

SEVERE POST-TRAUMATIC AND POST-ARTHROPLASTY ACETABULAR DEFECTS: BEYOND EXISTING CLASSIFICATIONS

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SUMMARY

Background: Acetabular bone defects resulting from post-traumatic malunion or nonunion present distinct morphological challenges compared to those caused by chronic aseptic loosening in revision hip arthroplasty. Chronic pelvic discontinuity, characterized by the complete dissociation of the superior and inferior hemipelvis through the acetabular columns, represents a complex clinical entity with increasing incidence due to the rising volume of primary and multi-revision total hip arthroplasties.

Objective: This article evaluates current classification systems, diagnostic modalities, and surgical management strategies for severe acetabular defects and chronic pelvic discontinuity.

Key Points: While the Paprosky system is widely utilized, it often fails to adequately describe post-traumatic defects, necessitating newer frameworks like the Sen classification. Diagnosis requires ruling out infection and utilizing advanced imaging, specifically thin-slice helical CT with metal artifact reduction, to assess bone stock and column integrity. Surgical objectives include anatomical restoration of the center of rotation and acetabular offset. Reconstructive options range from traditional cages and structural allografts—which demonstrate high long-term failure rates—to contemporary techniques such as acetabular distraction, highly porous tantalum components with modular augments, and cup-cage constructs. For unclassifiable or extreme defects, custom-made 3D-printed titanium triflange implants offer a salvage solution, though they are constrained by high costs and production lead times.

Conclusion: Management of severe acetabular deficiency and pelvic discontinuity remains technically demanding. Although modern porous implants and patient-specific reconstructions show promising early-to-mid-term stability, clinical outcomes are frequently complicated by high rates of infection, dislocation, and mechanical failure.

KEYWORDS

Acetabulum; Arthroplasty, Replacement, Hip; Reoperation; Bone Diseases, Metabolic; Pelvic Bones

INTRODUCTION

Bone defect patterns in post-acetabular fracture malunions are different from those in revision hip arthroplasty. Bone defects due to aseptic loosening of cemented or cementless arthroplasty are due to a gradual process that occurs over a longer period of time. These bone defects, seen after fractures, are acute and are determined mainly by the initial fracture pattern and initial surgical intervention.

Due to excessive bone loss, orthopaedic surgeons seldom see severe late post-traumatic or post-arthroplasty acetabular defects which are not easily classified into existing systems. When such acetabular defects are treated with conventional reconstruction techniques, standards for anatomical restoration of center of rotation and acetabular offset are not often met.

Acetabular defects due to malunion or nonunion of old acetabular fractures are rare due to recent improvements in implants and surgical skills. However, when they do appear, their management is problematic.[\[1\]](#)

Chronic pelvic discontinuity (PD), or pelvis dissociation, in total hip arthroplasty (THA) is the loss of structural continuity (fracture) between the superior and inferior parts of the pelvis. It progresses through the anterior and posterior columns of the acetabulum so that the superior bone structures of the pelvis are completely dissociated from the inferior ones. Biology, mechanics and thus the healing potential of PD is similar to atrophic nonunions. It is relatively uncommon, but its incidence is increasing due to an increasing number of primary and multi-revision THAs.[\[2\]](#),[\[3\]](#)

CLASSIFICATION

A classification system should accurately describe the problem, assist pre-operative evaluation and surgical pre-operative planning, and should predict outcomes. The recent Sen et al classification of late post-traumatic acetabular defects clearly reveals the patterns of post-traumatic nonunions and malunions.[\[1\]](#) In the commonly used Paprosky classification, PD is often associated with IIIB and infrequently with IIC and IIIA bone defects.[\[4\]](#) However, the Paprosky classification fails to describe post-traumatic defects, and occasionally, orthopaedic surgeons encounter other acetabular bone defects which are not described by existing classification systems (Figure 1).



Figure 1A: AP radiograph of a failed right THA in a 69 year old female patient with a history of three revision THAs

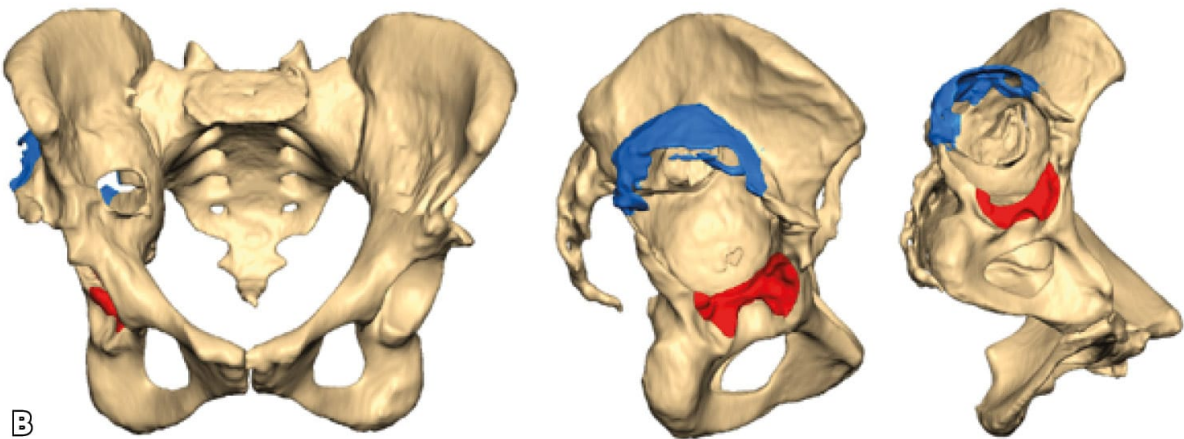


Figure 1B : 3D modelling (using an OMAR, thin slice, CT-scan) of the unclassified severe acetabular defect

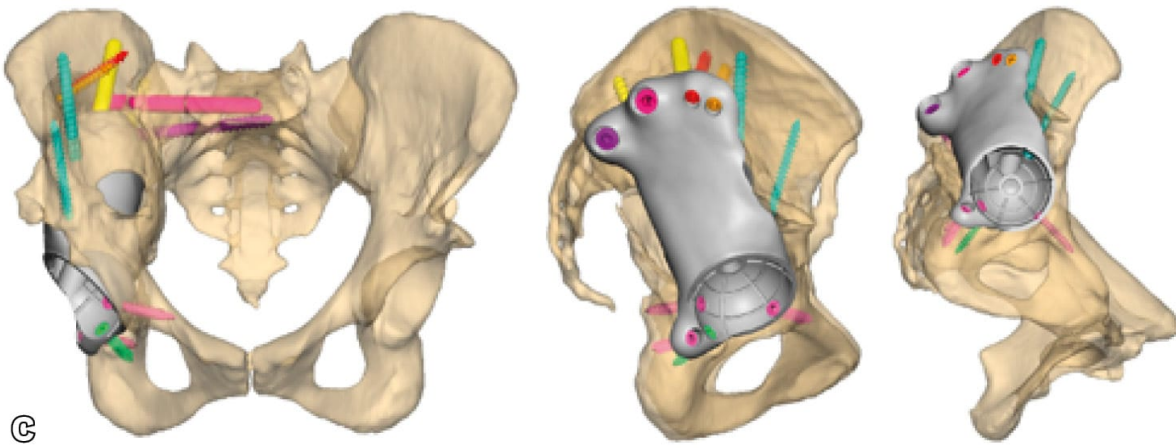


Figure 1C : 3D model of a custom-made reconstruction acetabular implant developed for the treatment of this patient

DIAGNOSIS

As a general principle, first ruling out infection is mandatory in all cases of acetabular defects.

Conventional anteroposterior and lateral radiographs may initially be used for pre-operative planning for both post-traumatic and post-arthroplasty severe bone defects. PD should be suspected in cases with excessive osteolysis or fracture. When Kohler's line and the tear drop is violated, and if moderate to severe ischial lysis is observed, and the cup and femoral head have migrated vertically more than 3 cm, one can safely suspect PD.[4],[5] However, the diagnosis of both post-traumatic malunion or nonunion and the diagnosis of PD in standard imaging views are difficult due to the fact that the implants obstruct full visibility of bone defects, especially when the posterior column is involved.[2],[3] The use of a helical CT-scan and, more recently, the use of CT-scan thin slices in three planes, in combination with metal artifact reduction techniques, have improved diagnostic accuracy (Figure 2).[6],[7] Occasionally, a pre-operative CT angiogram is performed, when the removal of an intra-pelvic acetabular cup is planned. Despite technological improvements, one has to understand that resulting bone loss is usually greater than that which is initially anticipated during pre-operative planning.



Figure 2: Pre-operative PD diagnosis using helical CT-scan. Frontal view (arrow shows the fracture line) is diagnostic (A), while transverse view is inconclusive (B).

Intra-operatively, nonunion and a PD diagnosis are made by applying stress, using a Cobb elevator, to the inferior hemipelvis (anterior and posterior column) in an anteroposterior direction and observing movement between the superior and posterior parts of the acetabulum.

MANAGEMENT STRATEGIES

The treatment goals are the anatomical restoration of the center of rotation, acetabular offset and the achievement of long term interface stability using revision arthroplasty acetabular implants.

On order to achieve this, surgeons face several challenges such as the classification of bone defects, the selection of appropriate implants, choice of surgical technique and possible bone grafts. There is also a high incidence of intra- and post-operative complications, post-operative mechanical failures and an absence of criteria for evaluating clinical and radiological outcomes.[2],[3] Surgery should be carefully planned and the orthopaedic team should be prepared for the unexpected, changing techniques and using various implants and grafts as appropriate. Most surgeons prefer the posterior approach which allows for wider exposure and possible extension. Extended trochanteric osteotomy, when indicated, allows for even wider exposure and acetabular visibility.

Severe post-operative defects. Principles of management and outcomes of specific patterns are not clearly reported in the literature. Based on the Sen clacification,[1] types 1, 2, 3-A and 5 can be treated with surgical techniques used in revision THA surgery. For severe defects (such as 3-B, 4-A and 4-B), the restoration of hip center of rotation, cup offset, inclination and anterversion and hip stability can be achived only with custom-made implants (Figures 3 and 4).

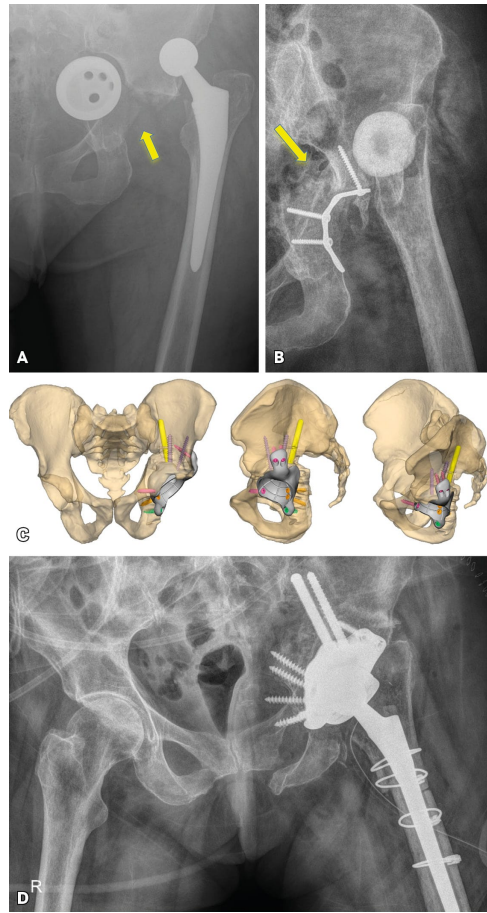


Figure 3: AP radiograph of a periprosthetic left acetabular fracture in a 72 year old female patient (A). AP radiograph of failed minimal fixation resulting in a 4-B acetabular malunion (B). A 3D dimensional model of the malunion and of a custom made acetabular implant were created based on OMAR, thin slice, CT-scan (C). Post-operative radiographs of the custom made acetabular implant, at four years, with satisfactory outcome, is shown (D).

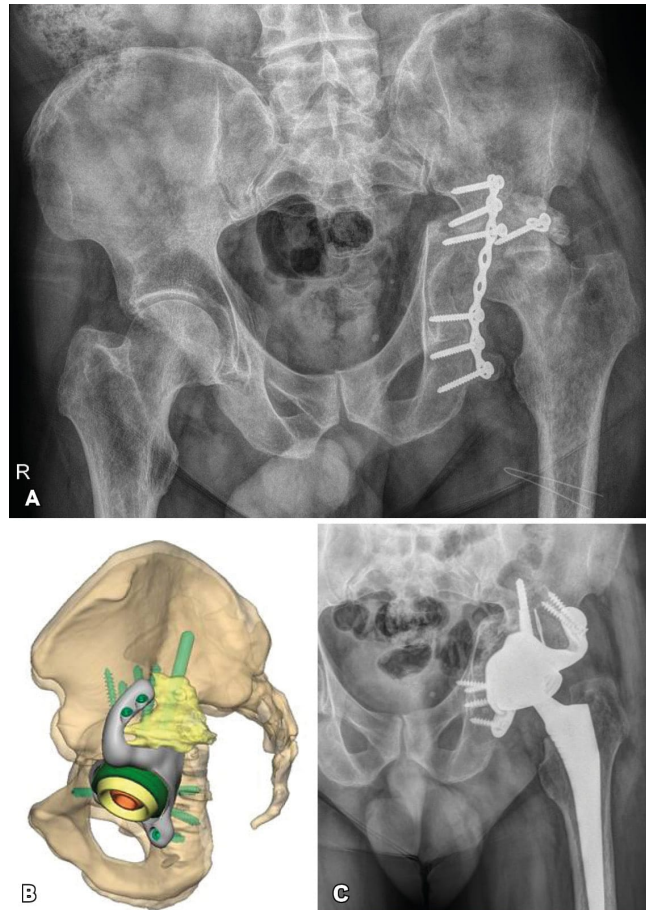


Figure 4: AP radiograph of a failed internal fixation of an acetabular fracture resulting in a 3-B malunion in a 52 year old female patient (A). A 3D dimensional model of the malunion and of a custom made acetabular implant were created based on OMAR, thin slice, CT-scan (B). Post-operative radiographs of the custom made acetabular implant, at five years, with satisfactory outcome, is shown (C).

Chronic PD and unclassified severe defects. The goals of reconstructive surgery are the following: identification and confirmation of the problem; removal of PD scar tissue leaving clean bone edges; re-establishment of the continuity of the superior and inferior hemipelvis with implants and bone graft when necessary; achievement of stability of the reconstruction, and, if possible, restoration of bone stock.^[2]

Several reconstruction techniques are available:

Cages and Rings with graft. Historically, massive bulk allograft, used with a cemented liner in the setting of severe bone defects had a 50% failure rate.^[8] In the past, reconstruction cages and rings have also been used extensively to reconstruct severe acetabular bone defects and PD. Structural or morsellised bone allografts were used in order to fill the acetabular defect and then a cage or ring was used to protect the grafted area until the allograft was incorporated by creeping substitution. Acetabular components were then cemented in an appropriate orientation. Several manufacturers have developed various ilioischiol (onlay or inlay) or non-ilioischiol spanning cages and rings. However, despite reports of early satisfactory outcomes, many of these devices were later withdrawn due to subsequent mid- and long-term failures (Figure 5a).^{[9],[10]}

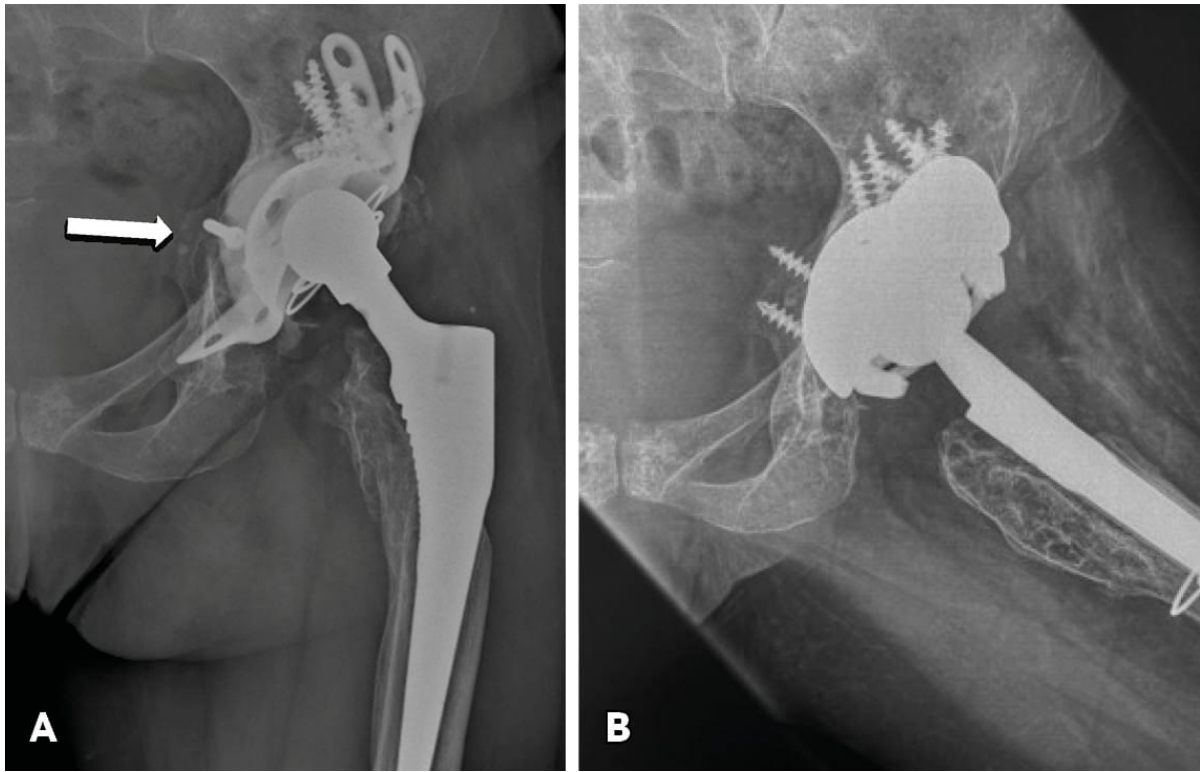


Figure 5: AP radiograph of a painful left THA in a 42 year old female patient with a history of two revision THAs (A). Based on a CT-scan diagnosis (Figure 2), PD was treated using TM acetabular cup and augment (B).

Internal fixation with acetabular reconstruction. Plate and multiple screw fixation are used in combination with cementless acetabular cups in order to stabilise a post-traumatic acetabular nonunion or a PD. Single plating of either the anterior or posterior column or double plating of both the anterior and posterior column through a combined ilioinguinal and posterior approach have been suggested.[\[2\],\[11\]](#)

Acetabular distraction with cementless acetabular cup. Following the removal of scar tissue and mobilisation of the discontinuity site (often a difficult task) laminar spreaders or Cobb elevators are used in order to pull apart and expand the defect before the implantation of a cementless acetabular component. The distracted PD bone edges then apply compression forces to the implant, improving reconstruction stability.[\[12\],\[13\]](#)

Tantalum cementless acetabular cups with augments. TM and related (e.g. Cription) technology acetabular components fixed with multiple holes superiorly and inferiorly (ilium, pubic and ischial rami) in combination with augments have recently been used in severe acetabular defects and chronic PD, especially in those with good bone stock (Figure 5b).[\[14\]](#) Implants made of highly porous structural materials (e.g. Tantalum and Cription) have demonstrated an improved friction coefficient for initial stability and better bony ingrowth for late stability. Early and mid-term outcomes are encouraging, allowing for extending the indications for their use (Figure 6).[\[15\]](#)

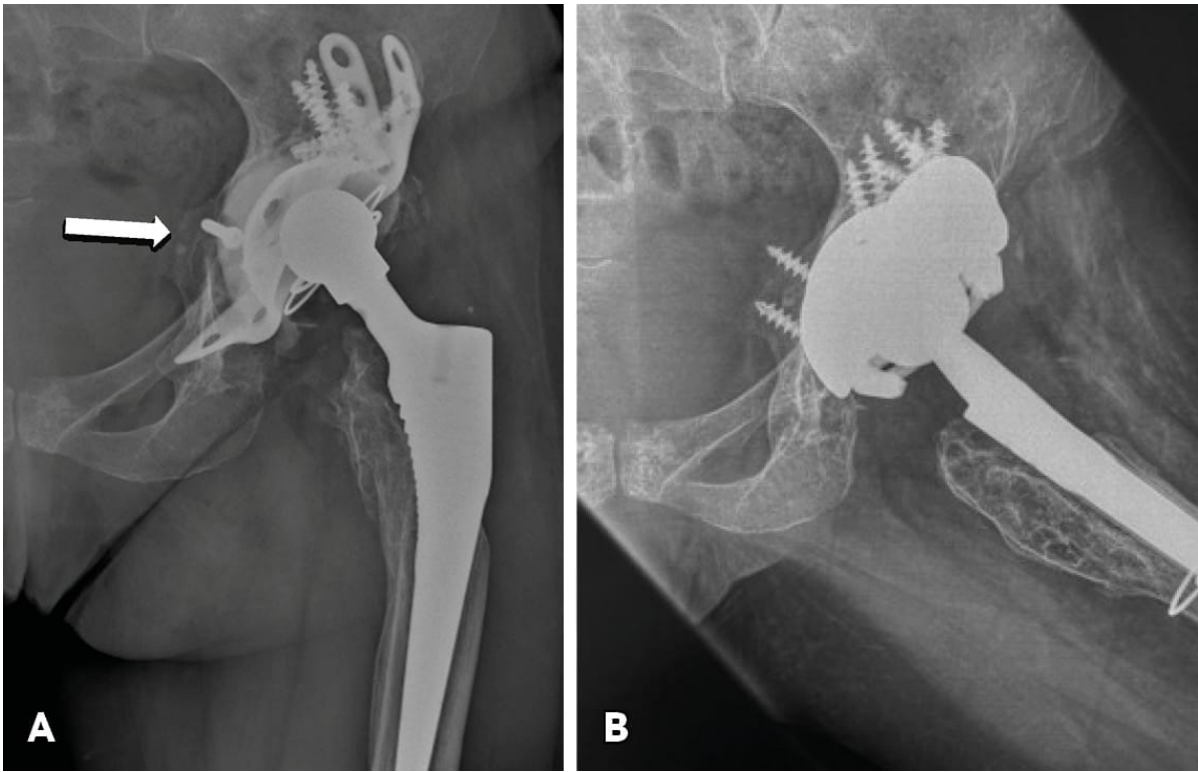


Figure 5: AP radiograph of a painful left THA in a 42 year old female patient with a history of two revision THAs (A). Based on a CT-scan diagnosis (Figure 2), PD was treated using TM acetabular cup and augment (B).

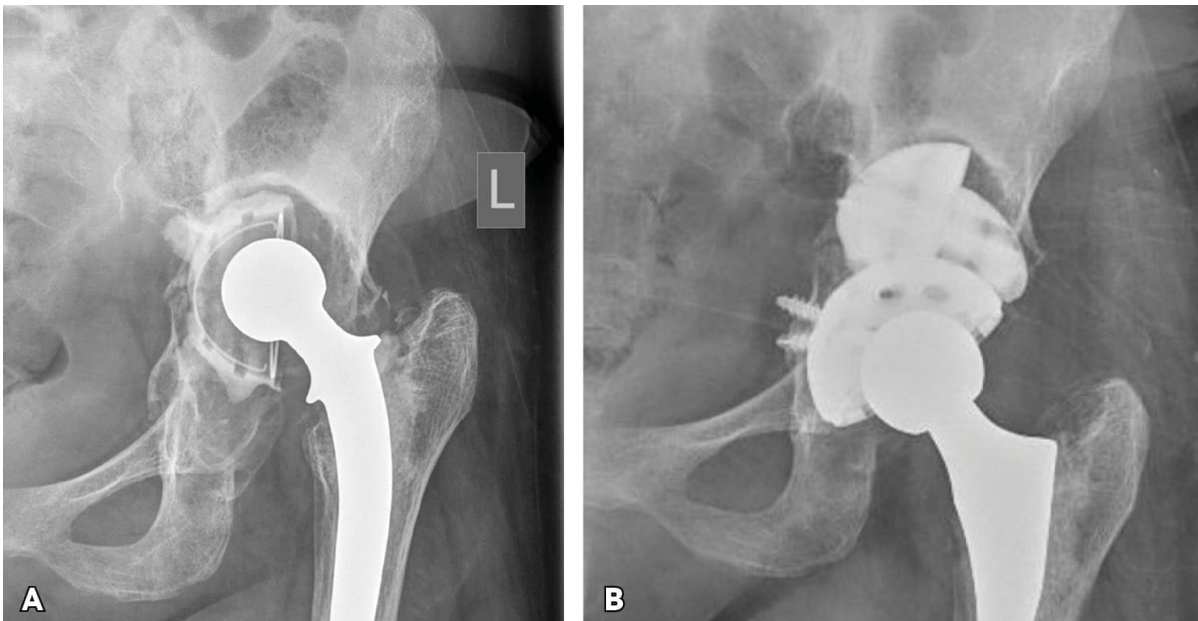


Figure 6: AP radiograph of a painful left THA in a 52 year old female patient with a history of avascular necrosis due to sickle-cell anaemia (A). PD was treated with CRIPTION acetabular cup and “double deck” augments (extended indications) with satisfactory outcome at 6 years (B).

Cup and cage construct. This technique involves the placement of a highly porous Tantalum jumbo acetabular cell or cup against the host bone, bridging the acetabular defect. On the top of the cell, a special inlay cage is placed which spans the defect and is fixed into the ilium and ischium.^[16] Tantalum augments are also used when necessary. “Half” cup cage reconstruction (removing the distal flange from the “full” cup-cage construct in order

to address technical problems with its distal insertion) has also been introduced.[17] Mid-term outcomes are favourable and this technique has gained in popularity.[18],[19]

Triflange and tumour like custom made acetabular implants. Modern technology allows the production of personalised implants for special conditions. These type of implants are custom made, porous coated titanium implants and are considered the last therapeutic salvage option, before excisional arthroplasty, for severe acetabular defects and PD. The implants are designed and manufactured based on pelvic models created by thin-slice pelvic 3-D CT-scans with metal subtraction software (Figures 7 and 8). Early and mid-term outcomes are encouraging but premium cost and length of production time limit their use.[20],[21],[22]

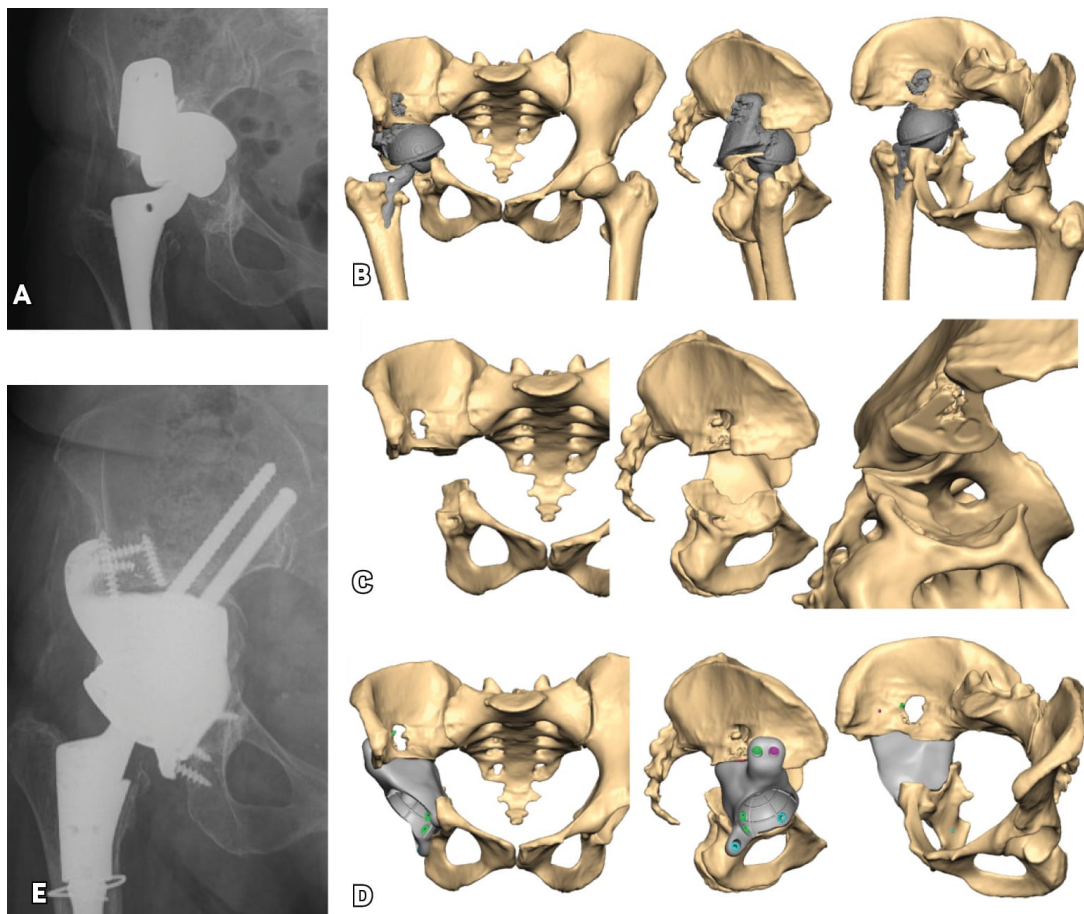


Figure 7: AP radiograph of a failed right THA in a 76 year old female patient with a history of three revision THAs (A). The pre-operative three dimensional model of the failed THA was created based on OMAR, thin slice, CT-scan (B), the PD model, following the removal of the implants (C) and the custom made implant model are shown (D). Post-operative radiographs of the custom made acetabular implant, at three years, with satisfactory outcome, is shown (E).

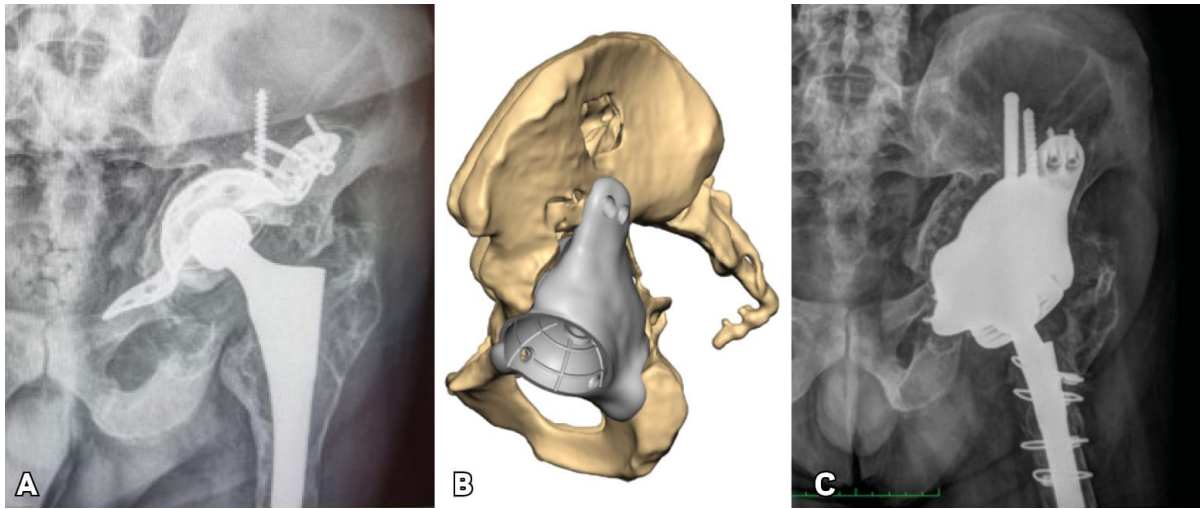


Figure 8: AP radiograph of a failed THA in a 65 year old male patient with a history of congenital hip disease and four revision THAs, is shown (A). A pre-operative three dimensional model of a custom made acetabular implant was created based on OMAR, thin slice, CT-scan (B). Post-operative radiographs of the custom made acetabular implant, at two years, with satisfactory outcome, is shown (C).

Concerns for the use of custom made implants are related to the accuracy of the image based technique used for their production, the accuracy of the implant 3D fitting and implantation, the appropriate surgical approach and exposure and the manufacturing and biology of the implant-bone interface.[\[23\]](#),[\[24\]](#),[\[25\]](#)

Clinical outcomes. A literature search shows that comparisons of the results of these techniques are difficult. Clinical reports are inconclusive because they present early to mid-term outcomes in a small number of patients with dissimilar bone defects, treated with different strategies and implants.^{2,3} However, all authors agree that late post-traumatic malunions and nonunions, severe acetabular defects and PD are challenging clinical entities in adult hip reconstructive surgery, and despite the fact that contemporary surgical techniques are promising, the cost is high and results are complicated by a high incidence of infection and dislocation.

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