MENTORS IN ORTHOPEDICS

CUP-CAGE RECONSTRUCTION FOR SEVERE ACETABULAR BONE LOSS AND PELVIC DISCONTINUITY

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SUMMARY

Background: Management of severe acetabular bone loss and pelvic discontinuity in revision total hip arthroplasty remains a significant surgical challenge. Traditional ilioischial antiprotrusio cages often fail due to a lack of biological ingrowth, leading to mechanical fatigue and hardware failure.

Objective: This article describes the surgical technique and clinical outcomes of cup-cage reconstruction, a hybrid construct designed to provide immediate mechanical stability and facilitate long-term biological fixation.

Key Points: The technique utilizes a porous trabecular metal acetabular component supplemented by an antiprotrusio cage. Key surgical steps include thorough debridement to bleeding host bone, morselized allograft impaction, and precise screw fixation into the ilium and ischium. In a series of 35 cases with Paprosky type 2C to 3B defects, the five-year implant survivorship was 89%. The mean Harris Hip Score improved from 30 preoperatively to 71 postoperatively. While effective, the procedure carries risks of sciatic nerve injury and iatrogenic pelvic dissociation during inferior flange placement. Dual-mobility liners are frequently employed to mitigate the risk of postoperative dislocation in patients with abductor deficiency.

Conclusion: Cup-cage reconstruction is a reliable salvage option for major uncontained acetabular defects and pelvic discontinuity. The construct provides sufficient initial stability to allow for secondary osseointegration of the porous shell, demonstrating favorable mid-term durability and functional improvement in complex revision scenarios.

KEYWORDS

Arthroplasty, Replacement, Hip; Reoperation; Acetabulum; Bone Resorption; Pelvis

INTRODUCTION

The management of severe acetabular bone loss in revision total hip arthroplasty (THA) is technically demanding. In cases of major column defects with less than 50% host bone contact, adequate implant fixation with a hemispherical cup and screws alone is not feasible. Furthermore, in cases of pelvic discontinuity (PD) the inherent stability of the hemipelvis is compromised resulting in persistent micromotions across the acetabulum and subsequent implant loosening[1-5]. These complex situations have traditionally been managed with the use of ilioischial antiprotrusio cages. However, since there is no bone ingrowth into the cage, the screws or flanges eventually break, leading to high long-term failure rates[6-12].

Cup-cage reconstruction has evolved as a viable option to treat these challenging revision cases[13]. This construct typically consists of a trabecular metal (TM) acetabular component (Zimmer Biomet, Warsaw, Indiana) fixed with multiple screws and an antiprotrusio cage placed over the cup. The cage provides initial stability to the cup to allow its bone ingrowth. The first reports on mid-term clinical outcomes of this technique in the management of severe acetabular bone deficiencies and pelvic discontinuity are promising[14-19].

IMAGING AND INDICATIONS FOR CUP CAGE CONSTRUCTS

Preoperative radiological assessment with plain radiographs and CT is commonly performed (Fig. 1).

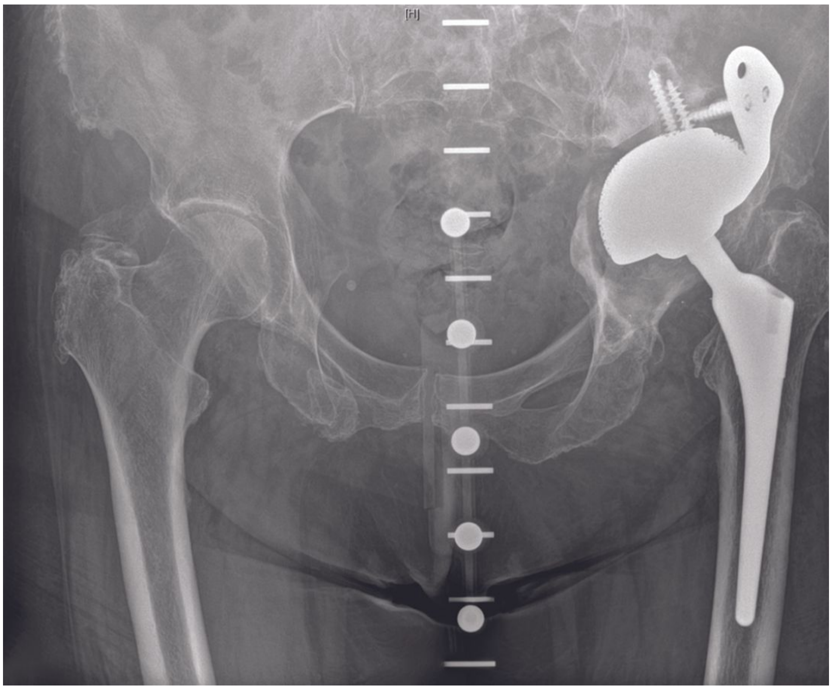

Figure 1: Preoperative radiograph showing a loose acetabular component with a Paprosky type 3B defect with pelvic discontinuity.

However, the acetabular defect type, the quality and location of the remaining host bone and the presence of PD is based on intraoperative findings. Despite a precise preoperative planning and the existence of multiple classification systems to describe acetabular deficiencies to guide the therapeutic approach, in many cases, the decision to use a cup cage construct is made intraoperatively. If stable acetabular reconstruction cannot be achieved through the implantation of a TM cup, with or without augmentation, a cage is placed over the cup to supplement the immediate stability until secondary biological fixation of the TM cup can occur. Thus, cup cage constructs are well suited to all defects which preclude rigid fixation and durable stability using a porous hemispherical cup, with or without the use of augments. These include large combined defects with less than 50% bone stock as well as pelvic discontinuities. Cup cages may be an ideal indication when significant osteolysis is noted about the ischium and posterior column. Standard hemispherical revision components lacking adequate fixation in this location and cages alone are predisposed to subsequent failure. Cup cage constructs may also be considered as an alternative reconstruction option in acute acetabular fractures of the elderly.

SURGICAL TECHNIQUE

With the patient in lateral decubitus position, an anterolateral or posterior approach to the hip is performed dependent on the approach that had been previously used (Fig. 2).

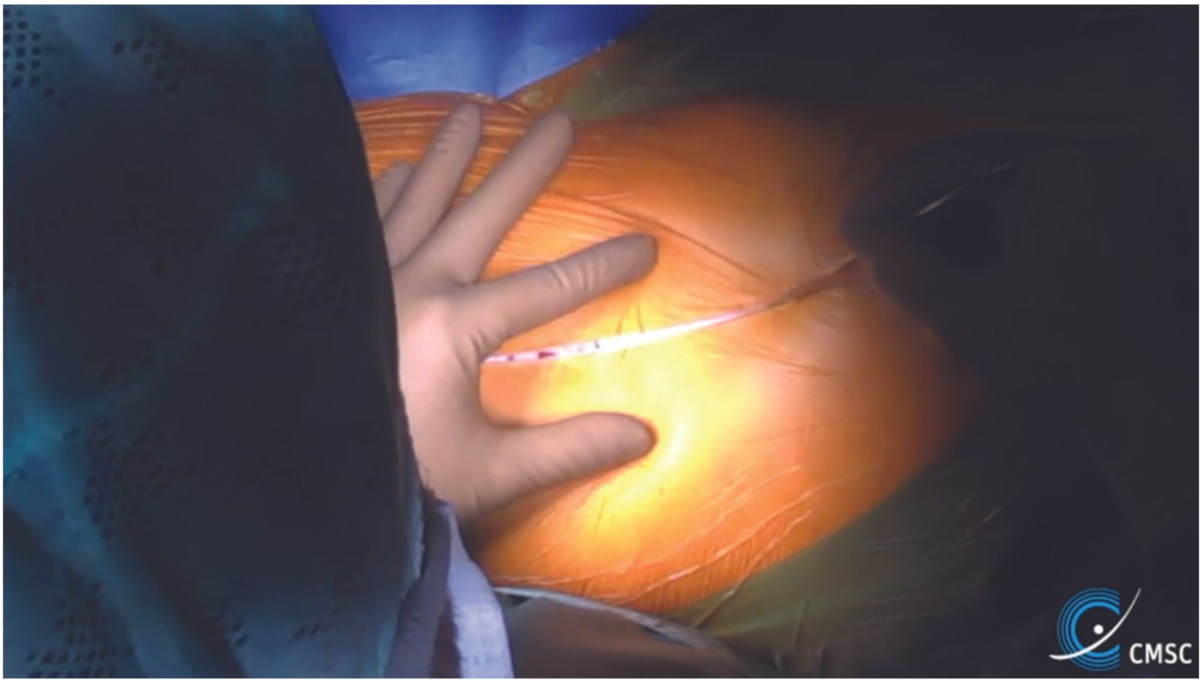

Figure 2: Anterolateral or posterior approach with the patient in the lateral decubitus position.

After joint exposure, a synovial aspiration is performed followed by a complete resection of the capsule; both samples are sent for microbiological analysis. Afterwards, a complete exposure of the acetabular rim extending to the cranial ilium is performed followed by complete removal of the previous acetabular component (Fig. 3).

Figure 3: Complete removal of the loose acetabular component.

A thorough debridement of the acetabulum is performed providing adequate exposure of the entire acetabular rim and segmental rim defects (Fig. 4).

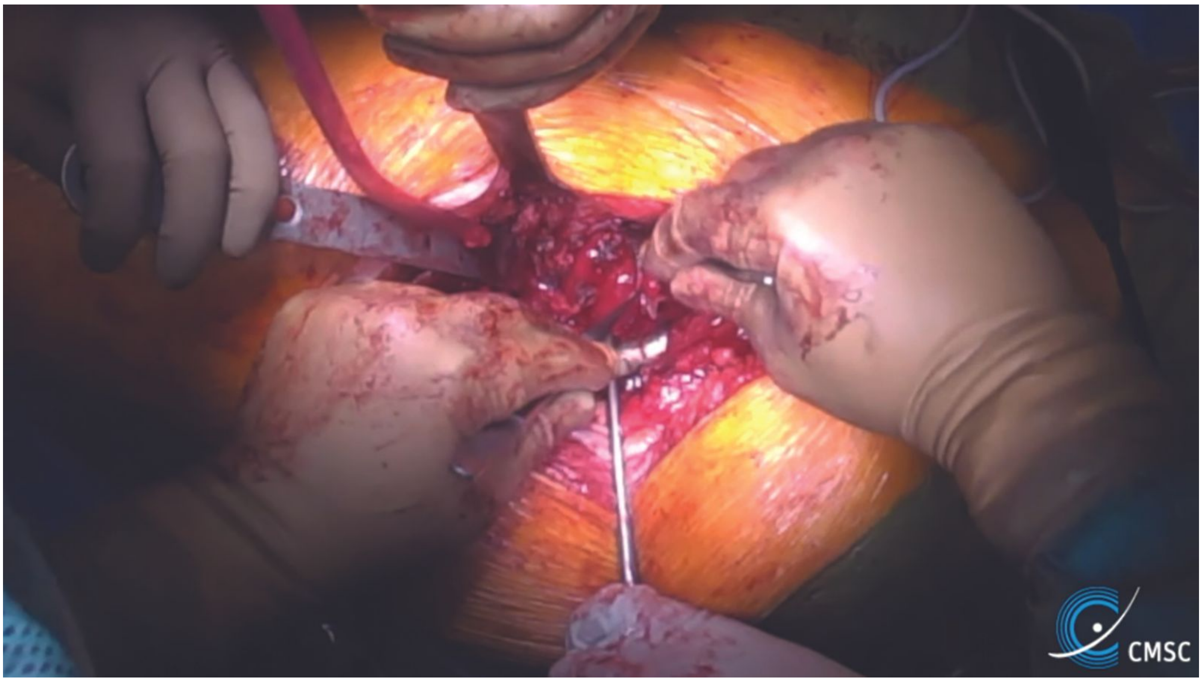

Figure 4: Thorough debridement for adequate exposure of the entire acetabulum.

Afterwards, the sclerotic bone is gently reamed to remove all prominences and smooth the residual acetabular cavity until even bleeding host bone is seen (Fig. 5).

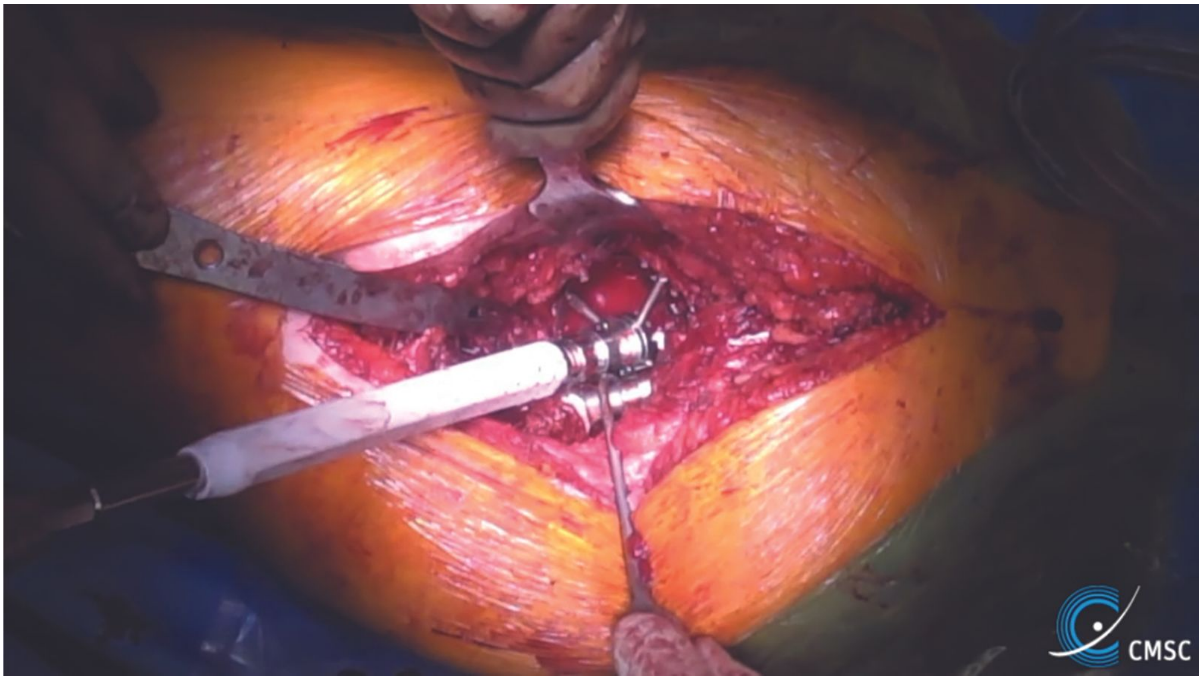

Figure 5: Gentle reaming of the sclerotic bone until even bleeding host bone is seen.

This fresh bleeding bone is essential to guarantee the osseointegration of the TM cup. However, excessive force during reaming is not advised as it can further destabilise the hemipelvis. In the underlying case a Paprosky type 3B defect with complete lysis of the posterior wall is present (Fig. 6).

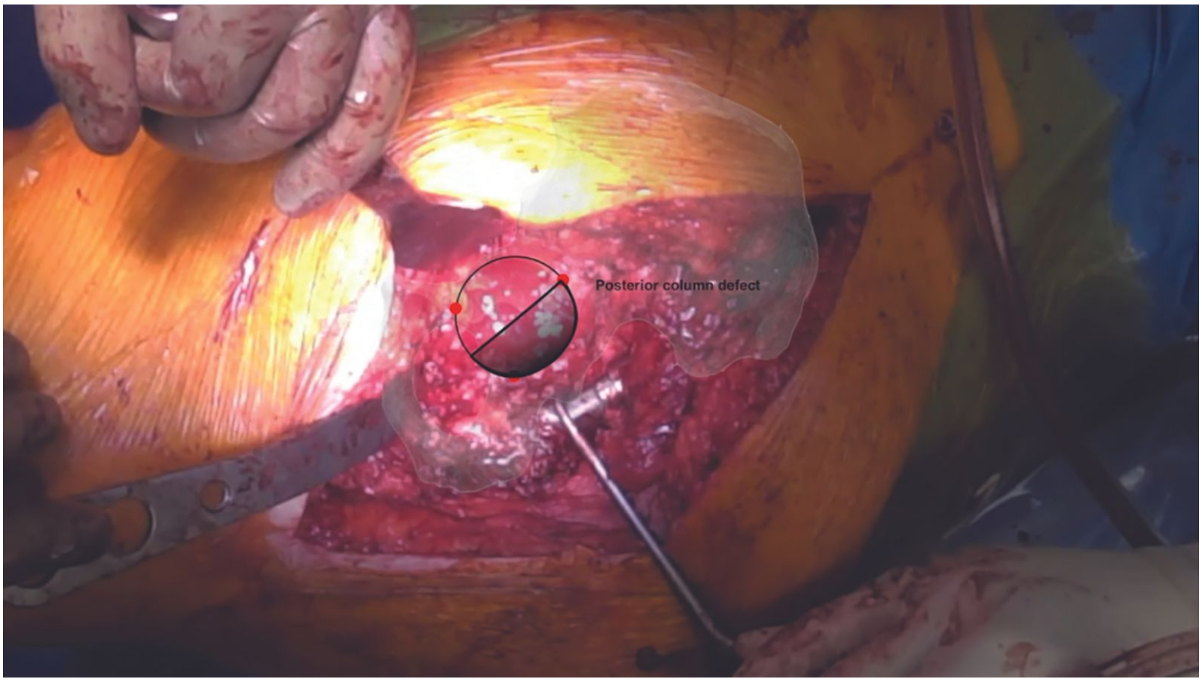

Figure 6: Assessment and classification of the acetabular bone loss. In the underlying case a Paprosky type 3B defect with complete lysis of the posterior wall was present.

In the next step, a hemispherical reamer or acetabular trial is used to determine cup size and need for an augment, with the goal of removing as little host bone as possible while re-establishing the anatomic hip rotation centre. Depending on the acetabular defect pattern and residual host bone, the TM cup is then prepared for adequate screw placement and stable fixation. For this purpose, the metal ring around the rim of the revision cup is removed and holes are drilled through the cup adjacent to the available host bone (Fig. 7).

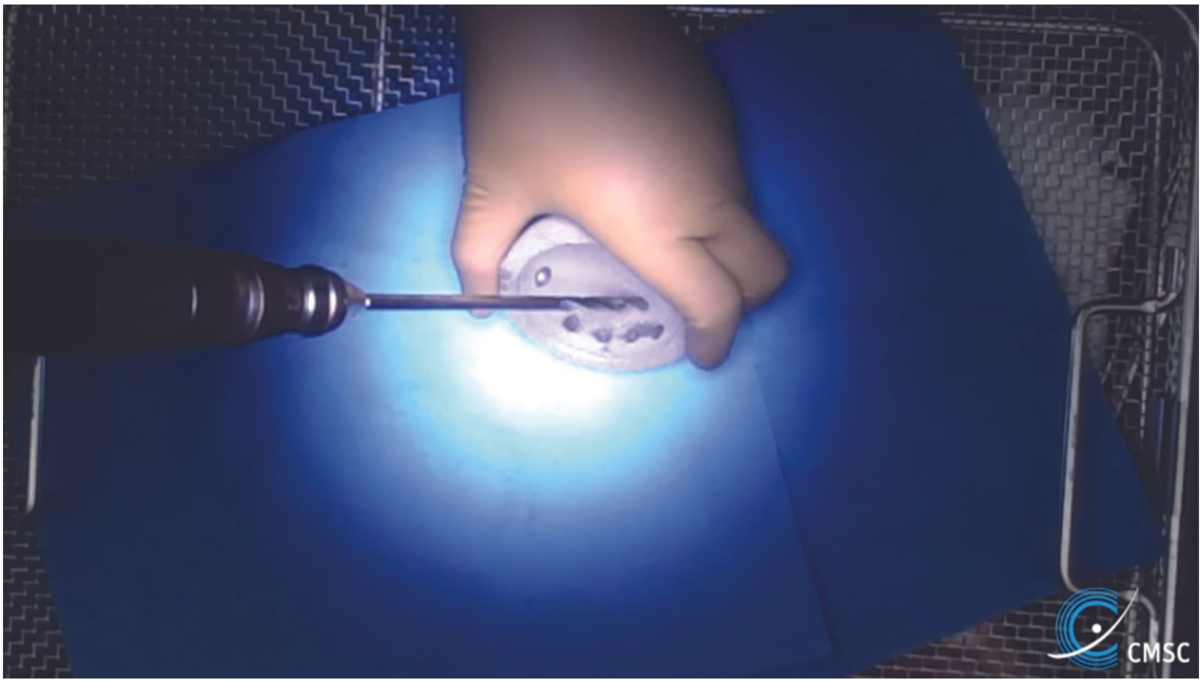

Figure 7: Drilling through the TM acetabular component for proper screw placement to the available host bone.

The cup is rinsed thoroughly to remove any metal debris before implantation. The drilling through the TM acetabular component is approved by the manufacturer only in the revision model (00-7000-056-20; Zimmer Biomet).

The defect is then filled with cancellous allograft and impacted by using reverse reaming, particularly at the site of PD, if present. The goal is to maximize initial mechanical stability to facilitate bone ingrowth from the intact host bone into the acetabular component and augments over the initial few months after surgery.

The TM cup is then placed within the acetabulum so that the edge of the shell ends flush with the acetabular rim for maximum host bone contact, best-possible press-fit and supplementary screw fixation. In the presence of PD, the implant is sized 2 mm larger than the last reamer to apply some distraction to the PD. Although not always possible, at least two screws with good purchase, each aiming in a cranioventral direction into the anterior iliac wing (Fig. 8a) and in a caudoventral direction towards the superior pubic ramus or the ischium (Fig. 8b), are placed to augment the initial press-fit of the TM shell. The screws for the shell are predominantly aligned towards the anterior aspect of the hemipelvis to avoid interfering with the fixation of the cage.

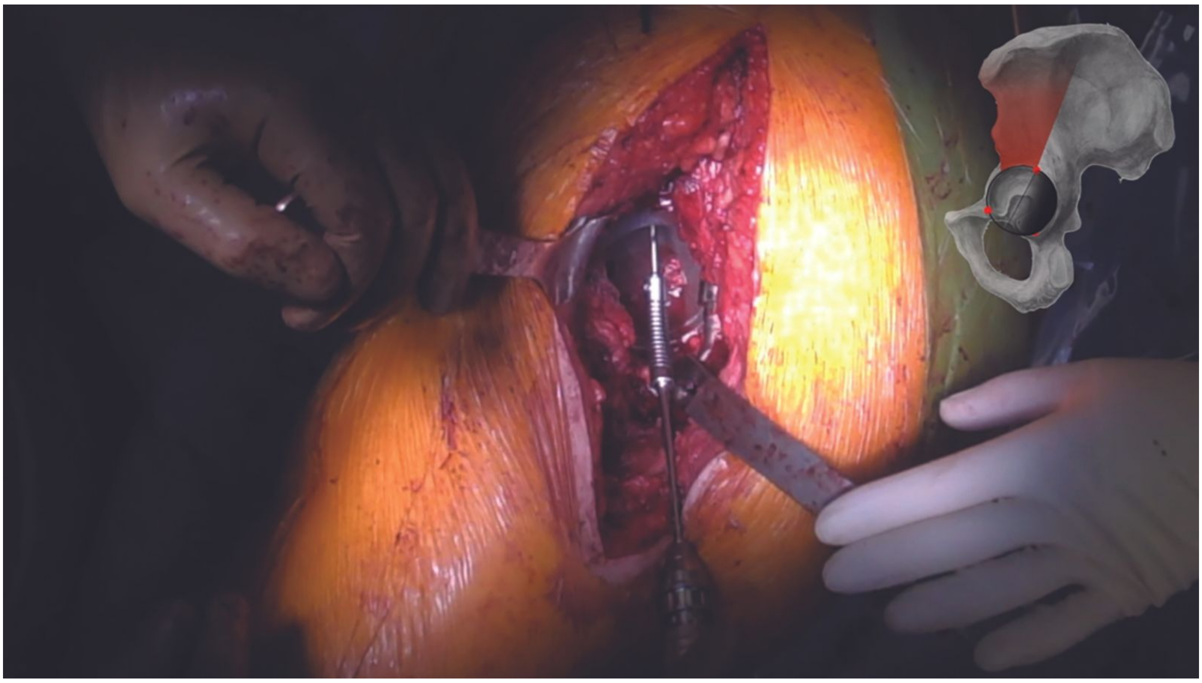

Figure 8a: Placing screws into the acetabular dome.

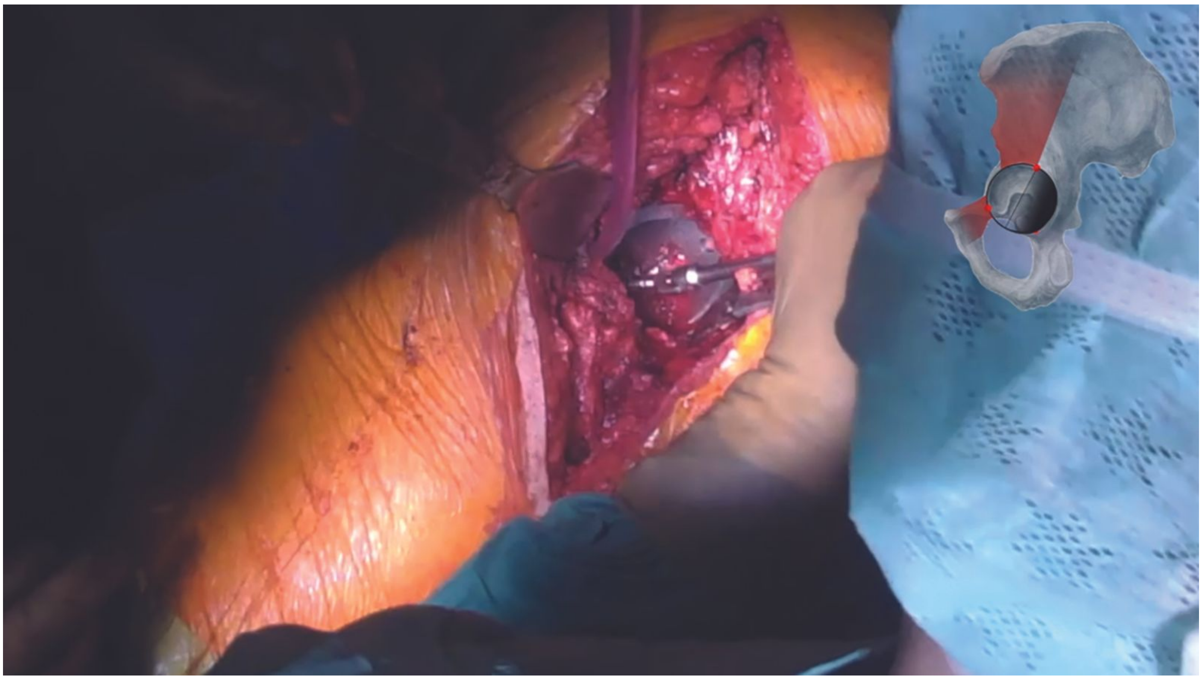

Figure 8b: Placing screws into the pubis.

An appropriate antiprotrusio cage is introduced. To prepare the cage for implantation, the superior and inferior flanges are bent. The inferior fixation of the cage is obtained by bending the base of the ischial flange into a medial position so that subsequent horizontal impaction forced the ischial flange into the ischium (Fig. 9).

Figure 9: Bending the ischial flange of the cage into a medial position for horizontal impaction into the ischium.

Before impaction, the ischium is opened with a lambotte chisel. Although not always possible, at least two screws are then placed through the cage and the cup in a cranial direction into the acetabular dome (Fig. 10).

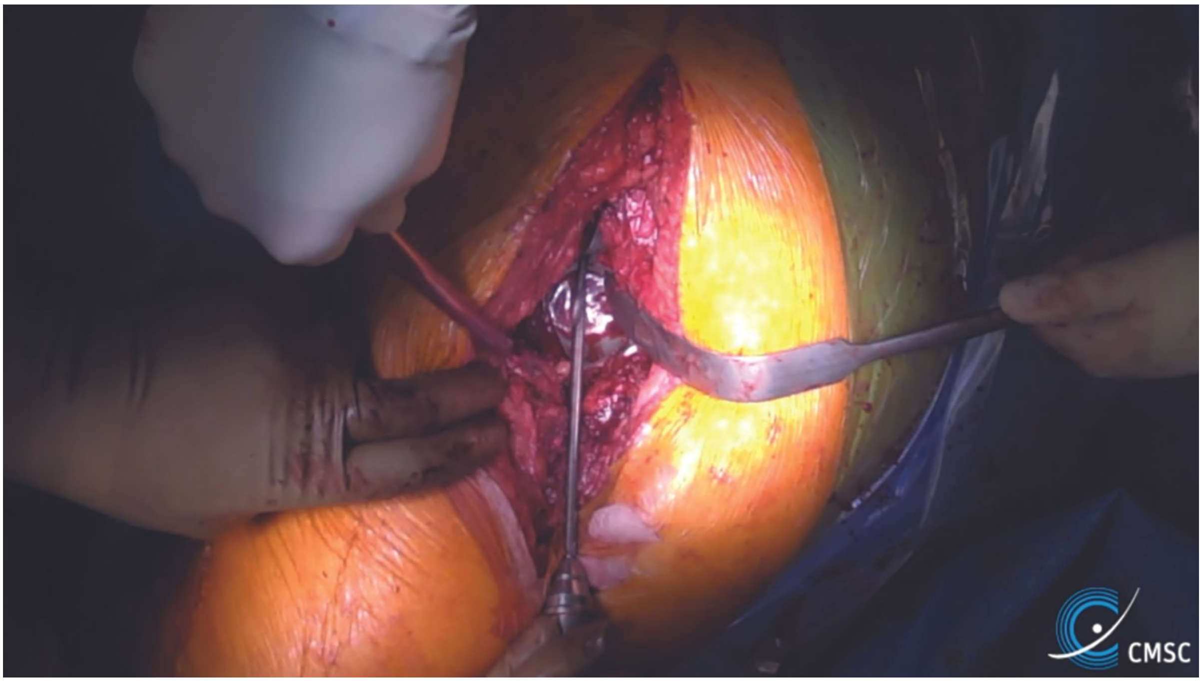

Figure 10: Placing screws through the cage and the cup.

These additional screws through both the cage and the cup especially guarantee the stability of the entire construct. The anchorage of the superior flange depends on the construct stability. However, at least three horizontal screws are used to secure the iliac flange to the ilium being careful not to damage the extrapelvic (superior gluteal nerve and artery) and intrapelvic (internal iliac and obturator vessels) structures (Fig. 11).

Figure 11: Secure the superior flange of the cage to the ilium.

Finally, a polyethylene liner is cemented into the cup-cage construct with an appropriate degree of inclination (40°) and anteversion (15°) independent of the position of the cage. In cases with severe abductor deficiency, a dual-mobility cup is utilized to prevent dislocation (Fig. 12).

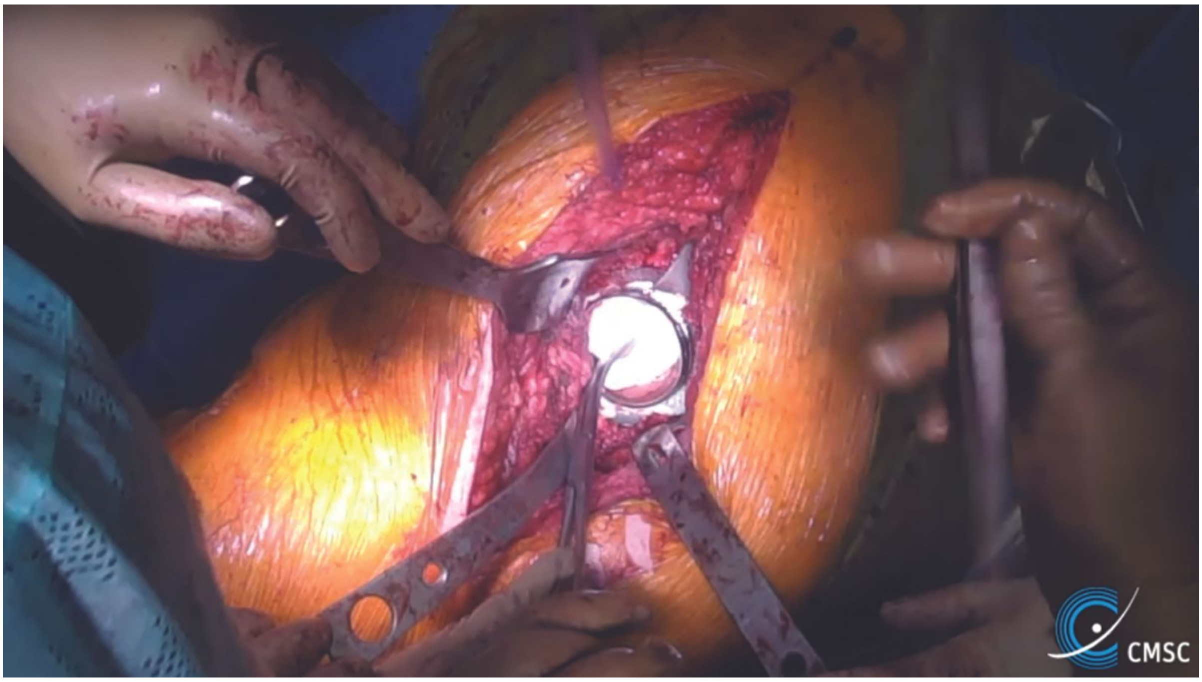

Figure 12: Cementation of the liner or dual-mobility cup into the cup-cage construct.

During cementation, the cement bonds to all components of the cup-cage construct to eliminate micromotions between the individual components. Finally, a trial reduction is done to confirm leg length, horizontal offset, stability and range of movement (Figs. 13 and 14).

Figure 13: Trial reduction to confirm leg length, horizontal offset, stability and range of movement.

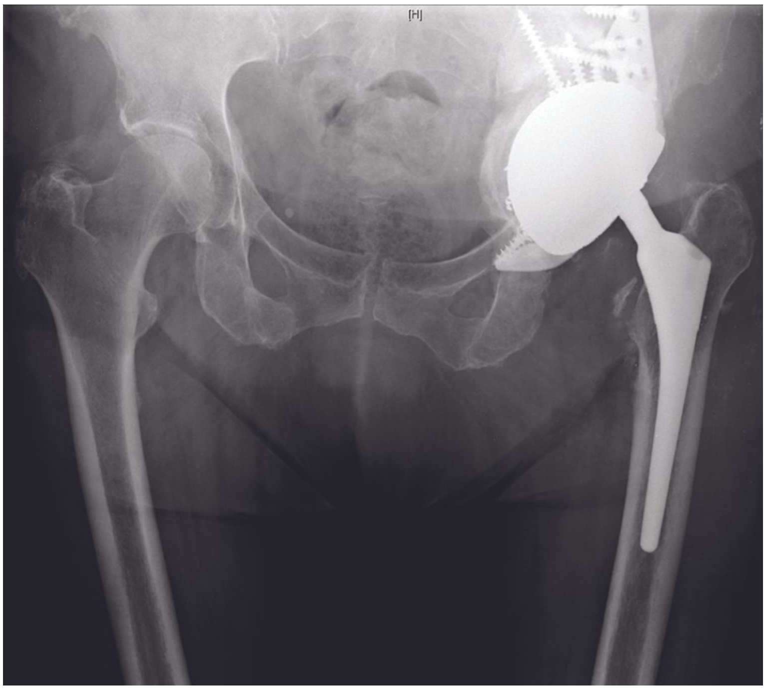

Figure 14: Postoperative radiograph showing a cup-cage reconstruction with a dual-mobility cup.

POSTOPERATIVE REHABLITATION

Postoperatively, patients are mobilized with partial weight bearing for the first six weeks with gradual increase to full weight-bearing thereafter, depending on the intraoperative construct rigidity and follow-up radiographs. After three months, full weight bearing is allowed. Late postoperative programs should comprise weight-bearing exercises with hip-abductor eccentric strengthening.

OUR EXPERIENCE

The mid-term results of a consecutive series of 35 cases have been previously reported[19]. In this series, the mean age at the time of surgery was 70 years (42 to 85) and all patients had an acetabular defect graded as Paprosky Type 2C through to 3B, with 24 hips (69%) having PD. The mean body mass index was 26 kg/m2 (17-38) and a mean of 3 (1-7) prior reconstructive procedures had been performed. The mean time from primary THA to cup-cage reconstruction was 16 years (1-35).

In 7 hips (20%), TM augments (Zimmer Biomet) were used to fill the gap between the superior flange of the antiprotrusio cage (Zimmer Biomet) and the iliac wing and 9 hips (26%) required a cage with a long iliac flange. The fixation of the entire cup-cage construct involved a mean of 8 screws (6-11). In 15 hips (43%) a POLARCUP Dual-Mobility System (Smith & Nephew, London, United Kingdom) was introduced due to severe atrophy of the abductors. A total of 12 hips (34%) had concomitant revision of the femoral component. The mean operative time was 187 minutes (122-292).

With revision for any cause defined as the endpoint, the overall implant survivorship of the cup-cage construct was 91% (95% CI 76 to 97) at one year and 89% (95% CI 72 to 96) at five years (Fig. 15).

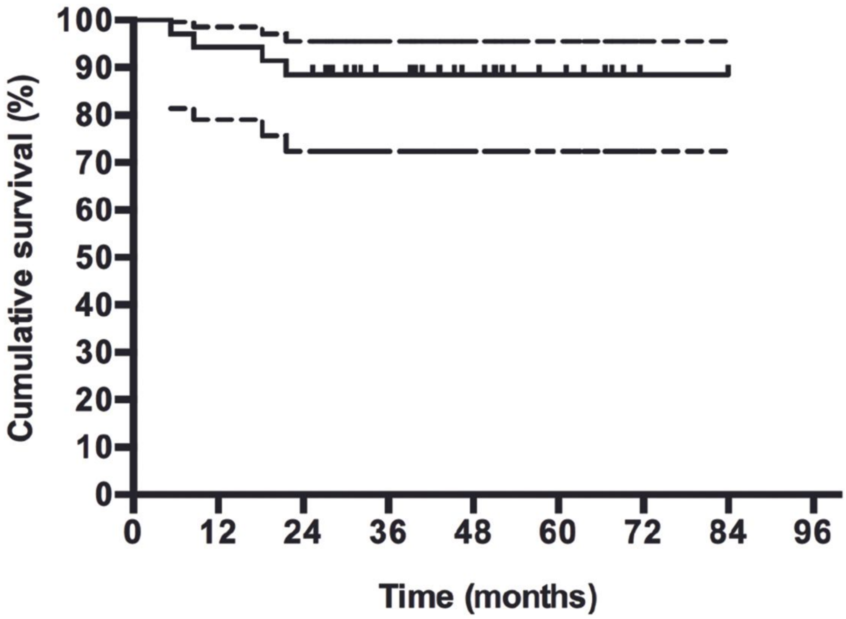

Figure 15: Graph showing the overall implant survivorship for the cup-cage reconstruction of a series of 35 patients.

At a mean follow-up of 47 months (25 to 84), only 1 of the 11 hips (9%) without PD had required revision, whereas in the presence of PD 3 of 24 hips (13%) required revision surgery. No revision surgery was carried out for aseptic loosening in the entire cohort. A total of 6 hips (17%) had at least one complication, 4 of which (11%) required revision after a mean postoperative time of 13 months (5-22). The Harris Hip Score (HHS) improved significantly from a mean of 30 (15-51) preoperatively to 71 (40-89) postoperatively. The results are summarized in Table 1.

Variable	No PD (n=11)	PD (n=24)	All hips (n=35)
Follow-up (mths)*	49 (31 to 42)	46 (25 to 84)	47 (25 to 84)
Re-revision (for any reason) (%)	1 (9)	3 (13)	4 (11)
Dislocation	1 (9)	1 (4)	2 (6)
Periprosthetic infection	0 (0)	2 (8)	2 (6)
Sciatic nerve lesion	0 (0)	2 (8)	2 (6)
5yr implant survivorship†	91%	88%	89%
Preoperative HHS*	33 (18 to 51)	29 (15 to 50)	30 (15 to 51)
Postoperative HHS*	70 (54 to 84)	72 (40 to 89)	71 (40 to 89)

Abbreviations: HSS, Harris Hip Score; PD, Pelvic discontinuity
*Data presented as means with ranges / † estimated by Kaplan-Meier method

Table 1: Results comparing hips with and without pelvic discontinuity.

CONCLUSION

Cup-cage reconstruction for severe acetabular deficiencies demonstrates good clinical results and excellent stability at the mid-term. If stable fixation cannot be obtained through the use of a TM shell with or without augments, the cup-cage technique offers a reliable option for the treatment of major uncontained acetabular defects involving the posterior column and PD.

A major drawback of the technique is the risk of sciatic nerve injury or iatrogenic pelvic dissociation during inferior flange insertion. Therefore, cautious dissection is advised for insertion of the inferior flange into the ischium with fluoroscopic assistance. Only when severe ischial osteolysis or the rotational alignment of the cage prohibits a safe and stable fixation of the ischial flange, would we advocate to remove the ischial flange to create a so-called half-cup-cage construct. In these cases, screw fixation of the shell within the superior pubic ramus is advised to achieve the maximum possible construct stability.

Although complication rates are relatively high with infection and dislocation accounting for most revisions, cup-cage reconstruction compares favorably with other reported techniques in this complex patient population. Long-term surveillance is necessary to prove its durability.

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