the nutrient arteries is essential for bone formation and resorption,[6] and is thus essential to remodeling. To maintain the blood flow necessary for bone remodeling, if the periosteum is removed, it is necessary to cover the bone with tissue that has good blood flow.

The vascularized latissimus dorsi free flap and free omental flap are candidate tissues for covering the femur and filling the dead space. Free omental flaps have complications associated with laparotomy in 5.6% of cases, and require cooperation with the gastrointestinal surgery team.[7] The vascularized latissimus dorsi free flap is one of the most versatile flaps due to its ease of harvesting, stability of blood circulation, and abundant tissue volume,[8] and we used it for the currently reported patient.

More than 5 years after surgery, there are no signs of recurrence, and the patient can walk and can drive using knee joint orthosis. The function of the affected limb is good. The combined use of the bone ISP and the vascularized latissimus dorsi free flap seems to be effective in preservation of the function of the limb affected by femoral sarcoma suspected of bone infiltration.

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