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Static Evaluation of Shear Loading Associated with Extension/Compression of the CerviCore Intervertebral Disc
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Introduction: Migration of intervertebral devices is a multifaceted phenomenon which includes mechanical factors such as disc loading and transfer of motion. Clinical factors such as bone quality, site preparation and sizing also play a role. The purpose of this study was to measure compressive and shear loading transfer within the CerviCore Intervertebral Disc under neutral and extension conditions.

Material and methods: Six caprine FSUs were implanted with a CerviCore intervertebral disc. Pressure sensitive film was placed between the superior and inferior components of the device. Wedges were fabricated to provide extension angles of 0°, 5°, 10° and 15° between the superior and inferior vertebral body. For each angle, a compressive load of 100N was applied to the FSU and maintained for 30 seconds to permit pressure film exposure. Pressure film analysis was performed using a Topaq system.(Figure 1) For each extension condition, peak and mean values for contact stress, force and area were computed. The neutral or 0° extension condition was used as the control condition. The remaining extension conditions were subjected to computation of shear stress and force through the relationships:

Shear Stress = TAN(Extension angle) x Compressive Stress
Shear Force = TAN(Extension angle) x Compressive Force

Results: Compression: A significant increase in contact area was detected at 15° of extension as compared to both the neutral (0°) and 5° of extension. The mean and maximum compressive force was significantly increased at 15° of extension as compare to both the neutral (0°) and 5° condition. No significant difference was detected in maximum compressive pressure or mean compressive pressure regardless of extension angle.

Shear: The mean and maximum shear pressure was significantly increased at all extension angles. The mean and maximum shear force was significantly increased at 15° of extension as compare to both the neutral and 5° condition. Mean and maximum shear force was significantly increased at 15° of extension as compared to both the neutral (0°) and 5° condition.

Discussion: The resulting compressive contact area and forces were increased in a similar manner at the various extension angles. Since both parameters increase at comparable rates the contact pressure (defines as force/area) remains essentially constant. Shear loading can be viewed as the force indicative of tendencies for migration. Though statistically significant increases in both mean and maximum shear pressure were observed at all extension angles, the maximum shear force computed was 41N and is considerably lower than the value determined for pullout the device in the neutral position.[(226±6.2)N] The low shear force denotes a low propensity to migration of the device based on mechanical factors alone. Based on this data, the CerviCore disc displays a low tendency to migrate anteriorly due to forces generated under extension.