

CLINICAL RELEVANCE OF ACETABULAR EROSION IN YOUNG PATIENTS WITH A BIPOLAR HIP PROSTHESIS

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In elderly patients bipolar hip prostheses are often used for intracapsular fractures of the femoral neck and are often complicated by pain after a few years; this pain is frequently related to acetabular erosion seen on xray.

In this study 18 bipolar hip prostheses were used in the treatment of a proximal femoral sarcoma in a young patient population (mean age : 39.6 years). Their quality of life was evaluated by TESS and MSTTS scores, after a mean follow-up of 81.8 months (range 8-171 months). A radiologic grading system was used to assess acetabular erosion on plain xrays. The patients did not report significant pain, they enjoyed a very good quality of life, and they did not show any obvious acetabular erosion. The use of a bipolar implant appears as a good alternative to total hip replacement in the treatment of relatively young patients who have to undergo proximal femoral tumor resection procedures and have a normal acetabulum.

Keywords : bipolar prosthesis ; hemiarthroplasty ; hip ; acetabular erosion ; quality of life ; tumor.

Mots-clés : prothèse bipolaire ; hémi-arthroplastie ; hanche ; érosion acétabulaire ; qualité de vie ; tumeur.

INTRODUCTION

Bipolar hip prostheses are commonly used in older people who sustained a displaced intracapsular femoral neck fracture. In the literature, there are important discrepancies regarding the outcome of these hemiarthroplasties (12, 19). Primary endoprosthetic replacement has been advocated to improve survival while eliminating the problems

associated with fracture fixation and healing and by allowing early mobilization (9). A bipolar prosthesis is technically easier to implant than a total hip prosthesis, there are fewer dislocations (8, 15) and the operation time is less than with a total hip prosthesis. The most significant problems observed are femoral stem loosening, acetabular sclerosis and erosion and protrusion of the prosthesis into the pelvis (11). The risk of late acetabular erosion can be predicted based on the anticipated longevity of the patient and the level of activity (17). Bipolar arthroplasty is therefore not widely accepted as the first choice in young patients. We used hemiarthroplasty in a relatively young population who needed a proximal femoral resection because of a malignant tumor. Eighteen such patients were reviewed. We evaluated the radiographic changes during follow-up. We assessed the functional ability and quality of life of these patients, and related the quality of life to the radiographic changes.

MATERIAL AND METHODS

Eighteen patients with a malignant tumor of the proximal femur were treated with proximal femoral resection, reconstruction by allograft (except patients with the Kotz prosthesis) and insertion of a bipolar hip

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Table 1. — Details of the patients

	Gender	Side	Age at operation	MSTS score	TESS score	Radiographical evaluation	Follow-up (in months)	Diagnosis
1	male	left	15	90	100	fair	166.00	Ewing sarcoma
2	female	left	53	73	77	excellent	91.00	MFH
3	male	left	37	77	93	excellent	77.00	chondrosarcoma
4	female	right	33	X	X	excellent	29.00	osteosarcoma
5	male	right	60	43	57	excellent	93.00	chondrosarcoma
6	female	right	56	57	88	good	171.00	chondrosarcoma
7	female	left	48	67	90	excellent	47.00	chondrosarcoma
8	male	left	16	X	X	excellent	24.00	Ewing sarcoma
9	female	left	21	40	71	excellent	62.00	Ewing sarcoma
10	female	right	50	57	70	excellent	23.00	osteosarcoma
11	male	right	28	87	96	excellent	146.00	chondrosarcoma
12	male	left	17	67	80	excellent	164.00	chondrosarcoma
13	male	left	36	100	100	excellent	112.00	chondrosarcoma
14	female	right	25	X	X	excellent	8.00	Ewing sarcoma
15	male	right	63	60	82	good	102.00	chondrosarcoma
16	male	left	52	80	91	excellent	37.00	chondrosarcoma
17	male	left	76	X	X	excellent	83.00	chondrosarcoma
18	female	left	27	97	76	excellent	37.00	Ewing sarcoma

(X) = deceased.

prosthesis. The inclusion criteria for these patients were : primary sarcoma of the proximal femur, attempt at curative operation, and no metastases at diagnosis. Eighteen patients had a final clinical and radiographic evaluation (table I). At the time of the surgical procedure the mean age was 39.6 years (range, 15 to 76 years) ; there were 10 male and 8 female patients. Eleven operations were on the left side and seven were on the right side. None of the patients had a dysplastic acetabulum or had any prior surgical treatment for one or both hips. A cemented stem was used ; the acetabulum was not reamed in any of the procedures. The mean follow-up was 81.8 months (range, 8-171 months). The diagnosis was chondrosarcoma in ten cases, Ewing sarcoma in five, osteosarcoma in two and malignant fibrous histiocytoma in one. The types of bipolar prosthesis used were : Mallory-Head in 8 cases, Osteonics in 3, Kotz in 3, Muller in one and Lord in 3. The radiographic changes of the bipolar articulation were assessed on xray (15). Migration, subluxation, dislocation and pelvic reactions such as sclerosis were measured by two well-centered anteroposterior radiographs : one postoperative film and another taken at final follow-up examination (fig. 1). As the normal femoral head varies only slightly from a true hemisphere (22, 24, 25), the size of the head of the endoprosthesis could easily be integrated in the

measurements. Four distances were measured on each radiograph (36 radiographs) using the Imagika 2.05 software in a computer-aided study. Every distance was recorded four times by two different observers. Any rotation of the pelvis alters the measurements (26) ; therefore the fixed distance between the teardrop and the proximal acetabular rim was used in the calculations. With these results we could determine the proximal and medial erosion, the thickness of the superior joint space and the degree of subluxation of each hip. Every patient was graded in one of four categories (15) : E (excellent) : no loss of joint space superiorly, no migration in either the medial or proximal direction, no subluxation, no pelvic reactions ; G (Good) : slight loss of joint space (0.5 – 1.0 mm), no migration, subluxation < 1/4 of diameter of prosthesis, slight sclerosis ; F (fair) : complete loss of joint space and migration < 1 cm, subluxation > 1/4 diameter of prosthesis, moderate pelvic reaction ; P (Poor) : complete loss of joint space and migration > 1 cm, dislocation, severe sclerosis. Acetabular erosion is seen radiographically, starting as a condensation of trabeculae at that part of the acetabular dome that takes the greatest contact stress. To evaluate the quality of life, 14 patients were asked to complete the TESS-score (4) (Toronto Extremity Salvage Score), a measure for physical disability, and MSTS-score (6) (Musculo-

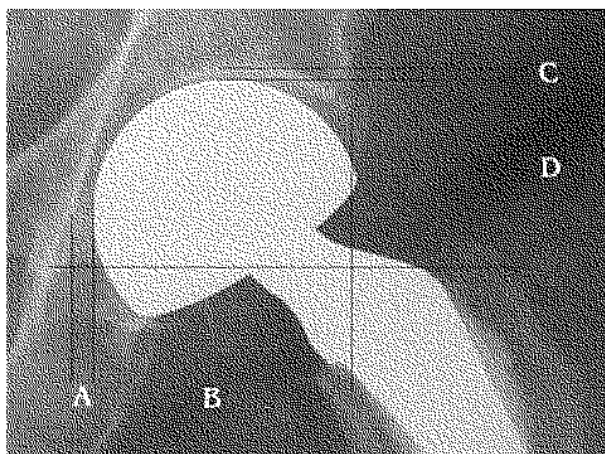


Fig. 1. — Radiographic assessment of a bipolar endoprosthesis; Morris *et al.* (15), used with permission.

A = Teardrop-to-prosthesis distance; B = Superolateral acetabular corner-to-medial prosthesis distance; C = Superior joint space; D = Teardrop-to-superior prosthesis distance. Medial migration is estimated by comparing the teardrop-to-prosthesis distance on the two successive radiographs. Superior migration is estimated by comparing the teardrop-to-superior prosthesis distance on the two radiographs, and subluxation is estimated by comparing the superolateral acetabular corner-to-medial prosthesis distance on the two radiographs. Sclerosis is seen in the juxtacetabular metaphyseal bone superiorly.

Grading : Excellent (E) = no joint space narrowing, no medial migration, no superior migration, no subluxation, no sclerosis. Good (G) = joint space narrowing, no medial migration, no superior migration, subluxation $< \frac{1}{4}$ of the femoral head, slight sclerosis. Fair (F) = Complete loss of joint space and migration < 1 cm, subluxation $> \frac{1}{4}$ diameter, no dislocation, moderate pelvic reaction. Poor (P) = Complete loss of joint space and migration > 1 cm, dislocation, pelvic discontinuity or severe sclerosis.

skeletal Tumour Society Rating Scale). In the TESS-score evaluation, the patient is asked to fill out a questionnaire with 32 questions. Each question asks about the difficulty performing a specific activity over the previous week. The difficulty is graded on a 5-point Likert-type scale from not at all difficult (rated 5) to impossible to do (rated 1). In the MSTS-score the surgeon assigns numerical values (0-5) for each of six categories : pain, function, emotional acceptance, support, walking and gait. These two scores (MSTS and TESS) were correlated with the radiological findings.

All scores were evaluated with SPSS 9.0 software. We used Spearman's correlation test in evaluation the MSTS, TESS and the radiographic grading.

RESULTS

Eighteen bipolar prostheses were implanted. At the time of the final examination, 4 patients were deceased. One patient with Ewing sarcoma died of pulmonary and skeletal metastases. There was one patient with a chondrosarcoma who died of local recurrence and bone metastases. One patient died of pulmonary metastases. Another died of local recurrence. Two living patients have diagnosed pulmonary metastases. One femoral stem became loose and was revised. One patient had allograft revision due to nonunion between the allograft and the host bone. We had no postoperative dislocations. One patient with a postoperative hematoma received prophylactic antibiotic therapy.

The other 14 patients were clinically examined and were asked to fill out a questionnaire (TESS). The measurements of the xrays showed an intra-observer variance of 5.5 % for distance A, 0.3% for B, 15.3 % for C and 0.4% for D. The inter-observer variance was 3.1% for distance A %, 3% for B, 15.4% for C and 9.2% for D. There was no radiographic grading difference between the two observers. Based upon these radiographic changes, there were 15 (83%) excellent, 2 (11%) good and one (6%) fair result. The two good results had slight joint space narrowing without medial or superior migration. There was one patient with acetabular erosion ; his xray showed severe narrowing of the joint space and slight medial migration. The mean MSTS-score was 71.1 ; standard deviation 19 ; range : 57-100. The mean TESS-score was 83.6 ; standard deviation 13 ; range : 43-100. We found no correlation between the radiological grading and both scores. Indeed the TESS-scores were better in the good and fair groups than in the excellent group. The mean TESS in the excellent group was 81.9 (range : 57-100) ; in the good group 85 (range : 82-88), and it was even better in the fair group : 100. Thus in the 3 patients with sclerosis on plain xray the overall quality of life is nevertheless excellent (> 80 points). The MSTS scores were respectively : 71.6 (range : 40-100) ; 58.5 (range : 57-60) and 90. The patient who had sclerosis on xray and was graded fair on radiologic evaluation was 15 years old at time of the

procedure and has one of the longest follow-up periods : 166 months. Nevertheless his functional outcome is excellent (TESS : 100, MSTS 90). In the good group the MSTS is not high (58.5) probably owing to the higher age (56 and 63 years) and extensive resection of proximal hip musculature. We found a positive correlation of 0.708 between the TESS-score and the MSTS-score ($p = 0.005$).

DISCUSSION

The identification of some pelvic landmarks like the teardrop and superolateral acetabular corner are difficult to standardize. This could explain the interobserver differences. The joint space thickness showed the greatest inter- and intraobserver variance, because the slightest inaccuracy in this measurement resulted in a considerable error. Nevertheless these differences did not affect our radiologic grading because each observer used the same landmarks on the two consecutive xrays.

The first use of a metal implant to replace a proximal femur was by Moore and Bohlman (14) in 1940 in a patient with a giant cell tumor of the proximal femur. Success in this specific case spurred the development of hemiarthroplasty for the treatment of arthritis, fractures and tumors.

The main reason for the development of a bipolar prosthesis instead of a unipolar type was to reduce the incidence of acetabular erosion. Some types of bipolar hemiarthroplasties (e.g. Monk) were modified from "soft-top" (polyethylene head) to "hard-top" (metal head) with different postoperative outcomes (12, 19). Another reason for the development of a bipolar prosthesis was the possibility of easy conversion to a total hip prosthesis (23).

The overall rates of acetabular erosion following bipolar hemiarthroplasty range from 0% (5) to 24% (20). Wetherell *et al.* (27) demonstrated no erosion with increasing follow-ups, but as soon as acetabular erosion begins, it appears to progress at a steady rate. Takoata *et al.* (21) reported that bipolar prostheses have an advantage in avoiding and reducing acetabular erosion. A study by Rae *et al.* (18) reported no significant acetabular erosion in patients over 80 years of age.

The response of acetabular cartilage to load against metal has been studied in dogs (2) and in humans (1, 3). In both studies progressive degenerative changes occur at the articular cartilage of the acetabulum.

McGibbon *et al.* (13) concluded that acetabular degeneration was explained by repetitive stress from the metal implant on the acetabular cartilage, but the degeneration did not appear to be related solely to friction between cartilage and the endoprosthesis. In patients with a subcapital femoral fracture acetabular erosion may also occur as a result of impact causing injury to the acetabular cartilage at the time of the accident (5).

The behavior of bipolar implants was studied by Phillips (16). The movement of the bipolar prosthesis depends on the condition of the acetabular cartilage. The author proved that the movements are initiated at the surface which has the lowest friction. In fracture and tumor groups, where the acetabular surface is normal, the outer head glides easily at the surface of the acetabulum and acts primarily as a unipolar prosthesis. In cases where the acetabulum is more arthritic, the friction of the outer metal shell on bone is higher and therefore the movements occur primarily at the inner metal on polyethylene interface, so that the prosthesis acts as a bipolar arthroplasty. Verberne *et al.* (23) pointed out that the built-in bearing joint is barely functioning after three months. Because the inner joint becomes fixed after a short period of time, a bipolar prosthesis cannot be expected to be better in preventing acetabular wear than a unipolar hemiarthroplasty. Nevertheless Devas *et al.* (5) observed no acetabular erosion after hemiarthroplasty. On the other hand, Lachiewski *et al.* (10) demonstrated that at least 30% of the hip motion occurred between the femoral stem and the acetabular cup.

Because most of our patients had an extended surgical procedure, these operations often required resection of large amounts of proximal hip musculature. This diminishes the functional ability of these patients ; therefore they are probably less mobile and less active. Besides, the wide resection of muscles leaves the arthroplasty unstable and at risk for dislocation. Bipolar implants are inherently more stable than total hip prostheses (15).

An explanation for the good results with this type of prosthesis in this specific population is given by the knowledge that the articular cartilage is of excellent quality and does not give pain on articulating against a metal surface (7).

In these relatively young patients, we can indeed assume the cartilage of the acetabulum is in very good condition. The shear stress between metal and cartilage is therefore less than with older people who sustained a subcapital fracture of the hip (5). We recorded only one patient with incipient acetabular erosion on plain xray ; similar findings have been made following hemiarthroplasty for avascular necrosis of the femoral head (8).

Bipolar hip prosthesis does not require acetabular reaming ; thus it eliminates the risk of contaminating the acetabular bone with tumor cells. Acetabular reconstruction is avoided so no press-fitting, screwing or cementing is required ; finally, a hemiarthroplasty is more stable, as stated earlier.

When implanting a bipolar hip prosthesis there are some technical demands. Exact fit of the prosthetic head into the acetabulum is important (5). About 90% of the early failures after hemiarthroplasty can be explained through technical errors such as oversized prosthetic head, wrong choice of size and neck length, and loosening and varus pivot (9). Undersizing the prosthetic head may damage the acetabulum and give early protrusion (5, 9). When insufficient femoral neck is resected, the excessive pressure on the acetabular cartilage produces erosion (5).

Lestrangle *et al.* (11) reported that the use of cement improves results in bipolar hemiarthroplasty. Cementing the stems may lower the incidence of dislocation because it prevents retroversion of the prosthesis.

CONCLUSION

The use of a bipolar implant is a superior alternative in the treatment of relatively young patients with a proximal femoral tumor resection procedure. In a young population the acetabular cartilage is of good quality and does not give pain on articulating against a metal surface. Even in those cases where slight sclerosis developed, pain was not a

significant problem after a mean follow-up of 81.8 months.

A bipolar prosthesis has some major advantages : no development of pain, fewer dislocations, no tumoral contamination of the pelvic compartment, decreased surgery time and ease of technique. A disadvantage of a total hip prosthesis is the risk of acetabular loosening. We are aware of the small number of patients ; nevertheless we believe a bipolar hip prosthesis to be a good, acceptable treatment option in selected cases.

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SAMENVATTING

G. KIEKENS, J. SOMVILLE, A. TAMINIAU. Klinische relevantie van acetabulaire erosie bij jonge patiënten met een bipolaire heupprothese.

Bij oudere patienten wordt een bipolaire heupprothese voornamelijk geplaatst bij de behandeling van subcapi-

tale femurhalsfracturen. Frequent ontwikkelen zij na enkele jaren tijd pijnklachten welke gerelateerd worden aan acetabulaire erosie. In deze studie wordt een hemiarthroplastie gebruikt bij de behandeling van een sarcoma van het proximale femur bij een jonge patiëntenpopulatie (gemiddelde leeftijd : 39,6 jaar). De levenskwaliteit werd geëvalueerd dmv. de TESS-score en MSTS-score na een gemiddelde follow-up van 81,8 maanden (8-171). We gebruikten een radiologisch gradatiesysteem voor het berekenen van de acetabulaire erosie met behulp van een standaard anteroposterieure röntgenopname.

De patiënten hadden geen duidelijke pijnklachten, hadden een zeer goede levenskwaliteit, en vertoonden geen evidente acetabulaire erosie. Het gebruik van een bipolaire heupprothese is een zeer goed alternatief bij deze jonge patiënten met een normaal acetabulum die een resectie van het proximale femur dienen te ondergaan.

RÉSUMÉ

G. KIEKENS, J. SOMVILLE, A. TAMINIAU. Corrélation entre les résultats cliniques et l' érosion acétabulaire mesurée chez des patients jeunes porteurs d' une prothèse de hanche bipolaire.

Chez des patients âgés, les prothèses bipolaires sont surtout utilisées dans le traitement des fracture sous-capitales du fémur ; ces patients se plaignent souvent de douleurs que l'on attribue à l' érosion acétabulaire. Les auteurs ont étudié dix-huit prothèses bipolaires implantées pour une tumeur maligne du fémur proximal dans une population jeune (âge moyen : 39,6 ans). La qualité de vie a été évaluée selon le score TESS et le score MSTS. L' érosion acétabulaire a été mesurée sur une radiographie de face en utilisant une méthode assistée par ordinateur.

Avec un follow-up moyen de 81,8 mois, les patients ne rapportent pas de douleurs importantes, ont une bonne qualité de vie et ne présentent pas d' érosion acétabulaire importante. L' utilisation d' un prothèse bipolaire est une bonne alternative chez des sujets jeunes qui doivent subir une arthroplastie de hanche et ont un cotyle normal.