Adjuvant Superior Ramus Screw Fixation in Type 2B Acetabular Defects: A Biomechanical Model.

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INTRODUCTION:

The rising number of total hip arthroplasty (THA) procedures over recent decades is paralleled by an increased revision THA (rTHA) burden, predominantly due to instability, infection, aseptic loosening, and periprosthetic fracture. Adjuvant screw fixation is essential for component stability, biologic fixation, and favorable clinical outcomes. In the setting of acetabular bone loss, screw fixation in the posterosuperior quadrant may be insufficient. We evaluated the biomechanical integrity of a supplemental screw in the superior ramus in a 2B acetabular bone loss model. We hypothesized that superior ramus screws will significantly enhance biomechanical construct strength and initial stability.

METHODS:

Twelve *fourth*-generation hemipelvis Sawbones were used in the study and a type 2B bone defect was created in each model using a size 64 mm reamer in the posterosuperior acetabular dome. Each hemipelvis was reamed line to line for a size 56 mm Redapt porous, modular shell (Smith and Nephew, Memphis, TN) and was secured using non-locking acetabular screws. Three experimental groups (n=4) consisted of the following screw configurations: two superior dome screws (DS-only), two superior dome screws with a superior ramus screw (DS-SR), and two super dome screws with a superior ramus screw and an ischial screw (DS-SR-I). Samples were loaded on a universal test frame (TA Instruments, ElectroForce 3550; Eden Prairie, MN, USA) using a 15kN load cell. Similar to a previous study (Meneghini et al, 2010), samples were potted in Field's Metal with the ischium oriented upwards. Loading was applied with a steel cantilever attached to the nadir of concavity of the implant (**Fig. 1**). The protocol included a low-force cyclic loading phase, in which samples were loaded between 1-10 Nm at 1 Hz for 1000 cycles, followed by a destructive loading phase, consisting of a ramp-to-failure at 1 mm/s. Custom MATLAB code (MATLAB R2023a, Mathworks, Natick, MA, USA) was used to determine low-force cyclic stiffness, as well as high-force bending stiffness, maximum moment, and maximum angular displacement. Implant groups were compared for all parameters with one-way ANOVA with Tukey's post-hoc test ($p<.05$) in Prism 10 (GraphPad Software, La Jolla, CA, USA).

RESULTS:

No differences in low-force cyclic stiffness were detected across implant groups. However, DS-SR-I implants showed higher bending stiffness and maximum moment compared to both groups with fewer screws. Notably, all implants in the DS-SR-I group failed within the body of Sawbone, as opposed to the implant location. The DS-SR group had mixed failure modes (one failed in sawbone, three failed at implant location) and the DS-only samples all failed at the implant.

DISCUSSION AND CONCLUSION:

In this study we found that supplemental placement of a screw in the superior ramus provides significant stability and improves fixation of acetabular shells in Type 2B acetabular bone loss models. Surgeons should consider all boney corridors when addressing acetabular bone loss in rTHA.

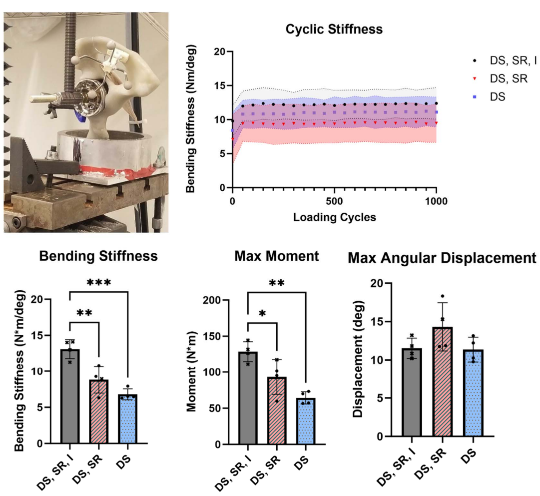

Figure 1: Representative image of loading apparatus. Measured outcomes: cyclic stiffness, bending stiffness, max moment, max angular displacement