Dual mobility design socket use in preventing total hip replacement dislocation following tumor resection

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KEYWORDS
Dislocation; Total hip replacement; Dual mobility cup; Hip tumor; Tripolar arthroplasty; Quality of life

Summary
Introduction: Total hip replacement (THR) following hip tumor resection incurs a high risk of dislocation. We assessed the incidence of dislocation associated with use of a dual mobility cup, and the functional results achieved.
Hypothesis: Use of a dual mobility cup would reduce the risk of THR instability following hip tumor resection.
Material and methods: We analyzed dislocation rates in a retrospective series of 71 dual mobility cup THRs implanted following the resection of a tumor hip condition: 33 primary bone tumors and 38 bone metastases. The presenting pathology was diagnosed anatomically, and surgery classified in terms of adopted abductor system strategy. Functional results were assessed in terms of pain (analgesia on the World Health Organisation [WHO] scale), assisted walking and Musculoskeletal Tumor Society (MSTS) score.
Results: An overall rate of 9.8% dislocation was observed, taking into account all etiologies and contexts together. More precisely, this rate resulted from a compound figure of 5.2% in bone metastasis and 15% in primitive bone tumor. Dislocation risk depended less on etiology than on the surgical management of the abductor system, being 3.5% in the case of abductor conservation, 9.5% in the case of abductor sectioning/reinsertion, and 18% in the case of gluteus medius muscle or nerve resection. Functional improvement was consistently observed, especially in bone metastasis. At the maximal follow-up, 32 patients were...
Introduction

Total hip replacement (THR) in a context of hip tumor has a high rate of associated complications [1—3]. These mainly comprise infections, at rates ranging from 6 to 21% according to the study, and dislocation, at rates ranging from 0 to 41% [1—8]. These figures are much higher than the 0.6—4% reported for THR unrelated to cancer [9].

Whatever the type of surgery and of tumor, THR in a context of tumor involves multiple and sometimes associated risk factors [10]: (a) poor anatomic restoration, especially in case of extensive bone resection for primitive tumor; (b) muscular insufficiency due to tissue and nerve resection for the same reasons; and (c) muscle shock associated with infectious complication, postoperative irradiation or tumor invasion.

Dual mobility sockets, intended to reduce the incidence of dislocation [11—13], are thus of great interest in hip tumor surgery. We here report a descriptive retrospective study of the incidence of dual mobility socket THR dislocation associated with primitive or metastatic hip tumor.

Material and methods

Patients

This was a retrospective series from three centers, comprising 71 THRs using dual mobility sockets in indications of hip-region tumor. There were 33 cases of primitive bone tumor (19 males, 14 females) and 38 of bone metastasis (14 males, 24 females). Patients were followed up until the study date, January 1st 2007, giving a mean FU of 3.3 years (range, 0.6—7.1 years) for the primitive bone tumors and of 1.25 years (range, 0.2—7.9 years) for the metastases. Mean patient age was 46.3 years (range, 15—81 years) for the primitive tumors, and 61 years (range, 34—86 years) for the metastases. Mean preoperative body-mass index (BMI) was 23.3 for the primitive tumors, and 24.3 for the metastases.

Bone metastasis distribution according to primitive tumor and primitive tumor histology were both classical (Fig. 1). Anatomically, femoral involvement was classified as head/neck and/or intertrochanteric and/or subtrochanteric, in view of the sometimes extensive superior femoral pathology. Acetabular involvement was classified on the modified Huntingdon system [14,15] as grade I (segmentary defect with intact column), grade II (medial acetabular wall involvement with risk of medial migration of the femoral head), or grade III (massive cavity defect). There were several cases (10 bone metastases and four primitive bone tumors) of bipolar involvement associating predominant acetabular pathology with the femur. Associated fractures were also recorded, as was history of surgery in the affected hip. Table 1 presents these data. Thirty-eight patients had preoperative chemotherapy and 17 preoperative local radiotherapy. Complementary treatment comprised adjuvant chemotherapy for 42 patients, with associated local radiotherapy for 32 of these.
Table 1  Anatomic lesion description according to bone metastasis or primitive bone tumor etiology. In 14 cases, femoral involvement was associated with predominant acetabular lesion.

<table>
<thead>
<tr>
<th>Lesion Description</th>
<th>Bone Metastasis (38)</th>
<th>Primitive Bone Tumor (33)</th>
</tr>
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<tbody>
<tr>
<td>Femoral lesion (41) including 14 associated with acetabular lesions</td>
<td>Head/neck region: 20</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>and/or Intertrochanteric region: 20</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>and/or Subtrochanteric region: 11</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Total: 23 (including 10 associated lesions of the acetabulum)</td>
<td>18 (including 4 associated lesions of the acetabulum)</td>
</tr>
<tr>
<td>Acetabular lesion (30)</td>
<td>Class I: 7</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Class II: 4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Class III: 4</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Total: 15</td>
<td>15</td>
</tr>
<tr>
<td>Former surgery</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Associated fracture</td>
<td>25</td>
<td>6</td>
</tr>
</tbody>
</table>

*And/or* for femoral lesion indicates the main localization of the lesion and his dissemination to adjacent region of the proximal femur.

**Surgical techniques**

Regardless of etiology, surgical techniques were classified into 3 levels (*Fig. 2*):

- type 1 (28 cases): consolidation surgery, involving little resection except lesion curettage, with standard implant reconstruction (associated to a dual mobility socket), cementing and, usually, osteosynthesis (support ring, plate, pin, etc.);
- type 2 (21 cases): more extensive surgery, but conserving the abductor system (conservation of gluteus medius muscle and innervation, reinsertion of tendon or of greater trochanter), whatever the extent of bone resection;
- type 3 (22 cases): resection involving the gluteus medius muscle or nerve.

The femoral component was standard for 15 patients, long-stemmed for 22 and a tumor reconstruction component for 34. In 38 patients, the femoral component was cemented. Various dual mobility sockets were used: 29 Avantage™ (Biomet, Valence, France), 19 Saturne™ (Amplitude, Neyron, France), 14 Novae™ (SERF, Décines, France), and nine other. Forty-one were cemented. In type-3 surgery, 45 days’ hemibermuda immobilization was generally prescribed.

**Assessment methods and results**

Two parameters were studied pre- and postoperatively: pain score, in terms of World Health Organisation (WHO) level I, II or III analgesia; autonomy, in terms of assisted walking (none, one cane, two canes, frame, impossible). The Musculoskeletal Tumor Society (MSTS) quality of life score [16] was calculated postoperatively. General health status was assessed pre- and postoperatively by the Performance Status score used by chemotherapy physicians (*Table 2*).

Figure 2  Classification of surgery according to attitude to abductor system: Type 1 (a): Consolidation. Type 2 (b): Section-reinsertion of abductor system. Type 3 (c): Resection involving gluteus medius muscle or nerve.
Table 2  General status according to the WHO Performance Status score (0 to 4). Correspondence with Karnovsky scale.

<table>
<thead>
<tr>
<th>General status</th>
<th>World Health Organization (WHO) scale (1979) Performance Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karnovsky scale</td>
<td></td>
</tr>
<tr>
<td>Capacity for working or physical activity</td>
<td>100% 0 0 Normal, unrestricted outside activity</td>
</tr>
<tr>
<td>Normal with moderate difficulty</td>
<td>90% 1 Reduction in intense physical effort</td>
</tr>
<tr>
<td>Limited</td>
<td>80% 2 No outside activity, but able to walk &gt; 50% of time</td>
</tr>
<tr>
<td>Capacity for domestic activity</td>
<td>70% 3 Strictly personal needs; confined to bed &gt; 50% of time</td>
</tr>
<tr>
<td>Normal, without assistance, but effort impossible</td>
<td>60% 3 Limited to personal needs</td>
</tr>
<tr>
<td>Limited to personal needs</td>
<td>50% 4 Total incapacity; frequently or constantly bed-ridden</td>
</tr>
<tr>
<td>Minimal with occasional assistance</td>
<td></td>
</tr>
<tr>
<td>Incapacity for elementary needs</td>
<td>40% 4 Total incapacity; frequently or constantly bed-ridden</td>
</tr>
<tr>
<td>Permanently</td>
<td></td>
</tr>
<tr>
<td>Frequently bed-ridden</td>
<td>30%</td>
</tr>
<tr>
<td>Bed-ridden</td>
<td>20%</td>
</tr>
<tr>
<td>Moribund</td>
<td>10%</td>
</tr>
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</table>

Results

Dislocation rate

There were seven cases (9.8%) of dislocation despite the use of a dual mobility socket.

There were two cases of dislocation (5%) in the metastasis group. One occurred at postoperative Day 7, secondary to a fall, in a cachectic patient suffering from small-cell lung cancer with multiple metastases, who died within the month: a femoral metastasis without acetabular involvement had been treated by consolidation surgery (type 1), with a standard cemented femoral component and cemented dual mobility socket, without acetabular reconstruction and with abductor conservation. The second dislocation occurred at 5 months postoperatively, in a patient with metastatic breast cancer; surgery had been much more aggressive in this case, with sectioning of the gluteus medius and its nerve and section-reinsertion of the trochanteric medallion onto a femoral tumor reconstruction component (type-3 surgery); the patient could walk with the help of one cane, and died three years postsurgery due to further metastasis. Both dislocations were reduced by external maneuver under general anesthesia, without surgical revision.

There were five cases of dislocation (15%) in the primitive tumor group. Three (10%) were isolated, without associated socket loosening ("isolated dislocation"). One occurred at 1 month postoperatively, and required surgical reduction, and remained isolated. Another, at 3 weeks postoperatively, was likewise reduced by surgery, but developed associated infection. The third also occurred at 3 weeks postoperatively, associated with scar disunion; all surgical samples proved negative. Two further dislocations (5%) were associated with socket mobilization in dual mobility dislocation ("loosening dislocation"). Polyethylene wear required respectively early and late revision surgery in these two cases. Four of the five dislocations (80%) involved Harrington grade III primitive acetabular bone tumor requiring large reconstruc-
tion following resection. The fifth case was of superior femoral involvement, which remained isolated following external maneuver. Three of the five cases involved sectioning of the gluteus medius and its nerve (type-3 surgery); the other two involved greater trochanter sectioning and reinsertion onto a femoral reconstruction component (type-2 surgery).

These dislocation rates vary according to the type of resection: 3.5% in case of abductor conservation, versus 9.5% for type-2 surgery and 18% for gluteus medius muscle or nerve resection (Table 3), i.e., dislocation appeared to be more frequent in case of acetabular involvement and of sacrifice of the hip stabilization system (type-3 surgery), although the small sizes of our subgroups precluded any statistical demonstration of significant difference.

Other postoperative complications

There were nine cases of infection: three were associated with bone metastasis surgery, including two remote hematogenic contaminations during immunodepression episodes of chemotherapy and required surgical revision; four deep infections (12%), detected on bacteriology, were associated with primitive tumor surgery.

One case of acetabular loosening occurred 7.5 years after bone metastasis surgery in a patient in remission of cancer, and required revision. In primitive bone tumor cases, there were three revisions for socket loosening concerning acetabular component mobilization with failure of Puget reconstruction for primitive pelvic bone tumor, requiring bone reconstruction revision.

Functional evolution

Functionally, postoperative pain as reported by bone metastasis patients was markedly improved, requiring WHO grade III analgesia in only five cases, grade II in five and grade I in 12, with 16 patients no longer taking analgesics (Fig. 3a). In primitive tumor patients, preoperative pain was less intense and likewise showed improvement, with 16 patients no longer taking analgesics, grade I analgesia in 11, grade II in five and grade III in just one patient (Fig. 3b).

Seven bone metastasis patients could walk without assistance postoperatively, 18 used one cane, six used two, six used a walking frame, and one failed to resume walking (Fig. 3c). Seven primitive tumor patients could walk without assistance postoperatively, 15 used one cane, nine used two, and two used a walking frame; all were able to resume walking (Fig. 3d).

Postoperative Performance Status showed systematic improvement, especially in bone metastasis (Fig. 3e and f). The mean MSTS functional score for tumor surgery reconstruction [16] at end of follow-up in surviving patients was 68.1% ± 23.5% in case of bone metastasis (Fig. 3g) and 59.6% ± 17.5% in case of primitive bone tumor (Fig. 3h).

General evolution

In terms of general evolution, there was deterioration in 27 of the 38 bone metastasis patients, stabilization in seven and remission in only four. Six were lost to follow-up, at a mean 4.2 months (range, 7 days to 1 year). Nineteen died, at a mean 11.1 months (1—39 months); 13 were alive at a mean 18.3 months’ FU (3—84 months). Sixteen required surgery for metastasis in bone or other

Figure 3  Functional evolution of bone metastases and primitive bone tumors. Pre- and postoperative assessment of pain (WHO analgesia grade) (a and b), of walking (c and d), performance status score, (e and f), and MSTS score (g and h).
Dual mobility design use in preventing total hip replacement dislocation

The overall dislocation rate of 9.8% following dual mobility socket implantation in hip tumor surgery, whatever the etiology and context, was relatively low compared to literature data [3,4,7,8,17–24]. Incidence varied according to initial etiology, with 5.2% in case of bone metastasis and 10% in case of primitive bone tumor, and according to type of resection, with 3.5% in case of abductor system conservation and 18% in case of gluteus medius muscle or nerve resection. Moreover, most dislocations were early (within the first postoperative year), in contrast to classical reports of late dislocation associated with dual mobility sockets [25], suggesting deficient joint coaptation as a factor, whether due to resection or functional impairment of soft parts.

The dual mobility socket was most effective in the treatment of metastases, whatever the location or associated treatment. The 5.2% dislocation rate was low compared to literature reports [18,22,24]. We therefore consider this prosthetic as especially indicated in this etiology, particularly as the issue of long-term implant aging associated with dual mobility sockets is less urgent in this population in which, despite progress in anticancer therapy, median survival ranges from 5.6 to 19 years, depending on the series, with 15% 5-year survivorship [3,5,21,26]. Dislocation is classically more frequent in implant reconstruction following primitive hip tumor resection [3,8,23]. Several techniques have been suggested to limit this complication: some authors recommend bone allograft, to facilitate muscular fixation [8,27,28]; others use ‘‘fibrosing’’ synthetic mesh around the joint reconstruction [23,29,30]; others again use retention cups, despite their inherent disadvantages [2,3,11,21]. We opted for dual mobility sockets in this indication: they failed to control dislocation sufficiently in the case of zone-2 peri-acetabular resection, especially in the case of abductor muscle resection or impairment; in the case of femoral tumor resection with prosthetic reconstruction, however, they did control dislocation as effectively as other techniques [8,27,28].

More than etiology, it was the type of surgery which turned out to relate to dislocation risk. And more than the extent of femoral resection or simple consolidation surgery, it was type-3 resection (involving the abductor system muscles or nerves) that was associated with high dislocation rates. The major dislocation risk factor was thus the surgical attitude towards the hip abductor muscles, rather than the degree of osseous involvement. Harrington grade-III acetabular surgery caused less dislocation in case of metastasis than of primitive tumor. These findings agree with classical dislocation risk-factor data in this subpopulation, as abductor system resection is proportional to the degree of acetabular involvement. In such indications, even when, as was generally the case in the present series, a postoperative orthesis is prescribed, dual mobility socket reconstruction should be considered with caution and alternative techniques should be explored. Prolonged postoperative hemibermuda immobilization, however, appeared to be useful.

The study confirmed the effectiveness of surgery for the severe preoperative pain associated with hip bone metastasis. This impact on pain and on functional impairment concerned even patients with short survival expectancy. Similar benefit was also observed in terms of Performance Status. In bone metastasis, the MSTS score confirmed the general trend of our results, with patients tending to report satisfaction. In case of primitive tumor, the MSTS scores were lower, as cancer resection and large subsequent scale reconstruction, while accepted by patients as necessary, nevertheless greatly impaired functional status.

The present survivorship results agree with previous reports [3,5,6,14]: 15% at 5 years in the case of bone metastasis, and 55 to 100%, depending on etiology, in case of primitive tumor. Even so, bone metastasis is no longer a short-term death sentence. Survivorship was especially improved in the present series in the case of breast metastases, with patients still alive 84 months postsurgery, and later consulting for metastasis in other locations. These findings confirm the interest of long-term surgical results and optimal general management involving multidisciplinary decision-making. Our primitive bone tumor results were unfortunately in line with previous findings [17,20,26], with only 17 patients (53.1%) surviving more than 52 months (range, 16 months to 19 years) and 50% remission, whatever the histology.

Patient survival can be expected to improve yet further in the future, but implant fixation and survivorship should not be overlooked. With this in view, we generally opted for cemented fixation with a metal-back socket. Despite initial doubts [31,32], Langlais et al. [33] recently reported encouraging results. Retrospective clinical findings, moreover, confirmed the generally satisfactory survivorship of dual mobility sockets [34]. Their 10-year survivorship in young (< 50 years) active patients, however, remains low [35,36]. Their use should therefore be reserved for patients at high risk of instability, which is notably the case in tumoral pathology of the hip.

Conclusion

The present retrospective multicenter study assembled a large series of dual mobility socket THRs for bone tumor. It confirmed the interest and efficacy of the technique in a pathology involving a high risk of instability. Results seemed to be better in case of metastasis around the hip, but the surgical attitude towards the abductor muscles emerged as the major risk factor for dislocation. In type-3 surgery resecting the gluteus medius muscle or its innervations, dual mobility sockets fail to ensure sufficient prevention of dislocation, and other techniques probably need to be associated. There also remains the issue of long-term survival of dual mobility sockets in young patients, whose life expectancy is likely to be improved in the future thanks to adjuvant treatments.
Conflicts of interest

None.

References


