Case Report

Removal of a well fixed cemented acetabular component using biomechanical principles

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ABSTRACT

Background: Removal of well fixed components can be a complex problem facing an orthopaedic surgeon during revision hip arthroplasty. As the burden of revision hip surgery increases, techniques have been described to enable safe and reliable removal of well fixed components. Removal of well fixed cemented components requires different considerations to the removal of cemented components. Polymethylmethacrylate bone cement and polyethylene have unique biomechanical properties.

Method: We present a step-by-step technique to reliably and safely remove a well fixed cemented acetabular component and underlying cement during revision hip arthroplasty.

Results: This reproducible technique is presented with intra-operative photography and a detailed description of the necessary steps to remove a well fixed cemented acetabular component.

Conclusion: Consideration of important underlying biomechanical principles of polymethylmethacrylate bone cement and polyethylene can aid the safe removal of a well fixed cemented acetabular component in revision hip surgery, reducing risk to underlying bone.

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1. Introduction

The success of total hip arthroplasty, along with increasing healthy life expectancy, is likely to contribute to an increased burden of revision hip arthroplasty for wear. The main indications for revision hip arthroplasty today are aseptic loosening, dislocation, infection and pain.^{1,2}

Removal of old well fixed components is one of many complex aspects of revision arthroplasty facing the orthopaedic surgeon. Techniques for removal of well fixed femoral components, both cemented and un-cemented, are well described, however there remains little literature regarding the removal of a well fixed cemented acetabular component. Previous techniques offer different approaches this problem including the use of pneumatic devices, burrs and a variety of reamers, drills and corkscrews.^{3–7}

Polymethylmethacrylate bone cement has high load to failure in compression, however in tension this is reduced significantly. This technique allows the controlled separation of the implant–cement interface under tension to effectively loosening the acetabular component. Polyethylene has a high modulus of

elasticity and hence elastic recoil. Whilst polyethylene is easy to mark and cut, the elastic recoil easily traps the cutting device before it can pass all the way through. The surrounding bone is often relatively weaker than the construct itself.

We describe a method for sectioning of the polyethylene cup and controlled disruption of the implant–cement interface to allow safe and reliable removal of the well fixed cemented acetabular component.

2. Case

A 78-year-old male presented with recurrent dislocation of cemented primary total hip replacement. The original procedure, for arthritis secondary to haemochromatosis, was complicated by recurrent dislocation. Revision surgery was indicated for recurrent dislocation due to loss of soft tissue integrity. The acetabular component was well fixed. The femoral component was removed to aid acetabular exposure. Informed consent was provided by this patient for use of intra-operative photography for inclusion in this article.

2.1. Surgical technique

A standard approach the hip is made at the discretion of operating surgeon. In this case a posterior approach was made.

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Once the hip is dislocated the femoral component is either removed, or retracted to facilitate exposure of the acetabular component. Removal of fibrous tissue and so-called “pseudocapsule” in a methodical manner to adequately expose the full rim of the polyethylene acetabular component is required.

Once the acetabular component is adequately exposed, a central 6 mm drill hole is created down to the underlying cement (Fig. 1). The audible and tactile change in drilling between the polyethylene and cement will alert the surgeon once the implant is perforated. Subsequently, a 6 mm drill is then used to sequentially perforate a mapped quartile of the hemisphere down to the underlying cement and an oblique drill hole is created joining the previous drill holes within the substance of the cup (Figs. 2 and 3). The drill holes are then joined up using a thin acetabular cup cutting tip osteotome (Stryker(c)), thus completely sectioning one quarter of the hemispheric component from the other three quarters (Figs. 4 and 5). Occasionally the osteotome does not fully cut medially but this will become obvious with the next step and can be addressed again. In this case a central 10 mm drill hole was made, as pictured, however we now do not perform this step routinely.

Once the polyethylene is sectioned, a 5 mm straight revision osteotome is then driven into the rim of the separated quarter across the rest of the cup. Using the osteotome as a lever, this segment removed from the underlying cement by levering inward (Figs. 6 and 7). The osteotome is removed from the explanted quarter (using a hammer as the elastic recoil traps the osteotome) and re-inserted into the remaining three quarters (Figs. 8 and 9). With a simple circular twist, once again levering towards the cup centre, the remaining three quarters of the polyethylene is removed (Fig. 10).

The underlying cement mantle is typically preserved by this technique and can be left in or removed at the discretion of the surgeon and demands of the surgical procedure (Fig. 11).

In this case we removed the cement mantle after removal of the acetabular component. The technique for removing the underlying

Fig. 2. Further 6 mm drill holes are made along one quarter of the polyethylene.

cement mantle involves splitting the brittle cement with a straight narrow disposable osteotome in a random pattern, working from the margin of the mantle itself by creating local stress risers leading to fracture (the osteotome is not inserted deep into the cement). The cement fractures and comes away easily from the underlying bone. It is important to work steadily across the cement mantle and perpendicular to the surface, breaking it up gradually

Fig. 1. A central 6 mm drill hole is made through the polyethylene component to the underlying cement.

Fig. 3. An oblique drill hole is then made connecting the series of drill holes made to the centre component.

Fig. 4. The polyethylene is sectioned along the line of drill holes using a thin polyethylene cutting osteotome.

in small pieces (Fig. 12). Once the entire cement mantle is fractured, the pieces can be removed, often leaving some underlying fibrous material which can be easily removed with a curette and irrigation (Fig. 13). The underlying bone is preserved for preparation of the revision component as desired (Fig. 14).

Fig. 6. A straight osteotome is then driven across the sectioned quarter of the polyethylene towards the centre of the component.

3. Discussion

The technique described in this article has been developed over time to safely and reliably remove a well fixed acetabular component without disruption of the surrounding bone.

Fig. 5. The polyethylene is sectioned along the second line of drill holes.

Fig. 7. The sectioned quarter is then levered inwards to remove the portion from underlying cement.

Fig. 8. A mallet is used to remove the polyethylene from the straight osteotomy.

Polyethylene has a high modulus of elasticity and can therefore withstand a large deformation before failure. This property of polyethylene means that attempting to simply section the polyethylene, without drill holes, prior to removal will almost certainly lead to jamming of the implement before any sectioning occurs due to elastic recoil and frictional resistance. By drilling a

Fig. 10. Levering inwards with a circular twisting motion will disrupt the remaining polyethylene from the underlying bone cement.

series of holes in the polyethylene, the volume of polyethylene to be cut is much reduced, therefore reducing the likelihood of the cutting instrument becoming jammed. The sharp drill cuts easily through soft polyethylene and the contrast with higher young's modulus cement is easily noted.

Fig. 9. The straight osteotomy is then placed into the remaining three quarters of the polyethylene component.

Fig. 11. The intact cement mantle is preserved after removal of the polyethylene component.

Fig. 12. The cement mantle is fractured with a disposable straight osteotome.

Cement has high load to failure in compression, but relatively low in tension. The described technique creates a stress riser between the polyethylene and cement when the holes are drilled. The first quarter of the polyethylene cup is then distracted from the cement mantle rupturing the implant–cement interface under tension. The remaining three-quarters of the cup can then be

Fig. 13. Fibrous tissue underlying the removed cement mantle.

Fig. 14. The preserved native bone following removal of the component and cement mantle.

“folded in” in a similar manner, using an osteotome jammed in the polyethylene as a joystick.

Removal of the underlying cement by fracturing it with an osteotome relies on delivering a sudden force to a small area of relatively brittle cement, causing it to fail by creating a local stress riser. The brittle nature of the cement with very little elastic or plastic deformation potential and will fail easily in this manner. By fracturing the cement mantle in a random pattern close to the edge of the mantle, this will create multiple stress risers, which will facilitate disruption of the entire cement mantle. This random pattern could be compared to so called “crazy paving” used to surface foot-paths and driveways. By fracturing off multiple small pieces of the cement mantle, removal from underlying bone is facilitated.

Techniques described separately by Anspach and Paprosky, rely on specialised equipment in addition to the requirements of a revision arthroplasty.^{3,4} Using the hemispherical reamer to reduce the thickness of polyethylene cup, as described by de Thomassen et al., does generate large volumes of polyethylene reamings and risks blunting the reamer on underlying cement.⁵ Use of two cork-screw devices, as described by Judas et al., mostly closely resembles the described technique by inducing a distraction force across the component–cement interface.⁷ In our experience the disadvantage of this technique is the un-predictability of the separation of the cup from the cement mantle.

We have used the 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 removal of the well fixed cemented acetabular component using some simple biomechanical principles.

Conflicts of interest

The authors have none to declare.

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