INTRODUCTION:
Cervical spine disc degeneration afflicts 40% of individuals above 40 years of age and surgical intervention for cervical pain and dysfunction have increased eight-fold from 1999 to 2004. With ever increasing options for surgical intervention including, but not limited to spinal fusion, disc arthroplasty, discectomy and decompression, the applications of these interventions should be examined. Unfortunately, in spite of the growth of cervical spine surgeries, there still exists much debate as to the restorative / surgical height of a motion segment. Few studies have examined the correct fit/size of spacer/disc replacement device in fusion or arthroplasty surgeries. These spacers/devices are available in various sizes, and the surgeon chooses one based on personal training experience and individual evidence. There have been no guidelines on selection of these sizes which may depend on presenting disease state, severity of degeneration, age, sex and height. The objective of this study was to evaluate the inter-surgeon consistency in measuring disc height, grading the severity of disc degeneration, and finally in selecting the best spacer/disc size for a given patient scenario.

METHODS:
Two orthopedic surgeons and two neurosurgeons evaluated cervical spine MR images of 11 cadaveric samples. The MRIs (3-Tesla T2-weighted) were examined in the sagittal plane and each surgeon measured the grade of degeneration of the C5-C6 intervertebral disc using the Pfirrmann method. Next, each surgeon measured the anterior-posterior diameter for the superior and inferior part of the disc. Disc height was measured in the middle of the disc to obtain maximum disc height using the Mimics software version 14.11 (Materialise US, MI, USA). Each measurement was done only once, although surgeons were allowed to correct any measurements (Figure 1). Once these measurements were made, the surgeons used their best of knowledge and clinical experience identified the size of disc replacement device they would use intraoperatively if these were surgical cases. The disc generation grade, disc height measurement and suggested disc spacer/device size for the 11 spines were statistically analyzed between surgeons using one-way intraclass correlation coefficient (ICC) single measure using SPSS Statistics 17.0 (IBM Corporation, NY, USA) for between surgeon agreement.

RESULTS:
When evaluating the C5-C6 disc degeneration grade, the surgeons agreed very well with ICC = 0.79 for single measures statistics. On average they identified one disc with no degeneration, four grade II, three grade III, and three grade IV severity of degeneration. The disc height measurements ranged from 1.65 mm to 7.19 mm for C5-C6 disc and surgeons showed very high reliability with an ICC = 0.83 for single measures statistics. The between-specimen standard deviation of the within-specimen maximum difference between any two surgeon measurements was 1.35 mm (Figure 2). When asked to choose the surgical disc spacer / arthroplasty size, the agreement between the surgeons diminished with ICC = 0.11 for single measures statistics (Figure 2).

DISCUSSION:
There is excellent surgeon agreement on Pfirrmann grade and consistency in height measurement between the observers. Therefore other variables must account for the variation in implant size choice. These may include a desire to over or under stuff the disc space, assessment of adjacent segment disc size as a potential sizing tool or other unrecognized factors. The surgeons are using a lot of information in choosing disc size for a given patient, for example, the extent of disc collapse, adjacent disc height, general patient anthropometry (vertebral body size), unloading of the facets, and personal experience in amount of decompression performed and settling/subsidence expected. There is no model which utilizes these factors together to effectively decide on the optimal distraction of a disc space. This lack of consensus is also present in our current study in spite of agreement of other objective measures. Unfortunately, to our knowledge, there have been no studies which recommend the best approach to choose a specific size of device.

Given the heterogeneity of surgeon disc space fill characteristics, this may significantly alter procedure performance characteristics in as of yet to be determined ways. This study demonstrates a need for standardization procedures for consistency in selection of appropriate disc size which incorporates: disease condition, level of disc degeneration and subject anthropometry. Also, this kind of pre-operative measurement procedures may help to reduce the risk of over or under distraction which might adversely affect facet joints and adjacent discs. A pre-operative evaluation of disc spacer/device sizing will also decrease intra-operative time for the selection of disc sizes.

SIGNIFICANCE:
This study identifies that in spite of different sizes available for cervical disc degeneration surgery, there is little agreement on the best size for a disc spacer/device. Thus, there exists a need for an examination into the most appropriate sizes for disc spacers/devices for optimal surgical outcomes for patients afflicted with cervical spine pathology or injury.