INTRODUCTION

Initial stability of cementless acetabular shells affects their osseointegration capabilities and is critical for their long term fixation in the acetabulum. Previously, it has been identified that implants subjected to motion of 40µm will be surrounded in part by trabecular bone but also in part by fibrocartilage and fibrous tissue, and those that are subjected to 150µm of motion will be surrounded by dense fibrous tissue [1]. The purpose of this study is to compare the press fit stability of a high coefficient of friction, 3-dimensional ingrowth coated acetabular shell with a 2-dimensional ongrowth coated acetabular shell that has a successful clinical history of more than 10 years.

METHODS

Specimen Information
In this study, 44mm outer diameter (OD) Trident hemispherical acetabular shells (Stryker Orthopaedics, Mahwah, NJ), with arc-deposited CP Ti coating (2-D coating) were compared to 44mm OD Tritanium Primary hemispherical acetabular shells (Stryker Orthopaedics, Mahwah, NJ) with CP Ti porous coating (3-D coating) that has been reported to have a coefficient of friction of 1.01 [2]. The components were tested in two different density solid rigid polyurethane blocks - 15 lb/ft³ and 30 lb/ft³ to simulate different bone qualities. The polyurethane test blocks (Pacific Research Labs, Vashon, WA) were machined to create hemispherical cavities for the shells to be assembled. The diameters of the cavities were chosen per the recommended reaming techniques in the surgical protocols for these products. A 1mm under ream for 2-D coating shells in 30 lb/ft³ foam blocks, a 2mm under ream for 2-D coating shells in a 15 lb/ft³ foam blocks, and a 1mm under ream for 3-D coating shells in both 15 lb/ft³ and 30 lb/ft³ foam blocks were chosen. The components were prepared for the stability test by seating the shells into the foam blocks with an axial compressive force until the shells were fully seated, which was confirmed by visually examining the rim as well as through a hole at the base of the block. The time between shell insertion and stability testing was controlled to prevent the shell’s press-fit from being affected due to the viscoelastic property of the polyurethane blocks.

Testing Procedure
The press-fit stability was evaluated by applying a tangential load to the rim of the shell and measuring the displacement 180° away from the point of load application. This was accomplished by placing blocks with the shells press-fit into the cavity on a mechanical test frame (MTS, Eden Prairie, MN) and held rigidly in place on the test plate. A metal load applicator was positioned over the rim of the shell while a Linear Variable Displacement Transducer (LVDT) transducer (RDP Electroengine, Pottstown, PA) was placed on the opposite side of the rim and secured to the test plate (figure. 1). The metal load applicator was then translated axially with respect to the central axis of the shell, at 0.0254mm/s until the shell dislodged from the foam block. Data acquisition was done at 25 Hz with the load applied, and LVDT displacement values recorded. The data then was analyzed to determine the force required to displace the shell tangentially by 40µm and 150µm. Any initial settling of the shell was discounted while determining the load values.

RESULTS

Statistical analysis was performed using an unpaired student’s t-test at 95% confidence level.

For both 15 and 30 lb/ft³ polyurethane block densities, it was determined that the difference in average load to displace the shell by 40µm and 150µm between 2-D and 3-D coated shells was statistically significant (p < .05)

DISCUSSION

In this study, we assessed the stability of two different acetabular shells in polyurethane blocks by measuring their resistance to tangential forces that act between the shell-bone interface. Our method is similar to previously published studies that compared press fit stability of acetabular shells with different surface treatments (fibermesh/beaded/plasma spray) [3]. The porous nature of the 3-D coating is designed for enhanced osseointegration and improved long term implant fixation. In addition, it has a high coefficient of friction that aids in initial stability. The results of this study suggest that shells with the 3-D fixation surface may have better initial stability upon implantation than a predicate shell with a clinically successful arc deposited CP Ti ongrowth coating [4] [5].

SIGNIFICANCE

This study highlights the benefits of a three-dimensional fixation surface that has been engineered to have high coefficient of friction and provide better initial stability in the acetabulum than previous generation coatings.

REFERENCES