INTRODUCTION:

Spinal fusion surgery, a relatively invasive procedure, has been shown to be an effective treatment of lumbar instability, deformity, and debilitating lower back pain.\(^1\) Interbody fusion, typically performed as Anterior Lumbar Interbody Fusions (ALIF) and Transforminal Lumbar Interbody Fusions (TLIF), involves the removal of the intervertebral disc and scraping of the bony endplates to promote fusion of the vertebra across the disc section. Closkey et al.\(^2\) has shown in an in vitro model that disc removal greater than 30% is needed to promote fusion supporting loads greater than 600N. Unfortunately, there have been no clinical studies to validate this work by comparing the amount of disc removed to clinical outcomes. Knowledge of the optimal disc volume to remove intra-operatively would produce surgical guidelines for traditional fusion and support minimally invasive surgical techniques for interbody fusion. Therefore, the goal of this study is to identify the relationship between the percentage of disc material removed intra-operatively and clinical outcomes for interbody fusion procedures.

METHODS:

A retrospective correlation study was performed wherein patient pre-operative MR images were analyzed and compared with intra-operative measurements and clinical outcomes. 22 subjects were evaluated in this IRB approved study (0905E66342). The patients’ pre-operative disc volume was computed using MR images and a semi-automated software algorithm. Intra-operative disc volume removal was measured and annotated in the patient chart. The percent disc volume removal as calculated from the intra-operative volume and pre-operative volume was then compared with post-surgical outcomes.

Imaging-Based Disc Volume Measurement: Pre-operative disc volume measurements were obtained by analyzing pre-operative MRIs with Mimics version 12.01 software. Thresholding was used to differentiate between pixels belonging to the disc and those of surrounding tissues and then edited by hand to ensure inclusion of only disc material. The area of the pixels were automatically integrated over all slices to obtain both a 3-D model and a volume measurement.

Intra-operative Disc Volume Measurement: During spinal fusion surgery, disc material removed was placed into a 30 mL syringe and calculated the volume. These methods were validated with a porcine intervertebral disc volume computed from MRI and a semi-automated software algorithm. Intra-operative disc volume removal was measured and annotated in the patient chart. The percent disc volume removal as calculated from the intra-operative volume and pre-operative volume was then compared with post-surgical outcomes.

DISCUSSION:

This study identified the relationship between the percentage of disc material removed intra-operatively and clinical outcomes from interbody fusion procedures. Since clinical outcome is a multifactorial concept including both surgical components and patient history, compliance, and psychosocial factors, the correlation of surgical outcomes and specific surgical criteria is difficult. Limitations of this study include the use of an convenience sample of patients who had pre-operative MR and intra-operative syringe measurements. The image-based volume measurement was scaled similar to other studies due to the spline fit's minimization function. The syringe validation herein was controlled as to minimize the loss of tissue which may be impossible to reproduce minimally invasive techniques.

REFERENCES: