Available online at www.sciencedirect.com

ScienceDirect

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

Original Article

Evaluation of the effect of custom burr holes on a surgeon's sense of screw fixation in revision porous metal cups

Mark A. Nyland [a], Brent A. Lanting [a], Hristo N. Nikolov [b], Lyndsay E. Somerville [a], Matthew G. Teeter [a,c,d,*], James L. Howard [a]

[a] Department of Surgery, Schulich School of Medicine & Dentistry, The University of Western Ontario, Ontario N6A 5B7, Canada
[b] Imaging Research Laboratories, Robarts Research Institute, Ontario N6A 5B7, Canada
[c] Department of Medical Biophysics, Schulich School of Medicine & Dentistry, The University of Western Ontario, Ontario N6A 5B7, Canada
[d] Surgical Innovation Program, Lawson Health Research Institute, Ontario N6A 5A5, Canada

ARTICLE INFO

Article history:
Received 22 April 2015
Accepted 27 September 2015
Available online 19 October 2015

Keywords:
Revision hip replacement
Porous metal
Screw fixation
Biomechanics

ABSTRACT

Background/Aims: It is common practice to burr custom holes in revision porous metal cups for screw insertion. The objective of this study was to determine how different hole types affect a surgeon's sense of screw fixation.

Methods: Porous revision cups were prepared with pre-drilled and custom burred holes. Cups were held in place adjacent to synthetic bone material of varying density. Surgeons inserted screws through the different holes and materials. Surgeon subjective rating, compression, and torque was recorded.

Results: The torque achieved was greater ($p = 0.002$) for screws through custom holes than pre-fabricated holes in low and medium density material, with no difference for high density. Peak compression was greater ($p = 0.026$) through the pre-fabricated holes only in high density material.

Conclusion: Use of burred holes affects the torque generated, and may decrease the amount of cup-acetabulum compression achieved.

1. Introduction

Trabecular metal (TM), a porous tantalum material, was developed by Zimmer, Inc. (Warsaw, IN, USA) in the late 1990s. Its design is intended to promote the ingrowth of native bone due to its high (80%) porosity, low modulus of elasticity, and high frictional characteristics.[1] Due to these characteristics, TM revision cups have become a popular implant for use in complex acetabular revision surgery. Recent experience published by Skytta et al.[2] published their results on 827 acetabular revisions using TM revision shells

* Corresponding author.
E-mail address: matthew.teeter@lhsc.on.ca (M.G. Teeter).
http://dx.doi.org/10.1016/j.jor.2015.09.007

and found a very low 3-year revision rate of 2% for aseptic loosening.

In revision total hip arthroplasty, there must be initial stability of the cup in the acetabulum for bony ingrowth to occur. Stability can be achieved by using a press-fit technique and augmenting this with acetabular screws. In certain cases, adequate fixation may not be achieved by using the prefabricated holes in the acetabular cup. Revision TM cups offer the opportunity for surgeons to burr customs holes in the TM to allow for screw placement wherever the surgeons feel there may be adequate native bone.[3] Although it is not included in the technique guide provided by the manufacturer, it is described in the literature and is a common practice amongst revision surgeons.[4] These custom holes frequently differ in size and geometry from the prefabricated holes. Although used routinely, the biomechanics of inserting screws through custom holes and its effect on cup fixation have not been evaluated. The objective of this study was to determine the surgeon's sense of screw purchase as well as quantify the change in biomechanics of screw insertion through pre-fabricated and custom-burred holes.

2. Materials and methods

Two Zimmer revision TM cups were obtained and used for the study protocol. Bone cement was cleared using an acetone solution. Custom burr holes were created in a standardized fashion using one pass of the 3.2 mm burr perpendicular to the cup surface at that point. This size was chosen to be similar to the use of a 4 mm by Siegmeth et al.[4] previously reported in the literature. A recess was then created for the screw head using the same burr such that a minimum of 2.5 mm of TM remained (Fig. 1). This is the technique that is employed clinically in revision cases at our institution.

In order to standardize the density of the material for all screw insertions, synthetic bone blocks were used in our trials. Three varying densities of synthetic bone blocks were obtained to model varying quality of cancellous bone (Sawbones Open Cell Blocks, Pacific Research Laboratories, Vashon Island, WA).

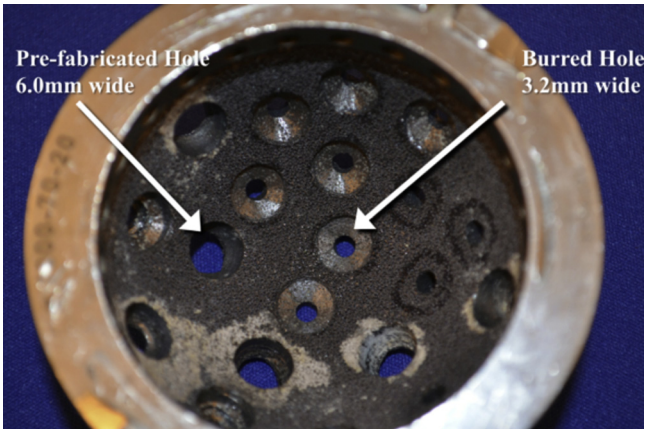

Fig. 1 – Trabecular metal revision cup showing prefabricated and custom burr holes.

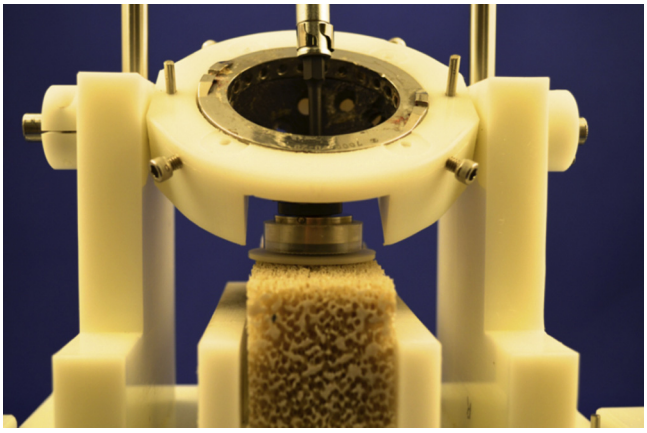

Fig. 2 – Testing apparatus used for screw insertion. The testing apparatus allowed the investigators to ensure that screw insertion occurred perpendicular to the face of the synthetic bone block.

The densities selected were 0.09 g/cm^3, 0.24 g/cm^3, and 0.48 g/cm^3 to resemble low, medium, and high bone density, respectively.

A custom apparatus was designed to securely hold the revision TM cup and synthetic block in alignment for screw insertion (Fig. 2). The apparatus allowed for horizontal screw insertion, in order to better replicate the intra-operative experience. A load washer (LCMWD-2KN, Omega Engineering Inc., Stamford, CT) was placed between the TM cup and the bone block in order to measure cup-bone compressive forces. Three fellowship-trained arthroplasty surgeons participated in the testing. For each screw insertion, the surgeon was blindfolded and instructed not to apply any axial load. Each screw was inserted by the surgeon using a digital torque driver (DID-4, Sugisaki Meter Company, Japan), which was used to measure both the peak torque and end torque (at final screw-turn) from insertion. The surgeons were informed when the screw head had engaged the cup, since their sense of vision was removed for blinding purposes. A total of 24 screws were inserted in a randomized order that was unknown to the surgeon to represent clinically relevant scenarios.

The study protocol was divided into three phases. For the first phase, each surgeon inserted two 30 mm acetabular screws (Zimmer) into each of the three varying densities of Sawbone material. The peak torque, end torque, and the surgeon's subjective rating for how well the screw was fixed (using a 10-point scale) was recorded. The 30 mm screws are the most common length of screw used with the TM cups for enhanced fixation at our institution. However, the addition of the load washer for compression measurement required the use of a longer screw to ensure proper screw purchase. To ensure that the use of a longer screw did not modify the surgeon's perception or the magnitude of torque achieved, for the second phase of our testing, each surgeon inserted two 50 mm acetabular screws into each of the three varying densities of Sawbone material. The peak torque, end torque,