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Case report

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

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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 revisioned THA component removed (figure 3). Then promade

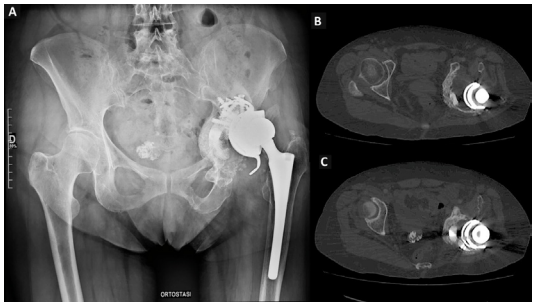

Figure 1 Preoperative X-ray (A) and CT scan (B,C) images showing triflange acetabular cup failur.

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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 rimplantation, 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.

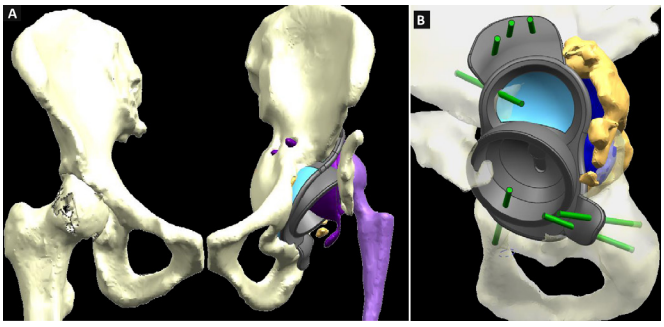

Figure 3 Three-dimensional reconstruction with the correct bone screws position (A,B).

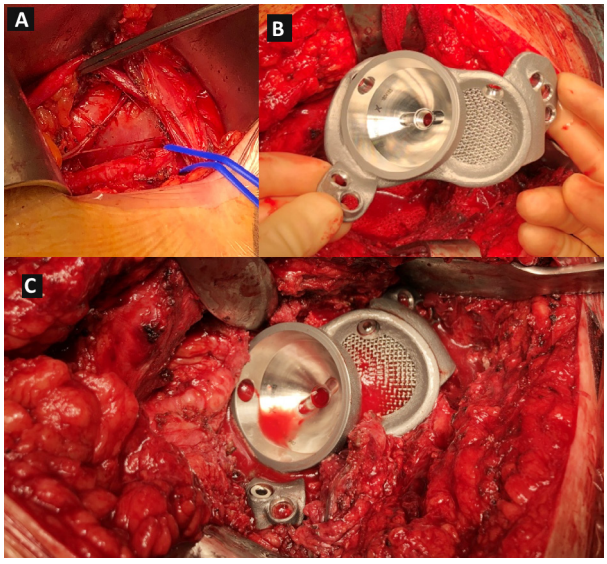

Figure 4 Surgical procedure. (A) Anterior approach in supine position to isolate the vascular bundles. (B,C) Intraoperative image of final implant stabilised with screws.

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

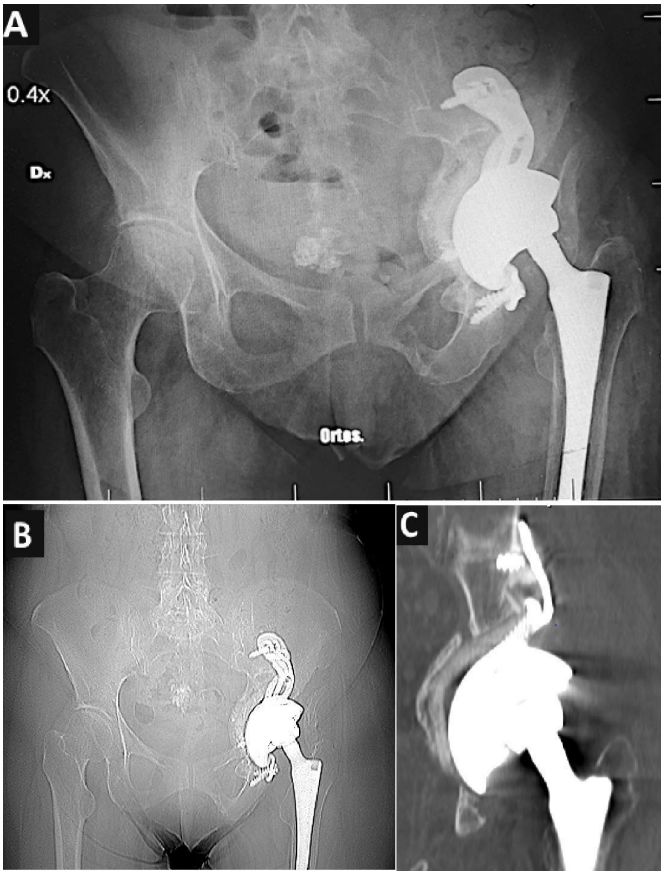

Figure 5 Postoperative X-ray (A) and CT scan (B,C) showed accurate placement of the acetabular component.

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 (demineralized 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 infer ior 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.

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