

Original Articles

Complications of Pelvic Resections*

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Summary. The authors report on complications that occurred with 63 pelvic resections. There were 43 complications: 13 infections, seven cases of nerve palsy, 12 cases of vascular or visceral damage, six mechanical and five aesthetic complications. Infection and vascular and visceral damage were more frequent in anterior arch resections, neurological damage in iliac wing resections, and mechanical complications in periacetabular resections. The treatment and outcome of the complications are reported.

Pelvic resection is becoming a common alternative to hindquarter amputation in tumor surgery. The preoperative workup [16,22], the surgical technique [10,14,19,23], and the oncological [1-11,13,15,20,21,24] and functional [2,17,18] results have been the subjects of many previous studies. However, there are only nonspecific reports on perioperative and late complications related to the different types of pelvic resection and their final outcome. Since these complications can affect the result of the surgical procedure, the attempted reconstruction, and the final function of the limb, the surgeon should be aware of the type of complication specific for each procedure in order to be able to prevent and ultimately treat such complications.

For this reason we reviewed our cases, focusing our attention on the complications and their outcome; the oncological results (analysis of metastases

and local recurrences) are not discussed here, having been reported in previous papers [2,10].

Methods

We reviewed all patients who underwent pelvic resections from 1968 to 1985. Patients' charts and roentgenograms were reviewed in order to assess perioperative and late complications.

Pelvic resections were divided into three major types, according to Enneking's classification [6]: iliac wing resections (type I); periacetabular resections (type II); anterior arch resections (type III).

On the basis of the extension of the resection, a type-I procedure was subdivided into three classes: IA if a wedge resection of the iliac wing was performed without interruption of the pelvic ring; IB if a resection of the whole thickness of the ileum was performed with interruption of the pelvic ring; IC when a complete resection of the iliac wing with the sacroiliac joint was performed.

A type-III procedure was also subdivided into three classes: IIIA when the resection of the anterior arch included the inferomedial part of the acetabulum; IIIB when a monolateral resection of the anterior arch was performed; IIIC when a bilateral resection of the anterior arch was performed.

The continuity of the pelvic ring was interrupted in all but IA procedures.

Complications were graded in four grades in order of progressive severity:

Grade 0: no complications

Grade 1: "minor" complications, not requiring specific treatment and not altering the attempted reconstruction or functional result, although prolonging hospital stay and/or recovery time

Grade 2: "major" complications, possibly requiring specific treatment (surgical and/or medical) and prolonging hospital stay and recovery time, but not altering the attempted reconstruction or the functional result, although possibly endangering either reconstruction or functional result

Grade 3: "major" complications, possibly requiring specific treatment (surgical and/or medical) and altering the attempted reconstruction and functional result

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Patients

From 1968 to 1985, 62 patients with primary bone tumors of the pelvis underwent pelvic resection at the Bone Tumor Center of the Istituto Ortopedico Rizzoli. There were 41 chondrosarcomas (peripheral 24, central 11, clear cell 1, mesenchymal 2, dedifferentiated 3), ten Ewing's sarcomas, two fibrosarcomas, two malignant fibrous histiocytomas, two osteosarcomas, one radiation-induced sarcoma, one angiosarcoma, one giant cell tumor, one aneurysmal bone cyst, and one echinococcus cyst. Forty-two patients were male and 20 were female, ranging in age from 7 to 66 years (mean 34 years). There were 63 pelvic resections in 62 patients, one patient having a type-IA procedure for a chondrosarcoma of the iliac wing and 10 years later a type-IIA pelvic resection for a local recurrence.

Twenty-two patients had a type-I resection (IA 13; IB 5; IC 4). Among nine patients who had IB and IC resections, seven had no reconstruction of the pelvic ring, and the remaining part of the pelvis was allowed to approach the sacrum; in two patients the pelvic ring was reconstructed with autogenous bone graft and internal rigid fixation.

Twenty-nine patients had a type-II procedure, either of the acetabulum alone or associated with an iliac or anterior arch resection (I + II 6; II 5; II + III 18). The attempted reconstruction consisted in iliofemoral arthrodesis in eight patients, in ileofemoral pseudarthrosis in 14 patients, in ischiofemoral arthrodesis in two patients, in ischiofemoral pseudarthrosis in two patients, in joint and pelvic ring reconstruction with grafts and screws in two patients, and in no reconstruction (flail limb) in one patient. When an arthrodesis was attempted, screws and/or a plate were used for internal rigid fixation. When pseudarthrosis was planned, metallic wires were usually used to temporarily maintain the ileofemoral contact; in one case percutaneous Steinmann pins were used, and in another no fixation was performed.

Twelve patients had a type-III procedure (IIIA 7; IIIB 3; IIIC 2). Two of seven patients with a IIIA procedure had temporary stabilization of the hip joint with percutaneous Steinmann pins. Only one patient underwent attempted reconstruction of the anterior arch with bone graft.

All patients received perioperative antibiotic treatment. In IA, IIIB, and IIIC procedures no cast was applied. In other cases a hip spica cast was applied for 2 months and an upper leg-hip spica cast for another month. Sixteen patients had had preoperative adjuvant treatment (chemotherapy 8; radiation therapy 5; both 3).

All patients were followed up continuously in the outpatient clinic; follow-up ranged from 6 months to 12 years (average 3.3 years).

Results

In type-I procedures (22 cases) 12 patients (55%) had no complications (IA 8; IB 2; IC 2), while 12 complications occurred in the remaining ten patients. There were four grade-1 complications (three in IA resections, one in IC resections) and eight grade-2 complications (three in IA resections, four in IB resections, and one in IC resections). Details about the types of complications, their treatment, and outcome are summarized in Table 1.

In type-II procedures (29 cases) 15 patients (52%) had no complications (I + II 4; II 4; II + III 7). There were 19 complications in the remaining 14 patients (Table 2). Two patients with a type II + III resection had multiple grade-3 complications (three and four respectively). There were seven grade-1 complications (one in I + II resections and six in II + III resections), one grade-2 complication (II + III), and 11 grade-3 complications (one in I + II, one in II, and nine in II + III resections).

In type-III procedures (12 cases) two patients (17%) had no complications: both had a IIIB resection. There were 13 complications in ten patients, three having two complications each (Table 3). We had one grade-I complication (IIIA resection), nine grade-2 complications (seven in IIIA, one in IIIB and one in IIIC resections), and three grade-3 complications (one in IIIA and two in IIIC resections).

Infection

The overall infection rate was 21%. It was 14% (4/28) in patients who had resection of the iliac wing alone or together with periacetabular bone (i.e., IA, IB, IC, and I + II resections) and 30% (9/30) in patients who had anterior arch resection alone or associated with periacetabular resection (i.e., IIIA, IIIB, IIIC, and II + III resections). Four of 16 patients (25%) who had preoperative adjuvant treatment developed infection; only six of 47 patients (12%) who did not receive adjuvant therapy had infection. Two of six patients who received massive bone grafts developed infection. The infection rates as related to the different type of osteosynthesis are shown in Table 4.

Most infections were due to Enterobacters. All of them healed with surgical débridement and local antibiotic therapy (Fig. 1d). In all but one case they required removal of the osteosynthesis material and/or bone graft (if present) and caused failure of the arthrodesis (if attempted). The average healing time of infection was 4 months (range 1 to 15 months). Four patients had stiffness of the knee due to the prolonged immobilization in a cast. Slough of the wound required plastic surgery (musculocutaneous flap) in four patients.

Nerve Damage

There were three cases of nerve palsy among 22 patients who had type-I resections; not included in Table 1 are another three patients with type-I resections in whom the sciatic or femoral nerve had to be resected because it was included in the tumor mass. There were three cases of nerve palsy among the type-II resections: two of these were associated with

Table 1. Complications in resections of the iliac wing

Complication	No. of cases	Type	Grade	Treatment	Outcome	Observations
Deep infection and wound necrosis	3 ^a	2 IB 1 IC	Grade 2	Surgical débridement, antibiotic local infusion, plastic surgery (2)	Healed after 2, 2, and 4 months respectively	<i>Staphylococcus epidermidis</i> (2) <i>Pseudomonas</i> (1) Preop. cht & rxt (2) Preop. cht (1)
Nerve damage ^b	3 ^a	IA	2 Grade 2 1 Grade 1	Medical treatment and physical therapy in 2 cases	Spontaneous regression at 7, 10, 10 months	Femoral nerve palsy (2) Femoral nerve irritation (1)
Hematoma	1	IA	Grade 1	—	Spontaneous drainage	—
Thrombophlebitis	1	IB	Grade 2	Medical treatment	Healed	Lower limb edema for 8 months
Displacement of bone graft	1 ^a	IB	Grade 2	—	Epiphyseal subluxation	Patient walks with crutches without pain
Abdominal hernia	3 ^a	IC, IA IA	2 Grade 1 1 Grade 2	—	Permanent	No clinical, only aesthetic problems

cht, Chemotherapy; rxt, radiation therapy

^a Two complications occurred in one patient

^b Three more cases had section of major nerves for oncological reasons

Table 2. Complications in periacetabular resections

Complications	No. of cases	Type	Grade	Treatment	Outcome	Observations
Deep infection	4 ^{a,b}	II + III	3	Surgical débridement (repeated in 1 case), removal int. fixation in 3 cases, Plastic surgery in 1 case	Healed after 1, 3, 8, 15 months	<i>St. aureus</i> + <i>Str. piog.</i> <i>Proteus</i> + <i>Acinetobac.</i> <i>Prot.</i> + <i>Enteroc.</i> + <i>E. coli</i> <i>Enterobacter</i> + <i>Proteus</i> In 3 cases of attempted arthrodesis pseudarthr. developed after internal fixation removal. Restr. of knee motion in all cases because of prolonged immobilization.
Superficial infection	2	I + II II + III	1	General antibiotic therapy	Healed within 1 month	<i>E. coli</i> + <i>Enterobacter</i>
Nerve damage	3 ^{a,b}	2 II + III 1 II	3	Medical plus physiotherapy	One compl. regr. after 12 months; 1 part. recov after 3 months; 1 still permanent after 8 months	Sciatic + femoral palsy in 2 cases associated with vascular problems
Postoperative arterial thrombosis	2 ^{a,b}	II + III	3	Thrombectomy	Recovery without further vascular problems	Femoral artery 1 case, iliac artery 1 case
Intraoperative iliac vein lesion	1	II + III	2	Vascular suture	Recovery without consequences	Intraoperative blood loss 5000 cm ³
Sudeck's dystrophy of the knee	1	II + III	1	Physiotherapy	Recovery without consequences	—
Intraoperative iliac wing fracture	1	II + III	1	None	Healed	No consequences
Femoral migration	2 ^a	I + II II + III	3	None	Deterioration of funct. results	A flail hip resulted in an attempted ischiofem. pseudarthr. when wires broke Adduct. deform. resulted after loosening of K-wires in an ileofem. pseudarthr.
Loosening of screws in a Cobra plate	1	II + III	1	None	Arthrodesis obtained	No consequences
Abdominal hernia	2	II + III	1	None	Permanent	No clinical, only aesthetic problems

^a Four complications occurred in one patient

^b Three complications occurred in one patient

Table 3. Complications with anterior arch resection

Complication	No. of cases	Type	Grade	Treatment	Outcome	Observations
Deep infection	3 ^{aa}	2 IIIC 1 IIIA	2 Grade 2 1 Grade 3	Medical in 1 case, surgical débridement in 2 cases (plus removal of graft and int. fixat. in 1 case; plus plastic surgery in 1 case)	Healed at 2, 2, and 3 months	<i>E. coli</i> ; <i>P. vulgaris</i> <i>Ps. aeruginosa</i> 1 patient had had preop. rxt (9000 rads) and cht
Delayed wound healing and superf. infection	1	IIIA	1	Local medication	Healed at 3 months	Patient with preop. cht
Postoperative SPE palsy	1	IIIB	2	Medical and physiotherapy	In regression when patient had local recurrence and died of metastases	Postoperative
Intraoperative bladder lesion	2 ^a	IIIA	2	Surgical repair	Healed with no consequences	1 case required a second surg. procedure. The lesion was produced during dissection of tumor from bladder
Lymphedema	2 ^{aa}	IIIA	2	None	Regressed after 1 year	—
Sexual impotence	1 ^a	IIIC	3	None	Persistent	—
Avascular necrosis of femoral head	2	IIIA	2	None	No clin. conseq. but prolonged non-weight bearing	1 patient had postop. rxt; 1 patient operated on for <i>Echinoc. granulosus</i> : both patients had hip dislocation and capsulotomy during resect.
Postoperative hip dislocation	1	IIIA	3	Surgical reduct.	Recurrent intrapelvic dislocation	Ileofemoral pseudarthrosis derived

SPE, Sciatic popliteal external nerve; rxt, radiation therapy; cht, chemotherapy

^a Two complications occurred in one patient

vascular problems (thrombosis of iliac or femoral artery), and ischemia may have played a major role. Only one patient had nerve palsy among the type-III resections: it began during the postoperative course, due to splint compression on the sciatic popliteal external nerve at the knee.

In all but two cases the nerve palsy recovered spontaneously with time.

Vascular and Visceral Complications

Vascular complications and visceral damage were rare in type-I, -I + II, and -II resections (2/33: 6%) and did not require any surgical treatment. In contrast, they were frequent in type-III or -II + III resections (11/30: 37%) and required intervention by a vascular and/or general surgeon in five cases; there were no further sequelae.

Minor alterations of the femoral head, probably due to avascular necrosis, were seen radiographically in two of the seven IIIA resections (these resections required hip joint capsulotomy and temporary intraoperative dislocation of the femoral head).

Mechanical Complications

Mechanical complications were observed in six cases in which the pelvic ring was interrupted or the acetabulum was partially or totally resected, thus requiring reconstruction. They were more frequent in type-II resections (Tables 2, 5). Type, treatment, consequences, and functional results of mechanical complications are reported in Tables 1–3. Four of six patients had worsening of their functional results due to mechanical complications.

Aesthetic Complications

Abdominal hernia may appear when abdominal muscles are resected or when refixation of abdominal wall muscles is not possible. Such a complication was seen in five patients.

Discussion

Pelvic resection has a high complication rate (43 complications among 63 procedures; 68%). Different

Table 4. Infection rate related to different types of osteosynthesis

Osteosynthesis	No. of patients	No. of patients with deep infection	(%)	Comments
None	31	4	13	Three of four patients had preop. adjuvant ther.
Percutaneous pins or wires	17	2	12	Both patients developed infection after reopen. of the wound due to vascular problems
Screws	8	2	25	One patient had preop. rxt, one had massive bone graft
Cobra plates	7	2	29	No other factors predisposing to infection



Fig. 1. **a** Clear cell chondrosarcoma in a 42-year-old male patient. **b** CT scan of the lesion shows involvement of the iliofemoral ramus up to the acetabulum. **c** Ilio-femoral arthrodesis was attempted after a wide resection using a Cobra plate as internal fixation. **d** Patient developed a deep infection postoperatively requiring surgical débridement, removal of the plate, and local treatment with antibiotic infusion. **e, f** Infection eventually healed but a flail hip resulted with worsening of the functional result

Table 5. Summary of complications in 63 pelvic resections

	Iliac wing (22 cases)	Periacetabular (29 cases)	Anterior arch (12 cases)	Total (63 cases)
Infection	3 (14%)	6 ^a (21%)	4 (34%)	13 (21%)
Nerve palsy	3 (14%)	3 ^b (10%)	1 (9%)	7 (11%)
Vascular and visceral damage	2 (9%)	4 ^c (14%)	7 ^d (58%)	13 (19%)
Mechanical	1 (5%)	4 (14%)	1 (9%)	6 (9%)
Aesthetic	3 (14%)	2 (7%)	—	5 (8%)

^a Five patients had type-II + III resections (periacetabular and anterior arch).

^b Two patients had concomitant vascular problems with prolonged limb ischemia.

^c All patients had type-II + III resections.

^d Two cases with avascular necrosis of the femoral head are included

types of resection produce different types of complications. A higher infection rate was observed in anterior arch resections, in patients who had had preoperative chemotherapy or radiation therapy, and in patients in whom massive bone grafts and/or plates were used for reconstruction. A high incidence of infections was observed by Letournel and Judet [12] with the ilioinguinal approach for acetabular fractures. We agree with these authors' attributing the high incidence of infection following surgery of the anterior pelvic arch to the constant formation of an intrapelvic hematoma and to the damage of the inguinal lymphatics draining the foot, the genital organs, the groin, the perineum, and the anal canal. This was confirmed by the fact that most of the infections in our cases were caused by Enterobacters. Preoperative antibiotic therapy and careful preparation of the bowel are recommended. Excessive prolongation of surgical time and extensive use of metallic devices or massive grafts are to be avoided whenever possible.

Neurological complications other than those related to oncological factors resolved spontaneously; they were seen mostly in iliac wing resections. The anatomical relation of the lumbar and lumbosacral plexus within the psoas and near to the sacroiliac joint may well explain these complications, rarely observed in other types of pelvic resections.

Vascular and visceral lesions can easily occur in anterior arch resections: vascular damage is due to the dissection and surgical manipulations during the procedure; lesions of the bladder and urethra may occur when osteotomy of the pubis is done or when sharp dissection of the tumor out of the bladder wall is required. When the tumor impinges on the ileo-femoral vessels, these have to be isolated and mobilized on soft rubber loops. Even the deep femoral artery has to be isolated and preserved whenever possible. If, however, the tumor is not attached to and displacing the vascular bundle, this should not be isolated, but simply identified, protected, and moved

medially and laterally. This gentle handling of the vessels prevents postoperative chronic edema of the limb. It is very important to apply a urethral catheter preoperatively, so that during the operation the surgeon can palpate it and avoid injuries to the urethra. Type-II and -III pelvic resections in particular should be carried out by a surgical team with experience of vascular and general surgery.

No reconstruction is needed after type-I or type-III pelvic resections. As previously reported [2, 10], for a type-I+II resection we recommend ischio-femoral arthrodesis using rigid internal fixation (rod or screws); in type-II resections, in which the neck of the ilium is preserved, we suggest iliofemoral arthrodesis with wires, screws, or a Cobra plate; in type-II+III resections we attempt iliofemoral pseudarthrosis using metallic wires for temporary coaptation.

To prevent abdominal hernia one may use a laparoplasty for the abdominal wall. However, we have reservations about the addition of another foreign body within the operative field.

In conclusion, not only is this surgery difficult; it also entails risks. It requires experience and repeated dissections and mock operations on the cadaver, a meticulous preoperative study of the patient, and frequently team work with the general (vascular, urology) surgeon.

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