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Extracorporeally irradiated autografts in pelvic reconstruction after malignant tumour resection

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Abstract We treated 15 patients suffering from an extracompartmental malignant pelvic tumour by resecting the affected part of the bone, irradiating it extracorporeally with 300 Gy, and reimplanting it after having removed the bulk of the lesion. Adjuvant therapies were used according to the type and extension of the tumour. Follow-up was an average of 4 years 6 months. Complications were seen in 13 patients. Most mechanical complications were related to the use of hip arthroplasties. Internal fixation of the graft failed in one case only, infection was seen in three cases, and seven patients died after local recurrence. Functional scores were fair. Although many complications were seen, this method remains our treatment of choice.

Résumé Nous avons traité 15 malades qui souffraient d'une tumeur pelvienne maligne extracompartmentale par résection de la partie affectée, 'irradiation extracorporelle de 300 Gy, puis réimplantation après avoir enlevé la charge de la lésion. Les thérapies adjuvantes ont été utilisées d'après le type et l'extension de la tumeur. Le suivi moyen était de quatre ans et demi. Treize malades ont eu des complications. La plupart des complications mécaniques étaient relatives à la prothèse de la hanche. La fixation de la greffe a failli seulement une fois. Il y a eu trois infections. Sept malades sont morts après une récurrence locale. Les scores fonctionnels sont moyens. Bien que beaucoup de complications puissent survenir, cette méthode reste notre traitement de choix.

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Introduction

Several strategies have been established to solve the problems inherent in the treatment of malignant pelvic tumours. In 1988 we first reported the technique of extracorporeal irradiation and reimplantation of the resected autograft, which was developed at our department [21]. Since then we have used and refined the technique.

Patients and methods

Fifteen patients, four women and 11 men aged between 12 and 65 (mean 38) years, with a malignant pelvic tumour were treated between 1977 and 2000 at our facility. All but one had a primary malignant bone tumour. The tumours were graded according to Enneking [4]. All tumours were extracompartmental.

The extent, and hence also the plane, of resection of the lesion was established by imaging techniques, including radiography, arteriography, CT-scan, MRI, and Technetium total body scanning. Biopsy remained essential to assess the type and differentiation of the tumour.

The surgical procedure consisted of three stages during one operative session. Firstly, the tumour was resected. The approach was planned according to tumour localisation. Care was taken always to include the biopsy tract in the resection specimen. Neurovascular bundles were respected as long as there was no tumoural invasion. The lesion was excised as widely as possible. Since resection with a wide margin is hard to achieve in this location, five resection margins in this series were marginal and five were intralésionale. Five resections were wide. The excision type was classified according to Capanna [3]. The resected piece was wrapped in three layers of sterile plastic bags and two layers of sterile drapes. It was then taken to the linear accelerator at the Centre of Nuclear Medicine. Secondly, extracorporeal irradiation of the resected piece was performed with a dose of 300 Gy. Finally, the graft was reimplanted after removal of all soft tissue and the bulk of the bony lesion. This last stage was performed after redraping the patient and removal of all instruments used in the first stage. Fixation of the graft was achieved by plating (Fig. 1). Five total hip replacements (THRs) were performed either because the hip had been resected due to tumoural invasion (Fig. 2) or because postoperative avascular necrosis of the femoral head was expected.

Eight patients received one or various modes of adjuvant therapy according to the tumour sensitivities as listed in Table 1.

Postoperative screening was performed at pre-set time intervals and consisted of blood tests, abdominal echography, CT-scan



Fig. 1 Patient 1: Resection type B2 of a chondrosarcoma stage IB and re-implantation of the irradiated part



Fig. 2 Patient 4: Total hip replacement with anti-dislocation cup

of abdomen and chest, radiography and MRI of the tumour site, and Technetium bone scanning with SPECT for bladder superposition [22].

The follow-up was an average of 4 years 6 months (range 1 year 6 months to 15 years 2 months). The functional outcome was evaluated by the EMSOS method [5].

Results

Seven patients died after local recurrence, six of whom had stage IIB or IIIB tumours and four of whom had distant metastases by the time of death.

Complications were noted in all but two patients. Most of the mechanical complications were related to the prosthesis. Of five patients who received a THR, two experienced recurrent dislocation due to insufficient mus-

cle strength. Of these, one patient had a reoperation. One other patient showed migration of the acetabular component. Graft-related complications occurred in only one patient: a non-union with loss of fixation presented after 2 months, necessitating a THR. In all other cases bony union was achieved. Graft resorption was noted but caused no functional impairment. Deep infection developed in three cases but was cured by antibiotic therapy.

The overall EMSOS score was 54% in our series. The deceased patients were rated before local recurrence developed. Pain was rated 86%, function 41%, emotional acceptance 49%, supports 46%, walking 62%, and gait 57%. The EMSOS score of the surviving patients was 64%, pain rating 90%, function 50%, emotional acceptance 52%, supports 60%, walking 65%, and gait 67%.

Discussion

In general, pelvic malignancies have a poor prognosis. Surgical treatment has a high frequency of marginal or even intralesional resections. Treatment by external irradiation is equally difficult because of the proximity of a number of visceral organs.

Tumour control should be the prime goal of any treatment. To achieve this, external hemipelvectomy was performed in the earlier days. The disadvantages of amputation are well known. Nevertheless, its 5–10% local recurrence rate proved to be a hard target for newly developed techniques.

Nowadays there is a growing enthusiasm for limb-saving surgery, as this does not interfere with wide resection of the lesion [9]. In general, one has to keep in mind that limb salvage as such carries a higher complication rate – a prolonged operating time and thus an increasing risk of contamination of the operating field, a higher amount of blood loss, and even injury to nerves resulting in a non-functional limb [14, 16]. Especially in pelvic reconstruction surgery, the complication rate is extremely high [11]. One also has to consider secondary interventions for various causes. The biggest advantage obviously is the preservation of a fairly functional limb with knee flexion.

Initially, surgeons performed an internal hemipelvectomy with or without attachment of the femur to the pelvic stump. This, however, resulted in severe leg shortening, large defects, huge dead space, painful motion, and absence of a true hip joint [6, 13, 15]. Subsequently, reconstruction techniques were developed aiming at replacement of the resected part to avoid these shortcomings. Techniques using endoprosthetic reconstruction have to deal with the fact that many tumours affect young adults, if not children [20]. The higher level of physical activity in this population may thus result in failure of device fixation or failure of the prosthesis itself [1, 5, 16, 19]. Immediate advantages of prosthetic reconstruction are early restoration of function and better patient comfort [10].

Table 1 *IM* intermediate, *W* wide, *THR* total hip replacement, *NED* no evidence of disease, *LG* low grade, *M* marginal, *DVT* deep venous thrombosis, *DOD* death of disease, *HG* high grade, *IL* intralesional, *OS* osteosynthesis, *AWD* alive with disease, *AP* Anus praeter, *MFH* malignant fibrous histiocytoma, *M* male, *F* female

No	Sex	Age	Tumour	Stage	Res	Margin	RT	CT	BT	Rec	Meta	FU	Outcome	Complications
1	M	35	Chondrosarcoma (exostosis)	IB	B2	IL						1 yr 6 mo	NED	OS screw in hip joint: replaced, dehiscence of abdominal muscle
2	M	44	Chondrosarcoma	IIB	A2	W						7 yr	NED	DVT
3	M	65	Chondrosarcoma (exostosis)	IB	C1	W			Y			2 yr 3 mo	DOD	Failure of plate OS after 2 mo → conversion to THR, migration cup
4	M	23	Chondrosarcoma	IB	B2	M						2 yr 1 mo	NED	Paresthetic sensations leg
5	M	57	Chondrosarcoma	IB	TH	M						15 yr 2 mo	NED	Progressive recovery sacral plexus palsy, orthosis for walking
6	M	51	Chondrosarcoma (exostosis)	IIB	C2	M	Y			Y(2)		9 yr	AWD	Deep infection, toxic colon → AP, DVT and lung embolus, impotence, plastic surgery for burned leg
7	F	12	Chondroblastic osteosarcoma	IIB	A3	M	Y	Y	Y	Y		2 yr 3 mo	DOD	Skin necrosis, necrosis of skin graft
8	F	18	Chondroblastic osteosarcoma	IIB	B3	M		Y		Y		1 yr 7 mo	DOD	Dehiscence of wound, deep infection, radicular pain after recurrence
9	F	26	Chondroblastic osteosarcoma	IIB	B3	IL		Y		Y		1 yr 1 mo	DOD	Sinus tract, skin problems, infection, hemipelvectomy for recurrence
10	M	37	Fibrosarcoma	IIIB	A1	IL	Y	Y		Y		8 mo	DOD	+ lymph nodes
11	M	17	Undiff. fibrosarcoma	IIB	B1	W						7 yr 8 mo	NED	2 × dislocation of THR, revision of THR, Trendelenburg gait, psychological problems
12	M	29	Ewing sarcoma	IIB	A1	W	Y	Y		Y		4 yr 4 mo	DOD	Skin slough and infection after biopsy for recurrence, renal problems
13	M	43	Hemangiosarcoma	IIB	B2	W	Y	Y	Y			7 yr 5 mo	NED	Sinus tract resection, twice skin graft after necrosis, dislocation THR, revision of THR, pain because of nerve root irritation OS, hip loosening
14	F	55	MFH	IIB	A3	IL	Y	Y	Y	Y		2 yr	DOD	Wound problems after resection recurrence
15	M	58	Meta hypernephroma	IIIB	B1	IL						4 yr 8 mo	AWD	

Autografts have several advantages over allografts: They do not contain foreign infectious or immunogenic agents [7, 18], the fit will always be perfect both at the host-graft junction and at the hip joint, and there is no need for maintaining an extensive allograft bone bank [8, 10, 14].

To use autografts in situ and still maintain tumour control means to get rid of live tumour cells within the grafts. Irradiating the graft does not compromise the graft's strength as much as autoclaving does. Furthermore, there is no denaturation of the matrix and therefore better preservation of the osteoconductive properties, resulting in a higher rate of union [2, 8, 17].

Infection is a serious complication, however. Excision of a pelvic tumour takes long time, even longer if vascular, neural, or splenic structures are involved. Whatever reconstruction technique used, excision is a common factor in all. No time is lost in fitting a graft if an autograft is used, and transmission of infectious agents is avoided. However, a bone graft or a prosthetic device is always a locus minoris resistentiae. Late infections are seen after a visit to the dentist or after a urinary tract infection. The surrounding soft-tissue envelope is immuno-compromised and provides little protection against invading organisms [23]. Large volumes of dead space or haematomas should be avoided. A major contributing factor is the skin: if skin slough or dehiscence appears infection is almost inevitable. Many authors attribute the higher infection rate in allografts to a subtle sign of rejection. Obviously, multiple operations will also result in higher infection rates [12].

Delayed or non-union is the most common complication. The consequence for the final outcome, however, is minor. Graft incorporation is influenced by the vascularity of the graft bed and the mechanical environment. As the graft is essentially acellular and avascular, all ingrowths have to be initiated at the host side. If the surrounding tissue is compromised by inflammation, chemotherapy, radiotherapy, or metabolic factors union will be negatively affected. In allografting an immunological reaction is found to be a contributing factor to this complication. In autografting this is avoided.

The complications, which may require additional interventions, mainly occur in the first 3–4 years. Afterwards the reconstruction remains stable. This is a strong argument in favour of grafting, especially in a young patient population.

Firm graft fixation and a prolonged period of non-weightbearing should prevent mechanical stress at the graft-host junction. Therefore, plate and screw fixation is preferred to Kirschner wire or tension band fixation. Additional stress because of a non-congruent hip joint can be avoided by using an autograft.

Limb salvage using this method carries a considerable risk of local recurrence, a risk that is probably higher than with hemipelvectomy. Irradiated autografts are extremely helpful in reconstruction of the pelvis and remain the method of choice at our department. The number of complications is high, but this essentially reflects

the difficulties encountered in this type of surgery and pathology. Late complications only occur if the reconstruction requires the use of a THR in combination with an irradiated pelvic autograft.

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