THE ACCURACY OF ACETABULAR REAMING IN TOTAL HIP REPLACEMENT

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Introduction
The stability of cementless cups depends upon the fit of the shell in the reamed acetabulum. Consequently, over-reaming can lead to increased micromotion or traumatic disruption with loss of cementless fixation. Therefore, it is critical that the surgeon knows the true size of the reamed acetabulum before implanting a cementless acetabular cup. In this study, high-precision laser-scanning techniques were applied to determine the actual “true” size of the acetabulum after manual reaming.

Materials and Methods
Twelve fresh/frozen hemi-pelvis (average age: 64 years, range: 42-89 years) were stripped of all soft tissue including any remnants of the acetabular capsule. The acetabulum of each hemi-pelvis was carefully reamed in 1mm increments using cheese-grater style reamers of one standard design until contact was achieved with the floor of the acetabulum. All reamers were obtained directly from the manufacturer and were previously unused. To keep enlargement of the acetabulum to a minimum, all reaming was performed in an axis perpendicular to the mouth of the acetabulum with the reamer oriented at approximately 40° of lateral opening and 15° of anteversion. Once the reaming was completed, a casting of the acetabulum was prepared using high-viscosity vinyl polysiloxane impression material (Baysolex, Miles Inc.). The spatial coordinates of approximately 40,000 points on the surface of each casting were measured at increments of 0.5 degrees and 0.5mm with a laser metrology system (Medar Inc.).

Using custom computer routines, a topographical map of the surface of each impression was developed. Points within aspherical, non-weight-bearing areas of the socket, including the acetabular notch, were excluded. The local diameter of the surface of the casting was calculated at each point on the weight-bearing surface and plotted in a frequency histogram. The average diameter of the acetabulum was then calculated from each histogram. The accuracy of the scanning measurement technique was determined by comparing the diameter of three reamed acetaboli measured using both the laser-based system and a 3D robotic arm (MicrScribe-3DX, Immersion Corp.).

Acetabular diameters determined using these methods agreed to within ±75µm.

The difference between the actual diameter of each acetabular specimen and the nominal diameter of the cheese grater reamer was defined as the “reaming error”. An ANOVA statistical test was performed to examine the association between the reaming error and the nominal reamer diameter.

Results
The acetabuli were reamed to an average of 56mm (range 54 to 58mm). After reaming, the lunate area of the acetabulum remained relatively spherical, with an average variation in diameter of only ± 1.1mm. Other areas of the socket, most noticeably the floor and the acetabular notch, deviated from sphericity by up to 4mm. The average error of reaming for all twelve specimens was 0.44 ± 0.10mm. The diameter of the reamed cavities varied from -0.27mm smaller than the nominal diameter of the hemispherical reamer to 1.0mm larger. Eleven of the twelve acetabuli were over-reamed during preparation by an average of 0.50 ± 0.08mm, while one acetabulum was under-reamed by 0.27mm.

There was no statistically significant difference between the error of reaming and the nominal reamer diameter (p = 0.752). The 56mm reamer produced the largest reaming error with an average of 0.69 ± 0.35mm while the 57mm diameter reamer had the lowest average error (0.33± 0.21mm).

![Figure 1. Histogram and graph of smoothed scanned data of an impression.](image1)

![Figure 1. Graph demonstrating the variation of reaming in this study.](image2)

Discussions
This study demonstrates that, under ideal circumstances, the diameter of the reamed acetabulum varies by approximately ± 0.5mm, compared to the nominal size of the hemispherical reamer. In clinical practice, acetabular reaming is expected to be less accurate due to many factors, including the true diameter of the reaming instruments, the reaming technique used by the surgeon and the elasticity of the pelvis. As the stability of cementless cups depends upon the degree of oversizing of the shell with respect to the reamed acetabulum, over-reaming can lead to inadequate fixation of the acetabular component with increased risk of excessive micromotion or traumatic disruption. For this reason, it is recommended that an accurate acetabular trial be used to measure the size of the implantation site so that an acetabular shelf of appropriate diameter may be selected independent of the nominal size of the hemispherical reamer.

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