INTRODUCTION:
Interbody spinal fusion is performed for a variety of clinical situations, including back pain, vertebral fractures, and tumor conditions that require stabilization of the vertebral segments. The fundamental goal of the interbody spinal fusion is to attain a solid fusion at the implant-vertebral interface. Subsidence is of significant concern when treating highly osteoporotic fusion patients primarily due to the loss of interface strength between the cage and the vertebral body. Subsidence of the interbody cage into the vertebral body may cause collapse of disc space, recurrence of spinal deformity and preoperative symptoms, or failure of the fusion. The proposed treatment methods to prevent interbody subsidence include: increasing the interbody device footprint to maximize contact area and reduce stress on the endplate, reinforcement of cancellous bone at load-bearing areas (endplate/screws) with PMMA and adding supplemental fixation to share load with the interbody cage.

METHODS:
Twenty-four osteoporotic and non-osteoporotic lumbar spines (L1 to L5) were obtained from tissue providers. Bone mineral density of the vertebral bodies (excluding the posterior elements) was measured by DEXA in the lateral plane (Hologic, Inc.). Individual vertebrae were dissected maintaining the bony endplates and systematically stratified according to A-P size and BMD into four experimental groups, each group comprising 9 specimens. Three groups consisted of BMD-matched osteoporotic bone (average BMD = 0.52 g/cm²) and a fourth group had non-osteoporotic bone (average BMD = 0.92 g/cm²). The test groups were as follows:
1. Osteoporotic bone + 18 mm wide cage (CoRoent XL),
2. Osteoporotic bone + 22 mm wide cage (CoRoent XL-W),
3. Osteoporotic bone + 18 mm wide cage + endplate reinforced with 2-4 cc’s of PMMA (injected using a lateral approach),
4. Non-osteoporotic bone + 18 mm wide cage.

Cage lateral length was selected to span the width of the apophyseal ring.

The vertebral bodies were mounted on a materials test frame (MTS 858 Mini Bionix) with the upper endplate aligned with the horizontal plane. The interbody device was positioned over the middle of the endplate and an axial load was applied to the interbody device to push it into the vertebral body (Figure 1). The loading rate was 0.2 mm/sec to a total of 6 mm. The force and displacement data were acquired and the maximum load to failure was determined.

RESULTS:
The results indicate that the maximum failure load was significantly lower in all the osteoporotic groups compared to the non-osteoporotic group (Figure 2). The 18 mm wide XL implant in osteoporotic vertebrae produced the least resistance to subsidence (46% of non-osteoporotic spine), as compared to the 22 mm wide XL-W implant (60% of non-osteoporotic), while the XL implant reinforced with cement provided the highest resistance to subsidence in the osteoporotic spines (71% of non-osteoporotic spine). However, there was no significant statistical difference in between the various groups of osteoporotic vertebrae. In contrast, the failure force with the XL-implant in the non-osteoporotic vertebrae was significantly higher than all osteoporotic groups.

DISCUSSION:
It was seen that a larger footprint (22 mm wide) cage with osteoporotic bone increased the resistance to subsidence by 30% over the smaller 18 mm width. Endplate/vertebral reinforcement with PMMA increased the load to failure by 56% over the smaller cage without cement. A larger increase in strength could possibly be expected by using both PMMA and the XL-W implant. However, neither of these approaches alone provided strength equivalent to non-osteoporotic bone.

The results thus provide a biomechanical rationale for using larger footprint interbody devices especially in osteoporotic patients as they improve surface contact area to the endplates and reduce the stress on the endplates. A further conclusion can also be drawn that vertebral cement augmentation increases the resistance to subsidence.