Primary tumor of the periacetabular region: Resection and reconstruction using a segmental ipsilateral femur autograft


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Summary

Introduction: Bone reconstruction, after periacetabular tumour removal, is a complex procedure that carries a high morbidity rate and can result in poor clinical outcomes. Among the available options, the Puget pelvic resection-reconstruction procedure uses an autograft from the ipsilateral proximal femur to restore the anatomical and mechanical continuity of the pelvic ring before inserting an acetabular implant.

Hypothesis and goals: This reconstruction technique satisfactorily restores the pelvic anatomy such that functional results and morbidity are comparable to alternative reconstruction techniques.

Patients and methods: This was a retrospective study of 10 patients with an average age of 38.2 years (range 19 to 75) at the surgical procedure (performed between 1986 and 2007). There were five chondrosarcomas, three Ewing tumours, one plasmacytoma and one giant cell tumour. The position of the hip centre of rotation after reconstruction and autograft integration were evaluated on radiographs. Functional results were evaluated through the Musculoskeletal Tumor Society (MSTS) score and the Postel and Merle d’Aubigné (PMA) score.

Results: At the time of review, one patient was lost to follow-up and four had died. On radiographs, the hip centre of rotation after reconstruction was higher by a median value of 15 mm (range 5 to 35) and more lateral by a median value of 6 mm (range –5 to 15). Upon evaluation of radiographs at a median time of 40 months (range 6 to 252 months), the autograft was completely integrated in five patients and partially integrated in three patients (two patients had a local recurrence). There were no cases of autograft fracture or non-union at the junctions of the

KEYWORDS

Tumour;
Pelvis;
Acetabulum;
Resection;
Reconstruction;
Autograft

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Introduction

Primary and secondary bone tumours are fairly common in the pelvis. When localized to the periacetabular region, hip function (walking, sitting, and standing) is compromised. Patient autonomy is quickly and significantly altered, which can lead to the patient being bed-ridden. Although resection of primary pelvic tumours is well documented, reconstruction of the pelvic ring is not well described, especially when the pelvic ring is discontinuous. Multiple surgical techniques have been proposed. Enneking and Dunham [1], Erikson and Hjelmsedt [2] and then Steel [3] were the first to describe conservative procedures after resection of acetabular tumours. Later on, hemipelvic prostheses [4,5], saddle prostheses [6,7], structural pelvic allografts [8,9] and even sterilized autografts [10,11] were used to reconstruct the pelvis while preserving hip mobility; others preferred iliofemoral or ischiofemoral fusion [12] sometimes in combination with a vascularized autograft [13]. Hip transposition techniques [14] have also been described. Hemipelvic prostheses and structural pelvic allografts are used most often, but with notable complications such as infections [15], while procedures without reconstruction or that involve fusion give poor functional results.

Puget and Uthéza described a reconstruction technique that involved transposition of the ipsilateral proximal femur and subsequent placement of a total hip prosthesis [16]. The goals of this technique are:

- to implant a total hip prosthesis in the best anatomical position to optimize function, and;
- ensure long-term fixation through integration of a cortical-cancellous autograft, which in theory does not have the drawbacks associated with structural allografts (fracture, non-union) [17,18], and continued mechanical loading because pelvic continuity is restored.

We hypothesized that this reconstruction technique will satisfactorily restore pelvic anatomy, and that functional results and morbidity will be comparable to other reconstruction techniques. The goal of the current study was to test this hypothesis on a consecutive resection-reconstruction series using the Puget technique for primary pelvic periacetabular tumours.

Patients and methods

Patients

This was a retrospective study of 10 patients who were operated on between 1986 and 2007 for a primary pelvic bone tumour that extended into the acetabulum area. Our series included seven men and three women, with an average age of 38.2 years (range 19 to 75) at the time of surgery. The symptoms had been progressing for an average of 3.9 months (1 to 6 months) before the surgical treatment. All the patients presented with pain and one patient could not walk at all (Case No. 2). One patient had a preoperative motor impairment of the common peroneal nerve. The extent of the surgical excision was planned in all patients using a CT scan; magnetic resonance imaging (MRI) was also used in the five most recent cases. Preoperatively, four patients were given neoadjuvant therapy (chemotherapy in three cases and radiotherapy of the pelvis in one case). Among these patients, Cases No. 8 and 9 with a Ewing sarcoma had been included in the 1999 Euro-Ewing study and given neoadjuvant chemotherapy, thus postoperative radiation was not performed. Patient characteristics before the surgery (age, gender, histology, Enneking localisation, preoperative treatment) are summarized in Table 1.

Surgical technique

Surgical resection was performed in all patients with subsequent acetabular reconstruction with an ipsilateral proximal femur autograft, according to the technique described by Puget and Uthéza [16]. Prophylactic antibiotic treatment was given according to the current French Anaesthesia and Intensive Care Society (SFAR) recommendations at the time of the surgery. The surgical approach was based on the tumour location (anterior and/or posterior column) seen on the preoperative CT scan and MRI. The patient was placed in a surgical corset so that simultaneous dual approaches could be performed intra-operatively by tipping the patient: Judet-Letournel anterior ilio-inguinal approach or the Kocher-Langenbeck posterior approach (Fig. 1A and B). The excised piece was 11.5 cm long on average (range 7 to 15 cm). The average length of autograft was 13.5 cm (range 8 to 17 cm). The size was determined intra-operatively based on the size of the space to fill and measured from the...
Table 1 Preoperative and surgical data for the entire study population.

<table>
<thead>
<tr>
<th>Case</th>
<th>Age</th>
<th>Gender</th>
<th>Pathology</th>
<th>Enneking zone</th>
<th>Neoadjuvant treatment</th>
<th>Approach</th>
<th>Graft orientation(^b)</th>
<th>Graft fixation proximal/distal</th>
<th>Acetabular implant (Ø cup/Ø head)</th>
<th>Quality of excision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24</td>
<td>M</td>
<td>Ewing tumour</td>
<td>II + I</td>
<td>Chemo</td>
<td>Combined approach</td>
<td>Distal</td>
<td>Screw/plate + screw</td>
<td>Müller + cemented PE (44/22)</td>
<td>C</td>
</tr>
<tr>
<td>2</td>
<td>22</td>
<td>M</td>
<td>Isolated plasmacytoma</td>
<td>II + I</td>
<td>RT</td>
<td>Combined approach</td>
<td>Proximal</td>
<td>Screw/screw</td>
<td>Müller + cemented PE (50/28)</td>
<td>C</td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td>M</td>
<td>Giant cell tumour</td>
<td>II + III</td>
<td>—</td>
<td>Combined approach</td>
<td>Proximal</td>
<td>Screw/plate</td>
<td>Cemented PE (50/28)</td>
<td>Ma</td>
</tr>
<tr>
<td>4</td>
<td>38</td>
<td>M</td>
<td>Chondrosarcoma</td>
<td>II + I</td>
<td>—</td>
<td>Illo-inguinal</td>
<td>Proximal</td>
<td>Screw/screw</td>
<td>Müller + cemented PE (54/28)</td>
<td>Ma</td>
</tr>
<tr>
<td>5</td>
<td>75</td>
<td>F</td>
<td>Chondrosarcoma</td>
<td>II + I</td>
<td>—</td>
<td>Combined approach</td>
<td>Proximal</td>
<td>Screw/screw</td>
<td>Müller + cemented PE (52/28)</td>
<td>C</td>
</tr>
<tr>
<td>6</td>
<td>37</td>
<td>M</td>
<td>Chondrosarcoma</td>
<td>II + III</td>
<td>—</td>
<td>Illo-inguinal</td>
<td>Proximal</td>
<td>Screw/plate</td>
<td>Müller + cemented PE (46/22)</td>
<td>Ma</td>
</tr>
<tr>
<td>7</td>
<td>38</td>
<td>F</td>
<td>Chondrosarcoma</td>
<td>II + I</td>
<td>—</td>
<td>Combined approach</td>
<td>Proximal</td>
<td>Plate/screw</td>
<td>Cemented PE (44/22)</td>
<td>C</td>
</tr>
<tr>
<td>8</td>
<td>19</td>
<td>F</td>
<td>Ewing tumour</td>
<td>II + III</td>
<td>Chemo</td>
<td>Combined approach</td>
<td>Proximal</td>
<td>Plate/screw via acetabulum</td>
<td>Acetabular shell with screws (54/32)</td>
<td>C</td>
</tr>
<tr>
<td>9</td>
<td>31</td>
<td>M</td>
<td>Ewing tumour</td>
<td>II + III</td>
<td>Chemo</td>
<td>Combined approach</td>
<td>Proximal</td>
<td>2 plates/plate + screw</td>
<td>Acetabular shell with screws (48/28)</td>
<td>Ma</td>
</tr>
<tr>
<td>10</td>
<td>73</td>
<td>M</td>
<td>Chondrosarcoma</td>
<td>II + I</td>
<td>—</td>
<td>Combined approach</td>
<td>Distal</td>
<td>Plate/screw</td>
<td>Cemented PE (56/28)</td>
<td>Ma</td>
</tr>
</tbody>
</table>

F: female; M: male; Chemo: chemotherapy; RT: radiation therapy; PE: polyethylene; C: complete + wide; Ma: marginal; Ø: diameter.

\(^a\) Numbering corresponds to the chronological treatment order.

\(^b\) Orientation of grafted femoral head: proximal: head towards wing of ilium, distal: head towards ischium.
top of the femoral head to the cut on the diaphysis. After
the desired length of femur was removed, the proximal
femur was transferred to fill the space left by the tumour
resection and then attached to the anterior and posterior
arch of the pelvic ring. Fixation hardware was always placed
at the ends of the autograft and was never applied over the
entire length of the graft (Fig. 2A, B, C). The autograft was
oriented with the head either in a proximal (iliac) or distal
(ischium) position, so as to place the trochanter in the area
where the acetabulum had been resected. The greater
trochanter was reamed to reshape it into a new acetabular
cavity before the cup was implanted. A Muller reinforce-
ment ring was used in five cases. The average diameter of
the implanted cup (cemented polyethylene [PE] or metal
acetabular shell) was 50.5 mm (range 44 to 56); a 28 mm
femoral head was used in most cases. Five dual mobility
cups were used in this series. Surgical data are provided in
Table 1. The proximal femur was rebuilt using a cementless
modular prosthesis (PPTM System, Tornier, Montbonnot,
France). The diaphysis part of the prosthesis was a cement-
less rectangular stem, which was press-fit into place at the
junction of the metaphysis and diaphysis. A metaphysis base

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Reconstruction after resection of primary periacetabular tumour

Clinical and radiological evaluation

Evaluations were performed by an observer who was not involved in the surgical procedures (AP). The Postel and Merle d’Aubigné (PMA) score [19] was used for the clinical functional evaluation and the Musculoskeletal Tumor Society (MSTS) [20] score was used for the overall clinical evaluation. Radiological analysis was performed using standard A/P and three-quarters view radiographs of the pelvis. Patients who died early on (before the sixth postoperative month) were excluded from this radiographic analysis (Case No. 5). Autograft integration into bone was evaluated based on the criteria described by Nigro and Grace [21] (Table 2). Implant loosening was defined as migration of the implant by more than 5 mm and/or more than 5° change in orientation relative to the radiographs that were taken immediately after the surgical procedure. Ectopic ossification was evaluated based on the classification described by Brooker et al. [22]. Implant positioning and specifically the restoration of the hip centre of rotation was analysed on straight-on postoperative radiographs using the criteria described by Pierchon et al. [23], but adapted to our specific type of reconstruction (no pelvic teardrop on the resected side). The orientation of the acetabular implants (inclination, anteversion) and the length of the lower limbs were not assessed because reliable landmarks were not available on the radiographs. Blood loss was measured as the mean corpuscular volume loss through monitoring of haematocrit at D0 and at D3, along with the number of blood transfusions performed [24].

Results

Clinical results

Clinical and radiological results along with complications are described in detail in Table 3. Average surgical time was 5.2 h (range 4.0 to 6.5 h) and the mean corpuscular volume loss was 2700 ml (range 765 to 7148 ml), which consisted of a blood loss of 6750 ml (range 1912 to 17870 ml), and an average of 12.5 units of packed red blood cells (range 4 to 40) being transfused during the entire hospital stay. There were no intra-operative vascular complications. One patient had paresis of the common peroneal nerve after the surgical procedure, but this was already present before the procedure. The resection was labelled as wide and complete in five cases and marginal in five cases.

At the final review, one patient had been lost to follow-up and four patients had died (at 20.5 months on average, with a range of 5 to 39 months). Three patients had a local recurrence of the tumour and all of them had an initial resection that was labelled marginal. No cases of recurrence occurred if the excision had been labelled as wide and complete. Five patients were still alive during our review and had a median follow-up time of 82 months (range 40 to 264); three patients were free of any cancer and two patients had a local recurrence. The median MSTS score was 25 out of 30 (range 20 to 29), which was 83% (range 67 to 97%). The median PMA score was 13 out of 18 (range 12 to 18). All the living patients could walk again: one patient used two canes, two patients used one cane and the two remaining patients did not need additional support.

Radiographic results

The hip centre of rotation after reconstruction was higher by a median value of 15 mm (range 5 to 35) and more laterally by a median value of 6 mm (range —5 to 15). Radiological data were analysed for eight patients with a median follow-up of 40 months (range 6 to 252 months). Autograft integration was complete (stage 1) in five patients and partial (stage 2 or 3) in three patients. There were no fractures in the autograft or occurrences of non-union at the graft ends. There were two cases of resorption (stage 3) secondary to local recurrence that required surgical revision without changing the implants. One patient with a cemented cup (Case No. 10) presented with early aseptic loosening (9 months) with no radiotherapy or local recurrence; the graft appeared partially integrated on the radiographs (stage 2). This case was revised with a reinforcement ring and cemented cup. There were no cases of femoral loosening. At the last follow-up period, five patients had no ossification (grade 0), two patients had a grade I ossification and one patient had a grade II ossification; there were not grade III or IV ossifications.

Complications

Three patients had a dislocation at a median of 45 days (range 21 to 120 days) after the procedure. These were treated by closed reduction under general anaesthesia.
One patient (Case No. 7) had a recurrent dislocation that required acetabular revision with reorientation of the cup and replacement of the femoral neck; there were no further dislocations. One patient had a deep infection following revision for local recurrence (Case No. 9). The patient was treated with extensive, early debridement-lavage and given appropriate antibiotics; the infection did not return for more than 2 years after this episode.

There were nine surgical revisions in five patients in this series. Seven were attributed directly or indirectly to local recurrence; one revision was performed because of instability and one because of early acetabular loosening. There were no failures of the graft fixation hardware.

Discussion

Management of primary pelvic tumours that extend into the acetabulum is multi-faceted. Tumour resection often leads to a pelvic discontinuity. The wide range of procedures used [1—14,16—18] points to the difficulty in managing these cases and obtaining good surgical results. We prefer to use a reconstruction technique that involves transposition of the ipsilateral proximal femur and subsequent placement of a total hip prosthesis [16]. This reconstruction technique satisfactorily restored the pelvic anatomy such that functional results and morbidity were comparable to other reconstruction techniques. A significant number of complications occurred in our series and in other published series; however the fixation hardware and the surgical technique were not to blame.

This retrospective study has certain limitations. Only a few patients were included (10 patients), but the indication was narrowly defined: primary pelvic tumour that extends into the acetabulum. Only Biau et al. [25] have reported on use of a variation of the Puget technique in 13 patients, where eight had chondrosarcomas, three were metastatic tumours, one had a myeloma and one had a radiation-induced cancer. During the same period, our centre performed this same procedure in an additional 19 cases for secondary pelvic tumours (mainly originating in the breast), myelomas or tumours in neighbouring tissue (anus, uterus) that extend into pelvic bone due to proximity. Since the oncologic goals were different in these 19 cases, they were not included in this study series. Our study only included pre-existing primary tumours in Enneking zones II+I or II+III that were determined to be resectable during preoperative imaging tests. This series was homogeneous in terms of surgical technique and indications. This was a long-term retrospective study that had certain confounding factors. One patient was lost to follow-up and four patients had died, thus no statistical analysis was possible on the small number of patients who were available at the review stage. Although the follow-up period was short, it was comparable to other published studies [4—15,17,18,25—29] (Table 4).

The techniques used in this study led to satisfactory restoration of anatomical parameters, as demonstrated by the positioning of the centre of rotation in the reconstructed hip. Since we are the first to report on this variable, no comparison can be made to other published studies. The median PMA score for our series at the last follow-up point was 13 (range 12 to 18) and the median MSTS score was 83%; all patients were walking again with full weight-bearing. These results are comparable to the ones from Biau et al. [25] who reported an average PMA of 15 (range 13 to 17) after a 48 months follow-up (range 12 to 107). These results seem to be superior to ones reported for reconstruction with other techniques such as fusion [12], saddle prosthesis [6,7], hip transposition [30,31], including those intended to restore optimal hip positioning such as hemipelvic prostheses [5] or reconstruction with structural hip allografts [8,9]. Performing a resection only or pelvic amputation did not provide good functional results [26,27,31]. These good results require that the muscle mass be preserved, especially the gluteal group. To ensure good hip function, hip biomechanical parameters (position of centre of rotation, femur and acetabulum offset, limb length, etc.) must be restored so that the gluteal moment arm is optimal. A variation of the initial technique proposed by Biau et al. [25], which consists of preserving a strip of the trochanter to ensure continuity in the musculoskeletal system, is of particular interest here. When reconstruction is not possible or bone defects are present, one alternative is to use the McMinn cup, which has a tapered fluted stem that is embedded into the upper part of the posterior column or remaining wing of the ilium [32].

Our surgical technique consisted of using a cortical-cancellous autograft to restore continuity in the pelvic ring. Cortical bone has all the mechanical characteristics needed for the immediate weight-bearing of a total hip prosthesis. Grafts were obtained from the femur, the ilium or the ischium, depending on the extent of the acetabular defect. These grafts were prepared with the help of a ringreamer, in order to ensure optimal contact with the acetabular bone volume. Cortical trabeculae can be found in various parts of the ilium, the ischium and the femur. They are flap-shaped and their thicknesses vary widely. The ilium is the part of the pelvic bone that offers the best contact with the acetabulum during hip movements.

### Table 2: Graft integration into host bone, based on Nigro and Grace criteria [20].

<table>
<thead>
<tr>
<th>Stage</th>
<th>Radiological description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>Completely integrated into bone</td>
</tr>
<tr>
<td>Stage 2</td>
<td>Partially integrated into bone</td>
</tr>
<tr>
<td>Stage 3</td>
<td>Resorption</td>
</tr>
<tr>
<td>Stage 4</td>
<td>Inert graft</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Case</th>
<th>Mechanical complications and time frame</th>
<th>Tumour complications and time frame</th>
<th>Other complications and time frame</th>
<th>Treatment for complications (number of revisions)</th>
<th>Radiological result (integration based on Nigro and Grace [20])</th>
<th>Final clinical result MSTS/PMA</th>
<th>Condition at review (time after surgery in months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Long-term recurrence (pulmonary metastasis)</td>
<td>LTF</td>
<td>LTF</td>
<td>Stage 1</td>
<td>ND</td>
<td>D (39)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>LTF</td>
<td>LTF</td>
<td>LTF</td>
<td>LTF</td>
<td>LTF</td>
<td>LTF</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Local recurrence (60 months)</td>
<td>Revision (1)</td>
<td>Stage 3</td>
<td>21/13</td>
<td>AL (264)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Local recurrence (9 months)</td>
<td>Neurological</td>
<td>Revisions (4)</td>
<td>Stage 3</td>
<td>–</td>
<td>D (31)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Septic shock secondary to lung infection</td>
<td>ND</td>
<td>–</td>
<td>ND</td>
<td>–</td>
<td>D (5)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Dislocation × 1 (120 days)</td>
<td>Stage 1</td>
<td>–</td>
<td>D (7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Dislocation × 2 (21 days)</td>
<td>Revision (1)</td>
<td>Stage 1</td>
<td>29/18</td>
<td>AL (98)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Revision (1)</td>
<td>Stage 1</td>
<td>28/17</td>
<td>AL (82)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Local recurrence (18 months)</td>
<td>Infection (24 months)</td>
<td>Revision (2)</td>
<td>Stage 1</td>
<td>25/13</td>
<td>AL (52)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Dislocation × 1 (45 days) Looseining (9 months)</td>
<td>Revision (1)</td>
<td>Stage 2</td>
<td>20/12</td>
<td>AL (49)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LTF: lost to follow-up; ND: no data; D: died; AL: alive at review; MSTS: Musculoskeletal Tumor Society; PMA: Postel and Merle d’Aubigné.

### Table 4 Comparison to published studies.

<table>
<thead>
<tr>
<th>Type of reconstruction</th>
<th>Number of cases</th>
<th>Follow-up (months)</th>
<th>Complications (%)</th>
<th>Revisions (%)</th>
<th>Functional score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Infections</td>
<td>Local recurrence</td>
<td>Mechanical</td>
</tr>
<tr>
<td>Jaiswal et al. [25]</td>
<td>91</td>
<td>71</td>
<td>30</td>
<td>31</td>
<td>24.3</td>
</tr>
<tr>
<td>Ozaki et al. [5]</td>
<td>12</td>
<td>57</td>
<td>50</td>
<td>33.3</td>
<td>25</td>
</tr>
<tr>
<td>Aljassir et al. [6]</td>
<td>27</td>
<td>45</td>
<td>22</td>
<td>22</td>
<td>44</td>
</tr>
<tr>
<td>Cottias et al. [7]</td>
<td>17</td>
<td>42</td>
<td>17.6</td>
<td>29.4</td>
<td>64.7</td>
</tr>
<tr>
<td>Delloye et al. [8]</td>
<td>18</td>
<td>41</td>
<td>5.5</td>
<td>29</td>
<td>27.8</td>
</tr>
<tr>
<td>Langlais et al. [9]</td>
<td>13</td>
<td>84</td>
<td>18</td>
<td>18</td>
<td>33</td>
</tr>
<tr>
<td>Current series</td>
<td>10</td>
<td>82</td>
<td>10</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

TESS: Toronto Extremity Survival Score; MSTS: Musculoskeletal Tumor Society; PMA: Postel and Merle d’Aubigné.
to ensure the initial stability of the pelvic ring reconstruction. Cancellous bone has the biological assets needed to ensure integration with host bone. However, since this graft is not vascularized, it might behave like an allograft. No graft fractures were observed in this series. Two cases of osteolysis occurred, both after local recurrence. These were the only two cases where the hardware fixation had to be revised. To prevent osteolysis due to stress-shielding and ensure that the graft was mechanically loaded, the entire length of the graft was not attached. Delloye et al. [8] and Langlais et al. [9] estimated the rate of non-union to be 15% and the fracture rate to be 10 to 20% after reconstruction with structural pelvic allografts. Reaming can reduce the size of the cup implantation area in the graft’s trochanter part, so a reinforcement ring is often used. Nevertheless, in some cases, the host site may be suitable for a cementless implant with screws, as the implant could become integrated into the bone.

There were a significant number of complications in this study, as with any other pelvic reconstruction technique that is used after tumour resection (Tables 3 and 4). Six of the 10 patients had local complications that required one or more surgical revisions in five of these patients. Since only standard implants were used, the most common complication was dislocation early on (in three patients). Only one of these patients had no further dislocations after the revision procedures. To reduce the dislocation rate, Blau et al. [25] proposed a very strict postoperative protocol: traction-suspension for 2 weeks and then surgical corset worn for 6 weeks before weight-bearing is allowed. This seemed difficult to accomplish within the context of tumour surgery because it is important for the patients to be mobilized to preserve joint mobility and muscle tone, and prevent complications related to lying on one’s back. The instability has multiple causes: muscular deficiency because of the tumour resection, radiotherapy or repeated surgical procedures, difficulty in restoring satisfactory anatomy, poor orientation or placement of implants. The use of large diameter femoral heads, constrained cups or dual mobility cups [28] is an option, but these would only partially solve the problem because dislocation is mostly due to discoaptation secondary to muscular deficiency. If too much muscle has to be removed, implantation of a prosthesis and use of this technique does not seem to be indicated. We now systematically use dual mobility cups in these indications to reduce the dislocation risk. Other reconstruction techniques, notably use of the saddle prosthesis, can lead to near-term mechanical complications such as dislocation, proximal migration, fixation failure, etc. [7]. Although there was an elevated rate of local recurrence requiring revision in our study (three of 10 patients), the rate is comparable to other published studies. These recurrences were independent of the surgical technique, but required one or more revision procedures, one of which had a deep infection complication. In all the recurrence cases, tumour resection was classified as marginal, which highlights the need to get tumour-free edges [8,15]. A precise set of preoperative images is needed to plan the resection and choose the approach. Subjectively, use of simultaneous dual approaches (anterior and posterior) improved the extirpation of pelvic tumours, but this small patient series did not allow for statistical verification of this observation. A wide resection area is preferred to avoid resorting to adjuvant radiotherapy, which would be detrimental to the union and integration of the graft. One case of early aseptic loosening occurred at 9 months and required a surgical revision. This also was a case with marginal resection; no recurrence was found during the revision. The initial fixation might not have been optimal. A reinforcement ring should have been used in this case, as was used in half the patients in this series. There were no neurological complications; these are typically secondary to the tumour resection procedure and not the reconstruction technique itself. One infection occurred after a revision for local recurrence. This is the most serious complication as it can require repeated surgical procedures, which could affect the functional outcome [5,7–9,15,25,29].

Conclusion

The Puget pelvis reconstruction technique is appropriate for isolated acetabular tumours (zone II) or tumours that extend into the obturator ring (zone II + III), the wing of the ilium (zone I + II) or even all three zones. This procedure led to good mechanical and anatomical results. It was a reliable way to reconstruct the acetabular region to accept either a cemented or cementless cup. Preoperative imaging is essential to rule out any contra-indications: involvement of the femoral head, intra-articular extension into the hip joint, large tumour that requires large amounts of bone or muscle to be removed and may lead to significant prosthesis instability or tumour resection into the sacrum followed by uncertain results. Similarly, tumours in the neighbouring tissues (pelvic organs) that extend into bone are challenging to resect because of the risk of local recurrence. Since this is a demanding surgical procedure, the target population should be young and have sufficient life expectancy.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References


