THE EFFECT OF INCREASING THE CERVICAL DISC SPACE HEIGHT ON THE FACET JOINT

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ABSTRACT INTRODUCTION:
The use of the artificial disc in the cervical spine has just recently been utilized during surgery. Consequently, there is a lack of extensive outcome studies as long period of follow-up has not been conducted. It is therefore important to obtain some necessary information from a pilot study. A surgeon oftentimes attempts to increase the disc space and inserts a larger artificial disc in order to keep the intervertebral foramen open and the prosthesis stable. However, it is hypothesized by the current authors that such a procedure could have an adverse effect at the facet joints. To date, no study has addressed the effect that increasing disc height has on the facet joints in the cervical spine. This study is to evaluate how facet joint articulation is affected by increasing the disc space height in the cervical spine.

METHODS:
Computerized tomography images passing through the disc space and the center of the C4 to C7 facet joints (sagittal plane) were obtained from fifteen cadaveric cervical spine specimens. The articulation overlap of the facet joint at C4-5, C5-6, and C6-7 were measured with the Aquarius Image software at the CT scanner’s TeraRecon Aquarius Workstation. The images were then manipulated. The articulation overlap of the facet joints in the sagittal plane of the C4-5, C5-6, and C6-7 was measured. A 1mm incremental increase to a total 5mm in disc space height was performed to simulate the changes seen in disc replacement. The change in the facet joint articulation overlap and facet joint space in the sagittal plane at normal and each replacement was then measured using NIH Image J software (V1.33m).

For validation purposes, five cervical spine specimens were used to validate this technique and standardize the measurements. Two marking pins were inserted at a 10 mm distance on the vertebral body along with a millimeter ruler. A CT scan was then taken. The distance between the pins was measured by the ruler on the specimens and on the CT scan images with the Aquarius Image software at CT scanner’s TeraRecon Aquarius Workstation.

The mean, standard deviation, and increase percentage values were calculated for all measured dimensions. The differences between the articulation overlap and space of the facet joint at normal and different degrees of increase in disc space height were analyzed with the student’s t-test. The confidence level for significance was p<0.05.

RESULTS SECTION:
No significant difference was found between the measurements on CT images and gross specimens (P>0.05). In 15 specimens, the mean facet joint articulation overlap on the sagittal plane was 8.41 ± 1.01 mm (left) and 8.44 ± 0.94 (right) at the C4-5 level, 9.24 ± 1.53 mm (left) and 9.23 ± 1.57 mm (right) at the C5-6 level, 8.55 ± 1.23 mm (left) and 8.59 ± 1.58 mm (right) at the C6-7 level. There was no significant difference between the measured values on the left and right sides (P>0.05).

Each 1 mm incremental increase in disc space at the C4-5 level translated to a decrease in the facet joint articulation overlap in the sagittal plane by approximately 8%. The mean facet joint space increased approximately 0.8 mm. At the C5-6 and the C6-7 level, the articulation overlap decreased by approximately 7% and the facet joint space increased approximately 0.8 mm.

DISCUSSION:
The intervertebral discs separate the vertebrae of the spine. They have three basic functions: 1) to act as a ligament by holding the vertebrae together, 2) to act as a shock absorber to axial load and 3) to act as a pivot point, which allows the spine to flex, extend, and rotate. The cervical facet joints are formed by the superior and inferior articular processes of successive vertebrae. These surfaces are coated with hyaline cartilage. The surfaces of facets on the superior processes are concave. These processes project posteriorly and medially. The surfaces of facets on the inferior processes are convex. These processes are directed anteriorly and laterally. The superior processes are farther apart than the inferior processes.

Proper spinal motion requires that the disc and facet joints are both properly functioning. Facet joint degeneration and disc degeneration oftentimes occur together. When this occurs, one may be the primary problem while the other may be a secondary phenomenon as a result of altered spinal mechanics. Central and lateral spinal stenosis, degenerative spondylolisthesis, and degenerative scoliosis may all result from the abnormal mechanical relationship between the disc and facet joints.

The use of the artificial disc in the cervical spine has just recently been utilized during surgery. Consequently, there is a lack of extensive outcome studies as long period follow-up has not been conducted. There are some general concerns regarding the use of the artificial disc in cervical spine surgery. One common scenario is that the surgeon usually inserts a larger artificial disc in the cervical spine in order to keep the intervertebral foramen open and the prosthesis stable. However, it is hypothesized by the current authors that this procedure can inadvertently lead to a negative effect at the facet joints. No study has yet demonstrated what happens to the facet joints when an artificial disc is inserted during cervical spine surgery.

The current study indicates that intervertebral disc space height significantly affects facet joint articulation overlap. The mean decrease in facet joint articulation overlap in the sagittal plane was 8% at the C4-5 level and 7% at the C5-6 and the C6-7 level with each 1 mm increase in disc space height. Furthermore, the effect on facet joint space is considerable. A mean increase in facet joint space of 0.8 mm at C4-5, C5-6, and C6-7 occurs with each 1 mm increase in disc height (Tables 2, 3, 4). These results suggest that any increase in disc space height from the original position produces significant changes in the mechanics of the facet joint.

Although sagittal sections clearly represent and answer the objectives of the current study, it is believed that further research using three-dimensional images should be conducted. This study provides the basic input for such future investigations.

There is a significant decrease in the facet joint articulation overlap in the sagittal plane and an increase in the facet joint space following increase in the cervical disc space height. The inappropriate increase of the disc space height may result in facet joint subluxation and could lead to the accelerated failure of the artificial disc.

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