Can Application of CT Based Technology be used to Enhance Screw Placement in Revision THA?

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Disclosures:
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Introduction: Acetabular revision with a jumbo cementless cup is an effective technique to address many cavitory defects, however poor bone quality presents increased challenges in achieving reliable fixation. Conventional multi-holed revision acetabular cups provide an array of screw holes to allow the surgeon to select the most appropriate screw position and trajectory into areas of the pelvis with good bone stock and low risk of neurovascular injury. However, conventional screw trajectories perpendicular to the face of the cup may restrict access to areas of the pelvis even with the ability to angle the screws slightly. This study compares screw engagement and trajectories of a “generic” shell with a shell designed using computer tomography (CT) technologies to target “safe zones” of the acetabulum. Our hypothesis is that CT technologies, similar to those used in trauma applications and custom acetabular revision components, can help to design shells that achieve more reliable auxiliary fixation options in the revision THA setting.

Methods: To study a range of shell sizes (typically available in Ø54-80mm) a database of skeletally mature pelvic computer tomography (CT) scans [256 CT scans, Custom CT based program (SOMA™ V3.2, Stryker Orthopaedics, Mahwah, NJ) 158 males, 107 female, age range 30-93yrs (mean=65.3, mean male 64.8 & mean female = 66.1, p=0.48)] was divided into four (4) groups based on the diameter of the acetabulum [40-48mm, 48-52mm, 52-62mm, and 62+mm]. A representative model was chosen from each group. An acetabular shell was then virtually implanted, in which the inferior edge of the shell was placed at the inferior acetabular rim and the superior edge was placed against host bone at the superior margin of the posterosuperior bone defect. The computer analysis assumed a +Ø10mm acetabular reaming preparation, common in revision THA, and components were then virtually implanted at 45º inclination/20º anteversion. Cancellous bone screws were then virtually implanted in all available screw holes, taking the “safe zones” into consideration. The “safe zones” have been established and confirmed by prior studies as the posterior quadrants. The screw engagement in the pelvis was measured via computer analysis (ProEngineer, PTC, Mendham, MA) to determine auxiliary fixation potential. The parameters used to define a “useful” screw were that it must engage no less than11mm of the pelvis, and any additional length of engagement beyond 60mm was truncated, representing the shortest and longest commonly commercially available cancellous bone screw, respectively. Screws were virtually implanted into both the generic and the CT designed shells. The shells were rotationally oriented such that the “home run” screws, or screw with the longest trajectory into the posterior column of the ilium, were approximately matched. All screws were then assessed relative to their engagement into “safe zones”.

Results: As seen in figures 7 & 8, the study identified that a shell designed with CT technology consistently provided more auxiliary fixation options (25-125%) into the previously classified “safe zone” than the generic shell. The shell designed with CT technology also provided up to 86.3% (28.4-86.3%) more total screw engagement than the generic shell.

Discussion: CT technologies may help to design shells that provide more auxiliary fixation (quantity & length) by targeting areas of high bone stock. Using the anatomically targeted hole locations, more fixation options were achieved by placing screws in peripheral and radial hole locations. Some hole locations consistently targeted regions of deep boney purchase. The data is based on limited patient bone models, and should be not over generalized.

Significance: Many acetabular revisions are extremely difficult due to the need to maximize implant fixation, and CT technology based shell designs may help to address this clinical issue.

Acknowledgments: N/A

Fig. 3-6. 3. Illustration of the Generics shell highlighting the "bone cut" screw & "angle-of-fit" screw outside of "safe zone". 4) Generic shell screw area, highlighting "bone cut" screw. 5) CT Design shell highlighting "bone cut" screw & screw area into ilium.

Fig. 7-8. 7) Comparison of Generics shell vs. CT Design for No. of "useable" screw holes and 8) total screw engagement.

Fig. 9: Fluoroscopy image of CT designed shell in a cadaveric pelvis – illustrating multiple screw trajectories into ilium.

ORS 2014 Annual Meeting
Poster No: 1813