



OPEN ACCESS

Case report

Customised three-dimensional printed revision acetabular implant for large defect after failed triflange revision cup

Stefano Zanasi,^{1,2} Hassan Zmerly ^{3,4}

¹Hesperia Hospital, Modena, Emilia-Romagna, Italy
²University of Bologna, Bologna, Emilia-Romagna, Italy
³San Pier Damiano Hospital, Faenza, RA, Italy
⁴UCM (MT), LUDS, Lugano, Switzerland

Correspondence to
Professor Hassan Zmerly;
zmerly@msn.com

Accepted 25 March 2020

SUMMARY

Aseptic loosening is the most common cause for total hip arthroplasty revision. Acetabular cup revision is a significant challenge in the presence of a large bone defect. One of the options for cup revision in the presence of a large bone defect is the recently introduced customised three-dimensional (3D)-printed reconstruction. We present the case of a 68-year-old woman successfully treated with a customised revision acetabular implant for the failure of triflange cup in the presence of large acetabular defect. The modern orthopaedic surgeon must have full knowledge of customised 3D-printed reconstruction to have as a reserve solution for difficult hip revision surgery.

BACKGROUND

Aseptic loosening is the most common cause for total hip revision arthroplasty and numbers are projected to grow due to the high number of people undergoing primary hip arthroplasty.^{1–3}

Cup orientation and fixation are key to success in acetabular revision. The more challenging condition is the cup revision in patients with large bone defect that may be present in the first or subsequent revisions.^{4–6} One of the options for cup revision in the presence of severe defect is the recently introduced customised three-dimensional (3D)-printed reconstruction.

CASE PRESENTATION

A 68-year-old active woman presented with worsening left groin and lateral hip pain for 6 months that was aggravated by weight-bearing and shifting of body weight, particularly in bed. She also noted ‘noises’ coming from her hip with activity. Her medical history included repeated failed implant arthroplasties requiring multiple orthopaedic operations.

The patient had total hip arthroplasty (THA) at the age of 33 for osteoarthritis in grade 2 Crowe hip dysplasia, and had subsequently undergone multiple revision hip procedures. Her most recent left hip surgery, 2 years prior, was acetabular re-revision using a four flange acetabular Delta Revision cup component associated to a trabecular metal augment and bone graft in situ.

At baseline, the patient was confined to a wheelchair, using her lower limbs for transfers. She wore a 2.5 cm foot orthotic on her left lower extremity

to compensate for minor limping. On physical examination, she was 4 feet, 10 inches tall, weighed 148 lbs and had a body mass index of 30,9. She had 0°–90° of active flexion in both hips, muscle strength of 4/5 for hip flexion and extension and knee extension and flexion. She had ankle and big toe dorsiflexion strength of 0/5.

INVESTIGATIONS

Preoperative investigations showed cup migration and type 3B acetabular defect based on Paprosky classification, with massive periacetabular bone loss and pelvic discontinuity (figure 1); serial radiographs revealed a failed left acetabular multiflange component with loosening of the ischial flange, poor bone quality, disruption and medial protrusion of the missed acetabular medial wall, damage of the trabecular metal augment and 18 mm raising and 25 mm offset from the centre of rotation (COR).

CT imaging showed radiolucency medial to the acetabular component along with displacement of the ischial portion of the left multiflange, suggestive of severe loosening with medial wall damage and strong adherence of the iliac vessels to the bone graft. Tests for infection including erythrocyte sedimentation rate, C-reactive protein level and hip aspiration were negative.

TREATMENT

Preoperative CT scan planning using 3D reconstructions and computer modelling (in collaboration with the Medics Srl (Moncalieri, Torino, Italy)) enabled the production of a template of the left hemipelvis (figure 2) and the correct bone screws position with the previously revised THA component removed (figure 3). Then promade



Figure 1 Preoperative X-ray (A) and CT scan (B,C) images showing triflange acetabular cup failure.



© BMJ Publishing Group Limited 2020. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

To cite: Zanasi S, Zmerly H. *BMJ Case Rep* 2020;**13**:e233965. doi:10.1136/bcr-2019-233965



Figure 2 Three-dimensional production of a template of the left hemipelvis.

exclusive implants by Lima Corporation (Villanova di San Daniele del Friuli, Udine, Italy) realised the customised monobloc piece to restore the COR and the bone stock and level the lower limbs. To avoid any further complication during orthopaedic explant and reimplantation, our first surgical step was an anterior approach in supine position to accurately isolate the vascular bundles (figure 4A).

Then, with patient in a lateral position we proceeded with hip posterolateral approach to:

- ▶ Remove the previous implant.
- ▶ Use the pre-op anatomy model to identify the patient's anatomical landmarks.
- ▶ Determine the position and depth of the reaming to prepare the spherical cavity.
- ▶ Clean up the osteophytes.
- ▶ Assess by the flangeless trial component the correct reaming and cup position.

Finally, we used the trial implant to check flange fitting and press fit impacted the final implant that was further stabilised with screws (figure 4B,C) and finally coupled with poly insert.

Intraoperatively, it was necessary to elevate the sciatic nerve, which was encased in scar tissue adhering to the posterior ischium.

Despite the distalising and medialising of the acetabular component, the hip could be easily reduced. Stable reduction was achieved with the correction of the normal leg-length discrepancy.

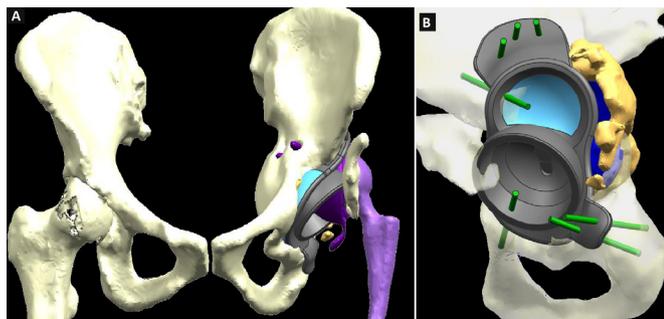


Figure 3 Three-dimensional reconstruction with the correct bone screws position (A,B).

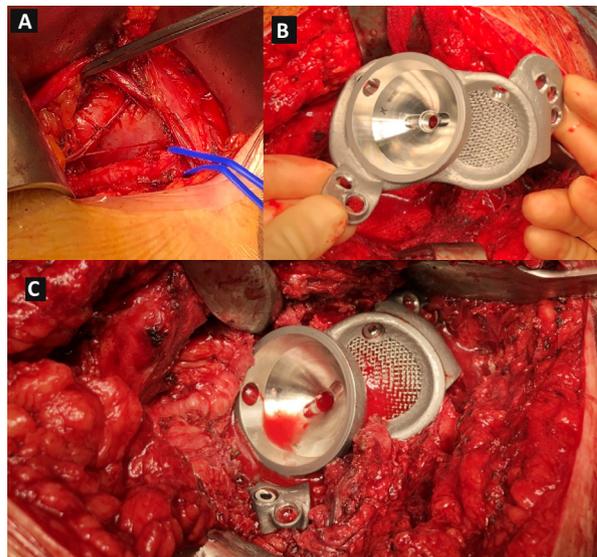


Figure 4 Surgical procedure. (A) Anterior approach in supine position to isolate the vascular bundles. (B,C) Intraoperative image of final implant stabilised with screws.

OUTCOME AND FOLLOW-UP

Postoperative radiographs and CT scan showed accurate placement of the acetabular component (figure 5). The patient was toe-touch weight-bearing for 6 weeks after surgery and weight bearing was increased gradually over 3 months. Four months after surgery, the patient left a contralateral cane and weight-bearing as tolerated for mid to short distances with no pain in her hip. Six months after surgery, the patient is very satisfied: she does not use any canes, weight-bearing is complete and she has no pain over long distances. She has made a complete recovery with a good quality of life.

DISCUSSION

Aseptic component loosening, along with infection and instability are the most common causes of failure after THA. Acetabular revision in patient with large bone defect that may be present in the first or subsequent revisions, as in the case of failed triflange revision cup with pelvic discontinuity, is a huge challenging problem. The main treatment options may include revision with cage and cup, bone allografts with plating, the use of iliac stem with or without hook, and the new introduced customised 3D-printed reconstruction.⁷⁻⁹ Without the usage of 3D-printing techniques the technical challenges of revision surgery are the difficulty in restoring the correct pelvic bone stock, placing the acetabular component in the right anatomical position and providing construct and joint stability.

The customisable implant option for Paprosky 3A-3B defects can have a biflange or triflange acetabular component.¹⁰ Unlike other techniques, the customised components are rigid, can better restore the COR and address large amounts of bone loss while providing immediate fixation using multiple screws.¹¹ The implants have the potential for biological ongrowth; a plasma-sprayed porous coating with a hydroxyapatite layer promotes bone ongrowth.

When a previous triflange acetabular implant has failed, leaving large acetabular defects, the surgeon must determine the reasons for failure so as to increase the chance of success of the next implant.¹² In this case, contributing factors included poor existing bone stock, the small number of screws used in

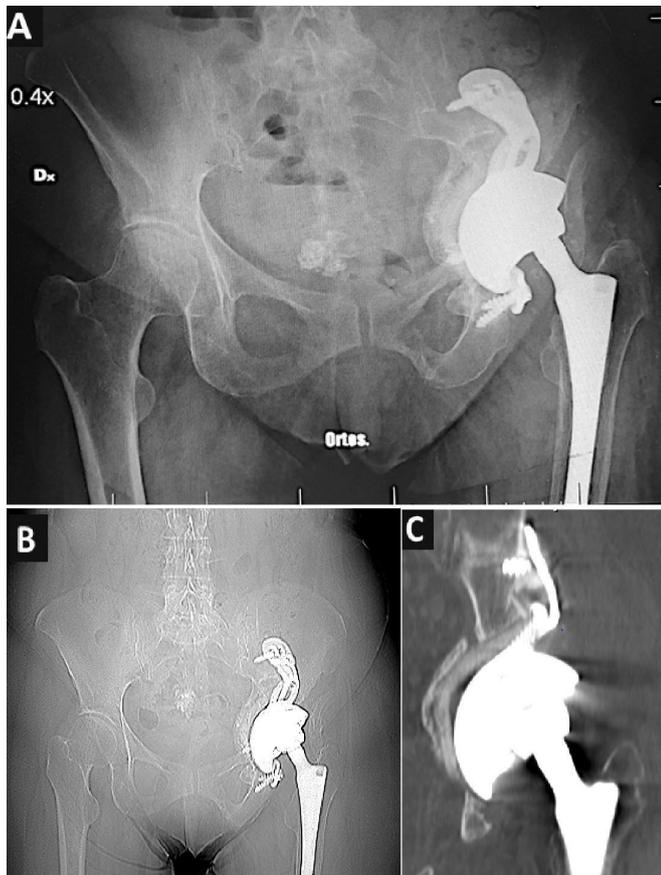


Figure 5 Postoperative X-ray (A) and CT scan (B,C) showed accurate placement of the acetabular component.

the ischial and ilial flanges, the older screw design with closely spaced shallow threads leading to reduced screw pullout strength and failure to medialise the cup as much as possible to improve hip biomechanics.¹³

The bioengineers as well as the surgical team looked for different solutions to enhance fixation while addressing the existing defect: after filling the lack of bone with bone pasta (deminerallized bone matrix (DBM) mixed with processed bone marrow that we harvested from the ipsilateral iliac crest), the cup was positioned with abduction 40° and anteversion 20°. Superior augment was Ø 65 mm as was the inferior one. Ensuring that critical sites were bypassed, Ø 6.5 mm compressive bone screws were positioned, two screws on the ischium, including a long 'homerun' screw which reduces the risk of ischial lift off (the most common mode of failure from posterior–superior directed forces of an adducted hip), one screw on the pubis and four on the ileum. Medialising the implant is necessary as the constrained liner effectively lateralises the hip centre by up to 3 mm.

This case also highlights the importance of the multidisciplinary approach that is often necessary for these complex cases with medial wall damage and intrapelvic adherence.¹⁴

When there is no chance to reconstruct severe bone stock due to implant arthroplasties revision mobilisation, any traditional device represents a challenge with a high percentage of failure within a short time. Developments in bioengineering and biotechnology now make it possible to close this gap even in cases of severe bone defect and damage.¹⁵ This technique was completely unknown before, but now it is becoming more available for difficult cases; however, it is an expensive method and not convenient to use in every centre. It is important that the

modern orthopaedic surgeon has full knowledge of this technique and can keep in reserve for difficult cases.¹⁶

Learning points

- ▶ Aseptic loosening is the most common cause for total hip arthroplasty revision.
- ▶ Acetabular cup revision is a significant challenge in case of multiple revision with large bone defect.
- ▶ One of the options for cup revision in the presence of a large bone defect is the recently introduced customised three-dimensional printed reconstruction.
- ▶ In complex cases with medial wall damage and intrapelvic protrusion multidisciplinary approach is often necessary.

Contributors SZ: conception and design, data collection, supervision, critical revision of the manuscript. HZ: conception and design, writing the manuscript, analysis and interpretation of data, technical and material support.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iD

Hassan Zmerly <http://orcid.org/0000-0003-3353-1759>

REFERENCES

- 1 Sheth NP, Nelson CL, Springer BD, *et al*. Acetabular bone loss in revision total hip arthroplasty: evaluation and management. *J Am Acad Orthop Surg* 2013;21:128–39.
- 2 Chang C-H, Hu C-C, Chen C-C, *et al*. Revision total hip arthroplasty for Paprosky type III acetabular defect with structural allograft and tantalum trabecular metal acetabular cup. *Orthopedics* 2018;41:e861–7.
- 3 Günther K-P, Wegner T, Kirschner S, *et al*. [Modular reconstruction in acetabular revision with antiprotrusion cages and metal augments : the cage-and-augment system]. *Oper Orthop Traumatol* 2014;26:141–55.
- 4 Makita H, Kerboull M, Inaba Y, *et al*. Revision total hip arthroplasty using the Kerboull acetabular reinforcement device and structural allograft for severe defects of the acetabulum. *J Arthroplasty* 2017;32:3502–9.
- 5 De Martino I, Strigelli V, Cacciola G, *et al*. Survivorship and clinical outcomes of custom Triflange acetabular components in revision total hip arthroplasty: a systematic review. *J Arthroplasty* 2019;34:2511–8.
- 6 Taunton MJ, Fehring TK, Edwards P, *et al*. Pelvic discontinuity treated with custom triflange component: a reliable option. *Clin Orthop Relat Res* 2012;470:428–34.
- 7 Yoshino K, Tsukeoka T, Tsuneizumi Y, *et al*. Revision total hip arthroplasty using a Cementless cup supporter and iliac autograft: a minimum of 15-year follow-up. *J Arthroplasty* 2017;32:3495–501.
- 8 Li H, Qu X, Mao Y, *et al*. Custom acetabular cages offer stable fixation and improved hip scores for revision THA with severe bone defects. *Clin Orthop Relat Res* 2016;474:731–40.
- 9 Berasi CC, Berend KR, Adams JB, *et al*. Are custom triflange acetabular components effective for reconstruction of catastrophic bone loss? *Clin Orthop Relat Res* 2015;473:528–35.
- 10 Malhotra R, Gautam D. Cup-Cage construct using porous cup with Burch-Schneider cage in the management of complex acetabular fractures. *Hip Pelvis* 2019;31:87–94.
- 11 Backup J, Salinas EA, Valle AGD, *et al*. Treatment of large acetabular defects: a surgical technique utilizing impaction grafting into a metallic mesh. *Hss J* 2013;9:242–6.
- 12 Barlow BT, Oi KK, Lee Y-Y, *et al*. Outcomes of custom flange acetabular components in revision total hip arthroplasty and predictors of failure. *J Arthroplasty* 2016;31:1057–64.
- 13 Kim K-C, Ha Y-C, Kang B-J, *et al*. Use of cementless acetabular component with a hook and iliac flanges in revision arthroplasty for massive acetabular defect. *J Orthop Sci* 2012;17:18–24.

- 14 Girard J, Blairon A, Wavreille G, *et al.* Total hip arthroplasty revision in case of intra-pelvic cup migration: designing a surgical strategy. *Orthop Traumatol Surg Res* 2011;97:191–200.
- 15 Xia R-Z, Zhai Z-J, Chang Y-Y, *et al.* Clinical applications of 3-dimensional printing technology in hip joint. *Orthop Surg* 2019;11:533–44.
- 16 Heunis JC, Cheah JW, Sabnis AJ, *et al.* Use of three-dimensional printing and intraoperative navigation in the surgical resection of metastatic acetabular osteosarcoma. *BMJ Case Rep* 2019;12:e230–8.

Copyright 2020 BMJ Publishing Group. All rights reserved. For permission to reuse any of this content visit <https://www.bmj.com/company/products-services/rights-and-licensing/permissions/>
BMJ Case Report Fellows may re-use this article for personal use and teaching without any further permission.

Become a Fellow of BMJ Case Reports today and you can:

- ▶ Submit as many cases as you like
- ▶ Enjoy fast sympathetic peer review and rapid publication of accepted articles
- ▶ Access all the published articles
- ▶ Re-use any of the published material for personal use and teaching without further permission

Customer Service

If you have any further queries about your subscription, please contact our customer services team on +44 (0) 207111 1105 or via email at support@bmj.com.

Visit casereports.bmj.com for more articles like this and to become a Fellow