

Case Report

## Two Revision Surgeries on Cemented Custom-made Tumor Prostheses

Yukihiro Yoshida\*, Yuki Okamura, Mamoru Akita, Masashi Taniguchi,  
Toshio Kojima, Eiji Osaka, and Yasuaki Tokuhashi

Department of Orthopedic Surgery, Nihon University School of Medicine, Itabashi-ku, Tokyo 173-8610, Japan

We performed revision surgery in 2 patients for stem fracture of a cemented tumor prosthesis that occurred more than 25 years after the initial surgery. For revision, the global modular replacement system (GMRS) was used. However, as bone cement in the bone could not be adequately removed, stems with respective diameters of 11 and 12.5 mm were used. In revision surgery for cemented tumor prostheses, adequate removal of residual bone cement is optimal. However, when there is a risk of fracture, it may be appropriate to insert a thicker stem after reaming the femoral canal as much as possible, and then fix the stem using the cement-in-cement method.

**Key words:** revision, custom-made tumor prosthesis, malignant bone tumor

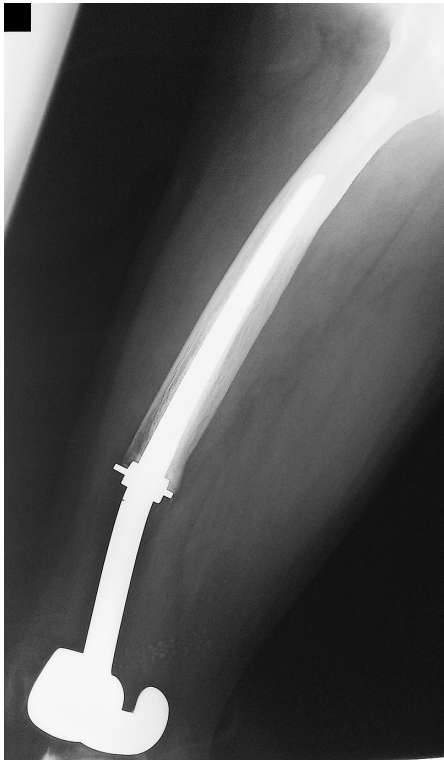
Fractures occur in a certain percentage of tumor prostheses irrespective of their type, necessitating revision surgery. In Japan in the 1980s, there were few useful tumor prostheses, and custom-made prostheses for individual patients were used. We encountered 2 patients who underwent revision surgery due to stem fracture of a cemented custom-made tumor prosthesis occurring more than 25 years after the initial surgery. Important points of revision surgery are reported with a brief review of the literature.

### Case Report

**Patient 1.** A 27-year-old male with an osteosarcoma of the right distal femur underwent preoperative chemotherapy and wide resection in our department in December 1984. For reconstruction, we ordered a custom-made tumor prosthesis, sending its design to Nemoto Ika Kogyo Co., Ltd. The stem on the femoral side was 13 mm in length, and was cemented.

The distal thirds of the vastus lateralis and vastus intermedius muscles and the distal part of the femur (24 cm) were resected. Postoperative chemotherapy was completed as planned, and the prosthesis was applied. The patient was discharged, and showed a favorable course without local metastasis or recurrence. In May 2012, he visited a local hospital due to blunt knee pain, but no abnormalities were detected in the prosthesis, and the course was observed. However, the knee pain did not improve, and he was referred to our hospital. X-ray examination showed fissures in the femoral component and stem base, and a diagnosis of stem fracture was made (Fig. 1). There were no findings such as loosening around the stem inside the femur. Bone cement remained at a site near the lesser trochanter, and reamers to remove bone cement inside the femur were also prepared according to the preoperative plan. As a new tumor prosthesis, the Global Modular Replacement System (GMRS: Stryker) was used.

The patient underwent revision surgery under general anesthesia. The skin incision in the previous sur-



**Fig. 1** A fractured tumor prosthesis. Plain X-ray examination showed stem fracture and deformation. There were no findings such as loosening around the stem inside the femur.

gery, 28 years prior, was used as the approach. The femoral component was soon reached, and the fracture area was exposed. Fracture was observed at the stem base, but there was no instability of the stem itself at the fracture site (Fig.2). The femoral component was integrated with the stem, but could be readily removed. Bone cement (about 5 mm thick) remained in the femoral canal on X-ray images, and reaming was performed with reamers. Our initial plan was to insert a stem with a diameter  $\geq 13$  mm. However, the appropriate degree of reaming could not be determined during the operation, and there was also a risk of femoral fracture. Therefore, a GMRS non-porous straight stem (diameter, 11 mm) was finally selected and inserted with the use of new bone cement. The standard femoral component and a GMRS extension piece (50 mm) were used. After the procedure on the femoral side, removal of the tibial component was initiated. However, this component had firmly bonded with the bone cement, and removal was difficult. The tibial component was fractured using an airtome and chisel, and bone cement



**Fig. 2** Surgical findings. Stem deformation and discoloration of the surrounding soft tissue showing metallosis were observed.

was removed from the tibial bone as much as possible. A 12-mm tibial stem (medium type) and a bumper, tibial sleeve, and MRH tibial insert (medium type) as the joint portion were used. After adequate irrigation, a drain was inserted, the wound was closed, and the operation was completed. Two weeks after the operation, the drain was removed, and range of motion training was initiated. Three weeks after the operation, walking training was initiated using a knee orthosis. He was discharged about 1 month after the operation. At present, about 11 months after the operation, he has had no symptoms of infection, and can walk with the knee orthosis without assistance (Fig. 3).

**Patient 2.** A 47-year-old female diagnosed with a femoral osteosarcoma underwent preoperative chemotherapy in our department. In 1985, a wide resection was performed under a diagnosis of osteosarcoma of the left femur. The limb was reconstructed using a Kyocera ceramic joint prosthesis. Roughly 30 years after the operation, she fell, sustained an injury, and was admitted to our hospital. X-ray examination showed a fracture at the stem base of the tumor prosthesis in the left femur (Fig.4). The femoral stem could be readily removed, and a new stem (diameter, 12.5 mm) was inserted using the cement-in cement method. This method was chosen because the amount of time required to remove the remaining cement in the femoral canal during surgery could not be predicted. Reconstruction was performed using a GMRS prosthesis, as in Patient 1. At present, 1 year after the operation, she can walk without assistance (Fig.5).

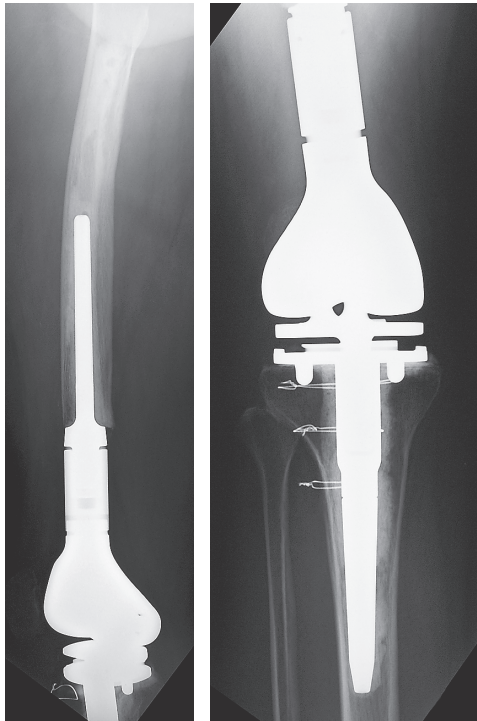


Fig. 3 Postoperative X-ray image. After removal of the fractured tumor prosthesis, revision was performed using the GMRS by fixation of the new stem using the cement-in-cement method.

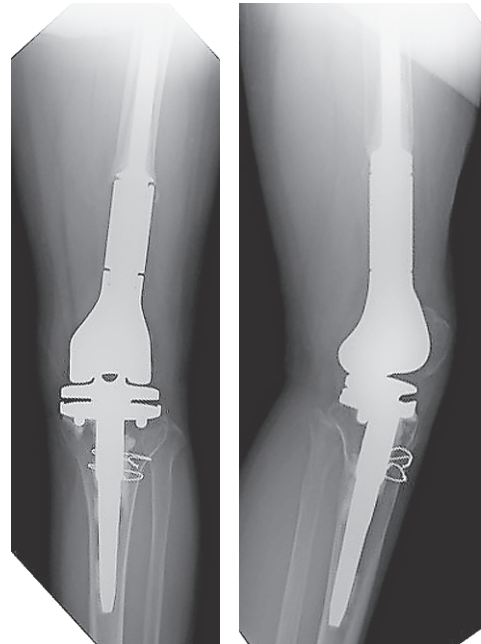


Fig. 5 Reconstruction was performed using a GMRS prosthesis; one year after the operation, the patient can walk without assistance.

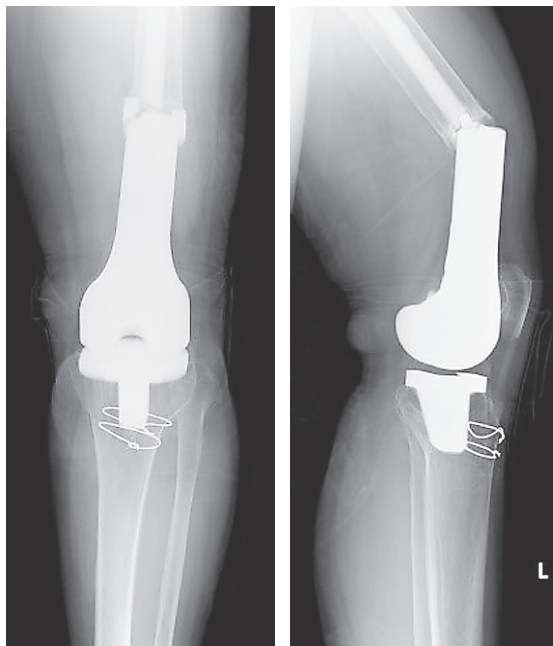


Fig. 4 Plain X-ray examination showed stem fracture and deformation. The fracture is visible at the bottom of the stem.

### Discussion

In Japan, in the early 1980s, limb reconstruction after resection of malignant bone and soft part tumors was performed by sending orders to manufacturers for custom-made prostheses. During this period, Kyocera custom-made prostheses were widely used. These custom-made tumor prostheses consisted of a stem made of monocrystalline alumina and a joint portion made of polycrystalline alumina [1]. Since the joint portion is the rotating hinge type, when bilateral collateral ligaments are resected, the knee joint itself is expected to become slightly unstable. Indeed, the patients in this study used their prosthesis in almost all situations in daily life. During that period, tumor prostheses were considered to be filling materials for large bone defects rather than artificial joints. In the mid-1980s, the Kotz modular femur and tibia reconstruction system (KMFTR: Stryker) began to be imported to Japan, and the hinge type KMFTR was used in most cases until its replacement by the HMRS. In 2001, Nakamura *et al.* reported short-term results of arthroplasty using ceramic rotating hinge type tumor prostheses in 8 patients with aggressive giant cell tumors (GCT) [2].

The revision surgeries in this study presented 2 major problems. One was the method of removing the residual stem after its fracture inside the bone. Fortunately, in both patients, the residual stem could be readily removed when the end of the broken stem was adequately exposed, such that the stem end could be grasped and longitudinally pulled out. When this procedure is impossible, there is no choice but to perform bone fenestration [3-5]. The second problem is treatment for bone cement remaining in the femoral canal. In revision THA, removal of bone cement remaining on the femoral side has required a challenging technique. When bone cement can be adequately removed, bone stock increases. However, cement removal involves the risk of bone fracture or perforation. Therefore, bone cement removal has been the subject of discussion over many years. Before surgery, we prepared various instruments such as chisels for bone cement removal [6]. However, during the operation, since complete removal of the residual cement was difficult and involved the risk of fracture, the procedure was changed to the cement-in-cement method. We reasoned that stem fixation using this method would decrease the risk of fracture. This method, in which old cement is not removed after stem removal, and a new stem is fixed with new cement, was first described by Greenwald *et al.* in 1978. Initially, this method was not reliable, and did not attract much attention for a long period. Around 1990, however, after various improvements in the technique, it began to gain more attention [7]. In 2009, Duncan *et al.* evaluated the mid-term results of the cement-in-cement method (mean follow-up period, 8 years) in 136 joints, and found that none of the required re-revision surgery due to stem loosening, demonstrating the marked reliability of this approach [8]. Based on our experience in this study, patients like ours who underwent reconstruction of a limb using a cemented tumor prosthesis in the 1980s and who now require revision surgery due to stem fracture are likely to increase in the future. In revision sur-

gery, it is optimal to remove cement as much as possible, and replace the old prosthesis with a tumor prosthesis having a thicker stem. However, when cement removal involves the risk of fracture, fixation of the new stem using the cement-in-cement method should also be considered. Finally, further observation will be needed because the follow up period of this our case was too short.

In conclusion, in revision surgery for cemented custom-made tumor prostheses, it is optimal to remove residual bone cement as much as possible. However, when cement removal involves the risk of fracture, revision using a tumor prosthesis with a thicker stem and the cement-in cement method is recommended.

## References

1. Suguro T, Inoue S, Moriya H, Endo F and Morikawa T: Clinical application of ceramic custom knee prosthesis for osteosarcoma. *Seikeigeka Ceramic Implants Kenkyukai (Orthopaedic ceramic implants: proceedings of Japanese Society of Orthopaedic Ceramic Implants)* (1981) 1: 229-232 (in Japanese).
2. Nakamura S, Kusuzaki K, Murata H, Takeshita H, Hirata M, Hashiguchi S and Hirasawa Y: Ceramic endoprosthesis for aggressive giant cell tumors near the knee: eight cases followed for more than 10 years. *Int Orthop* (2001) 25: 104-106.
3. Yoshida Y, Oaska S and Tokuhashi Y: Clinical experience of novel interconnected porous hydroxyapatite ceramic for the revision of tumor prosthesis: *World J Surg Oncol* (2009) 7: 76.
4. Unwin PS, Cannon SR, Grimer RJ, Kemp HB, Sneath RS and Walker PS: Aseptic loosening in cemented custom-made prosthetic replacements for bone tumours of the lower limb. *J Bone Joint Surg Br* (1996) 78: 5-13.
5. Mittermayer F, Windhager R, Dominkus M, Krepler P, Schwameis E, Sluga M, Kotz R and Strasser G: Revision of the Kotz type of tumour endoprosthesis for the lower limb. *J Bone Joint Surg (Br)* (2007) 84: 401-406.
6. Kubo S: Hip joint science. Kinpodo, Tokyo (2014) pp1052-1058 (in Japanese).
7. Greenwald AS, Narten NC and Wide AH: Points in the technique of recementing in the revision of an implant arthroplasty. *J Bone Joint Surg (Br)* (1978) 60: 107-110.
8. Duncan WW, Hubble MJ, Howell JR, Whitehouse SL, Timperley AJ and Gie GA: Revision of the cemented femoral stem using a cement-in-cement technique. A five - to 15 year review. *J Bone Joint Surg (Br)* (2009) 91: 577-582.