

Resection hip arthroplasty for malignant pelvic tumor

Outcome in 5 patients followed more than 2 years

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We describe the technique and outcome of resection hip arthroplasty with external fixator for malignant pelvic tumors involving the innominate bone. We used the procedure in 5 patients, all followed for more than 2 years. 4 of the patients are alive and 1 died of pulmonary metastasis. None of the patients experienced local tumor recurrence or infection. Lower limb function in 3 of the 5 patients was more

than 70% with Enneking's criteria (Enneking et al. 1993). These 3 patients could walk without support and passively flex the hip up to 90 degrees. This resection hip arthroplasty allows early weight bearing with hip motion. We believe it is an excellent alternative to other procedures, such as endoprosthetic replacement, reconstruction with allograft or arthrodesis.

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In order to obtain a functional lower limb after wide resection of malignant pelvic tumors involving the innominate bone, various reconstruction procedures have been reported (Harrington et al. 1986, Enneking and Dunham 1987, Campanacci 1990, van der Lei et al. 1992, Uchida et al. 1996, Abudu et al. 1997). However, most of them can result in serious complications such as infection, breakage or loosening of an endoprosthesis and fracture of the pelvis. Since 1991, we have combined resection hip arthroplasty with external fixation, to restore hip function. We present the surgical procedure and outcome in 5 patients.

Patients and methods

The mean age of the patients (3 women) was 36 (10–48) years. Case 1 had a malignant fibrous histiocytoma (MFH) of bone, case 2 a high grade malignant chondrosarcoma, case 3 a metastatic bone tumor from a uterus body carcinoma, case 4 a low-grade malignant chondrosarcoma and case 5 had an unclassified round cell sarcoma. 2 tumors (cases 2 and 3) arose from the ischium, 2 (cases 1 and 5) from the pubis and 1 (case 4) from the ilium. All involved the innominate bone but had not invaded the hip joint (type IIb with Enneking's classification (1983)). 4 patients had large tumors, expanding extraskeletally but 1 chondrosarcoma (case 4) was localized in the pelvic bone. While

4 primary tumor patients had no metastatic disease at the time of diagnosis, the metastatic bone tumor patient also had pulmonary metastases. The mean follow-up was 49 (31–68) months.

Tumor resection (Figure 1)

Wide tumor resection with partial pelvicotomy including the innominate bone was performed in all patients. At the hip joint, an intracapsular procedure was used in all patients, because the acetabular articular cartilage was found to be intact in the preoperative image analysis. Case 1 had a partial bladder resection, due to tumor invasion into the bladder wall, and case 3 underwent a hysterectomy for treatment of the primary lesion, during pelvic tumor resection.

Resection hip arthroplasty (Figure 2)

After total shaving of the articular cartilage, the femoral head was tightly connected to the osteotomy surface of the ilium, using a femoro-pelvic external fixator (Hoffman, Howmedica Inc.) after temporal fixation with wire (case 1) or polyethylene threads (cases 2, 3, 4, 5). In order to restore hip abduction, the greater trochanter resected with the gluteus medius muscle was fixed distally to the femur with screws in 3 patients (cases 2, 3, 5). In case 4, since limb shortening more than 4 cm after resection was expected, we performed a leg lengthening simultaneously through the middle portion of the femur by an external lengthening device.

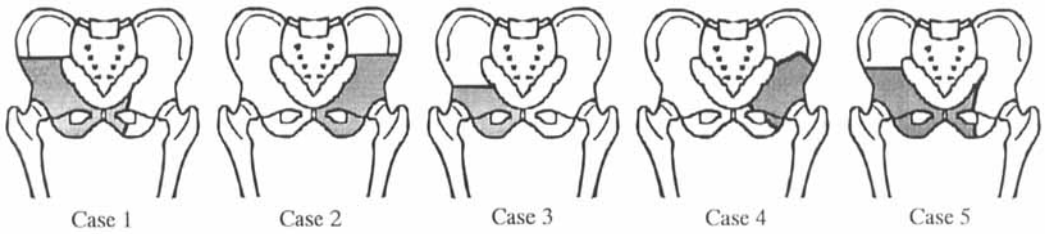


Figure 1. Diagram showing margin of partial pelvic resection for wide tumor resection in 5 patients.

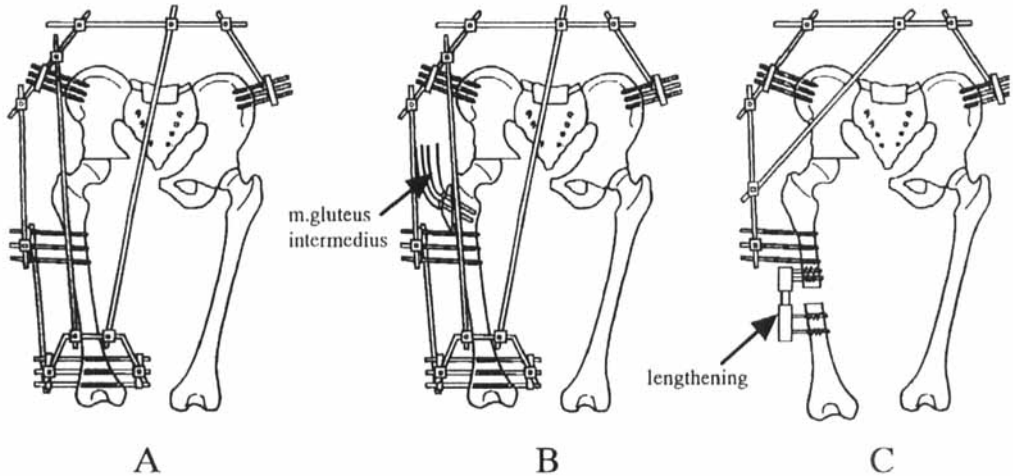


Figure 2. Variations in method of external fixation between the osteotomy surface of the ilium and femoral head. A case 1, B cases 2, 3, 5, and C case 4.

Postoperative rehabilitation

On the day after surgery, the patients could sit on the bed and exercises involving knee motion were initiated 1 week later. At 3 weeks, they used a wheeled cart to move and maintained a standing position on a tilting table, with the support of a physiotherapist. At 6 weeks, the external fixator was removed under local anesthesia and passive motion at the junction between the ilium and femoral head was immediately allowed. Using a hip extension-abduction supporting brace, the patients began to walk with double crutches at 10 weeks after surgery.

Results

Major complications were impotence in case 1 and femoral head necrosis in case 3. None of the patients developed infections. Leg shortening was 3 (2.0-3.5) cm, measured on an anteroposterior radiogram (case 4 received a 2 cm limb-lengthening correction). At latest follow-up, patients 4 and 5 were continuously disease-free, patient 1 had no evidence of disease after partial

resection of a single pulmonary metastasis, patient 3 was alive with metastases, patient 2 died of pulmonary metastases, which developed 4 years after resection. None of the patients had a local tumor recurrence.

Reconstructed lower limb function in cases 1, 2 and 4 was more than 70% with Enneking's criteria (Enneking et al. 1993) at the latest follow-up time (Table). These 3 patients could walk without a cane or brace, and also passively flex the hip up to 90 degrees without pain. They could easily drive an automatic transmission vehicle, because their knee and ankle motions were almost normal. 2 men returned to their

Results of lower limb function in patients (Enneking's criteria)

Case	Pain	Function	EA ^a	Support	WA ^b	Gait	Total %
1	4	4	5	4	3	3	77
2	4	4	5	4	4	3	80
3	3	3	2	1	2	2	43
4	4	4	4	3	3	3	70
5	4	2	3	0	1	1	37

^a Emotional acceptance. ^b Walking ability

previous work (engineer and medical doctor) and 1 woman worked as a housewife, without serious difficulty. Patient 3 needs double crutches for walking, because she had a femoral head necrosis which was caused by ligation of the medial and lateral femoral circumflex arteries. Patient 5, who suffered from bilateral sciatic nerve palsy which was caused by compression from the tumor, requires double canes and bilateral short leg braces for walking. She has no pain with full weight bearing, but motion of the resected hip joint is poor. Bone fusion occurred 2 years after surgery.

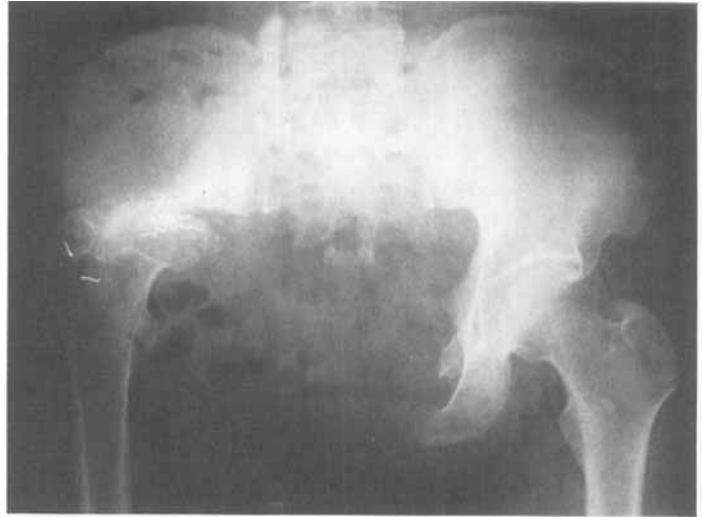


Figure 3. Anteroposterior radiograph of pelvis and formed hip joint at 68 months after resection arthroplasty in case 1.

Case reports

Case 1 (Figures 3-5)

This man was 46 years old at diagnosis. He had a skeletal MFH originating in the right pubic bone. The tumor involved the innominate bone but had not invaded the hip joint. Wide tumor resection including partial pelvicotomy and partial resection of the urinary bladder were performed, followed by resection hip arthroplasty, as described above. The patient is now, 5.5 years after surgery, alive without disease after thoracotomy and chemotherapy. Current radiographic findings showed osteosclerotic changes on

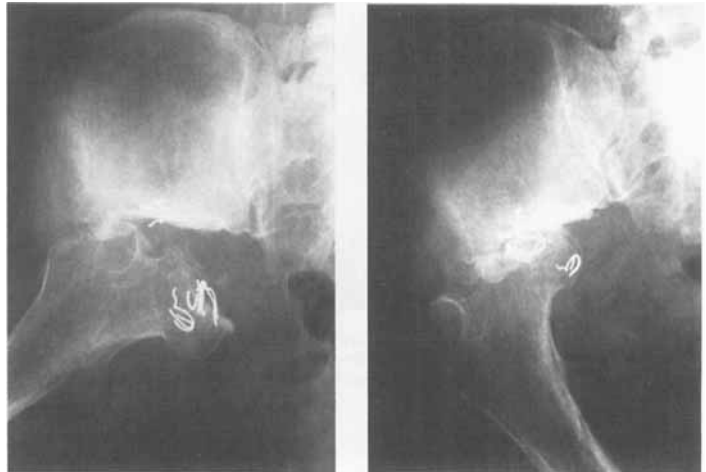


Figure 4. Dynamic radiograph of newly formed hip joint of case 1 (left in abduction position, right in adduction position).

the surface of both the ilium and femoral head. There was a collapse of the femoral head but different from that of femoral head necrosis which was recognized in case 3. A dynamic radiogram of the newly formed joint showed good movement of the femoral head and dislocation did not occur. A CT view also showed that the femoral head adapted to the ilium surface and there was abundant granulation tissue around the new joint. This patient is now working as an engineer as before surgery. He can walk more than 1 km without support and drive a car.

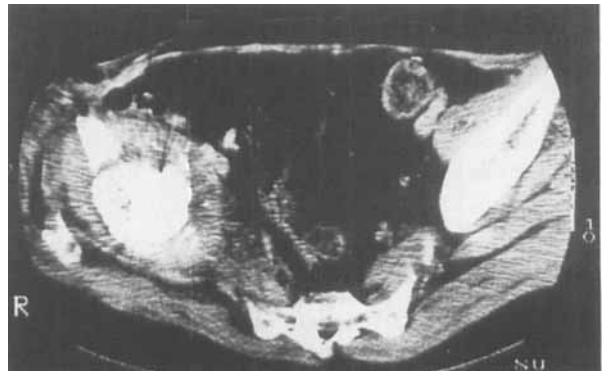


Figure 5. CT view of newly formed hip joint of case 1.

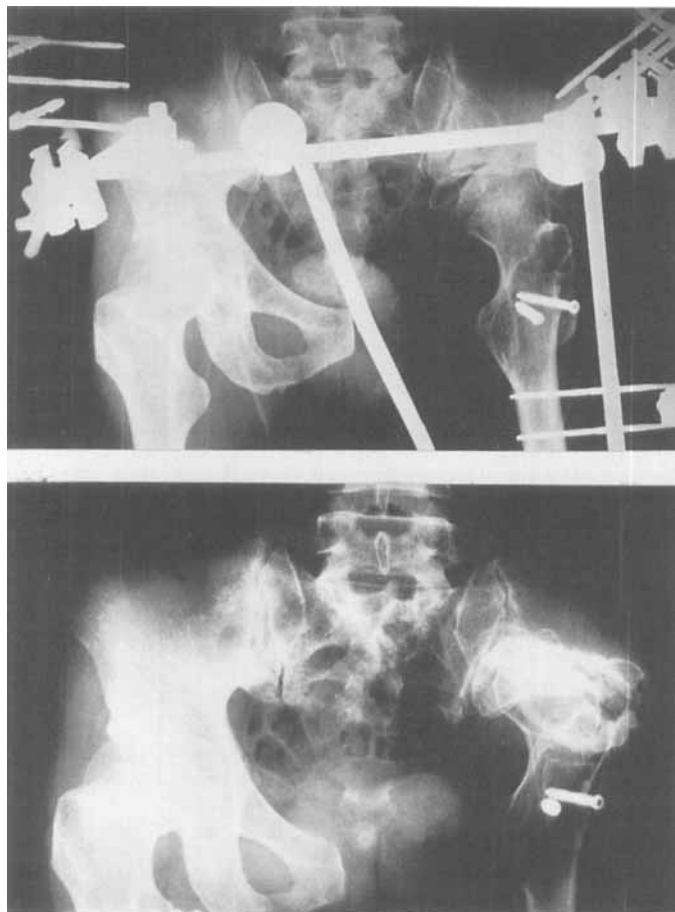


Figure 6. Anteroposterior radiograph (upper) of the pelvis and reconstructed hip joint of case 2 with the external fixation device, immediately after surgery. Radiograph of the hip joint newly formed between the left ilium and femoral head at 50 months after surgery (lower).

Case 2 (Figure 6)

This patient was a 49-year-old man who had a large high-grade malignant chondrosarcoma in the left pelvic cavity, originating in the ischium. He underwent a wide tumor resection and resection hip arthroplasty (Figures 1 and 2). Before surgery, he was working as a medical doctor in his private office and he returned completely to his work at 4 months after reconstruction. Until he died of pulmonary metastases, he could work actively without any difficulties.

Discussion

Various methods (Harrington et al. 1986, Campanacci 1990, van der Lei et al. 1992, Uchida et al. 1996, Abudu et al. 1997) have been reported for reconstruction of lower limb function after partial pelvicctomy,

including the innominate bone, for the treatment of malignant pelvic tumors (type IIb with Enneking's classification (1983)). Endoprosthetic reconstructions, such as partial femur and total hip replacement with a constrained (Uchida et al. 1996) or non-constrained joint (Abudu et al. 1997), or saddle-type implant (van der Lei et al. 1992) and artificial pelvis have been attempted and some showed good function (Abudu et al. 1997). However, most of these reconstructions have not been successful over the long term and major postoperative complications are common, such as dislocation of the joint, breakage of the implant and serious deep infection. Allografts and autoclaved or radiated autografts (Harrington et al. 1986) of the pelvis, which have been used for hip reconstruction, require long-term fixation before full weight bearing is possible. These bone graft procedures also require total hip replacement with an endoprosthesis, because grafted articular cartilage of the acetabulum rapidly degenerates. Arthrodesis (Enneking and Dunham 1987, Campanacci 1990) between the ilium and femoral head is an excellent reconstruction, because it is painless and entails no risk of long-term complications. However, it is difficult to achieve a painless rigid

bone union, due to the small contact area.

Steel (1978) reported a resection hip arthroplasty in 5 patients with pelvic chondrosarcoma after partial or complete resection of the hemipelvis. Our procedure maintains rigid fixation between the ilium and femoral head for the first 6 weeks by an external fixator, while Steel applied loose fixation by casting. It is much easier to maintain rigid fixation between the ilium and femoral head with an external fixator than with a cast. The external fixation method also makes patients more comfortable than a cast, because they can move the knee, use a wheeled cart and perform standing exercises without pain.

Our resection hip arthroplasty did not cause pain, unlike a pseudoarthrosis after failed arthrodesis (Enneking). In our procedure, the intentional formation of the new hip "joint" may be effective in relieving pain, because the femoral head is stabilized by granu-

lation tissue. In resection hip arthroplasty, we speculate that abundant granulation tissue containing woven bone and cartilage forms from the bone marrow of the ilium and the femoral head during the first 6 weeks, because it is a situation similar to fracture healing. After the removal of external fixation and the initiation of motion, this granulation tissue forms a thick pseudocapsule around the "joint" and fibrous cartilage accumulates at both osteotomy surfaces. We assume that this structure stabilizes the femoral head to the ilium. In a pseudoarthrosis after failed arthrodesis, the femoral head is displaced by weight bearing, which may cause serious pain. Advantages using our method are the low risk for postoperative infection, the short recovery period pending painless weight bearing and hip "joint" motion. The only disadvantage is limb shortening.

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