Journal of Clinical Orthopaedics and Trauma 10 (2019) 422–426

Contents lists available at ScienceDirect

Journal of Clinical Orthopaedics and Trauma

journal homepage: www.elsevier.com/locate/jcot

Case report

Use of high-speed burr and water-based lubricant in the partial removal of surgical plates: A technique Guide

Jon E. Hammarstedt[a,*], Grigory E. Gershkovich[b], Daniel P. Mass[b]

[a] Department of Orthopaedic Surgery, Allegheny General Hospital, Pittsburgh, PA, United States
[b] University of Chicago, Department of Orthopaedic Surgery, Chicago, IL, United States

ARTICLE INFO

Article history:
Received 26 February 2018
Received in revised form 10 May 2018
Accepted 24 May 2018
Available online 24 May 2018

Keywords:
Hardware removal
Revision surgery
High speed burr
Surgical hardware

ABSTRACT

Implant removal comprises 5% of all orthopaedic surgery procedures performed annually. Surgical indications range from implant failure, infection, non-union, and symptomatic hardware. Intra-operatively, surgeons need to prepare for complications including bony overgrowth, cold-welding, broken screws, and stripped screw heads. Large anatomic dissections required for complete hardware removal place the patient at increased risk of complications due to increased operating time and larger dissections. The authors present a safe and effective technique for the partial removal of surgical implants. The technique utilizes a high-speed burr to cut surgical plates, minimizing the total dissection and operative time. Sterile surgical laps covered in water-based lubricant capture metal debris to reduce tissue contamination as well as surgeon exposure to metal particles.

1. Introduction

Patients undergo surgical removal of orthopaedic implants for numerous reasons including implant failure, infection, non-union, soft-tissue compromise, and symptomatic hardware.[1] Implant removal poses an increased level of difficulty for orthopaedic surgeons in elective and revision surgeries due to the unpredictable intra-operative findings.[2] Large surgical dissections may be required to completely remove implants in order to relieve symptoms or to complete a revision surgery. This may put the patient at increased risk of complications secondary to larger dissections. Such risks include prolonged anesthesia, increased blood loss, increased postoperative pain and analgesia requirements, potential for neurovascular injury, and wound complications.[3] The authors present a simple technique for cutting orthopaedic plates, which is applicable to many types and sizes of implants. The technique reduces operating time, complications, and chance of foreign body inflammatory reaction from metal debris.[2,4]

2. Surgical technique

This described technique uses a high-speed burr (Stryker, Mahwah, NJ) to cut the surgical plate intraoperatively. We use a Stryker UHT drill that plugs into a Stryker core box with capabilities of 75,000 rpm. The drill is connected to a 3.2 mm by 18.3 mm helicoidal medium rasp (Stryker, Mahwah, NJ). First, the portion of the surgical plate that is to be removed is exposed through adequate dissection (Fig. 1). In order to minimize soft tissue contamination with metal debris from the high-speed burr, the surgical field and soft tissues are covered with sterile surgical lap sponges. The sponges are then coated with copious amounts of sterile water-based lubricant (Surgilube, HR Pharmaceuticals, York, PA), which surround the implant to be cut (Fig. 1). Water-based lubricant is readily available in most hospital settings and is typically used to ease discomfort when inserting catheters, endoscopes or other surgical instruments. Water-based lubricant is a highly viscous substance used to adhere airborne metallic particles released from the high speed burr, allowing easy suction removal of the metal debris and preventing contaminants from entering the body. Second, screw heads of the involved portion are exposed and removed. The high-speed burr is then activated at full speed and pressed lightly to the surgical plate at the level of an empty screw hole (Fig. 2). This decreases the amount of metal debris produced because less metal is subjected to the burr. Two hands are used at all times to help control the burr, prevent cuts at

* Corresponding author at: Department of Orthopaedic Surgery, Allegheny General Hospital, 1307 Federal Street, 2nd Floor Pittsburgh, PA 15212.
E-mail addresses: jon.hammarstedt@gmail.com (J.E. Hammarstedt), grigory.gershkovich@gmail.com (G.E. Gershkovich), dmass@bsd.uchicago.edu (D.P. Mass).

https://doi.org/10.1016/j.jcot.2018.05.015
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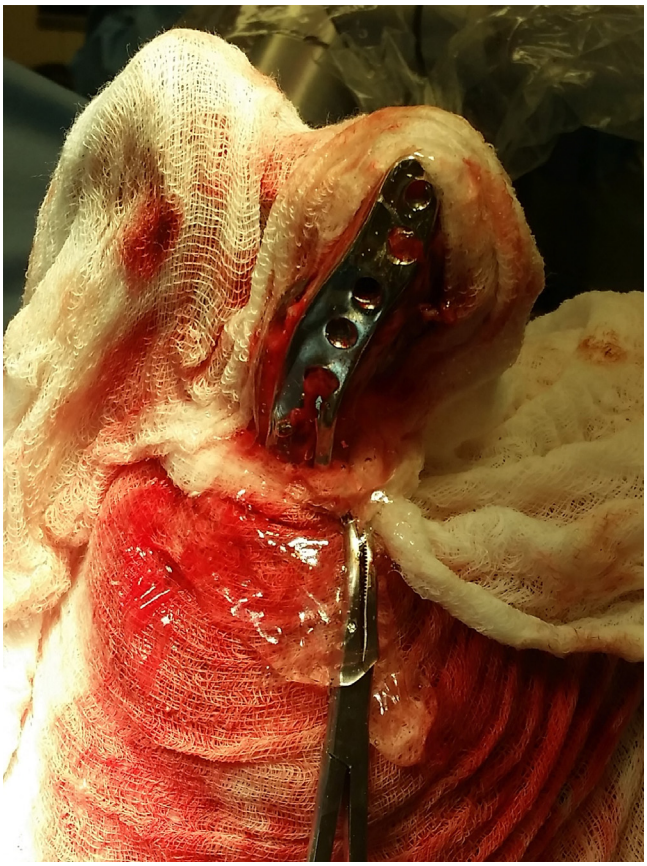

Fig. 1. Exposed surgical plate surrounded by sterile surgical lap coated in water based lubricant.

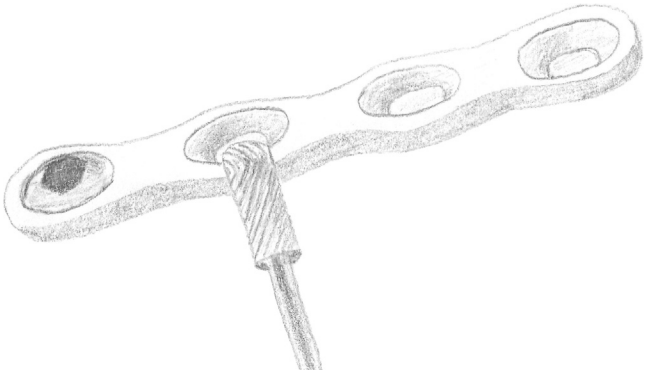

Fig. 2. Illustration depicting proper placement of high-speed burr on surgical plate in order to minimize surface area for cutting.

multiple levels, or the catching of soft tissue and sponges on the active burr. Gentle irrigation is used to prevent thermal damage to adjacent structures and suction is used to collect additional metal debris. The depth of the desired cut is deemed adequate when the plate may be bent out of the wound with the aid of a Kocher. Often the plate can be bent and will break prior to a complete cut. This will minimize any potential damage to the underlying bone by the burr. After adequate depth is achieved on one side, the high-speed burr may then be placed on the opposite side (Fig. 3). Fig. 4 depicts a completed burring through the surgical plate. A surgical hand rasp may be used to smooth the edges of the remaining metal plate. A complete list of pearls and pitfalls of the technique are described in Table 1.

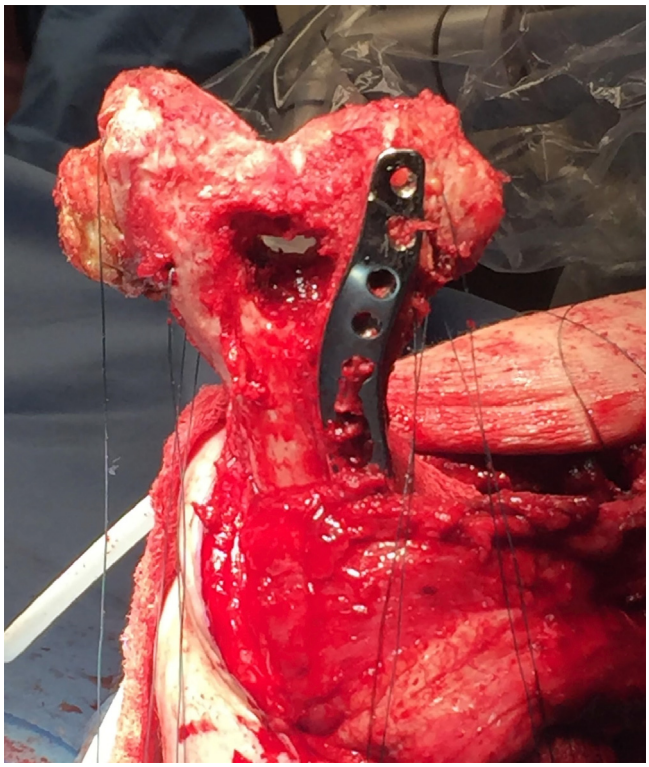

Fig. 3. Completion of cutting through one side of the surgical plate by the use of high-speed burr.

3. Case report

3.1. Case 1

A 38-year-old male with history of polytrauma after a car accident that was treated with open reduction and internal fixation of the left intra-articular olecranon and humerus fracture as well as humeral shaft fracture. The radiographic findings at time of presentation can be seen in Fig. 5. The patient presented with limited range of motion and pain at the surgical site attributed to prominent hardware and minimal soft tissue coverage. The decision was made to undergo hardware removal, kashiwagi-outerbridge procedure to improve motion, joint capsule debridement, internal joint stabilizer (Skeletal Dynamics, Miami, FL), and radial head excision. The previous incision was used and the olecranon plate was readily visible and removed without difficulty. The plate spanning the humerus was symptomatic on the lateral aspect of the distal humerus and the decision was made to cut the plate intra-operatively, removing only the distal portion. This reduced the surgical incision necessary for complete removal of the proximal portion of the humerus plate by 15 cm and prevented additional iatrogenic complications. The distal humerus was exposed with a standard posterior approach and surrounded with sterile surgical laps covered in water-based lubricant. A high-speed burr was then used to cut the plate while suction and irrigation were used. Postoperative radiographs are presented in Fig. 6.

3.2. Case 2

An 80-year-old female with multiple surgeries on her left proximal third humerus fracture presented with recurrent pain. Five years prior to presentation she was treated with open reduction and internal fixation with intramedullary nail and bone stimulator due to non-union after a fall. Three years after the initial

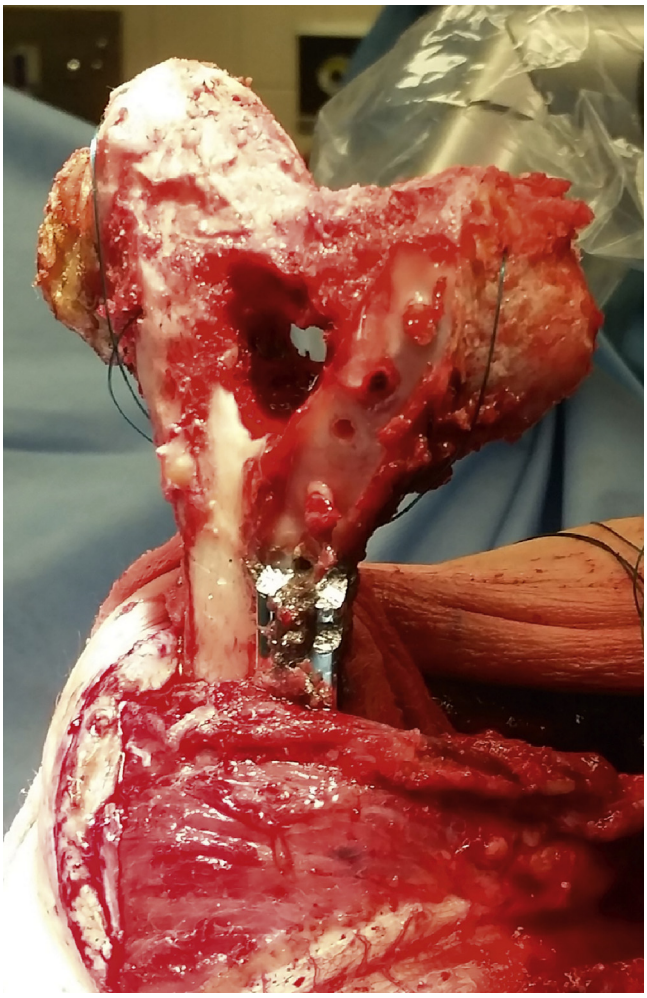

Fig. 4. Successful completion of partial urgical plate with demonstration of metal debris capture by sterile surgical laps covered with sterile water-based lubricant.

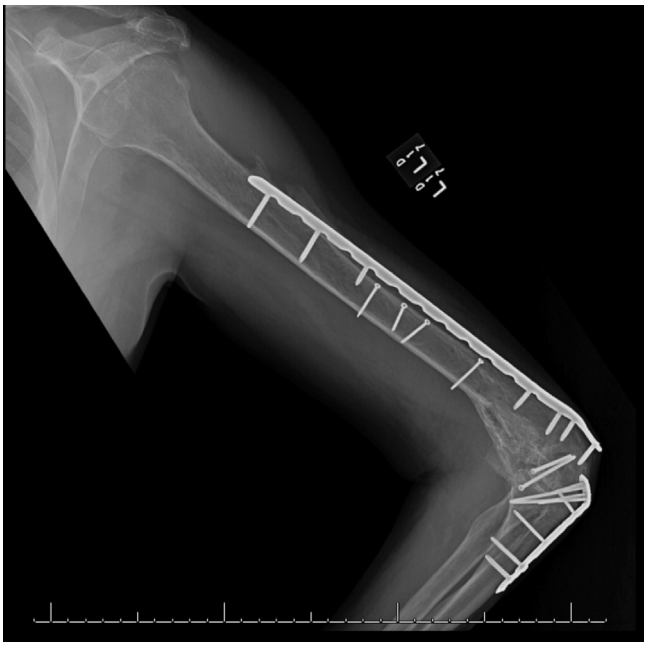

Fig. 5. Preoperative radiograph of a 38-year-old male with limited range of motion and pain demonstrating broken and prominent hardware in the posterior and lateral aspect of the distal humerus.

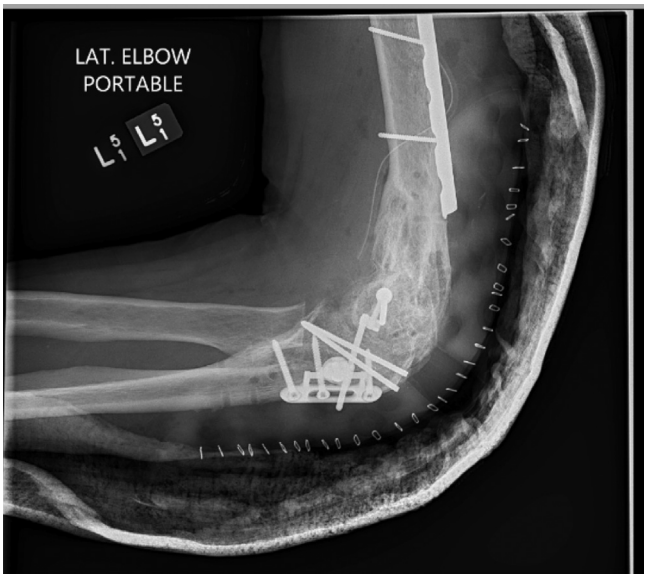

Fig. 6. Postoperative radiographs of 38-year-old patient undergoing hardware removal, kashiwagi-outerbridge, joint capsule debridement, internal joint stabilizer, and radial head excision. Intra-operatively the decision was made to remove only the symptomatic portion of the humeral plate to reduce anatomic dissection.

fracture, the patient was treated with revision open reduction internal fixation with dual plating and humeral shortening to achieve compression plating. After each of the first three surgeries, she developed transient radial nerve palsy. She also had significant glenohumeral osteoarthritis. Radiographic imaging at time of re-evaluation demonstrated persistent non-union and broken hardware (Fig. 7) and glenohumeral osteoarthritis. The decision was made for hardware removal and perform reverse total shoulder arthroplasty with proximal humeral replacement. Intra-operatively, the proximal humeral segment was excised and the humeral plate was cut to prevent stress risers in the distal humeral portion and to avoid exposure of the radial nerve. This minimized the magnitude of the surgical approach by an additional 12-centimeters and protected the radial nerve. The proximal plate was exposed and wrapped with sterile surgical laps covered in

Table 1
Pearls and pitfalls of the surgical technique of partial removal of symptomatic hardware using water-based lubricant.

Pearls:
Identification and protection of important anatomical structures prior to use of high speed burr.
Completely saturate surgical lap sponge with water-base lubricant and application circumferentially around portion of plate to be cut to reduce metallic debris
Adequate flow of irrigation to reduce potential thermal damage.
Thorough use of surgical rasp to smoothen the cut edges of implant to be retained.
Pitfalls:
Slipping of high-speed burr causing damage to adjacent soft tissue or neurovascular structures.
Incomplete smoothening of metallic edges creating symptomatic patient or damage to adjacent neurovascular structures.
Inability to completely remove all metal debris.

Fig. 7. Preoperative radiograph of an 80-year-old female with refractory pain demonstrating midshaft humeral non-union and broken hardware.

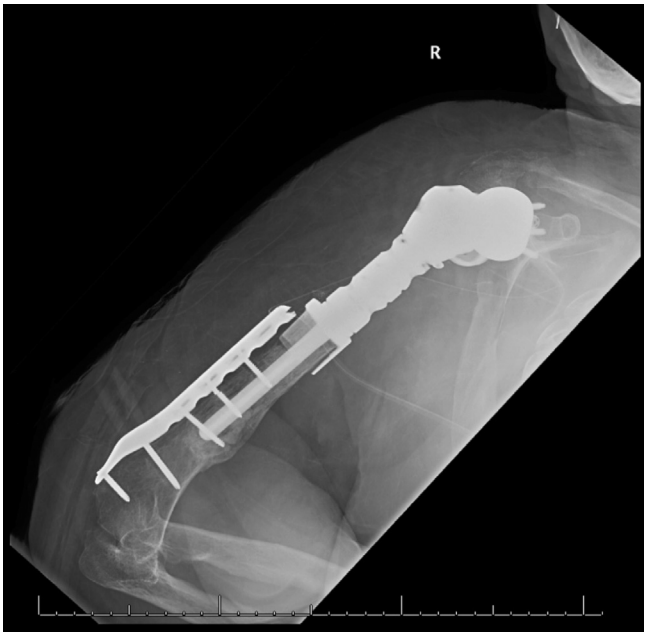

Fig. 8. Postoperative radiographs of 80-year-old female after open reduction internal fixation and reverse total shoulder arthroplasty. Intra-operatively the decision was made to remove only the necessary portion of the humeral plate to reduce anatomic dissection.

water-based lubricant. A high-speed burr was then used to cut the plate while suction and irrigation were applied. Latest radiographic images can be seen in Fig. 8.

4. Discussion

Removal of metal implants is a surgical procedure that is undertaken for many reasons including implant failure, non-union, infection, soft tissue compromise, and symptomatic hardware.[1] This is estimated to account for 5% of all orthopaedic procedures in the United States.[1] Like any surgical procedure, risks are inherent to implant removal operations. Risks include infection, wound complications, iatrogenic injury, unresolved symptoms, anesthetic complications, and foreign body inflammatory reaction from metal debris.[2,4] Patients should be counseled on the benefits and risks before undergoing hardware removal.

There are several techniques that may be employed by a surgeon intra-operatively in the surgical removal of implants due to the numerous obstacles one may encounter. Removal of surgical screws has been notoriously problematic and may prevent the removal of the entire implant. Techniques to create parallel planes, nail extractor hooks, vise-grip pliers, and screw removal systems have been reported with efficacy.[5,6] The use of a high-speed burr has been described for the removal of jammed locking screws and verified to reduce the amount of metal debris inside the wound by 27%.[7,8] Even the use of bolt cutters has been described as a technique to remove locking implant plates when specialized instruments are not available.[9] These techniques mainly focus on complications between the implant construct or screw to locking plate interface due to bone overgrowth, cold-welding, broken screws, or stripped screw heads. However, there is a paucity literature describing the partial removal of surgical plates. The authors present a technique for a partial removal of the orthopaedic implant that is symptomatic or necessary in order to complete a revision. The technique aims to reduce the surgical complications of increased operating time and neurovascular injuries associated with large anatomic dissections required with a complete implant removal while reducing metal debris that may cause a foreign body inflammatory reaction.

One of the important points of our technique is that it removes the portion of the implant in the symptomatic location for the patient while limiting anatomic dissection required for a complete removal. In the two cases presented, exposure of the entire posterior humerus would be required for complete removal of the implant. This would place the radial nerve at risk and prolong recovery due to extensive soft tissue dissection while increasing infection risk. Lovald et al studied the complication and hardware removal rates after open reduction and internal fixation of the humerus and found failure rates for implant removal of 10.2% with nonunion and mechanical complication as the most common complications.[10] While exact rates of complications for revision surgery are patient and surgeon specific, they do not come without risk.[3] Limitations of this technique include the inability to completely remove all metal debris, the potential for thermal damage to adjacent structures, rough edges due to inadequate rasping, and possibility for iatrogenic damage with the high-speed burr.

5. Conclusion

When removing surgical implants, it is essential to have all of the appropriate implant removal instruments available including carbide drill bits, high speed burrs, bolt cutters, and water-based lubricant. A partial removal of surgical implants may be an appropriate technique to remove hardware in the location of pain or to complete a necessary surgical revision. Partial implant removal reduces risk to the patient by reducing operative time and complications by decreasing anatomic dissections required in complete implant removal.

Funding

No outside source of funding was used for this study.

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