

Reconstructive Arthrodesis using a Non-living Fibular Graft with an Attached Periosteal Sleeve for Osteosarcoma of the Distal Tibia - A Case Report -

Jong-Woong Park, M.D., Jong-Hoon Park, M.D., Soon-Hyuck Lee, M.D.,
Woong-Kyo Jeong, M.D., and Si-Young Park, M.D.

Department of Orthopedic Surgery, College of Medicine, Korea University, Seoul, Korea

골막을 붙인 비골 이식술에 의한 원위경골 골육종의 관절고정 재건술 - 증례 보고 -

박종웅 · 박종훈 · 이순혁 · 정웅교 · 박시영

고려대학교 의과대학 정형외과학교실

According to previous reports, ankle arthrodesis is regarded as the best reconstructive procedure after limb salvage surgery for osteosarcoma of the distal tibia. Of the many arthrodesis options, vascularized fibular graft (VFG) is widely accepted as the most successful method. However, reconstruction using VFG is not always possible, because VFG is a complicated surgical procedure and is associated with high rates of morbidity at donor sites. The authors devised a novel reconstructive surgical procedure that exploits the osteogenic potential of the periosteum. A 10-year-old female patient with osteosarcoma of the distal tibia underwent limb salvage surgery and the ipsilateral distal fibula and periosteal sleeve were transported to the defect for ankle arthrodesis. The transported fibula and periosteal new bone formation acted as a dual strut bone graft providing better stronger stability than fibula alone transfer. The authors believe the proposed procedure is an easier alternative to the surgically demanding VFG method.

Key Words: Distal tibia, Osteosarcoma, Arthrodesis, Vascularized fibular graft (VFG)

Advances in multimodality treatments, including systemic chemotherapy, have made limb salvage surgery of the distal tibia increasingly feasible⁷⁾. According to previous reports, ankle arthrodesis is regarded as the best reconstructive procedure after limb salvage surgery for osteosarcoma of the distal tibia. Of the many arthrodesis options, vascularized fibular graft (VFG) is widely accepted as the most successful method. However, reconstruction

using VFG is not always possible, because VFG is a highly demanding surgical procedure and is associated with high rates of morbidity at donor sites. Meanwhile, some authors have reported a novel procedure using the intrinsic potential of the periosteum to bridge massive long bone defects^{6,7)}. The authors in this study devised a novel reconstructive surgical procedure that exploits the osteogenic potential of the periosteum as an

통신저자 : 박 종 훈
성북구 안암동 5가 126-1
고려대학교 안암병원 정형외과
TEL: 02-920-6609 • FAX: 02-924-2471
E-mail: pjh19642001@yahoo.co.kr

Address reprint requests to
Jong-Hoon Park, M.D.
Department of Orthopedic Surgery, Anam Hospital,
126-1, Anam-dong 5-Ga, Seongbuk-Gu, Seoul 136-705, Korea
Tel: +82,2-920-6609, Fax: +82,2-924-2471
E-mail: pjh19642001@yahoo.co.kr



Fig. 1. Osteoblastic osteosarcoma in a 10-year-old girl. After preoperative chemotherapy, anteroposterior (A) and lateral (B) radiographs of the ankle joint are showing a sclerotic lesion of the distal tibia. T1 axial (C) and sagittal (D) MR imaging demonstrate a well-consolidated extra-skeletal soft tissue mass in the distal tibia. These findings suggest that wide excision might be possible.

alternative to the VFG method.

CASE REPORT

A 10-year-old female patient with painful swelling of the distal tibia was diagnosed by open biopsy as having osteosarcoma. Imaging studies (plain radiographs, MRI, chest CT, and bone scanning) revealed that the Enneking stage was IIB. Preoperative chemotherapy, according to Rosen's T-10 regimen²⁾, consisted of weekly high dose methotrexate (12 g/m^2) for 2 consecutive weeks, followed by cisplatin (100 mg/m^2) and doxorubicin ($30 \text{ mg/m}^2 \times 2$ days). After preoperative chemotherapy (Fig. 1), wide *en bloc* excision and tibio-talar arthrodesis were performed. For the reconstruction of the created tibial defect, the distal segment of the ipsilateral fibula was transported. In order to preserve its periosteal blood supply, the distal one-half of the periosteum was attached to the transported fibula, while the proximal one-half of the periosteum was peeled out of its surrounding periosteum. Osteotomy was

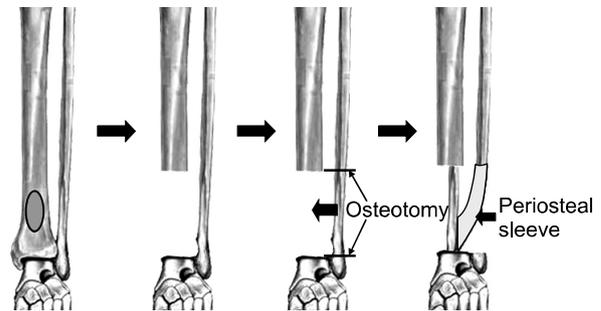


Fig. 2. Schematic diagram showing the proposed surgical technique. After tumor resection, a distal portion of the ipsilateral fibula is transported to the defect for ankle arthrodesis while maintaining its periosteal blood supply by attachment to the distal one-half of its periosteal sleeve.

performed, and the transport-segment was moved out of its periosteal sleeve (Fig. 2). The authors hollowed out a groove on the dome of the talus, and the distal fibula of the transported segment was impacted into the groove. Two plates were applied at the proximal and distal junctions to stabilize the reconstruction. A supplementary iliac bone graft was added between the periosteal sleeve and transported fibula. Postoperatively, a long leg

cast was applied for one month and was then converted to a PTB cast until achievement of solid union. According to the pathologic report, the margin of the specimen was free from tumor cells, and the degree of tumor necrosis was rated as Grade III (more than 90% necrosis). Post-operatively, the patient was treated with the same chemotherapeutic agents that had been given before surgery and was followed monthly at our

outpatient clinic by chest and affected bone radiography, at two months intervals. Chest CT and radionuclide bone scans were performed every three months for two years. New bone formation along the periosteal sleeve was detected at three months post-operatively (Fig. 3A), and complete graft union between the periosteal new bone and transported fibula was achieved at twelve months. A fracture of the transported fibula shaft that



Fig. 3. The authors hollowed out a groove on the dome of the talus and then the distal fibula of the transported segment was impacted into the groove. Two plates were applied at the proximal and distal junctions to stabilize the reconstruction at initial operation. New bone formation along the periosteal sleeve was detected at three months post-operatively (A), and a fracture of the transported fibula shaft developed at nine months post-operatively (B).



Fig. 4. Radiographs (A: tibia AP, B: tibia lateral, C: ankle AP, D: ankle lateral view) at two years postoperatively demonstrate that the transported fibula and periosteal new bone formation acted as a dual strut bone grafts providing better stability.

developed at nine months postoperatively (Fig. 3B) was treated with an autogenous iliac bone graft and secure with internal fixation using a single plate and multiple screws. At final follow-up (36 months postoperatively), the grafted fibula and periosteal new bone had united as one unit providing stable structural support to the lower leg (Fig. 4). According to the Musculoskeletal Tumour Society scoring system⁴⁾, the patient's postoperative functional score was 27 (90%). No evidence of local recurrence or distant metastasis was observed at final follow up.

DISCUSSION

Previously described surgical techniques for reconstruction include endoprosthetic replacement and allograft and/or microvascular fibular transfer by fibular transfer alone or by bone transport using distraction osteogenesis. Although ankle endoprosthetic replacement has occasionally been carried out in patients with osteosarcoma of the distal tibia, accumulated evidences have revealed many unwanted complications and high rates of failure^{1,8,9)}. Therefore, many authors agree that ankle arthrodesis is the best reconstructive procedure after wide resection of osteosarcoma of the distal tibia, although it has been associated with loss of ankle motion and frequent nonunion at the arthrodesis site³⁾. Of the many arthrodesis options, VFG is widely accepted as the most successful method. Because the living fibula has its own vasculature, unfavorable bed condition at the tumor resection site does not matter in the host-graft union⁵⁾. This point is important in tumor surgery, due to frequent lack of soft tissue coverage. Moreover, hypertrophy of the grafted fibula provides stronger support with time. Even though, non-vascularized autogenous fibular grafts hypertrophy, they are inferior to the VFG technique due to the lack of their own vasculature. Thus,

recently, vascularized fibular grafts are preferred by the majority of authors. However, reconstruction using VFG is not always possible, because VFG is a complicated surgical procedure and is associated with high rates of morbidity at donor sites. Furthermore, the protracted operation time required is unacceptable for small children who have just undergone preoperative chemotherapy. Many authors have expressed the need for a novel form of surgery that is technically easy, can be performed quickly, and has low donor site morbidity. Our proposed method was based on the theory that an *in situ* periosteal sleeve can provide new bone formation in itself^{6,7)}, and that vascularity might be maintained by retaining the periosteal sleeve of the graft fibula. It was inconvenient not to prevent fracture of the transported fibula due to inadequate secure fixation and used of dual plates at initial operation. A wrong decision in the initial operation allowed for formation of a stress fracture and nonunion. However, our result showed that the periosteal new bone formation and the transported fibula acted as a dual strut graft providing stronger structural support relatively early in the postoperatively period. We believe our method has several advantages, namely, easier graft harvesting, provision of a dual bone graft effect preventing stress fracture, and a direct blood supply to the graft fibula through the periosteal sleeve.

REFERENCES

1. **Abudu A, Grimer RJ, Tillman RM, Carter SR:** Endoprosthetic replacement of the distal tibia and ankle joint for aggressive bone tumours. *Int Orthop*, 23: 291-294, 1999.
2. **Burgers JM, van Glabbeke M, Busson A, et al:** Osteosarcoma of the limbs. Report of the EORTC-SIOP 03 trial 20781 investigating the value of adjuvant treatment with chemotherapy and/or prophylactic lung irradiation. *Cancer*, 61: 1024-1031, 1988.

3. **Casadei R, Ruggieri P, Giuseppe T, Biagini R, Mercuri M:** Ankle resection arthrodesis in patients with bone tumors. *Foot Ankle Int*, 15: 242-249, 1994.
4. **Enneking WF, Dunham W, Gebhardt MC, Malawar M, Pritchard DJ:** A system for the functional evaluation of reconstructive procedures after surgical treatment of tumors of the musculoskeletal system. *Clin Orthop Relat Res*, 286: 241-246, 1993.
5. **Hsu RW, Wood MB, Sim FH, Chao EY:** Free vascularised fibular grafting for reconstruction after tumour resection. *J Bone Joint Surg Br*, 79: 36-42, 1997.
6. **Knothe Tate ML, Ritzman TF, Schneider E, Knothe UR:** Testing of a new one-stage bone-transport surgical procedure exploiting the periosteum for the repair of long-bone defects. *J Bone Joint Surg Am*, 89: 307-316, 2007.
7. **Knothe UR, Springfield DS:** A novel surgical procedure for bridging of massive bone defects. *World J Surg Oncol*, 3: 7, 2005.
8. **Lee SH, Kim HS, Park YB, Rhie TY, Lee HK:** Prosthetic reconstruction for tumours of the distal tibia and fibula. *J Bone Joint Surg Br*, 81: 803-807, 1999.
9. **Natarajan MV, Annamalai K, Williams S, Selvaraj R, Rajagopal TS:** Limb salvage in distal tibial osteosarcoma using a custom mega prosthesis. *Int Orthop*, 24: 282-284, 2000.

= 국문초록 =

발목 관절 고정술은 원위 경골에 발생한 골육종의 사지구제술 후 재건술 가운데 가장 좋은 방법으로 알려져 있다. 많은 관절 고정술 중에 생비골 이식술이 가장 성공적인 방법으로 알려져 있지만, 술기가 어렵고 비골 공여부의 희생이 크기 때문에 항상 가능한 술식은 아니다. 이에 저자들은 골막의 골형성 능력을 이용한 새로운 방법을 시도하여 보았다. 10세 원위 경골에 발생한 골육종 여자 환아에서 사지구제술 후 동측의 비골을 골막을 붙여서 수평 이동하여 떼어낸 경골 원위부 골결손 부위에 이식하여 관절 고정술을 시행하였다. 최종 추시 상 이식된 비골과 골막선 주위의 골형성에 의해 이중 지주 골이식술의 양상을 보여 비골 단독 이식술을 시행한 것 보다 뛰어난 견고함을 보였다. 저자들은 본 연구에서 시행한 방법이 시행하기가 쉽지 않은 생비골 이식술을 대신 할 수 있는 좋은 방법의 하나라고 생각한다.

색인 단어: 원위경골, 골육종, 관절 고정술, 생비골이식술