

Clinical report

Experiences with total femur replacement for malignant bone and soft tissue tumors

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Background: Reasonable function can be restored after total femur replacement after massive resection of bone and soft tissue sarcomas of the thigh. The type of femoral prosthesis and surgical approach are tailored to the clinical characteristics of individual patients and to tumor anatomy. Though the complication rate is high, total femur replacement offers the patient limb salvage and a chance at functional ambulation.

Objective: We described the function and complications of total femur replacement performed at the institution as well as relevant literature reviews.

Methods: Seven patients underwent total femur replacement for the treatment of malignant bone and soft tissue tumors of the lower extremities between 1992 and 2010 at our institute. Ages ranged from 12 to 68 (mean=34) years. The tumor was pathologically diagnosed as osteosarcoma in two patients, Ewing's sarcoma in two, chondrosarcoma (grade 3) in one, soft tissue malignant fibrous histiocytoma in one, and bone metastasis from renal cancer in one. Follow-up periods ranged from 1 to 17 years (mean = six years three months). All patients underwent wide resection, using the Howmedica Modular and Reconstruction System in five cases and the Kyocera Limb Salvage System in two cases. Function, complications and outcomes were evaluated in these patients, and the usefulness of the operative procedures is discussed herein.

Results: The mean functional score was 60%. X-ray examination revealed migration in only one case. Complications were infection (n=2), bipolar head dislocation (n=1) and patellar fracture (n=2). The outcomes were DOD (died of disease) in three cases, NED (no evidence of disease) in two, AWD (alive with disease) in one, and CDF (continuous disease free) in one.

Conclusion: The results suggest that total femur replacement is useful as a means of reconstructing affected limbs in patients with malignant bone and soft tissue tumors, but that latissimus dorsi muscle transplantation, as well as other procedures, must also be considered in cases requiring extensive soft tissue resection to prevent infection. Furthermore, early one-stage revision is advisable in cases showing signs of infection.

Keywords: Femoral prosthesis, functional outcomes, malignant tumors, total femur replacement

There are numerous reports on tumor prosthesis use for the treatment of malignant bone and soft tissue tumors in the vicinity of the knee. Total femur replacement, a relatively rarely adopted method for reconstruction of affected limbs, employs a femoral prosthesis [1-9]. La Voie, Morris and Ward, and their colleagues, reported the functional results of total femur replacement in seven to 24 cases [10, 11]. In

our facility, a 17-year-old male with a Ewing sarcoma of the proximal part of the right femur underwent total femur replacement and was followed for a relatively long period, 16 years, after surgery, while overcoming complications associated with the tumor prosthesis, including infection, migration of the bipolar head and dislocation [12]. Including this case, we reviewed the outcomes of total femur replacement, the associated complications, and countermeasures taken in seven patients who underwent this operative procedure at our facility. We evaluated the usefulness of this procedure as a means of preserving affected limbs. The relevant literature is also discussed.

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Materials and method

This study involved seven patients who underwent total femur replacement at our facility between 1992 and 2010. The pathological diagnosis was osteosarcoma in two patients, Ewing's sarcoma in two, chondrosarcoma in one, soft tissue malignant fibrous histiocytoma (MFH) in one, and bone metastasis from renal cancer in one. Patient ages ranged from 12 to 68 (mean=34) years. Follow-up periods ranged from 1 to 17 years (mean = six years three months). Those with osteosarcoma or Ewing's sarcoma received chemotherapy before and after surgery. Wide resection (3 cm or more) was carried out in these osteosarcoma and Ewing's sarcoma cases, while preserving at a minimum one of the four quadriceps muscles, i.e. the rectus femoris muscle [13]. In the remaining three patients, wide resection (at least 1 cm) was carried out, with preservation of the rectus femoris muscle to assure the maximum amount of possible knee extension. For the patient with metastasis from renal cancer to the proximal part of the femur, open reduction and fixation of the metastatic focus with an intramedullary pin was performed. This patient, however, experienced a pathological fracture and required wide resection and total femur replacement 36 months after the initial operation. The tumor prosthesis used was the Howmedica Modular and Reconstruction System (HMRS) in five cases and the Kyocera Limb Salvage System (KLS) in two. In these seven cases, we analyzed complications, countermeasures against these complications, the International Society of Limb Salvage (ISOLS) functional scores of affected limbs [14], radiographic features, and outcomes.

Results

Functional evaluations

ISOLS functional scores were analyzed in our seven cases. Pain scores were 4 or 5 in all cases (mean=88.5%). Function was scored 3 in all cases (mean: 60%). Emotional acceptance was scored 2 or 3 (mean=54.2%). Support scores ranged from 2 to 5 (mean=57%). Walking was scored 2 or 3 (mean=57%). Gait was also scored 2 or 3 (mean=57%). The overall functional rating was 60% for our seven cases as shown in **Tables 1** and **2**.

Sacrifice of the quadriceps muscle

The extent and site of resection of the quadriceps muscles of the thigh were analyzed. Four of the seven patients underwent resection of three or more muscles. In two cases, two muscles were resected. The rectus femoris muscle was preserved in all cases (**Table 1**). The extent of resection was at least two out of three muscles in all cases.

Radiographic features

In all cases, radiographic evaluation in accordance with ISOLS criteria was carried out using radiograms taken during the most recent visit. In five cases, i.e., excluding the two with Ewing sarcoma, the follow-up period was short, and all showed excellent bone remodeling, interface and anchorage results. In case 2, migration of the prosthetic bone head toward the acetabulum was observed (**Table 3**).

Table1. Summary of seven cases with total femur replacement.

Patient no	Age	Gender	Diagnosis	Site	Type	Sacrificed quadriceps	Status (months)
1	12	F	Osteosarcoma	Middle&distal femur	HMRS	VL&VI	DOD (12)
2	18	M	Ewing sarcoma	Proximal femur	HMRS	VL&VI&VM	CDF (216)
3	17	M	Ewing sarcoma	Proximal femur	HMRS	VL&VI&VM	AWD (204)
4	56	M	MFH	Vastus lateralis	HMRS	VL&VI	DOD (15)
5	56	M	Chondrosarcoma	Proximal femur	HMRS	VL&VI&VM	DOD (16)
6	22	F	Osteosarcoma	Middle&distal femur	KLS system	VL&VI&VM	NED (25)
7	68	M	Metastasis of renal cancer	Proximal femur	KLS system	VL&VI	NED (41)

Table 2. Functional evaluations

Patient no	Pain	Function	Emotional acceptance	Supports	Walking	Gait	Total (%)
1	4	3	3	2	2	2	53
2	5	3	2	5	3	3	70
3	5	3	3	3	3	3	66
4	4	3	2	2	2	2	50
5	4	3	3	3	3	3	63
6	5	3	3	3	3	3	66
7	4	3	3	2	2	2	53

Table 3. Radiographic evaluations by ISOLS

Patient no	Bone remodeling	Interface	Anchorage
1	Excellent	Excellent	Excellent
2	Good	Good	Good
3	Excellent	Excellent	Excellent
4	Excellent	Excellent	Excellent
5	Excellent	Excellent	Excellent
6	Excellent	Excellent	Excellent
7	Excellent	Excellent	Excellent

Outcomes

Three patients (cases 1, 4, and 5) died of lung metastasis. In case 2, there was no evidence of either metastasis or recurrence and the rating was continuous disease free (CDF). Case 3, a patient with Ewing sarcoma, had lung metastasis and was rated as alive with disease (AWD) at the time of final evaluation. In case 6, lung metastasis was observed at the first presentation, but the patient was no evidence disease (NED) after chemotherapy and surgical resection of the metastases. Case 7, who had bone metastasis from renal cancer, is presently free of metastatic disease and rated as NED (Table1).

Complications

Complications included infection (n=2), bipolar head dislocation (n=1) and patellar fracture (n=2). Case 2 underwent one-stage revision due to an infection approximately 10 years after the initial operation. Five years later, this patient suffered dislocation of the bone prosthesis due to a fall and underwent invasive reduction. Seven years later, infection and bipolar head migration necessitated debridement and acetabular component installation. Furthermore, due to a soft tissue defect in the proximal

part of the femur, the articular prosthesis component was covered via transplantation of a rectus abdominis musculocutaneous flap. Case 3 also sustained a patellar fracture due to a fall, but was managed conservatively. Case 4 also developed an infection. In this patient, exudates from the wound became apparent soon after surgery, and methicillin-resistant *Staphylococcus aureus* was isolated from these exudates. Despite several sessions of debridement, remission was not achieved, and hip disarticulation was required one year after the initial operation.

Discussion

According to our literature search, total femur replacement was first reported in 1965 by Buchman [2]. There are fewer reports on total femur replacement for the treatment of malignant bone and soft tissue tumors than on arthroplasty around the knee [15]. Total femur replacement is sometimes performed as a salvage operation to deal with damage, infection and so on, of the prosthesis following total hip arthroplasty or knee arthroplasty [6, 15, 16]. Among the patients included in the present study, only one (case 7), who had metastasis from renal cancer to the proximal part of the femur, received a salvage

operation. In this patient, a pathological fracture developed in the proximal part of the femur, and invasive reduction and fixation were followed by local radiotherapy. However, the metastatic lesion gradually expanded over time, and total femur replacement was selected because no other viable method of femur reconstruction was available.

Regarding functional evaluation with the Musculo-Skeletal System Tumor Society (MSTS) rating system, the functional ratings reported by Schindler et al, Kalra et al and Christian et al were 77.3%, 72.6%, and 72%, respectively [1, 17, 18]. The rating for our patients was 60% on average, lower than those reported by previous investigators. The low rating in our patients is probably attributable to the following factors; 1) the number of cases analyzed was small, and 2) the mean rating for each item was low (54%-57% on average). Three of our seven patients died approximately one year after surgery, and the general conditions of all of our patients gradually deteriorated after surgery, resulting in unsatisfactory functional ratings for the affected limbs. We had the impression, however, that walking and gait functions in cases 2 and 3, after the surgical procedures described herein, were not very different from those of patients undergoing arthroplasty around the knee using tumor prostheses. As to the radiographic evaluation based on ISOLS criteria, the follow-up period was relatively short in our patients, and most were rated as excellent in terms of bone remodeling, anchorage and interface. Only case 3 showed migration of the prosthetic bone head toward the acetabulum.

Complications after the use of tumor prostheses, posing clinical problems, include infection, prosthetic breakage, loosening, dislocation, and so on. Among the cases studied herein, these complications were appropriately managed in case 2, allowing prolonged (16 years) preservation of the affected limb. Although controversy persists regarding countermeasures, treatment methods and other procedures for dealing with infection after this type of surgery, we controlled infection by means of early detection and one-stage revision [19]. It is also important to cover the articular prosthesis using a musculocutaneous flap with a rich blood supply [20]. Nerubay et al reported the incidence of deep infection to be 7% [7]. Kalra et al managed superficial infections using antibiotics and deep infections with two-stage revision.

In case 5 (soft tissue MFH), the tumor had invaded the bone in addition to soft tissue, and

combined resection, including the lateral and medial great muscles of the thigh and the total femur, was carried out. In this case, exudates from the wound became apparent two to three days after surgery. Despite repeated debridement, hip disarticulation was eventually required in this case. As to measures to be taken to prevent and manage infection after total femur replacement, our experience with the aforementioned cases suggests that in those with wide defects of soft tissue, it is essential to perform latissimus dorsi muscle transplantation, as well as to cover the prosthesis sufficiently. It is also important in such cases to detect signs of infection in early stages and to promptly perform one-stage revision.

Measures to deal with migration of the bipolar head toward the acetabulum include using a constrained acetabular component and converting to total hip arthroplasty at the earliest possible opportunity [22]. However, the optimal timing for use of a constrained acetabular component remains an open issue. Bipolar head dislocation is a common complication after total femur replacement. This complication may be attributable to resection of the hip abductor muscle which causes the total femur to assume the form of a long lever arm. The incidence of this complication was reported to be 11% by Kalra et al and 12% by Brend et al [1, 16]. Both groups reported that to avoid dislocation, it is advisable to use a constrained acetabular component and to reconstruct the hip with a prosthetic joint. At our facility, dislocation has been experienced by only patient (case 2), to date. We dealt with this dislocation by using an acetabular component, but an effective means of preventing this complication is lacking at present. Patient education does, however, appear to be an important element of preventing dislocation.

Conclusion

In patients with malignant bone and soft tissue tumors, the functions of the affected limbs following total femur replacement differed little from those after arthroplasty around the knee using tumor-type prostheses, indicating that total femur replacement is useful for affected limb reconstruction. However, in cases requiring extensive resection of soft tissue, particularly those requiring resection of 2/3 or more of the quadriceps muscles of the thigh, it is advisable to consider latissimus dorsi muscle transplantation, or similar procedures, to cover the femoral component sufficiently. Installing an acetabular component should

also be considered from the viewpoint of preventing dislocation of the tumor-type prosthetic bone head. If signs of infection develop, it is advisable to perform one-stage revision without delay.

All authors have no conflict of interest to declare.

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