

Case Report

Gastrocnemius musculotendinous flap for reconstruction of extensor mechanism after proximal tibial tumor resection

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A B S T R A C T

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Tumor prosthetic replacement and soft tissue reconstruction with a gastrocnemius muscle flap has been accepted as a standard procedure after proximal tibial resection for bone tumor. However, the extent of recovery of the muscle strength of the extensor mechanism has been unpredictable. We report a case of proximal tibia osteosarcoma in which the tumor was widely resected and replaced with tumor prosthesis. The extensor mechanism was reconstructed using a gastrocnemius flap including its tendinous part.

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1. Introduction

The proximal tibia is the second most common site of primary bone sarcomas. After wide resection of the tumor, the reconstruction modalities include allograft, arthrodesis, or tumor prosthesis.^{1–4} Tumor prosthesis is advantageous over allograft because it is more readily available, is easily modifiable to fit the bone defect, causes fewer complications, and allows earlier rehabilitation.⁵ On the other hand, the potential complications of tumor prosthesis include aseptic loosening of the prosthesis, infection, and failure of the extensor mechanism.² Malawer and McHale⁶ have proposed to use medial gastrocnemius muscle flap for reconstructing the extensor mechanism after resection of the proximal tibia and coverage of the tumor prosthesis. This technique has been accepted as a standard procedure. However, the extent to which the strength of the extensor mechanism can be regained is still unpredictable. At least 6 weeks of immobilization is still required after surgery before rehabilitation.⁷ Here, we present a case of proximal tibia osteosarcoma, in which the tumor was widely resected and replaced with tumor prosthesis. The extensor mechanism was successfully reconstructed with a gastrocnemius musculotendinous flap modified from the method described by Malawer and McHale.⁶

2. Case report

A 17-year-old boy was referred to our institution from a local hospital reporting pain and a growing mass on the upper aspect of left lower leg. The mass had grown rapidly in the last 2 months, and he experienced pain after performing any activity. He complained of local heat and swelling. A biopsy performed at the local hospital revealed a malignant lesion. After admission, plain radiograph of the left knee showed a mixed osteoblastic and osteolytic lesion in the proximal tibia with soft tissue extension (Fig. 1A). Magnetic resonance imaging of left knee revealed a heterogeneous mass (11 cm in size) at the metaphysis of the left tibia with extension to the diaphysis, the epiphysis, and the soft tissue. There was no definite evidence of intra-articular extension and neurovascular bundle invasion (Fig. 2). The computed tomography scan of the lung and technetium³ bone scintigraphy showed no evidence of distant metastases. On January 15, 2002, the biopsy was repeated through the previous operative wound. The pathologic results revealed osteosarcoma.

The patient was referred to the Oncology Department for neoadjuvant chemotherapy. On May 31, 2002, the patient underwent wide intra-articular resection of the left proximal tibia (13 cm), including the soft tissue mass and parts of the extensor muscle of the upper aspect of left lower leg. The previous biopsy tract was excised while resecting the tumor. The patellar tendon was sectioned 1 cm proximal to the tibia tuberosity.

The distal femur was resected and the skeletal defect was reconstructed using cemented custom-made knee prosthesis and involved the replacement of 13 cm of the proximal tibia (Rotating Hinge Knee System; United Orthopedic Co., Taipei, Taiwan). There was a porous-coated surface and a loop on the anterior portion of

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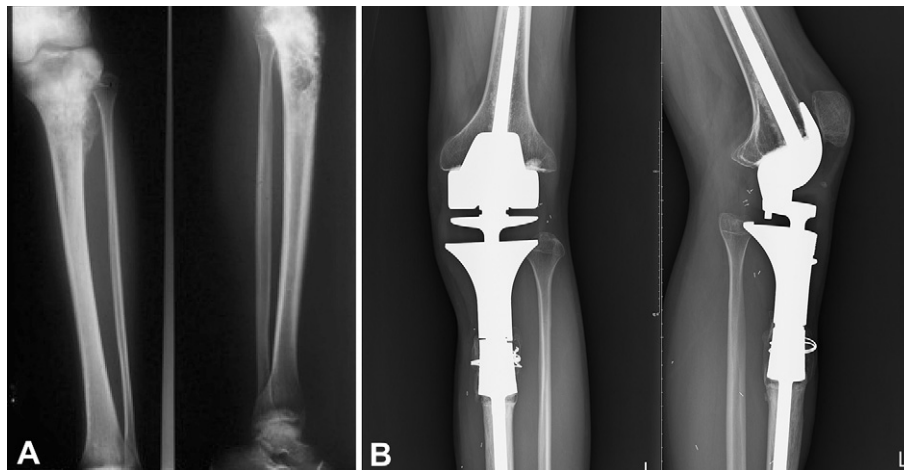


Fig. 1. (A) Radiograph of the left knee showing a mixed osteoblastic and osteolytic lesion in the proximal tibia with soft tissue extension. (B) Postoperative radiograph of the left knee at 6.5 years showing no loosening of the prosthesis and no evidence of tumor recurrence.

the tibial megaprosthesis to allow the attachment of the patellar tendon to the prosthesis. It is very important to preserve the sural vessels because they are the main pedicle to the muscle flap.

The patellar tendon was attached to the anterior loop of the tibial prosthesis by using nonabsorbable sutures in knee extension. The medial gastrocnemius was mobilized from the soleus muscles to the Achilles tendon. The muscle flap was resected as long as possible along with a portion of the Achilles tendon (1 cm × 3 cm).

A block of cancellous bone taken from the resected femoral condyle was placed between the undersurface of the patellar tendon and the anterior porous-coated surfaces of the tibial prosthesis, like a sandwich. It was tightly wrapped from the patellar tendon to the prosthesis using nonabsorbable sutures (Fig. 3A). Three pieces of autogenous bone plates taken from the resected femoral bone were used to span the porous-coated surfaces of the prosthesis and host tibia, which were fixed with a cerclage wire (Fig. 3A).

The harvested medial gastrocnemius musculotendinous flap was rotated by 360° over the prosthesis, and this part of the Achilles tendon was sutured to the patellar tendon (Fig. 3B). The remaining soft tissue, including joint capsule, pes anserinus, and the anterior compartment muscles, were sutured to the muscle flap.

Postoperatively, a long leg plastic splint was applied for 3 days. Subsequently, he was able to ambulate using bilateral crutches and wearing a hinged knee brace (range, 0°–60°). At the same time, a continuous passive motion exercise was conducted. The flexion angle of the knee brace increased gradually to 90°. Two weeks postoperatively, before discharge, he could flex the knee up to 80° with an extension lag of 10°. Six weeks postoperatively, the extent of motion of the knee brace was adjusted to 120°, and the patient could walk with the support of a crutch. Three months postoperatively, he could walk without any walking aid, and the arc of knee motion ranged from 10° to 110°. However, he continued



Fig. 2. (A) Magnetic resonance imaging of left knee revealed a heterogenous mass (11 cm in size) at the metaphysis of left tibia with extension to the diaphysis, the epiphysis, and the soft tissue. (B) The sagittal view showed the position of patellar tendon.

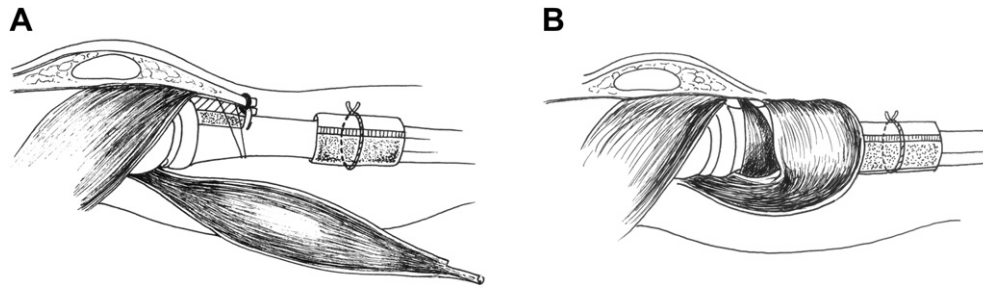


Fig. 3. (A) A block of cancellous bone was placed between patellar tendon and the porous-coated surfaces and wrapped using nonabsorbable sutures. (B) The medial gastrocnemius musculotendinous flap was rotated by 360° to wrap around the prosthesis, and the portion of Achilles tendon was sutured to patellar tendon.

wearing a knee brace for daily activity. Six months postoperatively, he could walk for 1 hour without any support and had no difficulties ascending or descending stairs. The motion arc of his knee was 5° to 110°. Six and a half years after operation, he was tumor free. In addition, no distant metastasis could be found. He experienced no limitation with respect to his walking ability and did not experience pain during his daily activity. The motion arc of his knee was 5°–110° (Fig. 4). The Musculoskeletal Tumor Society Function⁸ evaluation was excellent. The radiographs of the knee showed good alignment and no loosening of the megaprosthesis (Fig. 1B).

3. Discussion

Endoprosthetic replacement has been accepted as the primary choice of treatment after proximal tibial resection because of the high complication rates associated with allograft reconstruction (e.g. infection, nonunion, instability and fracture).^{4,5,9} The use of a medial gastrocnemius flap has been accepted as a standard procedure that solved the problems of soft tissue deficiency around the prosthesis, poor blood supply of the skin flap, healing of the patellar tendon, and potential infection after endoprosthetic replacement.^{6,10} However, healing of extensor mechanism to the prosthesis and the muscle flap is a complex procedure. It is important that the knee joint is kept immobilized for at least 6 weeks followed by gradual passive and active flexion.⁷ In a study of muscle function after extensor reconstruction and endoprosthetic replacement of the proximal tibia revealed that the sole gastrocnemius shift has less muscle strength than the combined procedure (gastrocnemius shift plus transposition of fibula) at angle portion between 60° and 20°.¹¹ If expressed in percentage with the non-operated leg representing 100%, the extensor muscle in the sole gastrocnemius shift reached 9% compared with 16% in the combined-technique group. The soft low elastic musculoligament connection in the reconstruction of sole gastrocnemius muscle flap does not provide sufficient tension, which is essential for any muscle contraction.¹¹ Improved extensor strength with early mobilization can be achieved if a stronger reconstruction is used.¹²

Malawer and McHale⁶ have mentioned that medial gastrocnemius acts as a soft tissue covering of the prosthesis, which avoids secondary infections, and as a means for the reconstruction of the extensor mechanism. However, because of inadequate tension provided between the patellar tendon and the muscle flap, a prolonged use of a knee–ankle orthosis is required between 6 and 9 months postoperatively. As a result, the patients treated by prosthetic replacement in their report had extension lag ranging from 0° to 30° and active knee flexion ranging between 80° and 95° at the final follow-up.

Bickels et al⁷ used a similar technique of extensor reconstruction with an additional autogenous bone graft in between the patellar tendon and the porous surface of the tibial prosthesis in 55 patients. Eleven patients (22%) had an extension lag greater than 20°. A period of immobilization of the operative limb for 6 weeks is required to allow healing of the extensor mechanism to the muscle flap. However, prolonged immobilization of the knee may result in scar contracture, muscle atrophy, and joint stiffness. One of the solutions is using a vascularized tendon graft sutured to the patellar tendon in adequate tension and early rehabilitation.

Our method of extensor reconstruction originates from the method described by Malawer and McHale.⁶ However, we harvest the medial gastrocnemius down to its tendinous part for about 3 cm, wrap it around the tibial prosthesis in 360° fashion, and suture the part of Achilles tendon to the patellar tendon. If the length of the musculotendinous flap is long enough, the Achilles tendon can be tightly sutured to the patellar tendon. Otherwise, a pie crust method of multiple cuts of the muscle part of the gastrocnemius is used. Fortunately, in the current case, the harvested musculotendinous flap is adequate in length for direct tendon-to-tendon suture.

The patient was allowed to start knee flexion gradually as early as 72 hours after operation. At 2 weeks, the patient achieved active knee flexion from 10° to 80° wearing a hinged knee brace. He returned to school as early as 3 months postoperatively, wearing a knee brace, and his arc of knee motion was from 10° to 110°. At 6 months, he quit wearing knee brace and had no problems in daily

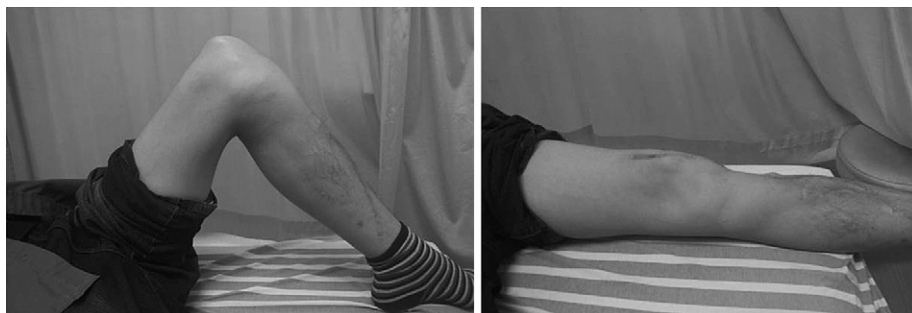


Fig. 4. Six and a half years after operation, the range of motion of his knee was 5°–110°.

activities, including ascending and descending stairs. Six and a half years after operation, he was free of tumor recurrence with a residual extension lag of the knee of 5° , which was quite less as compared with other reports.^{6,7} Furthermore, there was no weakness in plantar flexion of the ankle nor decreasing range of motion of the ankle. Whether 3×1 cm is the optimal size and length of the harvested Achilles tendon for extensor reconstruction necessitates further biomechanical study.

Our method of modified extensor reconstruction emphasizes direct tendon-to-tendon healing, which may be a stronger soft tissue construct than tendon-to-muscle healing^{11,12}; therefore, it may allow early rehabilitation and restore a better extensor muscle strength and decrease the extent of extension lag.⁹

4. Conclusion

Tumor prosthetic replacement and soft tissue reconstruction with a gastrocnemius muscle flap has been accepted as a standard procedure after proximal tibial resection for bone tumor. This modified extensor reconstruction may allow better tendon-to-tendon healing than tendon-to-muscle healing in conventional gastrocnemius muscle flap reconstructions. Besides, it may allow early rehabilitation and restore adequate extensor muscle strength in daily activities.

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