Surgical technique

Ultrasound gel minimizes third body debris with partial hardware removal in joint arthroplasty

Aidan C. McGrory a, *, Lee Replogle, MD b, Donald Endrizzi, MD a

a Division of Joint Replacements, Maine Medical Center, Falmouth, ME, USA
b Tufts University School of Medicine, Boston, MA, USA

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ABSTRACT

Hundreds of thousands of revision surgeries for hip, knee, and shoulder joint arthroplasties are now performed worldwide annually. Partial removal of hardware during some types of revision surgeries may create significant amounts of third body metal, polymer, or bone cement debris. Retained debris may lead to a variety of negative health effects including damage to the joint replacement. We describe a novel technique for the better containment and easier removal of third body debris during partial hardware removal. We demonstrate hardware removal on a hip joint model in the presence and absence of water-soluble gel to depict the reduction in metal debris volume and area of spread.

Introduction

The success and wide acceptance of joint arthroplasty and also internal fixation over the last half century has lead to the not uncommon need for removal of well-fixed hardware at the time of conversion surgery [1, 2]. High-speed tools such as carbide burrs, drills, or saws may be used to remove well-fixed hardware including implants, metal screws or plates. Metal, bone, or polymer third body debris may be a byproduct of the removal [3, 4].

This third body debris may cause component damage and act as a nidus for infection in the joint and surrounding tissue. Debris load (the concentration of phagocytosable particles found in a volume of tissue) is highly correlated with aseptic inflammation, which may further complicate post-operation recovery [2]. In addition, debris may lead to osteolysis, neuropathy, synovitis, periprosthetic bone loss, and loosening of the joint implant overtime [4-7]. Some types
of metal debris have also been implicated in cardiomyopathy, nephropathy, carcinogenesis, and a variety of other toxic health effects around the body [4,5].

Current methods for removal of third body debris employing suction, moist sponges, and irrigation systems are not only time consuming but also ineffective. Significant amounts of debris evade these methods and often remain embedded in muscle, subcutaneous tissue, or the joint space following these procedures. In this manuscript, we describe a novel method that is quick, inexpensive, and very effective for containment and easy removal of third body debris in cases of partial hardware removal. While some studies have examined similar techniques for third body debris removal, our study also provides a qualitative evaluation of the effectiveness of the procedure.

**Surgical technique**

Periarticular or intraarticular hardware, bone cement, or implant material must be removed in some cases with burrs, saws, or drills that may cause particulate debris. This is a typical situation encountered in patients with post-traumatic arthritis following open reduction, internal fixation of the acetabulum. The offending screw or plate might be exposed during the reaming of the acetabulum. Plate and screw removal in-toto, would be difficult and increase the morbidity of the surgery. Maximal debris removal may also be especially important in the instance of an incarcerated ceramic liner removal, where controlled fracture is advocated, but may be dangerous if third body debris is not properly removed [8].

In such cases we advocate for the use of clear, water soluble ultrasound gel (Parker Laboratories Inc., Fairfield, NJ) or a sterile surgical lubricating jelly (Johnson & Johnson Company, New Brunswick, NJ) around the region to be excised. In the example of an intraarticular screw, the area of metal to be removed is isolated and clear sterile jelly is placed over the screw. The high-speed burr is used and the shavings are collected in the gel. The high-speed burr is then suctioned and the wound is irrigated to remove any residual gel or debris. This process may be repeated as necessary.

To demonstrate the value of this surgical technique, we constructed a jig holding a Sawbones (Pacific Research Laboratories, Vashon Island, WA) hemipelvis with a pelvic reconstruction plate (SynthesDepuy, West Chester, PA) of a posterior wall fragment. We placed an intraarticular cobalt-chromium screw that was to be removed by high-speed burr (Fig. 1).

We next placed spray cohesive (3M Spray Mount, Maplewood, MN) on the acetabulum to catch any metallic fragments and mimic the environment of in-vivo removal, where fragments would adhere to surrounding tissue (Fig. 2). Using a high-speed burr, we removed the screw without and with surrounding ultrasound gel (Fig. 3a and b). Metal fragments were scattered throughout the acetabulum without the gel, but captured and concentrated in the gel when it was applied. Radiographs of the model confirmed this finding (Fig. 4a and b).

In an actual surgical setting, the use of moist sponges in the surgical field adjacent to the use of the gel and high-speed burr...
should also be considered, to minimize tissue exposure to debris. Further investigation may also elucidate the optimum technique for gel removal after the debris is trapped; specifically the quantitative benefits of repeat irrigation.

**Discussion**

Orthopedic hardware removal often presents many challenges including inability to completely remove the hardware, hardware breakage, bone loss, debris retention, and prolonged operating time. Conversion and revision arthroplasty often requires periarticular hardware removal for successful placement of implants. Surgeons therefore face the tribology concern of third body particles. For this reason, care must be taken to ensure maximal removal of debris where hardware removal is indicated.

Previously, moist sponges and thorough irrigation alone have been used to prevent debris retention during hardware removal. Our technique using sterile surgical lubricating jelly or ultrasound gel in addition to sponges and irrigation provides a novel way to reduce debris retention and its accompanying surgical complications.

**Summary**

Partial removal of hardware during some types of revision surgeries may create significant amounts of third body debris, and retained debris may lead to damage to the joint replacement. We describe a technique for the better containment and easier removal of third body debris during partial hardware removal and demonstrate the reduction in metal debris volume and area of spread in an experimental model.

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