A Custom-made Acetabular Implant for Paprosky Type 3 Defects

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Abstract: Acetabular revision is a challenging operation, especially when dealing with major bone loss and poor bone quality. This article describes a detailed approach to defect analysis, including measurement of bone deficiency and bone quality. A custom-made titanium implant, with precisely outlined flanges to the host bones of the ilium, ischium, and pubis, taking into account the bone quality for optimal screw purchase, was used to reconstruct the acetabular defect. Preliminary results for 12 patients who were retrospectively reviewed after a minimum follow-up of 18 months were promising. [Orthopedics. 2017; 40(1):e195-e198.]

Acetabular revision becomes more challenging with increasing bone loss and decreasing bone quality. Current solutions for acetabular reconstruction of large Paprosky type 3 defects include the use of bone impaction grafting, structural allograft, tantalum augments, ring and cage reconstruction, oblong cup reconstruction, cup-cage reconstruction, and triflange reconstruction.

The authors present a technique to analyze the defect in detail and to reconstruct the acetabulum using a custom-made trabecular titanium implant (aMace Acetabular Revision System; Mobelife, Leuven, Belgium) that matches the anatomy of the bone-deficient acetabulum, taking into account the patient’s bone quality to achieve primary implant stability.

Materials and Methods

In 2011 and 2012, the authors used this technique to treat 12 consecutive patients. The authors included patients with failed acetabular reconstructions and bone defects to such an extent that the use of regular techniques for reconstruction of large defects (ie, bone impaction grafting, solid bone graft, and anti-protrusio cages) was precluded. The authors were always able to introduce the custom device in the series of 12 and never had to resort to standard techniques as an escape.

Patients were retrospectively reviewed after a minimum follow-up of 18 months (range, 18-39 months). All patients were asked to answer a questionnaire, which included the 12-item Oxford Hip Score translated in Dutch and completed with extra questions described by Gosens et al, the Hip Disability and Osteoarthritis Outcome Score—Physical Function Short Form (HOOS-PS), the visual analog scale, and 2 core questions. The core questions were: (1) Would you recommend this procedure to a family member or friend? (2) How did your daily functioning change after the procedure? Complications were reviewed in the complication registration system. One patient was not available to complete the questionnaire. Incomplete parts of the questionnaire were excluded for review.

Pre- and postoperative scans of 8 patients were available for comparison of the planned and the postoperative center of rotation. The study had institutional review board approval and all patients gave informed consent.
First, patients had a computed tomography scan with a slice thickness between 1 and 2 mm of the complete pelvis. Special software was used to subtract all parts of the existing reconstruction to assess the ultimate bone defect (Figure 1). A descriptive Paprosky classification was used to assess the deficient acetabular rim and the anterior and posterior columns.

The next step was to calculate the total radial acetabular bone loss. The total radial acetabular bone loss classification is a quantitative, computerized method to assess the degree of acetabular bone deficiency in the acetabulum. It is based on advanced 3-dimensional computed tomography–based image processing and effective 3-dimensional anatomical reconstruction methodology. The output data consist of a ratio and a graph. Both can be used for direct comparison between specimens or acetabular sides. The ratio is a measure for the amount of original acetabular bone that is missing. The graph represents the remaining bony support in the radial direction (Figure 2). The software also allows an assessment of the bone quality with a color gradient from red (inferior) to green (excellent).

On the basis of this information, one porous augment and a cage were designed, as either a monoblock (Figure 3) or a modular construct, to restore the center of rotation and to compensate for the missing bone volume.

The implant was fixated with exactly planned (crossed) screw trajectories and screw lengths through the cup and the precisely outlined flanges to the host bones of the ilium, ischium, and pubis, taking into account the bone quality for optimal screw purchase (Figure 4). Screws also provide fixation of modular constructs in a similar manner.

During the entire process, the surgeon gave feedback on the defect classification, the design, and the implant orientation in the defect to optimize inclination, anteversion, and center of rotation of the construct.

During surgery, the surgeon was provided with an anatomical plastic model of the hemipelvis, trial implants in modular and monoblock fashion, and drill guides. The plastic model helps to identify the defect as assessed in the computed tomography scan analysis.
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<th>Patient No./Sex/Age, y</th>
<th>Follow-up, mo</th>
<th>Primary Diagnosis</th>
<th>Revision Reason</th>
<th>Paprosky Type</th>
<th>No. of Revision</th>
<th>Stems</th>
<th>Use of Bone Graft</th>
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Abbreviations: AVN, avascular necrosis of the femoral head; CHD, congenital hip dysplasia; F, female; HOOS-PS, Hip Disability and Osteoarthritis Outcome Score–Physical Function Short; M, male; OA, osteoarthritis; RA, rheumatoid arthritis; VAS, visual analog scale.

a Patients were asked which situation suited them the best.
b Unilateral hip problems.
c Hip problems and health problems that influence daily functioning.
d Bilateral hip problems.
e No stem revision but cerclage and tibia strut graft was used because of poor femoral bone.
Exposure was obtained using a posterolateral approach. Removal of a fixed femoral component is not mandatory. After release and careful tissue dissection, the entire acetabular defect was exposed, including the iliun, ischiun, and pubic bone. Osteophytes may have to be removed according to preparative planning. Morselized allograft bone may be used in cases of voids and cavitary defects between the host bone and the implant. It is used mostly in large medial defects to avoid filling these completely with titanium. Using the trial implants, the preplanned fit of the final implant to the acetabular defect was achieved (Figure 5).

Finally, the implant was introduced in the defect and fixed with the flange and cup screws using the drill guides. Intraoperatively, the length of all screws measured had to be compared with the planning. A dual mobility cup design was cemented into the custom-made implant to reduce dislocation risk (Figure 6) (Video).

RESULTS

The patients’ data are provided in the Table. Four patients had complications. There were no infections and no additional surgery was needed.

All patients were satisfied with their custom-made implant. All patients, except for patient 4, would recommend the treatment to a family member or friend. Most patients thought their daily functioning was improved after the custom-made implant except for patients 2 and 4, who thought their functioning was slightly worsened. Additionally, those 2 patients did not have better mobility or less pain of the hip after the procedure. All of the other patients had better mobility and less pain except for patient 9, who had less pain but not better mobility of the hip.

DISCUSSION

Custom-made implants for reconstruction of large acetabular defects are not new. The current technique, however, has several features that can be considered unique compared with the custom designs reported in the literature. Detailed acetabular defect analysis is the gateway to a descriptive classification, measurement of total radial acetabular bone loss, and reconstruction options. Bone quality assessment pre-determines crossed, not parallel, screw fixation options to obtain optimal fixation and primary implant stability. The final implant matches the patient’s anatomy not only with the custom-made augment filling the acetabular defect perfectly but also with the precisely outlined flanges over the iliun, ischiun, and pubic bone. Traditional augments and cages cannot accomplish this. Ultimately, the reconstruction restores the center of rotation. During the development process, the surgeon is providing feedback and the manufacturer can adapt to the surgeon’s recommendations.

Finally, several tools are available to assist the surgeon during the operation and to introduce the custom-made implant as accurately as possible according to planning.

Existing literature shows the difficulty of treating large defects with custom-made implants, with complication rates from 16% to 53%, re-revision rates from 11% to 35%, and component removal rates from 0% to 21.5%. This case series showed satisfactory clinical results, especially considering that most patients were also inhibited in their daily functioning because of the contralateral hip or other health issues. There were no cases that needed revision surgery and all of the patients were satisfied with the results. The cases with the worst outcomes were understandably those that were complicated by fractures.

CONCLUSION

The authors have described an integral approach to treat large acetabular defects that require a revision strategy different from the more common options available. Preliminary results in this small series are promising. The authors will continue with this technique and its follow-up for large acetabular defects.

REFERENCES