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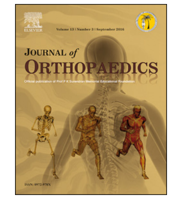

# Bone preserving techniques for explanting the well-fixed cemented acetabular component

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ABSTRACT

*Background:* Removal of a well-fixed, cemented acetabular component at the time of revision hip surgery can be complex. It is essential to remove the implant and cement mantle in a timely fashion while preserving bone stock and osseous integrity. The biomechanical properties of polymethylmethacrylate cement and polyethylene can be utilised to aid with the removal of well cemented implants which are often harder than the surrounding bone. While removal of loose components may be relatively straightforward, the challenge for the revision arthroplasty surgeon often involves the removal of well-fixed implants. Here, we present three established techniques for the removal of a well-fixed cemented acetabular component and one novel modification we have described before.
*Method:* We collate and review four techniques for removing well-fixed cemented acetabular implants that utilise the different biomechanical properties of bone cement and polyethylene. These techniques are illustrated with a photographic series utilising saw bones. A step-by-step approach to our new technique is shown in photographs, both in the clinical setting and with a "Sawbone". This is accompanied by a clinical video that details the surgical technique in its entirety.
*Results:* These techniques utilise different biomechanical principles to extract the acetabular component. Each technique has advantages and disadvantages. Our new technique is a simplification of a previously published extraction manoeuvre that utilises tensile force between cement and the implant to remove the polyethylene cup. This is a safe and reproducible technique in patients with a well-fixed cemented acetabular implant.
*Conclusion:* Understanding the biomechanical properties of polymethylmethacrylate bone cement and polyethylene can aid in the safe removal of a well-fixed cemented acetabular component in revision hip surgery. The optimal technique for removal of a cemented acetabular component varies depending on a number of patient and implant factors. This summary of the available techniques will be of interest to revision arthroplasty surgeons.

## 1. Introduction

Removal of a well-fixed cemented implant may be required due to malposition, infection, dislocation or polyethylene (PE) wear. Removing the implant in a timely and safe manner, while preserving bone stock, is paramount to the success of revision hip surgery. Multiple techniques are available to the revision arthroplasty surgeon. While some techniques involve removing the implant at the bone-cement interface[1],[2] others attempt to separate the cup at the implant-cement interface, followed by manual removal of the cement mantle.[3–8] Separation of the PE cup and polymethylmethacrylate (PMMA) can be achieved by utilising differences in the biomechanical properties of each. The PMMA to PE interface has a lower load to failure in tension than it does in compression.[3] Controlled separation of the implant-cement interface under tension can effectively lead to explantation of the acetabular cup. The soft material properties of PE also allow the material to be cut or reamed out.

The technique of extraction can be tailored to individual cases, all of which aim to remove the PE cup and PMMA bone cement in a timely fashion, generate minimal PE debris, retain bone stock and avoid fracture.

### 1.1. Technique 1: corkscrew extraction

This technique involves advancing a 6 mm drill centrally into the PE cup to the level of the implant-cement interface. A blunt nosed cork-

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**Fig. 1.** Introduction of the corkscrew following central drilling.

**Fig. 2.** Reaming of the PE acetabular component.

**Fig. 3.** Polyethylene debris following reaming of the cup.

**Fig. 4.** The cup is quartered, and an osteotome is placed into the PE.

screw is then introduced (Fig. 1). This technique utilises the discrepancy between the hardness of PE and PMMA. As the corkscrew advances through the PE, it encounters the PMMA. At the implant-cement interface the corkscrew is no longer able to penetrate into the PMMA however further turns of the corkscrew separates the polyethylene from the cement under tension. Distraction occurs at the implant-cement interface and the PE de-bonds from the PMMA. This technique has been utilised in the removal of polyethylene from metal back uncemented cups using the same biomechanical principles.[4] If required, additional force can be applied to the corkscrew once it is engaged in the PE in order to disengage the component from the cement mantle circumferentially.[6],[7]

This technique has the advantage of reduced torque force on the PE and potentially reduced damage to bone stock from compressive forces being applied to the bone of the acetabular rim with osteotomes. Care should be taken not to breach the cement mantle or medial wall with the drill. The medial wall once broken by the drill or corkscrew fails to provide a foundation for the distraction, should this happen another technique should be utilised.

### 1.2. Technique 2: reaming out the polyethylene component

This technique utilises the soft material properties of PE, which makes reaming into the acetabular component possible. Sharp metal instruments cut easily through soft PE, in contrast to cement, which has

**Fig. 5.** The quarter is removed.

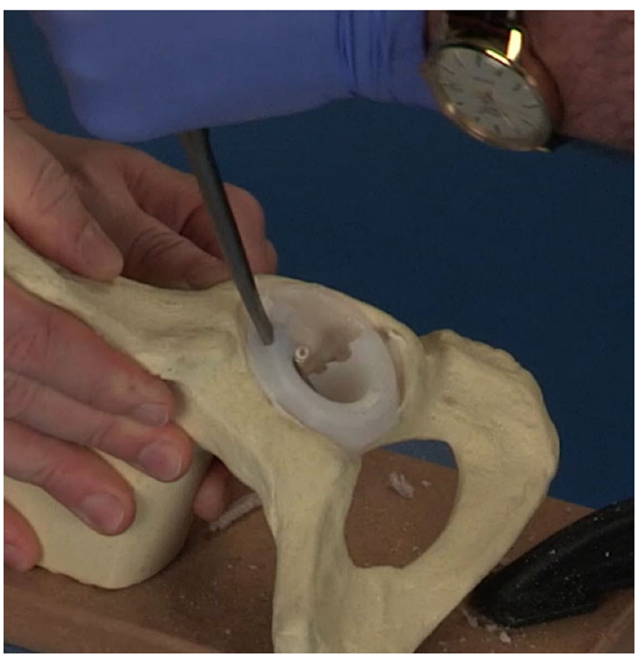

**Fig. 6.** Osteotome is placed into the remaining PE.

a higher Young's modulus of elasticity and hardness. A reamer two sizes below the outer cup diameter is selected and the cup is reamed out (Fig. 2). The reamer can be upsized to the component size as the operator progresses through the liner.

This technique avoids leverage on the component or acetabulum and utilises a compressive force to remove the PE. The process generates significant amounts of relatively small polyethylene debris (Fig. 3), which must be removed to avoid the possibility of third body wear in the revision. The average time required to remove an acetabular component using this technique has been reported as 16 min (15–20).[8]

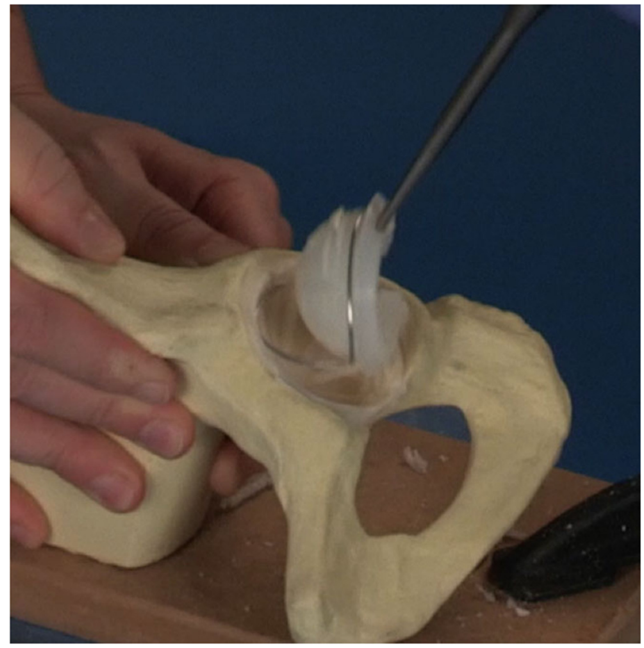

**Fig. 7.** The cup is levered out.

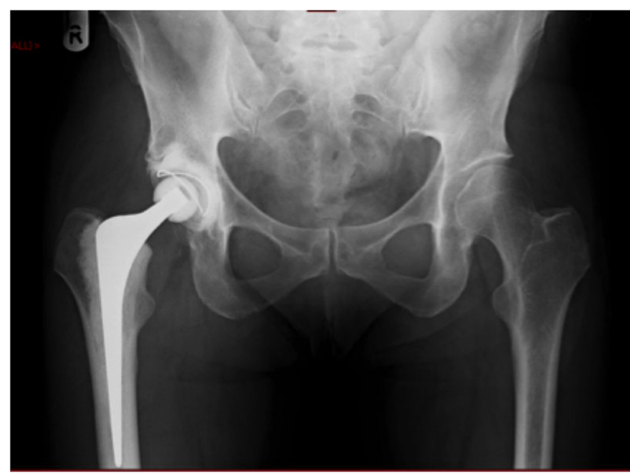

**Fig. 8.** Index procedure.

### 1.3. *Technique 3: quartering the acetabular component*

This technique involves the removal of a quarter of the component before full extraction is undertaken. A 6 mm drill is used to perforate a mapped quartile of the cup's hemisphere down to the underlying cement. The drill holes are then connected using a thin acetabular cup cutting tip osteotome. A straight osteotome is placed into the quadrant (Fig. 4), which is then removed (Fig. 5).

With this quadrant removed, the remaining acetabular component is able to deform and therefore de-bond from the cement mantle. A straight osteotome is placed through and across the remaining acetabular component (Fig. 6) and the polyethylene is levered away from the cement in a rotatory motion (Fig. 7).

The favourable low youngs modulus (hardness) of polyethylene is used to remove a quadrant after reducing the tendancy for the cutting osteotome to be trapped by the elastic recoil of the material by debulking the cut surface area by predrilling. Secondly, the ability to

Journal of Orthopaedics 15 (2018) 500–505


**Fig. 9.** Second dislocation of total hip replacement.

deform PE in tension is utilised to de-bond the remaining component from the cement mantle. Levering the component places torque force across the pelvis. The integrity of the acetabulum and cement mantle must be great enough to withstand the force required to de-bond the cup from cement without bone fracture. Removal of a quadrant allows the required force to be lower, thus reducing the risk of fracture.

### *1.4. Novel technique: polyethylene fold-in technique*

**Case**: A 59 year old lady presented with two late dislocations of an otherwise well performing hip replacement. The index procedure was performed 10 years prior for severe osteoarthritis (Fig. 8). There were no intra- or peri-operative complications. The first dislocation was a result of a traumatic fall and a closed reduction was performed. A further dislocation occurred one month later without trauma (Fig. 9). Several further episodes of subluxation led to the patient losing confidence in the hip replacement. It was decided to revise the hip replacement and attempt to re-orientate the components to improve stability.

### *1.5. Technique*

In this case, a standard posterior approach was utilised to gain access to the hip. The sciatic nerve was identified and protected. A capsulectomy was performed and the head dislocated. The acetabulum was exposed with the use of retractors. Circumferential removal of scar tissue allowed for adequate exposure of the acetabular component and an assessment of its orientation could be made. Linear wear of the polyethylene cup had occurred and a decision was made to remove the well-fixed prosthesis. Multiple 6 mm central drill hole were placed through the PE cup down to the level of the implant-cement interface (Fig. 10) in a radial manner to reduce the elastic recoil trapping of the polyethylene cutting blade. An acetabular cutting tip osteotome is utilised to section the cup in line with the drill holes (Figs. 11 and 12) down to the level of the cement-implant interface.

With the use of a mallet, a straight osteotome is positioned into the polyethylene 1 cm from the sectioned plastic across the articulating surface and onto the opposite face of the bearing surface (Fig. 13). The acetabular cup is then folded in on itself and, with a brisk rotating wrist movement, the cup was de-bonded from the cement (Video 1). The underlying cement was then addressed with the use of osteotomes using the brittleness of the cement. Post-operative radiographs were taken in the recovery room (Fig. 14).

## 2. Discussion

Safe and timely removal of a well-cemented acetabular component with preservation of bone stock is achievable using a variety of extraction techniques. When planning removal of a well-fixed cemented acetabular implant, an understanding of the biomechanical properties of bone, polymethylmethacrylate and polyethylene will help determine the ideal surgical technique. Thin polyethylene liners have less grip for cutting tools such as corkscrews. Thicker polyethylene implants will generate significant polyethylene debris if reamed and may be difficult to fold in on themselves. The quality of host bone should also be taken into account as it may be preferable to use compressive force through a reamer, as opposed to torque force through an osteotome, so as to avoid fractures.

## 3. Conclusion

We have used the novel technique described here in multiple revision procedures where a well-fixed acetabular component is encountered. We believe that the technique described offers a reliable, controlled and safe method for the removal of a well-fixed cemented acetabular component.

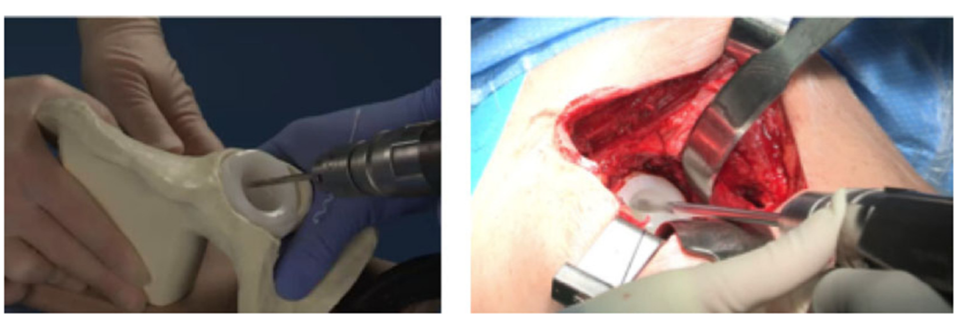

**Fig. 10.** Drill holes are placed in a straight line.

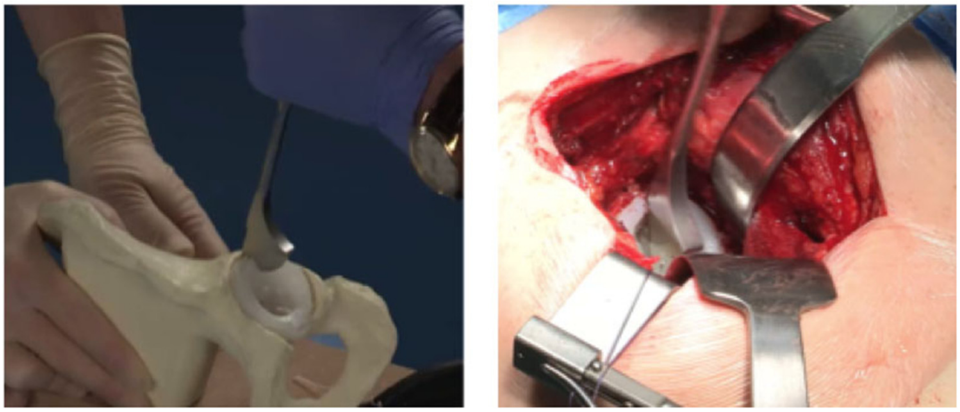

**Fig. 11.** An acetabulum cutting tip osteotome is utilised to section the PE.

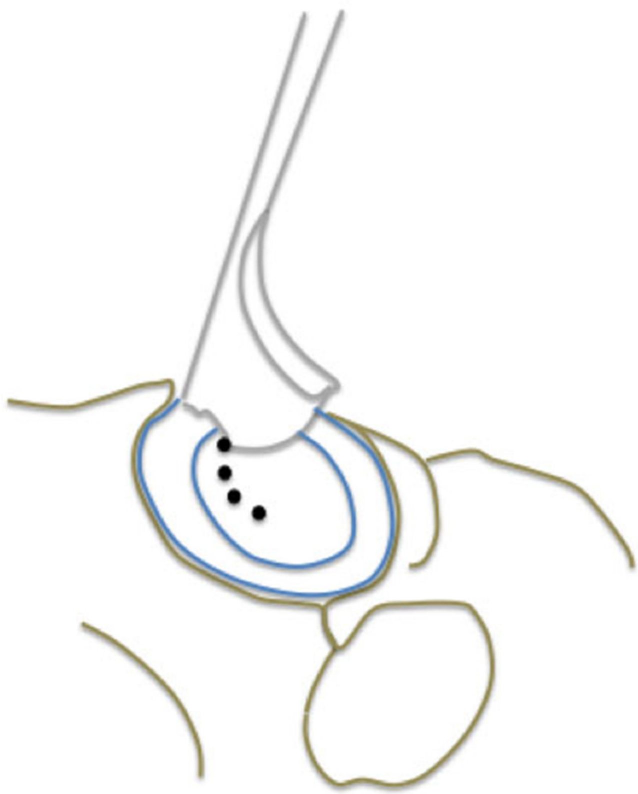

**Fig. 12.** Drill holes in a line are connected with acetabular cutting osteotome.


**Fig. 14.** Post-operative radiographs were taken in the recovery room.

**Fig. 13.** A straight osteotome is positioned into the polyethylene 1 cm from the sectioned plastic.

## Disclaimer

None.

## Conflict of interest

The authors declare there are no conflicts of interest.

## Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.jor.2018.03.037.

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