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TRABECULAR METAL CUP WITHOUT AUGMENTS FOR ACETABULAR REVISION IN CASE OF EXTENSIVE BONE LOSS AND LOW BONE-PROSTHESIS CONTACT

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Current evidences in revision hip arthroplasty suggest to treat severe acetabular bone loss with dedicated implants, such as anti-protrusio cages, stemmed cups, modular systems supplied with iliac flanges and obturatory hook. However recent literature is reporting satisfactory outcomes with simple elliptical Trabecular Metal cups. Purpose of the study was to evaluate mid-term results of such a surgical procedure. All hip revisions performed from 2008 to 2009 with implantation of a TMT multi-hole acetabular cup without augmentations were retrospectively reviewed. The cases with low-degree acetabular bone loss (stage I and II according to GIR classification), with surgical report poorly describing the bone defect, with inadequate pre- and post-operative x-rays were ruled out. Twenty-five cases were identified, but four were lost to follow-up. The twenty-one patients were 71 year-old on average (from 60 to 82), with stage IV bone loss in 6 cases and stage III bone loss in 15 cases. Mean interval from surgery to evaluation was 20.9 months (from 13 to 30). The evaluation included bone-prosthesis contact estimation, component position, survivorship, complications, final Harris Hip Score, presence of periprosthetic radiolucencies. Host bone-prosthesis contact was estimated to be about 35%. Only three implant were subsequently reoperated (for infection, early migration, recurrent dislocation). The HHS among non-reoperated 18 patients was 81.96 on average (from 63.44 to 95.82). Six cases showed thin radiolucencies in one of the three Charnley zones, while three cases showed radiolucencies in two. None of these images was evolutive, thus they were not considered signs of loosening. The mid-term results of this series confirm the hypothesis that a porous tantalum acetabular cup is an effective option to deal with difficult acetabular revisions. Although no extra-acetabular fixation device is available, the very high surface friction guaranteed by the material and the supplemental stability provided by trans-acetabular screws seem to be sufficient to allow satisfactory reimplantation even in severely damaged pelves.

The management of acetabular failures in total hip arthroplasty (THA) is strongly influenced by the periprosthetic bone loss. Conventionally revision THAs in case of severe bone defect ought to be performed with antiprotrusio cages (1) or roof rings (2)and bone graft (3). The introduction of relatively new highly porous materials in orthopaedics (Trabecular Metal and more recently Trabecular Titanium) has contributed to change these indications, extending the application of simple cups to more and more challenging revision scenarios.

Trabecular Metal (TM) is a trademark by Zimmer (Warsaw, IN, US) that defines a material made of pure tantalum deposited onto a low-density carbon skeleton characterized by a dodecahedron array of regular pores. Pore size ranges from 400 to 600 μm and mimics the cancellous bone structure, although TM turned out to be mechanically stronger than human cancellous bone. (4)

The porosity of TM is much higher than previous materials used for orthopaedic implants, ranging from 75% to 85%. This property, together with noticeable biocompatibility and bioactivity, is considered to be a key point to explain fast and extensive bone ingrowth observed so far. (6,7) The highly porous structure of such a material justifies not only the outstanding ingrowth performance, but also the relevant friction coefficient, that was estimated to be 40 to 75% higher than standard coatings. (8) This surface property may allow adequate primary fixation even in case of poor or no press-fit.

From 2005 so far only several series were published about THA revision with TM acetabular cup without augmentation (9,10,11, 12). Only two of them (11,12) dealt specifically with high degree of bone defect. Purpose of this study is to evaluate the mid-term results of porous tantalum cup reimplantation in the worst scenario of very

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low host bone-prosthesis contact.

MATERIALS AND METHODS

All hip revisions performed by our Division from 2008 to 2009 with implantation of a TMT multi-hole modular acetabular cup (Zimmer, Warsaw, IN, US) without augmentation were retrospectively reviewed. Exlusion criteria were stage I and II bone loss according to GIR classification (13), inappropriate surgical report (poorly describing the bone defect), inadequate pre- and post-operative x-rays. The GIR classification of periprosthetic bone loss is the official classification recognized by the Italian Association for Revision Arthroplasty, whose acronym was GIR at the time when this classification was developed (13). The low number of well defined stages makes this grading system extremely surgeon-friendly. Even though its use is limited mostly to Italian surgeons, we did not try to convert the GIR stage recorded in the surgical report into the supposedly equivalent stage of a worldwide accepted system, as this conversion might have been inaccurate. According to GIR classification, stage I is a concentric enlargement, stage II means one-wall defect, stage III multiple-wall defect with possible erosion of the lamina quadrilatera, and lastly stage IV is a pericetabular massive bone loss (up to the pelvic discontinuity). In this study only multiple-wall defects and massive periacetabular bone resorption were included.

Twenty-five cases were identified from the institutional data base, but four were lost to follow-up. Twenty-one cases, 13 females and 8 males, were available for clinical and radiological evaluation. The mean age was 71.28 ± 6.76 years (ranging from 60 to 82). Fifteen hips showed a stage III bone loss and six a stage IV. No complete pelvic discontinuity was ever observed, as a remnant of the posterior and/or the anterior column was always present at the time of revision. The diagnosis was aseptic looseneing in 17 cases, infection in 3 cases, recurrent dislocation in one case. When infection was the diagnosis for revision, the index procedure was the second step of a two-stage treatment, in which THA removal and antibiotic-loaded spacer implantation constituted the first step (occurred 2-4 months before). In four cases (three of which were the septic loosening cases) a complete THA revision was performed – with substitution of both the cup and the stem – while the remaining seventeen hips underwent just the acetabular revision. The surgical approach was direct anterior in 15 cases and direct lateral in 6. The mean interval from surgery to evaluation was 20.9 ± 5.51 months (ranging from 13 to 30).

The following data were collected:

- acetabular component size and number of screws;
- abduction angle and center of rotation height as measured on a pelvis post-operative anteroposterior (AP) view;
- bone grafing (structured or morcellized);
- bone-prosthesis contact, calculated on post-operative AP roentgenogram as the percentage of the cup profile matched by host bone;
- complications and failure rate;
- Harris Hip Score (14);
- presence and thickness of periprosthetic radiolucencies, located on AP view according to DeLee and Charnley's zones (15).

RESULTS

Implanted TMT acetabular component ranged from size 52 to size 64, with mode equal to 58mm. All the cups were fixed with screws (from 3 to 6, mode 4). The mean component abduction angle was 44.95 ± 6.68° (ranging for 35° to 57°), while the mean height of the hip center of rotation was 8.28 ± 6.67 mm above the contralateral hip (ranging from +1 to +28mm). All the acetabula were grafted with fresh-frozen homologous bone, 10 with morcellized chips alone, 11 with morcellized chips and structured graft (Fig. 1-2). The host bone-prosthesis contact was 35 ± 12% (ranging from 20% to 60%).

Four complications were recorded: two dislocations (9.52%), 1 infection (4.76%) and 1 early loosening (4.76%). One dislocation was managed with closed reduction under anesthesia and did not relapse, while the other three complications required further surgery: polyethylene insert reorientation and head lengthening in the second unstable hip, deep surgical debridement of the early infection and acetabular re-revision with larger cup in the early loosening case. If any case needing reoperation is considered a failure, this series showed a failure rate of 14.28% after 20.9 ± 5.51 months, but if the failure definition is limited to socket substitution, thus the failure rate decreases to 4.76%.

The last calculation of the Harris Hip Score averaged 81.96 ± 9.72, ranging from 63.44 to 95.82. If scores are divided into excellent (90-100), good (80-89), fair (70-79) and poor (<70), the distribution of clinical outcome classes is reported in table 1.

The radiological examination showed no radiolucent lines thicker than 1 mm on latest AP view of the hip. Of the 20 non-substituted sockets, 11 showed no radiolucencies at all, while 9 showed thin lucent lines (≤ 1mm) in just one acetabular zone (6 cases) or in two (3 cases). None of these findings turned out to be evolutive, if compared with previous x-rays. Thus they were not considered signs of loosening, but just of fibrous fixation.

DISCUSSION

The present case series shows low failure and

Tab. I. *Clinical outcome of the 18 patients who did not undergo further surgery after the index procedure.*

Outcome	Number of pts.	%
Excellent	5	27.78
Good	6	33.33
Fair	5	27.78
Poor	2	11.11

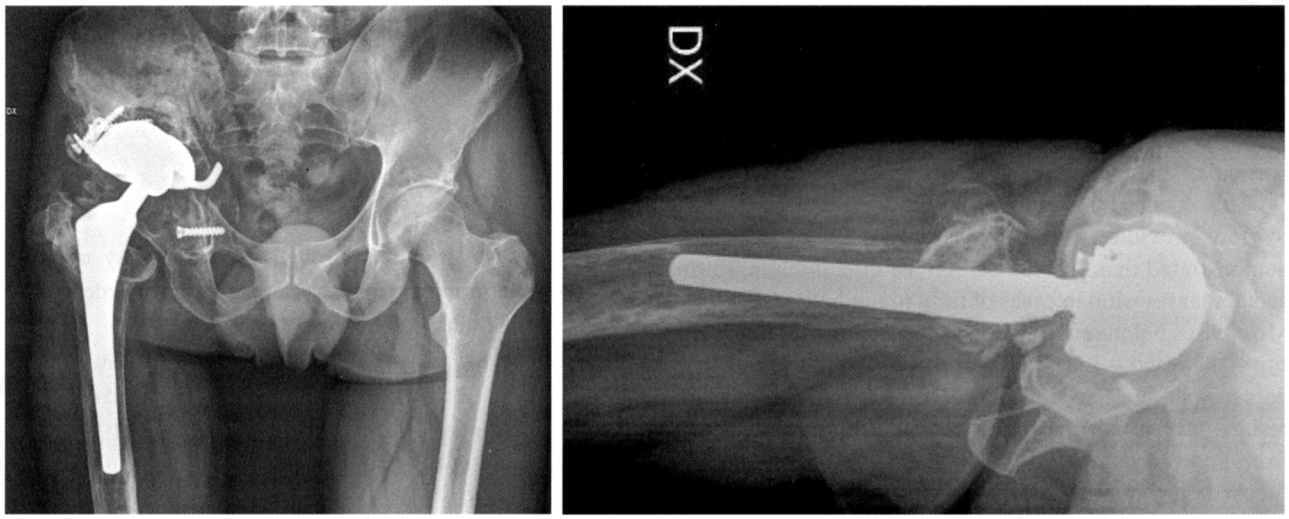

Fig. 1A/B. *Preoperative x-rays. Stage IV acetabular bone loss after reconstruction cage loosening.*

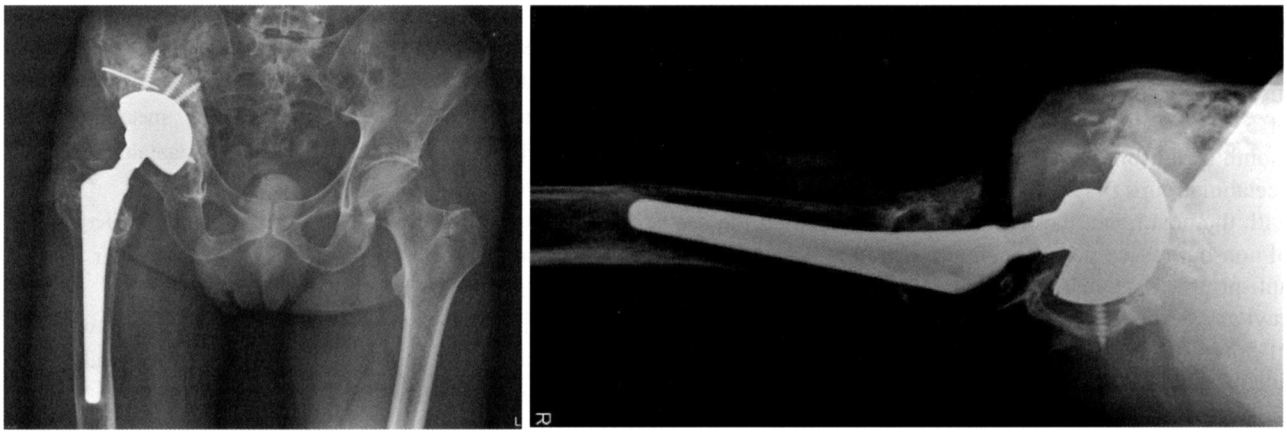

Fig. 2A/B. *Fourteen months after revision with TMT acetabular cup. Morcellized allograft was placed along the medial wall and a structural allograft was pinned in the superior pole of the defect. Notwithstanding the relevant elevation of the center of rotation, the HHS is 70 and no significant radiolucencies can be detected.*

complication rate and satisfactory clinical outcome when a non-buttressed Trabecular Metal cup is used for THA revision with severe pelvic bone loss.

Goodman et al. (16) reported a 24% failure rate at mean 4.6-year follow-up after 61 major bone loss reconstructions with reinforcement cage. Although our follow-up is definitely shorter, a re-revision rate as low as 4.76% is far below what was previously found and may be considered a relevant prognostic improvement.

Cup positioning was quite good as for inclination, since the mean abduction angle is close to the theoretically optimal value of 45° and few cups are significantly far from the average. In our opinion, such an accurate positioning is due to the absence of any anatomical bonds: hemispherical (or elliptical) components do not require to match any bony landmark, differently from stemmed, bilobed or multiple-flange devices. Thus the surgeon should be able to reach the optimal orientation as well as in primary replacement.

All the centers of rotation were higher than the contralateral ones, with a mean cranialization smaller than 1 cm. This elevation is likely related to the same reason for which the orientation is easy and accurate: since no anatomical landmarks are used for positioning (especially ischium or obturator foramen), no restraint prevents the socket from cranial implantation. However this downside does not seem to have affected the clinical outcome. It was very satisfactory among non-reoperated patients, whose 61.01% were classified good or excellent.

Several acetabula displayed radiolucent lines, mostly limited to one DeLee and Charnley's zone, rarely to two of them. None of these cup showed any tendency

towards frank loosening so far, although longer follow-up is required to define their long-term outcome. This finding is consistent with the hypothesis that Trabecular Metal develops strong fibrous ingrowth (17), that might compensate for weak or limited bone ingrowth in particularly severe bone defects.

The object of this retrospective study was investigated by few previous papers (9,10,11,12). Unger et al (9) demonstrated that this device may be effectively used for acetabular revision in cases of mild to moderate bone loss. Most cases belonged to Paprosky's grade II (18), were the rim – distorted – is still present, and in 55 out of 60 hips no screws were needed. Kim et al (10) achieved similar results, still in a wide range of pathoanatomical lesions from Paprosky's grade II to grade III. Lakstein et al (11) focused on contained large bone defects in which the host bone-prosthesis contact was less than 50%. Differently from our study, the Authors evaluated the contact area intraoperatively under direct visualization, and determined 19% as mean contact in their series. This percentage should not be compared with our result because of the different method of calculation. Anyway, this prospective series of 53 revisions showed four mechanical failures at 45-month mean follow-up, confirming the good fixation TM acetabular cups may achieve even in case of poor contact with the host bone. Kosashvili et al (12) reported the use of non-buttressed porous tantalum cup in re-revision after anti-protrusio cage or roof ring failure: although only cavitary defects were addressed, the significant amount of bone loss did not prevent the Authors from reaching adequate reconstruction and satisfactory outcome in 12 out of 15 patients. Even if pelvic discontinuity was never retrieved in our series, Sporer and Paprosky (18) already demonstrated that porous tantalum component may be effectively implanted in such a severe skeletal damage too. This series, however, often used the tantalum cup together with tantalum augments in order to fill the massive bone defect.

This study has several limitations. Firstly, the follow-up is too short to rule out any delayed failure due to insufficient osteointegration. Actually the cups surrounded by radiolucent lines extended beyond a single zone are strictly monitored in order to detect any possible migration. So far it did not occur. Secondly, the bone loss was staged with a classification system used mainly in the national setting, and this choice may hamper the comparison of our results with other series. However, this decision was made in order not to distort the judgement made by the surgeons in the operating room. Thirdly, the observer was not independent nor blinded.

In conclusion this retrospective case series confirms that porous tantalum modular cup may be successfully used to reconstruct severe bone defects in THA revision even without augmentations. This option may reduce the complexity of most acetabular revisions, avoiding the time-consuming steps of augment positioning or flange shaping.

REFERENCES

1. Berry DJ, Müller ME. Revision arthroplasty using an antiprotrusio cage for massive acetabular bone deficiency. J Bone Joint Surg Br 1992;74:711–715.
2. Gill TJ, Sledge JB, Mu¨ller ME. The management of severe acetabular bone loss using structural allograft and acetabular reinforcement devices. J Arthroplasty 2000;15:1–7.
3. Gross AE. Grafts and cages: managing massive bone loss. Orthopedics. 2000;23:973–974.
4. Bobyn JD, Stackpool GJ, Hacking SA, Tanzer M,Krygier J. Characteristics of bone ingrowth and interface mechanics of a new porous tantalum biomaterial. J Bone Joint Surg Br 1999;81:907-914.
5. Zardiackas LD, Parsell DE, Dillon LD, Mitchell DW, Nunnery LA, Poggie R. Structure, metallurgy, and mechanical properties of a porous tantalum foam. J Biomed Mater Res 2001;58:180-187.
6. Bobyn JD, Toh KK, Hacking SA, Tanzer M, Krygier JJ. Tissue response to porous tantalum acetabular cups: A canine model. J Arthroplasty 1999; 14:347-354.
7. Levine B, Della Valle CJ, Jacobs JJ. Applications of porous tantalum in Total Hip Arthroplasty. J Am Acad Orthop Surg 2006;14:646-655.
8. Stiehl JB: Trabecular metal in hip reconstructive surgery. Orthopedics 2005;28:662-670.
9. Unger AS, Lewis RJ, Gruen T. Evaluation of a porous tantalum uncemented acetabular cup in revision total hip arthroplasty: clinical and radiological results of 60 hips. J Arthroplasty 2005;20:1002–1009.
10. Kim WY, Greidanus NV, Duncan CP, Masri BA, Garbuz DS. Porous tantalum uncemented acetabular shells in revision total hip replacement: two to four year clinical and radiographic results. Hip Int 2008;18:17–22.
11. Lakstein D, Backstein D, Safir O, Kosashvili Y, Gross AE. Trabecular metal cups for acetabular defects with 50% or less host bone contact. Clin Orthop Relat Res 2009; 467: 2318–2324.
12. Kosashvili Y, Safir O, Backstein D, Lakstein D, Gross AE. Salvage of failed acetabular cages by nonbuttressed trabecular metal cups. Clin Orthop Relat Res 2010;468(2): 466-71
13. Pipino F, Molfetta L. GIR classification of acetabular and femoral bone loss in revision hip arthroplasty surgery. J

Orthopaed Traumatol, 2000;1(2):69-77.

14. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. *J Bone Joint Surg Am* 1969;51(4):737–755.
15. DeLee JG, Charnley J. Radiological demarcation of cemented sockets in total hip replacement. Clin Orthop Relat Res 1976;121:20-32.
16. Goodman S, Saastamoinen H, Shasha N, Gross A. Complications of ilioischial reconstruction rings in revision total hip arthroplasty. J Arthroplasty 2004; 19(4): 436-446.
17. Hacking SA, Bobyn JD, Toh KK, Tanzer M, Krygier JJ: Fibrous tissue ingrowth and attachment to porous tantalum. J Biomed Mater Res 2000;52:631-638.
18. Paprosky WG, Perona PG, Lawrence JM. Acetabular defect classification and surgical reconstruction in revision arthroplasty. A six year follow-up evaluation. *J Arthroplasty* 1994;9(1):33-44.
19. Sporer SM, Paprosky WG. Acetabular Revision Using a Trabecular Metal Acetabular Component for Severe Acetabular Bone Loss Associated With a Pelvic Discontinuity. J Arthroplasty 2006;21(6 Suppl 2):87-90