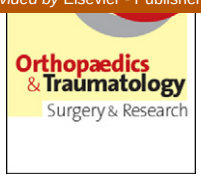
Available online at ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com



ORIGINAL ARTICLE

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

J.-M. Philippeau[a,*,b], J.-M. Durand[c], J.-P. Carret[c], S. Leclercq[d], D. Waast[a], F. Gouin[a,b]

[a] *Orthopedics Department, Hôtel-Dieu Hospital, place A.-Ricordeau, 44035 Nantes cedex 01, France*
[b] *Bone Resorption and Primitive Bone Tumor Physiopathology Research Laboratory, EA 3822, Inserm U957, School of Medicine, Nantes University, rue Gaston-Veil, 44000 Nantes, France*
[c] *Edouard Herriot Hospital, Ward T, place d'Arsonval, 69437 Lyon cedex 03, France*
[d] *Saint Martin Private Hospital, 18, rue des Roquemonts, 14000 Caen, France*

Accepted: 19 October 2009

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 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

DOI of original article:10.1016/j.rcot.2009.12.011.
* Corresponding author. Tel.: +33 6 84 54 37 66.
E-mail address: jmphilippeau@hotmail.com (J.-M. Philippeau).

1877-0568/$ – see front matter
doi:10.1016/j.otsr.2009.10.015

not using analgesics, six were taking WHO class III analgesics, 10 class II and 23 class I. Mean MSTS score was 68.1% ± 23.5% in bone metastasis and 59.6% ± 17.5% in primary bone tumor. Fourteen patients could walk without assistance, 33 with a single cane, 15 with two canes and eight with a walker; one patient had not been able to resume walking.
Discussion: In these indications, dual mobility cups use lead to lower dislocation rates than those reported in the literature. It proved especially effective in the case of bone metastasis and consolidation surgery. In the case of primary bone tumor, it failed to prevent dislocation following acetabular resection, especially when involving the abductor muscles and/or abductor innervation, although it provided lower dislocation rates, comparable to those experienced with other techniques, when applied to limited resection.
Level of evidence: IV. Retrospective therapeutic study.

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

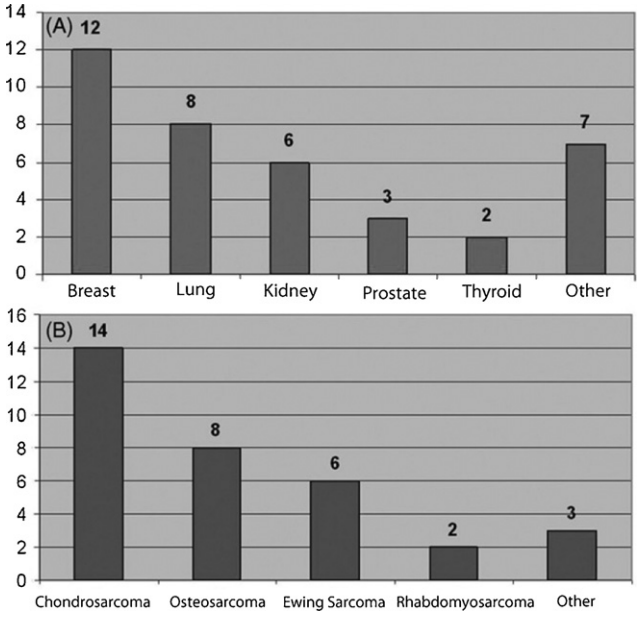


Figure 1 Type of primitive tumor and origin of metastases. A. Classic distribution of bone metastases according to primitive tumor: breast (12 cases), lung (8 cases), kidney (6 cases), prostate (3 cases), thyroid (2 cases), other (7 cases). B. Distribution of primitive bone tumors according to histology: chondrosarcoma (14 cases), osteosarcoma (8 cases), Ewing sarcoma (6 cases), rhabdomyosarcoma (2 cases), other (3 cases).

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.

		Bone metastasis (38)	Primitive bone tumor (33)
Femoral lesion (41) including 14 associated with acetabular lesions	Head/neck region	20	7
	and/or Intertrochanteric region	20	10
	and/or Subtrochanteric region	11	11
	Total	**23** (including 10 associated lesions of the acetabulum)	**18** (including 4 associated lesions of the acetabulum)
Acetabular lesion (30)	Class I	7	1
	Class II	4	2
	Class III	4	12
	Total	**15**	**15**
Former surgery		7	6
Associated fracture		25	6

And/or for femoral lesion indicates the main localisation 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 II 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).

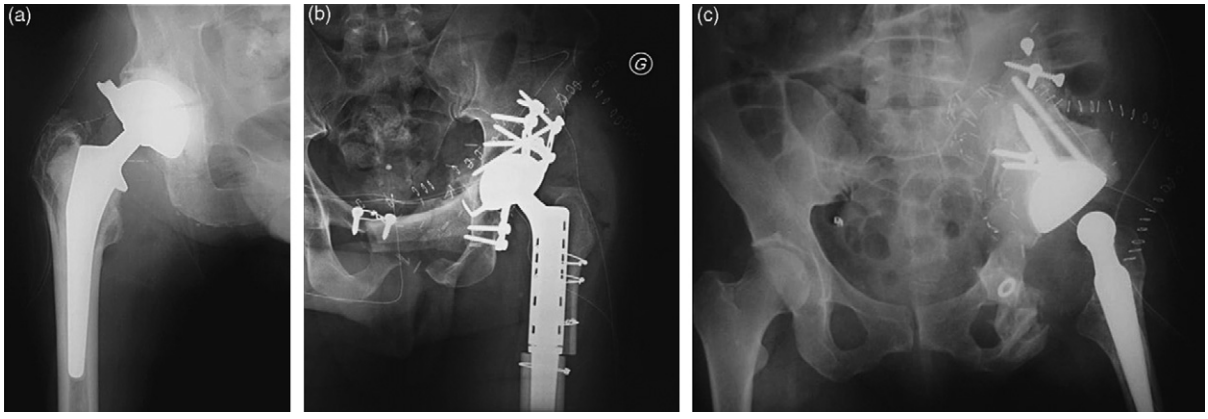


Figure 2 Classification of surgery according to attitude to abductor system: Type 1 (a): Consolidation. Type 2 (b): Section-reinsertion of abductor system. Type 3 (c): Resection involving gluteus medius muscle or nerve.

Table 2 General status according to the WHO Performance Status score (0 to 4). Correspondence with Karnovsky scale.

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

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-

Table 3 Dislocation rate according to type of surgery.

Type of surgery	Bone metastasis	Primitive bone tumor	Dislocation
Type I Consolidation	25	3	**1/28 (3.5%)**
Type II Gluteus medius or greater trochanter tendon reinsertion	8	13	**2/21 (9.5%)**
Type III Gluteus medius muscle or nerve resection	5	17	**4/22 (18.2%)**

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

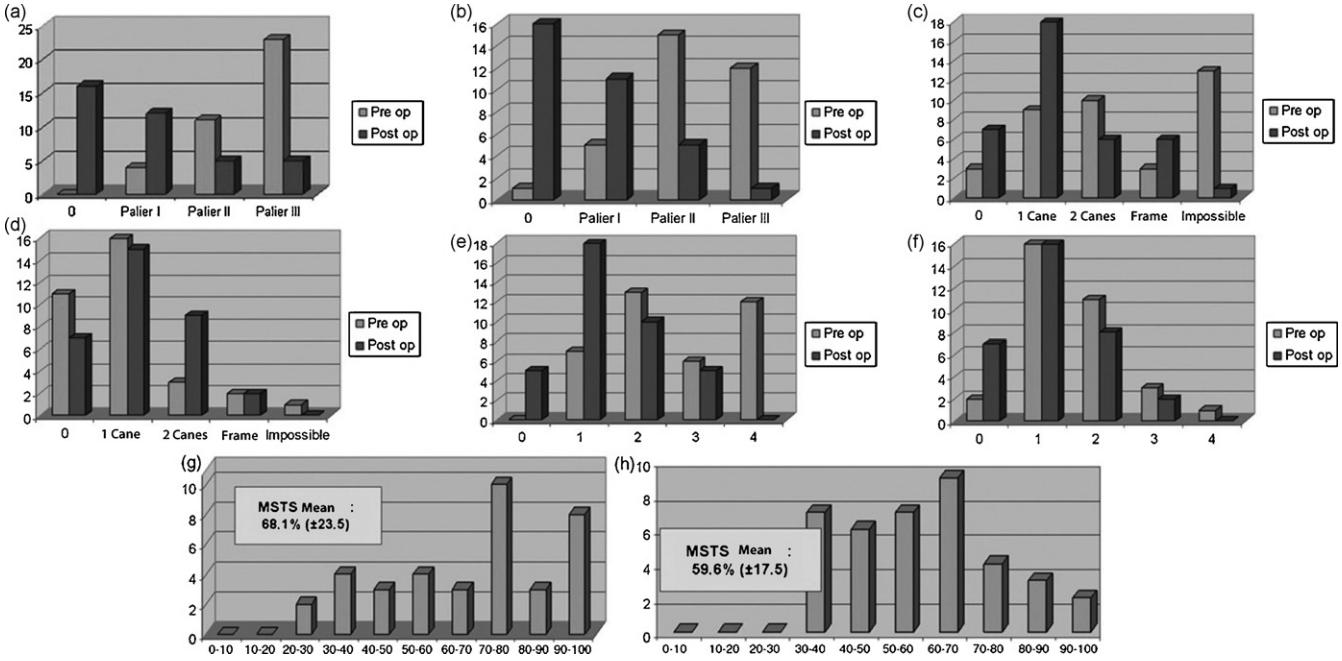


Figure 3 Functional evolution of bone metastases and primitive bone tumors. Pre- and postoperative assessment of pain (WHO analgesia grade) (a and b), of walking (c and d), performance status score, (e and f), and MSTS score (g and h).

locations. Sixteen primitive tumor patients were in remission, 14 showed recurrence and two were stabilized. Fifteen died, at a mean of just over 17 months (3—82 months); 17 were alive at a mean 52.1 months (16 months to 19 years). Only one patient was lost to follow-up, at six months postsurgery.

Discussion

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 prosthesis 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

[1] Anract P, Coste J, Vastel L, Jeanrot C, Mascard E, Tomeno B. Prothèse massive et prothèse manchonnée d'une allogreffe pour la reconstruction de l'extrémité supérieure du fémur. Rev Chir Orthop 2000;86:278—88.

[2] Bickels J, Meller I, Henshaw RM, Malawer MM. Reconstruction of hip stability after proximal and total femur resections. Clin Orthop 2000;375:218—30.

[3] Haentjens P, De Neve W, Opdecam P. Remplacement prothétique pour fracture pathologique de l'extrémité supérieure du fémur : prothèse totale ou prothèse intermédiaire ? Rev Chir Orthop 1994;80:493—502.

[4] Jacofsky DJ, Haidukewych GJ, Zhang H, Sim FH. Complications and results of arthroplasty for salvage of failed treatment of malignant pathologic fractures of the hip. Clin Orthop 2004;427:52—6.

[5] Kunisada T, Choong PF. Major reconstruction for periacetabular metastasis: early complications and outcome following surgical treatment in 40 hips. Acta Orthop Scand 2000;71:585—90.

[6] Lane JM, Sculco TP, Zolan S. Treatment of pathological fractures of the hip by endoprosthetic replacement. J Bone Joint Surg (Am) 1980;62:954—9.

[7] Sokolovski VA, Voloshin VP, Aliev MD, Zubikov VS, Saravanan SA, Martynenko DV, et al. Total hip replacement for proximal femoral tumours: our midterm results. Int Orthop 2006;30:399—402.

[8] Zehr RJ, Enneking WF, Scarborough MT. Allograft-prosthesis composite versus megaprosthesis in proximal femoral reconstruction. Clin Orthop 1996;322:207—23.

[9] Huten D. Luxations et subluxations des prothèses totales de hanche. Conférences d'enseignement de la Sofcot 1996;55:19—46.

[10] Gouin F, Gayet LE. Luxation des prothèses totales de hanche. Ann Orthop Ouest 2002;34:217—50.

[11] Beaule PE, Roussignol X, Schmalzried TP, Udomkiat P, Amstutz HC, Dujardin FH. Reprise de prothèses totales de hanche instables par prothèses tripolaires. Rev Chir Orthop 2003;89:242—9.

[12] Leclercq S, el Blidi S, Aubriot JH. Traitement de la luxation récidivante de prothèse totale de hanche par le cotyle de Bousquet. À propos de 13 cas. Rev Chir Orthop 1995;81:389—94.

[13] Guyen O, Pibarot V, Vaz G, Chevillotte C, Carret JP, Bejui-Hugues J. Unconstrained tripolar implants for primary total hip arthroplasty in patients at risk for dislocation. J Arthroplasty 2007;22:849—58.

[14] Harrington KD. The management of acetabular insufficiency secondary to metastatic malignant disease. J Bone Joint Surg (Am) 1981;63:653—64.

[15] Harrington KD. Orthopaedic management of extremity and pelvic lesions. Clin Orthop 1995;312:136—47.

[16] Enneking WF, Dunham W, Gebhardt MC, Malawar M, Pritchard DJ. A system for the functional evaluation of reconstructive procedures after surgical treatment of tumors of the musculoskeletal system. Clin Orthop 1993;286:241—6.

[17] Aboulafia AJ, Malawer MM. Surgical management of pelvic and extremity osteosarcoma. Cancer 1993;71:3358—66.

[18] Bohm P, Huber J. The surgical treatment of bony metastases of the spine and limbs. J Bone Joint Surg (Br) 2002;84:521—9.

[19] Cottias P, Jeanrot C, Vinh TS, Tomeno B, Anract P. Complications and functional evaluation of 17 saddle prostheses for resection of periacetabular tumors. J Surg Oncol 2001;78:90—100.

[20] Donati D, El Ghoneimy A, Bertoni F, Di Bella C, Mercuri M. Surgical treatment and outcome of conventional pelvic chondrosarcoma. J Bone Joint Surg (Br) 2005;87:1527—30.

[21] Haentjens P, de Neve W, Casteleyn PP, Opdecam P. Massive resection and prosthetic replacement for the treatment of metastases of the trochanteric and subtrochanteric femoral region bipolar arthroplasty versus total hip arthroplasty. Acta Orthop Belg 1993;59(Suppl. 1):367—71.

[22] Keating JF, Burke T, Macauley P. Proximal femoral replacement for pathological fracture. Injury 1990;21:231—3.

[23] Masterson EL, Ferracini R, Griffin AM, Wunder JS, Bell RS. Capsular replacement with synthetic mesh: effectiveness in preventing postoperative dislocation after wide resection of proximal femoral tumors and prosthetic reconstruction. J Arthroplasty 1998;13:860—6.

[24] Stark A, Bauer HC. Reconstruction in metastatic destruction of the acetabulum. Support rings and arthroplasty in 12 patients. Acta Orthop Scand 1996;67:435—8.

[25] Lecuire F, Benareau I, Rubini J, Basso M. Luxation intraprothétique dans la cupule a double mobilité de Bousquet. À propos de 7 cas. Rev Chir Orthop 2004;90:249—55.

[26] Schneiderbauer MM, Sierra RJ, Schleck C, Harmsen WS, Scully SP. Dislocation rate after hip hemiarthroplasty in patients with tumor-related conditions. J Bone Joint Surg (Am) 2005;87:1810—5.

[27] Mankin HJ, Gebhardt MC, Jennings LC, Springfield DS, Tomford WW. Long-term results of allograft replacement in the management of bone tumors. Clin Orthop 1996;324:86—97.

[28] Langlais F, Lambotte JC, Collin P, Thomazeau H. Long-term results of allograft composite total hip prostheses for tumors. Clin Orthop 2003;414:197—211.

[29] Gosheger G, Hillmann A, Lindner N, Rodl R, Hoffmann C, Burger H, et al. Soft tissue reconstruction of megaprostheses using a trevira tube. Clin Orthop 2001;393:264—71.

[30] Gosheger G, Gebert C, Ahrens H, Streitbuerger A, Winkelmann W, Hardes J. Endoprosthetic reconstruction in 250 patients with sarcoma. Clin Orthop 2006;450:164—71.

[31] Peraldi P, Vandenbussche E, Augereau B. Mauvais résultats cliniques des cupules cimentées avec métal-back. 124 cas au recul moyen de 21 mois. Rev Chir Orthop 1997;83:561—5.

[32] Harris WH, Penenberg BL. Further follow-up on socket fixation using a metal-backed acetabular component for total hip replacement. A minimum ten-year follow-up study. J Bone Joint Surg (Am) 1987;69:1140—3.

[33] Langlais FL, Ropars M, Gaucher F, Musset T, Chaix O. Dual mobility cemented cups have low dislocation rates in THA revisions. Clin Orthop 2008;466:389—95.

[34] Philippot R, Farizon F, Camilleri JP, Boyer B, Derhi G, Bonnan J, et al. Étude d'une série de 438 cupules non cimentées à double mobilité. Rev Chir Orthop 2008;94:43—8.

[35] Philippot R, Adam P, Farizon F, Fessy MH, Bousquet G. Survie à 10 ans d'une cupule double mobilité non cimentée. Rev Chir Orthop 2006;92:326—31.

[36] Passuti N, Philippeau JM, Gouin F. Friction couples in total hip replacement. Orthop Traum Surg Res 2009;95:27—34.