Acetabular Rings in Revision Total Hip Replacement


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**Purpose.** To assess the radiographic results of reconstruction rings used in surgical procedures conducted to revise large acetabular defects.

**Materials and methods.** A study was carried out to analyze the radiological evolution of 13 acetabular rings used in grade 3 and 4 patients, with a follow-up between 25 and 60 months (mean: 37 months). In all cases, allografts were placed underneath the ring and the cemented cup. The radiological measurements taken used as their landmarks the position, height and depth of the ring as well as the evolution of the center of the prosthetic head. The appearance of complications was also recorded, as was the restoration of limb asymmetry.

**Results.** There were three complications, an intraoperative vascular lesion, a posterior dislocation as well as a superficial infection. The average downward migration of the center of rotation was 4 cm. In no case was it necessary to reoperate. Limb asymmetry went down from a preop value of 6.3 cm to 3.1 at the immediate postop. After this, no changes were found in the radiographical measurements.

**Conclusions.** The use of an acetabular ring in revision THR enables the bringing down of the hip’s center of rotation as well as an early restoration of both the structure of the area and the bone stock without any serious complications.

**Key words:** total hip replacement, acetabular revision, acetabular ring.

Anillos de reconstrucción en la cirugía de revisión de las arthroplastias de cadera

**Objetivo.** Evaluar los resultados radiográficos de los anillos de reconstrucción utilizados en la cirugía de revisión de grandes defectos acetabulares.

**Material y método.** Se ha estudiado la evolución radiológica de 13 anillos de reconstrucción utilizados en grados 3 y 4, con un seguimiento mínimo de 25 meses y máximo de 60 (media de seguimiento: 37 meses). En todos los casos se utilizaron aloinjertos debajo del anillo y cúpula cementada. Las mediciones radiológicas usadas tomaban como referencia la posición, altura y profundidad del anillo, así como la evolución del centro de la cabeza protésica. También se registró la presencia de complicaciones y la recuperación de la dismetría de extremidades.

**Resultados.** Se presentaron tres complicaciones, una lesión vascular intraoperatoria, una luxación posterior y una infección superficial. El descenso medio del centro de rotación fue de 4 cm. En ningún caso fue necesario reincidir a los pacientes. La dismetría de extremidades disminuyó de 6,3 cm en el preoperatorio a 3,1 cm en el postoperatorio inmediato. Después no se encontraron modificaciones en la radiología.

**Conclusiones.** La utilización de un anillo de reconstrucción en la cirugía de revisión acetabular permite descender el centro de rotación de la cadera y recuperar precozmente la estructura y depósito óseo sin complicaciones graves.

**Palabras clave:** artroplastia total de cadera, revisión acetabular, anillo de reconstrucción.
rings. When there is a large amount of bone destruction, the rotation center is elevated and the placement of a conventional implant is impossible. In these cases, the placement of a reconstruction ring fixed to the iliac bone is recommended, amongst other alternatives. This technique stabilizes the reconstruction with a scaffold supported by allografts, making it possible to relocate the center of rotation and allowing cementing of the polyethylene liner. In this paper we present details of our experience with the use of reconstruction rings in cases of great acetabular bone loss.

MATERIALS AND METHODS

From January 1999 to September 2002 we carried out 81 replacements of the acetabular component in THRs. In 25 cases we placed cemented polyethylene cups, in 21 cases support or antiprotrusion rings and in 13 cases GAP® type reconstruction rings (*Graft Augmentation Prosthesis* (Stryker)). Follow-up was from 25 to 60 months, with a mean of 37 months. This GAP® type reconstruction ring (Figure 1) is made of titanium and has two upper extensions with holes for fixation by means of screws in the ilium or ischium and a lower hook which can be moulded and adjusted to the lower rim of the acetabulum. The extensions may be trimmed and moulded so that they adapt to the anatomical configuration of the ilium. The ring was placed after cleaning and regularizing the acetabulum and placing and impacting allografts extracted from bone bank femoral heads. After cementing, a polyethylene cup was inserted in the metal cavity (Figure 2). The orientation, inclination and anteverision, can be modified to increase stability and conformity with the prosthetic head. The first model, GAP-1®, only had screw holes in its external part; in the GAP-2® model, the whole ring surface has holes.

The mean age of patients was 71 years old (56-83), 5 were male and 8 were female. The mean time to surgery, after primary surgery, was 122 months (8-276 months). The approach was anterior in 9 cases and postero-lateral in the other 4. The failed component was a Charnley model in 3 cases, PCA in 5, 2 Müller cups, and other 3 different non-cemented cups. Eleven patients received a non-cemented 28 mm cup and 2 patients a 22 mm diameter cup. Bone defects were classified according to Gross et al² (Table 1) using preoperative X-rays and direct observation at the moment of surgery. Mean OR time was 110 minutes (85-165). In 8 cases the femoral component was revised during the same operation and 6 modular stems with shaft support and 2 models of head-shaft fixation were implanted.

Mean hospital stay was 8 days (11-26). In all cases the limb was kept from weight bearing for 2 months. In the preoperative X-ray, the distance from the center of the prosthetic head to the inferior bi-ischial line was measured, this measurement was compared with that obtained during the immediate postoperative X-ray. To assess X-ray results, we measured the immediate postoperative X-rays and then those carried out every 6 months. Four measurements were taken in the postoperative X-rays: distance from the center of the prosthetic head to the inferior bi-ischial line (A), distance from the center of the prosthetic head to the medial rim of the acetabulum (B), distance from the lowest point on the ring to the bi-ischial line (C) (Figure 3) and the acetabular angle in the antero-posterior X-ray (intersection of the bi-ischial line and the inclination of the ring). We also determined limb dismetry, capacity to walk, need of support to walk and complications during follow-up.

### Table 1. Classification of acetabular defects according to Gross et al²

<table>
<thead>
<tr>
<th>Type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Without significant bone loss</td>
</tr>
<tr>
<td>2</td>
<td>Cavitary defect with acetabular columns and rim intact</td>
</tr>
<tr>
<td>3</td>
<td>Non-contained segmental defect affecting less than 50%</td>
</tr>
<tr>
<td>4</td>
<td>Non-contained segmental defect affecting more than 50%</td>
</tr>
</tbody>
</table>
RESULTS

Following the classification by Gross et al, 7 patients presented type 3 defects (Figure 4) and 6 presented type 4 defects (Figure 5). No patients were lost to follow-up. In one case there was a iatrogenic lesion of the femoral vein that required suture. One patient, 22 days after the implant, suffered a posterior dislocation that was manually reduced without any alteration of the result. Another patient had a superficial infection that was cured with local dressing and antibiotics. There was a mean descent of the rotation center of 4 cm (1.8-5.8). The inclination of the component was 46.4° (45-55°). No modification was seen in the angle of the acetabulum with the passage of time. In the immediate postoperative the mean of distance A was 9.5 cm (7-11), the mean of distance B was 4.5 cm (3.5-6) and the mean of distance C was 4.2 cm (3.7-6.2). At the end of the follow-up period the mean of distance A was 9.2 cm, the mean of distance B was 4.2 cm and the mean of distance C was 4 cm. The dismetry of the lower limbs decreased from a mean of 6.3 cm to a mean of 3.1 cm. Eight patients walked without external support, 4 with the help of a walking stick and another with crutches with forearm support.

DISCUSSION

The first difficulty encountered when treating acetabular bone defects is their classification. The assessment of the amount of osteolysis that takes place after the failure of an acetabular cup is essential to determine the surgical tech-
nique to be used. However, the determination of the size of the defect is difficult when only conventional X-rays are available. Other recommended methods include the progressive assessment of the bone defect with a series of X-rays and, although not yet standardized, reconstruction by means of axial tomography.

Different classifications of bone loss after acetabular loosening have been proposed. The classifications published by Paproski et al, Engh et al, Gross et al and by D’Antonio et al, recommended by the American Academy of Orthopaedic Surgeons, are those mainly followed in the literature. However, there is a conviction that none of these classifications is sufficiently reliable as far as inter or intra observer differences, nor do they contribute information on the preoperative situation of the remaining bone, which makes their usefulness doubtful. However, and especially when comparing results, it is necessary to classify bone defects and intraoperative findings, since a defect seen in the preoperative X-ray is usually found to be greater during surgery.

We have used the classification by Gross et al, which, as well as ordering defects according to their morphology and size, gives an idea of the most advisable therapeutic options. In the case of type 1 defects, conventional primary surgery cups are recommended; in type 2 defects, if 50% of the receptor bone is in contact, a diced allograft is used with a standard non-cemented cup or a jumbo cup. If contact is less than 50%, it is advisable to use an impacted graft with a mesh and a cemented cup or impacted graft with a support ring and a cemented cup. If the defect is general, a reconstruction ring must be used that comprises both ischium and ilium. In type 3 defects it is necessary to elevate the rotation center and advisable to implant an oblong cup or structural allograft that will support less than 50% of the prosthetic cup. In type 4 defects, a reconstruction ring and allografts must be used. If, with this type of defect, there is also a pelvic defect, it is necessary to assess the need for an osteosynthesis plate and a reconstruction ring.

There have been many papers published on the aseptic movement of acetabular components. The need for an implant-receptor bone contact greater than 50% is a premise that differentiates therapeutic alternatives. If this contact is possible, the best solution is a press-fit cup or a jumbo cup also placed using primary fixation. The placement of a cup

Figure 5. (A) Type 4 defect. B) X-ray at 32 months.
with a high rotation center is supported by some authors\textsuperscript{10}, whereas bilobulated components have been the cause of failure in near 25\% of cases with a medium follow-up\textsuperscript{1,11}.

If that minimum contact is not possible, multiple different therapeutic possibilities are contemplated in the literature. In isolated and localized segmental or cavitary defects, the use of a support ring with allografts beneath the cup and cementation of a polyethylene cup is a valid alternative\textsuperscript{12,13}. However, some authors\textsuperscript{14}, analyzing different types of support rings, find 17\% of slippage and 23\% of reoperations with a mean follow-up of slightly more than 4 years. Other authors\textsuperscript{15}, however, show good results and blame the failures on the filling of defects with cement or a contact greater than 60\% between the allografts and the prosthetic cup.

Another surgical option is the technique using compacted grafts\textsuperscript{16} that transforms the defects into cavitary defects using meshes and screws, allografts, and eventually, the placement of rings and cages\textsuperscript{17}. In some series\textsuperscript{18}, a technique using compacted grafts has shown survival of up to 92\% at 15 years. In patients under 50 years of age with acetabular defects and bone loss, results have been published of a survival rate of 80\% at 20 years\textsuperscript{19}.

When the defects are extensive and medial or large and cavitary, reconstruction rings in association with allografts have shown good results\textsuperscript{20,21}. Many publications in the literature refer to this technique based on the biomechanical unloading of the allografts. Evolution times are still short\textsuperscript{22} and ring migrations that have been reported during the initial period later seem to stabilize\textsuperscript{23}.

The use of a reconstruction ring, such as the one we used, is an attractive alternative that increases the robustness of the assembly, stimulates the compressive forces of the allografts and allows an early restoration of the bone stock (Figure 6). Furthermore, the position of the rotation center is recovered thanks to the lower hook. On the other hand, cementation of the polyethylene liner modifies the verticality and ante\textsuperscript{o} retroversion, increasing the stability of the new joint. In large series, survival of these assemblies was up to 75\% with a 15 year follow-up\textsuperscript{24}. It is advisable, during surgery, to use diced allografts and that the cement mantle should be a minimum of 2 mm\textsuperscript{25}.

Our series has a short follow-up and we have only carried out X-ray assessment. However, some studies\textsuperscript{24} hold that clinical assessment of these techniques lacks solidity, since both cup and stem are assessed at the same time in patients who have undergone multiple surgeries. We have used the failure criteria already described by other authors: breakage of a screw or hook, migration greater than 4 mm either horizontally or vertically, change in acetabular angle.
greater than 5° or need for another operation. There were few complications, just 1 posterior dislocation, 1 superficial infection and 1 intraoperative vascular lesion. We did not observe slippage or motion of the ring or the cemented cup in any patient. Nor were any breakages of material seen. We had no failures nor re-interventions. In other series ring loosening was seen in 6% of cases, dislocations in 10%, and cemented cup slips in 5%. X-ray results in our series show that, during the time of evolution studied, there were no marked proximal or medial migrations of the ring.

Pelvic defects are the most severe bone defect, they cause 0.9% of acetabular revisions, and they are defined as a visible fracture or a bone defect that includes both acetabular columns with medial slippage or rotation of the lower semipelvis with relation to the upper semipelvis. Different alternatives are recommended for the treatment of this condition, such as the use of a plate on the posterior column and the use of a porous non-cemented cup, the use of a strut allograft protected by a reconstruction ring or a reconstruction ring supported by cancellous bone allografts. Authors agree that if stable fixation with a reconstruction ring cannot be achieved that joins the ischium and the ilium with screws or hooks, a posterior osteosynthesis plate must be used.

After reviewing the abundant literature on the treatment of acetabular defects it is difficult to summarize the surgical indications. There are different classifications and definitions of the defects and even the concepts of rings and cages are confusing. Taking the work carried out by Cuckler as a basis, we believe that the algorithm in Figure 7 is a good protocol that may be used as a guide to determine the most appropriate surgical technique to be used.

REFERENCES

Figure 7. Algorithm of surgical indications (modified Cuckler).


Conflict of interests: We, the authors, have not received any economic support to carry out this study. Nor have we signed any agreement with any commercial firm to receive benefits or fees. On the other hand, no commercial firm has provided nor will provide economic support to non-profit foundations, educational institutions or any of the other organizations that we are members of.