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Jumbo cups for revision of acetabular defects after total hip arthroplasty: a retrospective review of a case series

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Abstract The treatment of acetabular bone defects presents a great challenge in revision total hip arthroplasty (THA). The purpose of this study was to evaluate the clinical and radiological outcome of revision THA using jumbo cups for acetabular reconstruction after applying the bone-grafting technique. We studied 17 patients with acetabular defects ranging from Type 2A to Type 3A according to Paprosky`s classification. According to the AAOS-score twelve patients were classified as Type II and five patients as Type III. Uncemented press-fit cups with an outer diameter larger than 64 mm were used in all cases. Fifteen patients received morselized bone allografts. In eight patients an additional screw fixation was necessary. The mean follow-up period was 82 months (range 33–149). The mean Harris Hip Score was preoperatively 62 and at the time of the last follow-up examination 83 points ($p = 0.007$). Two acetabular components failed, one due to aseptic loosening and another one due to septic loosening. There was a trend of displacement of the femoral head centre towards the infero-lateral position after using jumbo cups that approached statistical significance ($p = 0.065$). Closure of acetabular defects of Types 2A to 3A according to Paprosky's classification and type II to III according to the AAOS-score respectively can be satisfactorily accomplished using jumbo cups after applying the bone-grafting technique.

Keywords Aseptic cup loosening · Jumbo cup · Press-fit technique · Revision of failed total hip arthroplasty · Impaction bone grafting

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Introduction

There are various surgical procedures for revision of the failed acetabular component. Reconstruction of the acetabulum with allogenic bone grafts has produced encouraging results: Sloof et al. [20] used the impaction bone grafting technique to apply bone chips and metallic meshes in patients with massive acetabular osteolysis. Good results have also been achieved by transplanting bulk allografts [3]. Saleh et al. [17] demonstrated good results in a follow-up study of patients who had been treated with large acetabular shaped allografts. Our own group [18, 22] also reported favourable results after applying large bone allografts and femoral head allografts to reconstruct pelvic cavitary defects. The aim of these allografts is to restore the original anatomy so that an acetabular component can be implanted.

Once the hip centre has been reconstructed, there are numerous reconstruction techniques available for revision of the acetabulum, ranging from custom-built implants [3, 12], which are mainly implemented in tumor surgery, to pedestal cups, which are considered to produce satisfactory results in the management of acetabular failures [15].

Furthermore, antiprotrusio cages or rings (e.g. Burch Schneider ring) with a cemented inlay-socket can be inserted. The results of defect closure using bone cement and cemented implants, however, have been unsatisfactory [23]. Jumbo cups have opened up further strategies for revision of failed cup components. Hendricks and Harris [6], Patel et al. [15], Whaley et al. [23] and Lachiewicz et al. [10] all reported a reasonably good outcome in long-term follow-up studies. The purpose of this study was to evaluate the results of acetabular reconstruction using jumbo cups after applying bone allografts to build up bone stock.

Methods

Between September 1989 and June 2001 we performed revision surgery using a jumbo cup, an acetabular component of ≥64 mm in diameter, in 17 patients with aseptic prosthesis loosening. The results achieved with this group, consisting of seven female and 10 male patients, were assessed retrospectively following approval by the university ethics committee and the local authorities according to the official guidelines (Table 1). The diagnoses for original THA was osteoarthritis in eight hips, femoral neck fracture in two, tuberculous arthropathy in one, avascular necrosis in one and dysplasia in five hips.

At the time of the index surgery the average age was 60 years, ranging from 44 to 78 years. Five patients were classified as Type 2A, three as 2B, four as 2C and the remaining five as Type 3A according to the classification proposed by Paprosky et al. [14]. According to the American Academy of Orthopaedic Surgeons (AAOS) score twelve patients were classified as Type II and five patients as Type III. Total revision surgery had to be performed in nine patients, whereas an isolated revision of the acetabular cup was performed in the other eight cases. In ten cases the joint was accessed from the left and seven operations had to be performed from the right. All operations were carried out by the same surgeon using a lateral approach according to Bauer et al. [2]. Primary hip revision surgery was performed in nine patients, seven underwent a second revision, and one patient a third revision procedure. All patients received a single dose antibiotic prophylaxis in order to decrease the risk of postoperative infection.

In 15 cases the acetabular defect was closed using morselized bone to build up a bone stock. In all cases uncemented porous-coated cups Duraloc 100 and Duraloc 1200 (for screw fixation) (64–72 mm) (DePuy, Kirkel-Limbach, Germany) were used. Eight cups were fixed with screws and nine cups were implanted in a press-fit technique without screws.

Follow-up examination

The average period of follow-up was 82 months after surgery (33–149 months). Post-operatively, each case was examined radiologically and clinically at intervals of 1–2 years; the data were collected according to the Harris Hip Score which was established in order to standardize classification of the follow-up examination.

Table 1 Synopsis ($n = 17$)

Patient ($n = 17$)	Sex	Revision status	Type of exchange	Acetabular defect based on Paprosky et al.	Acetabular defect based on AAOS-score	Additional allografts	Additional screws (number)
1	M	II	C	IIa	II	I	0
2[a]	M	II	C	IIc	II	I	0
3	M	I	C	IIa	II	I	0
4	F	II	S	IIIa	III	I	3
5[b]	F	I	S	IIc	II	I	0
6	F	II	C	IIc	II	I	0
7	M	I	C	IIIa	III	Ø	0
8[b]	M	I	S	IIIa	III	I	2
9	M	I	C	IIa	II	I	0
10	F	II	S	IIIa	III	I	0
11	M	I	C	IIb	II	I	2
12[a]	M	II	S	IIb	II	I	0
13	F	II	S	IIIa	III	I	4
14	F	I	S	IIb	II	I	3
15	M	I	C	IIa	II	I	2
16	M	I	S	IIa	II	Ø	2
17	F	III	S	IIc	II	I	3

F female, *M* male, *I–III* primary–tertiary exchange, *C* complete, *S* socket

[a] Patient died during the follow-up period

[b] Lost to follow-up due to a prosthetic failure

Radiographs of the pelvis were taken according to a standardized procedure consisting of an anterior–posterior projection and a Lauenstein view.

The osseous integration of the cups was evaluated using the criteria compiled by Paprosky et al.: an osseous bridging between the cup and the pelvic bone is required. Migration of >4 mm by the prosthetic cup indicates failure, as does a continuous radiolucent line of >1 mm between the bone and the cup in all of the three DeLee–Charnley zones.

X-ray assessment for all cases was carried out using the MediCad-system Version 2.06 (Hectec, Niederviehbach, Germany). The software was calibrated by measuring the artificial femoral head diameter. The orthograde distance between the obturator line and the centre of the prosthesis head was estimated pre- and postoperatively. The obturator line was used as a criterion to determine the pivotal point of the displacement. To assess the lateralisation of the femoral head's pivotal point, the horizontal distance from the teardrop figure to the femoral head centre was measured (Fig. 1).

The collected data was analysed using a two-sided Student's-two-tailed t test and the significance was set at ($p < 0.05$) (Excel 2003, Microsoft, NY, USA).

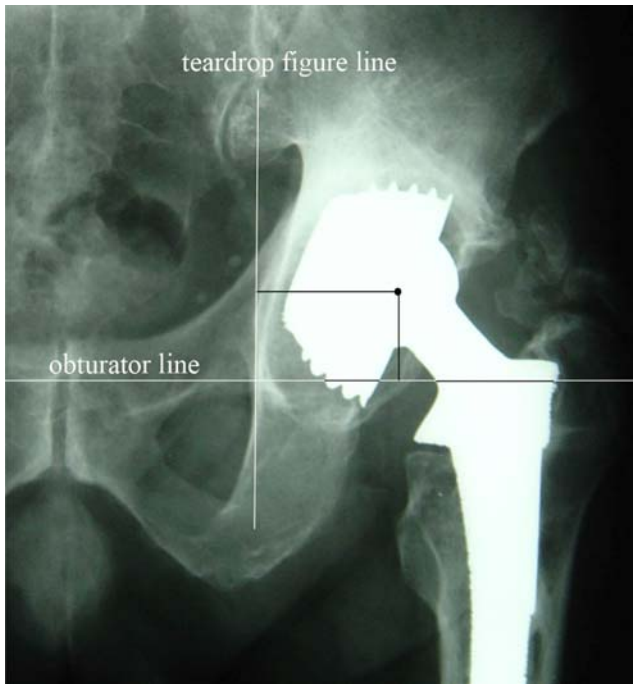

Fig. 1 The orthograde distance between the obturator line/the teardrop figure line and the centre of the prosthesis head was estimated pre- and postoperatively

Results

The mean preoperative Harris Hip Score was 62. The average value for pain was 30 (range 0–44) and for range of motion 24 (range 0–47). Immediately following surgery all of the jumbo cups were solidly attached to the host bone (Figs. 2, 3).

There were two implant failures that had to be excluded from the final analysis of the follow-up examinations. In the other patients the average Harris Hip Score was 83 at the time of follow-up ($p = 0.007$). The average rating for pain given by the patients was 41 (range 10–44), for range of movement the average score was 34 (0–47) (Fig. 4).

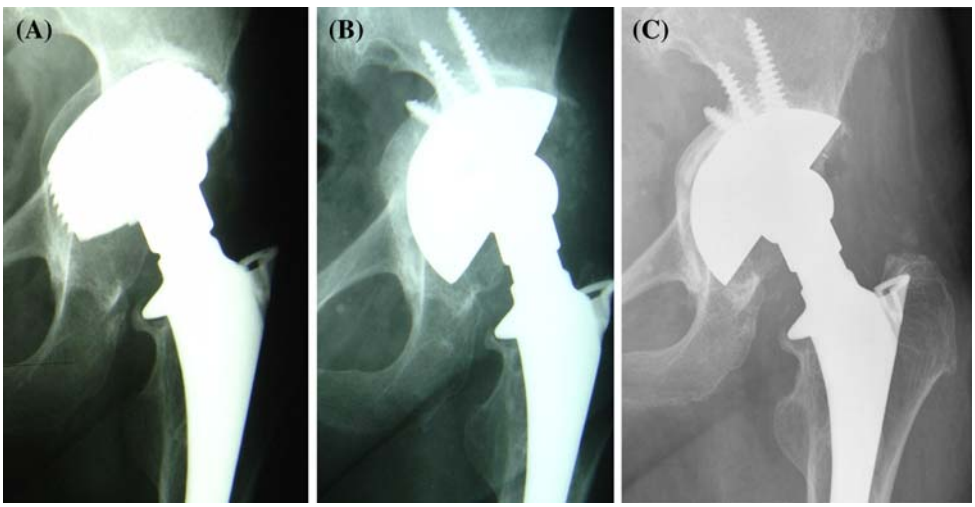

Fig. 2 Radiographs of a female patient (Patient 13) who initially underwent a right total hip arthroplasty. Radiolucencies are present in the inferior aspect of the cup. The anterior–posterior radiograph was taken when the patient was 61 years old preoperatively with a cementless loosened cup on the left side (**a**) and after revision surgery with a cup of 68 mm outer diameter. The cup was fixed with four screws (**b**). The X-ray (**c**) was taken 6 years after index surgery. There was excellent contact of the cup and no evidence of osteolysis. Harris Hip Score was 89 points

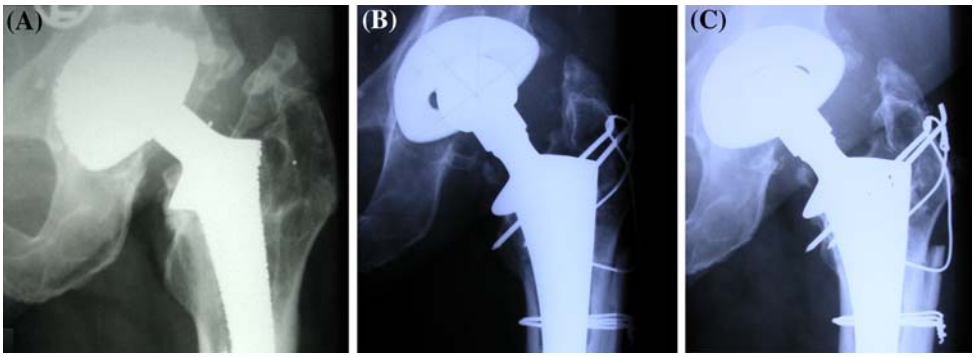

Fig. 3 Radiographs of a male patient who initially underwent a right total hip arthroplasty (patient 12) and revision surgery of the stem with a fracture of the trochanter and additional strut graft transplantation before cup revision. The anterior–posterior radiograph was taken when the patient was 61 years old preoperatively with a cementless loosened cup on the left side and after revision surgery with a cup of 66 mm outer diameter. The cup was fixed without screws (**b**). The X-ray (**c**) was taken 4 years after index surgery. There was excellent contact of the cup and no evidence of osteolysis. Harris Hip Score was 84 points

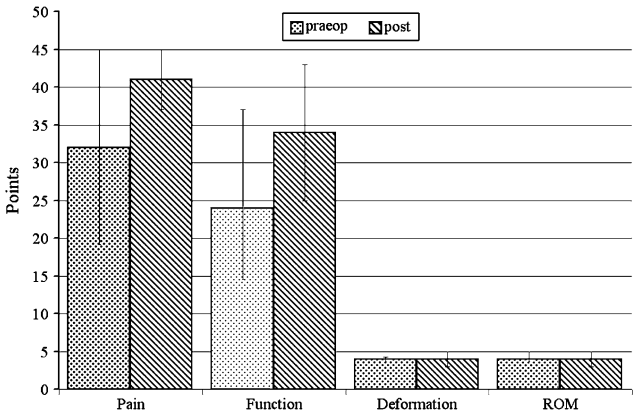

Fig. 4 Harris Hip Score preoperatively and at the time of last follow-up examination $n = 17$

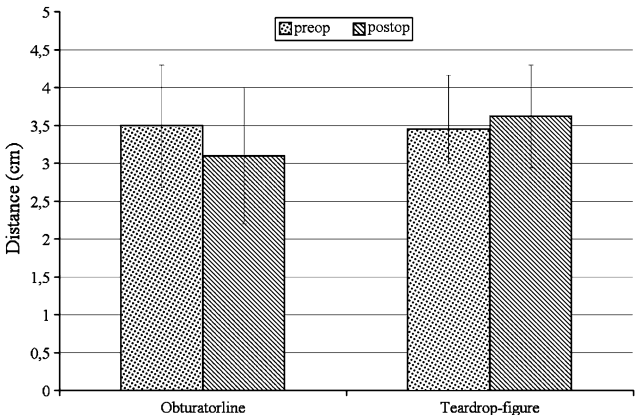

Fig. 5 Distance from obturator line and tear-drop figure to the prosthesis head centre ($n = 17$)

The average distance between the obturator line and the centre of the prosthesis head was 3.5 ± 0.8 cm (2.2–5.4 cm) preoperatively and 3.1 ± 0.9 cm (1.8–4.8 cm) postoperatively $p = 0.065$. The orthograde distance to the teardrop figure for the estimation of the lateralisation of the femoral head centre was preoperatively measured as 3.45 ± 0.72 cm (2.4–5 cm) and postoperatively 3.62 ± 0.68 cm (2.4–4.8 cm) $p = 0.065$ (Fig. 5).

Comparison of the post-operative radiographs with those taken at the time of follow-up revealed no migration of the acetabular component, such as an inclination or an anteversion. The measured distances from the obturator line and the teardrop figure to the femoral head showed no significant difference between isolated cup revision and total hip revision.

Two patients died during the follow-up period, therefore, the last follow-up examination made during their life-time was included in the final follow-up examination. The cause of death was not associated with the revision surgery.

Two prostheses (patients 5 and 8) failed, one due to new loosening and one due to infection. Microbiological assays performed for patient 5 were positive and we, therefore had to assume septic loosening. Three weeks postoperatively patient 5, therefore underwent surgery to treat a fistula originating from the surrounding soft tissue and extending to the prosthesis. However, this procedure could not prevent the development of a deep hip joint infection and in a further operation resection arthroplasty (Girdlestone) had to be performed.

In the second case (Patient 8) aseptic loosening was the cause of failure. Eight months after the initial revison this patient underwent a further surgical procedure during which a worsened Paprosky classification was determined. Starting from an initial Paprosky score classified as 2C, a new defect, classified as 3A was detected. The new defect was reconstructed with a Burch-Schneider ring.

Further complications which occurred postoperatively in four of the patients whose findings were included in the final analysis were as follows: One patient (patient 1) suffered from hip dislocation twice. This complication at day 7 and 14 postoperatively had to be treated with a Dollinger hose: After this treatment no further dislocations

occurred. Another two patients (patients 2 and 4) suffered from low-grade wound infection, which was treated by conservative methods. The fourth patient (Patient 9) suffered from postoperative bleeding that had to be treated by revision surgery two days after the initial operation. At revision surgery the haematoma was revised.

Discussion

Acetabular bone defects still remain a great challenge in revision THA surgery. A good postoperative outcome depends on many preconditions. In our study the uncemented jumbo cups showed satisfactory mid-term results in revision surgery of the hip after bone grafting. There was only a slight, though not significant displacement of the femoral head centre towards a lateral inferior position after using jumbo cups to improve biomechanical function of the hip joint.

As confirmed by many authors, uncemented cups produce satisfactory results in revision surgery. Moskal et al. [11] published a study in 1997 on cementless acetabular revision performed in 31 patients with good postoperative results in 94% of the cases. Lachiewicz et al. [9, 10] published a follow-up study reporting good results after revision surgery with cementless cups and additional screw fixations. A study by Tanzer et al. in 1992 [21] also showed fair to excellent results using cementless components in revision surgery. Finally, Silverton et al. [19] support the results of the authors mentioned above. Large acetabular cavities can be satisfactorily reconstructed with large porous-coated hemispherical jumbo cups [6, 13, 15, 23].

As there is so far no general definition of the jumbo cup, we included in our study all patients with prosthetic failure and associated acetabular defects that had to be treated with a cup of $\geq$64 mm diameter. Patel et al. and Whaley et al. [15, 23] characterized the jumbo cup as having a diameter of >65 mm in men and of >61 mm in women due to the smaller relationship between the acetabulum and the pelvic diameter in women compared to men. Ito et al. [7] defined jumbo cups by the ratio of component size to the pelvis and hip joint. Hendricks and Harris refer to these large cementless hemispherical acetabular components as "so-called" jumbo cups [6].

The jumbo cup offers numerous advantages. It requires a large area of contact between the cementless cup and the host's bone. In porous-coated jumbo cups a 60% coverage of the autochthonal bone is believed to be essential for ingrowth of the cup [8]. Additionally, the displacement of the femoral head centre results in a lateral inferior position, which is associated with a biomechanical improvement [10].

For additional fixation, screws can be helpful. Although screws support the primary anchorage of the revision cup, one cannot disregard the risks associated with this kind of fixation as published by Obenhaus et al. [13]. In our study we did not find any differences between screw- and non-screw-fixation. In cases with an insufficient anterior or posterior wall, jumbo cups often tend to fit very well. There are no specific criteria which indicate when a jumbo cup is likely to fit without further attachment. Therefore the decision to secure the cup by additional means depends on the intraoperative findings and the surgeon's discretion. In cases with severe damage associated with an inadequate press-fit, many surgeons tend to anchor the implanted socket with additional screws.

We, therefore, recommend an uncemented revision component, adapted to the individual anatomy of the patient that has to be well fixed. Finally, the jumbo cup enables use of a thicker acetabular component which accommodates a larger femoral head and thus reduces the risk of dislocation.

The rate of complications in our study highlights the complexity and dimension of this kind of operative procedure. Our results with the uncemented Duraloc cup (DePuy, Kirkel Limbach, Germany) cannot be compared to any other kind of cup because they have different hemispheres and surfaces. Furthermore, we have no experience with any other large-diameter porous-coated cups.

Besides the jumbo-cup, many other surgical strategies are described in the literature. There is no standardized procedure for the reconstruction of acetabular failure, and therapy depends on the surgeon's experience in each individual case. The limited rebuilding of surrounding osseous tissue in the acetabulum after implantation of a jumbo cup may cause problems if the jumbo cup later needs to be revised.

Conclusion

In view of the advantages and disadvantages mentioned above it has to be pointed out that acetabular defects can be augmented properly with a jumbo cup. A firm primary anchorage of the revision cup is very important for the postoperative outcome. It is conceivable that the jumbo cup technique cannot be used if the superoinferior diameter of the acetabulum is greater than the anteroposterior diameter. In this case an allograft augmentation should be performed. Small remaining defects within the acetabulum can be filled with bone grafts, especially by the impaction grafting technique which can lead to reconstruction of the osseous defects and is beneficial for the postoperative result of the jumbo cup.

We, therefore, favour the use of large-diameter uncemented cups for acetabula with defects of the 2B-3A-Type according to Paprosky, after the defects have been downgraded with bone grafts.

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