INTRODUCTION:
Anterior cervical discectomy and instrumented fusion (ACDFI) is a procedure commonly used in the treatment of cervical radiculopathy and myelopathy. ACDFI involves placing an appropriately sized interbody graft into the distracted discectomy site to facilitate an arthrodesis across the discectomy site. The distractive force needed to insert the graft and the resultant compressive force across the graft following insertion are dependent upon the size of the graft and affect clinical outcomes. Distraction of the anterior column and the placement of an appropriately sized interbody graft indirectly decompresses the nerve roots exiting the foramen by increasing foramenal height and volume. Overdistraction may unload the posterior articular pillars thereby subjecting the anterior graft and vertebral endplates to excessive compressive loads. Underdistraction of the anterior column during ACDFI and the placement of an undersized graft result in a loose interference fit and higher risk of extrusion secondary to inadequate compression across the graft to maintain stability within the interspace. Underdistraction and the placement of an undersized graft during ACDFI may contribute to graft extrusion, pseudoarthrosis or axial neck pain.

Typically, grafts are sized by qualitative intraoperative distraction, interference fit, and/or preoperative radiographic measurement of disc height at the operative or adjacent level. These methods lack the ability to objectively quantitate the distractive force necessary to place the interbody graft and the resultant compressive force across the graft. The purpose of this study is to investigate the relationship between distractive force across the disc space and the subsequent compressive force across the graft during ACDFI. If such a relationship can be determined it will be possible to predict the compressive force across the graft by the distractive force required for graft insertion. The long term goal of establishing this relationship would be to correlate this data with clinical outcomes including endplate failure with graft subsidence, pseudoarthrosis, and axial neck pain.

METHODS:
Intraoperative measurements were obtained from 22 discectomy sites in 16 patients undergoing one and two level ACDFI. The data collected in this study included discectomy sites between C3 and C7. The data collected from these discectomy sites included 1 (4.5%) from C3-4, 3 (13.6%) from C4-5, 11 (50%) from C5-6, and 7 (31.8%) from C6-7. The age of the subjects in this study ranged from 29 to 66 years of age and the average age was 49 years old. With regard to gender, 62.5% of the patients in this study were female and 37.5% were male. This study protocol was reviewed and approved by the William Beaumont Hospital Human Investigations Committee. Informed consent was obtained from all subjects preoperatively.

The surgical procedure employed a standard left sided Smith-Robinson approach to the anterior cervical spine. Caspar distractor and pins 12 mm in length were placed in a standard fashion above and below the disc space. A complete anterior discectomy was performed. The endplates were prepared for the interbody allograft. The Caspar retractor was then removed in preparation for data collection.

A calibrated Caspar distractor* (RA Denton Corporation, Rochester Hills, MI) (Figure 1) was used to measure load until the soft tissue tension resisted further distraction and the strut graft load cell could just be placed into the interbody space. Force was measured immediately prior to insertion of the subminiature interbody load cell (Sensotec, Columbus, OH) 6 mm in height (Figure 1). This custom designed load cells was hermetically sealed and capable of sustaining autoclave sterilization for intraoperative use. Initial compressive force was measured immediately following distractor removal.

The statistical significance and correlation between the distractive force across the discectomy site and the subsequent compressive force across the load cell was investigated with the Pearson Correlation Coefficient (r).

RESULTS:
The average distractive force across the discectomy site was 32.91±10.44 lbs to allow for the insertion of a 6 mm subminiature load cell. The subsequent initial compressive force across the interbody load cell was 17.58±5.77 lbs following distractor removal. A total of 22 data sets were obtained during this study from 16 patients. The Pearson Correlation Coefficient between the distractive force and the subsequent compressive force was r = 0.847 (p=0.005), which demonstrated a statistically significant linear correlation across the range of distraction and subsequent compression investigated (Figure 2). Regression analysis was also conducted to determine if a relationship was present in distractive force versus patient age (r=-0.173, p=0.442), distractive force versus operative level (r=0.115, p=0.610), compressive force versus patient age (r=0.42, p=0.853) or compressive force versus operative level (r=0.14, p=0.951). However, no trends or statistically significant correlations were observed between these other variables.

DISCUSSION:
This study demonstrated a statistically significant linear correlation between the distractive force applied across the discectomy site and the subsequent compressive force across a load cell placed in the interbody space following distractor removal (p=0.005) in an in vivo ACDFI model. Future goals for this project include the incorporation of long-term clinical and radiographic outcomes regarding ACDFI. Comparing the data obtained in this study to endpoints such as graft or endplate failure and resultant graft subsidence, pseudoarthrosis and axial neck pain will provide clinically useful data and instruments to improve the outcomes of ACDFI. The data and instrumentation implemented in this study may prove a useful tool in ACDFI and in other interbody devices including emerging cervical disc replacements. The ability of the surgeon to reproducibly obtain proper ligament tension across the discectomy site and predictable compression across the implant will allow for more reproducible outcomes and possibly avoid potential complications.

REFERENCES:

Figure 1 – Cervical Distractor(left) & Strut Graft Load Cell (right)

Figure 2 – Distractive Force versus Graft Compressive Force

Distractive Force Relative to Initial Graft Compression in an In Vivo Anterior Cervical Discectomy and Fusion Model

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