Mobi-C® Possesses Axial Compressibility Similar to the Native Disc

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Introduction

Complete disc arthroplasty (CDA) has become a common alternative to anterior cervical discectomy and fusion (ACDF) for treatment of disc degeneration of the cervical spine.[1,2,3] CDA not only restores disc height, but also returns motion to the diseased level.[3,4,5,6,7] Each CDA design restores motion a little differently.[7] In the native spine, the functional spinal unit is thought to possess six degrees of freedom, three translations (anterior/posterior, medial/lateral, and axial), and three rotations (flexion/extension, lateral bending, and axial rotation).[4] Competitive disc designs limit motion in some of these degrees of freedom to provide stability to the diseased level. For example, ball-in-socket designs provide only three degrees of freedom, allowing all three rotations but fixing all translations. Ball-in-trough designs provide four degrees of freedom, allowing for three rotations and anterior/posterior translation. Mobi-C possesses a novel design in which five modes of motion are thought to be allowed (Figure 1).[6] The only mode thought to be limited is axial compression. In this study, that hypothesis was tested by measuring the axial stiffness of healthy cervical functional spinal units (FSU's), implanting Mobi-C into those levels, and again measuring the axial stiffness of cervical FSU's implanted with Mobi-C.

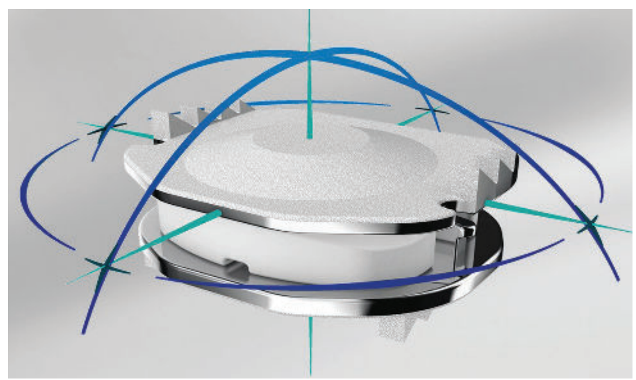

Fig. 1 *Mobi-C device with degrees of freedom depicted*

Materials and Methods

Fourteen cervical functional spinal units were dissected from seven cadaveric specimens. Of the 14 FSU, four were C3-C4 and C5-C6, while three were C4-C5 and C6-C7. Each FSU was prepared for biomechanical testing, and tested using a single-gimbal servo-hydraulic spine simulator (Bionix® Spine Kinematics System, MTS Corporation, Eden Prairie, MN, USA). The specimen was fixed inferiorly to an x-y table to prevent shear loading and superiorly to a gimbal controlling flexion/extension, lateral bending, and axial rotation angle (Figure 2).

Fig. 2 *Specimens were tested in axial compression and flexion extension (left) prior to and following Mobi-C implantation (right)*

Testing consisted of three cycles of axial compression in displacement control at 0.05 mm/s up to 200 N. Displacement and load was measured throughout all three cycles. Each specimen was tested in the native condition and after implantation of Mobi-C. Axial stiffness of each test was measured as the slope of the force-displacement curve between 100 and 200 N. In addition, the difference in peak displacement at 200 N between the two interventions for each specimen was calculated.

Each specimen was also tested in flexion-extension up to ±2 N-m in each intervention. Total range of motion was compared between the intervention in the raw state as well as normalized to the intact condition. For all data gathered, a battery of normality tests were run to determine whether or not the data followed a Gaussian distribution. Following this, the appropriate (parametric or non-parametric) paired t-test was used to assess for significance (p=.05).

Results and Discussion

The average difference in axial displacement between the native and Mobi-C states was -0.15 mm (Figure 3). This result means that the Mobi-C implantations compressed 0.15 mm more than the native states on average. This result was not significant (p=0.06). The average axial stiffness for the native and Mobi-C states were 341.3 ± 106.1 N/mm and 260.5 ± 77.9 N/mm respectively (Figure 4). The native disc was found to be significantly more stiff than the FSU with a Mobi-C implanted (p=0.01).

For the flexion-extension test, no significant differences (p=.3) were measured between the raw ROM values (Figure 5). No significant differences (p=.1) between the ROM values were measured again when the ROM were normalized to the intact state (Figure 6).

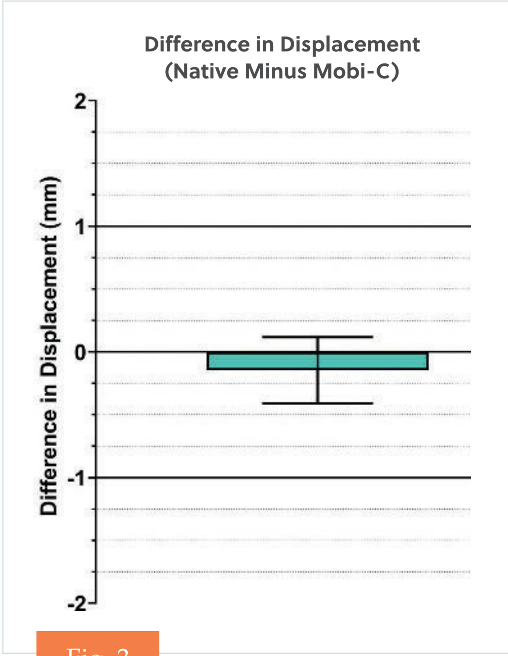

Fig. 3

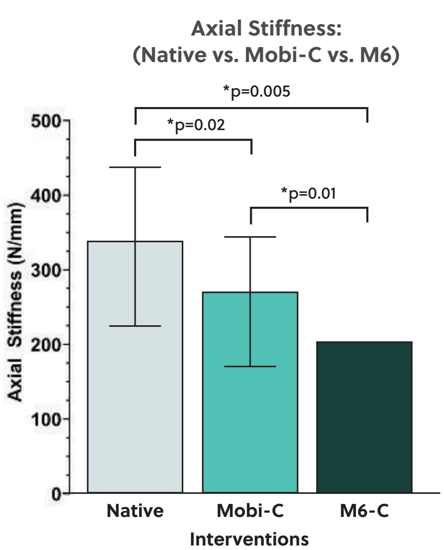

Fig. 4

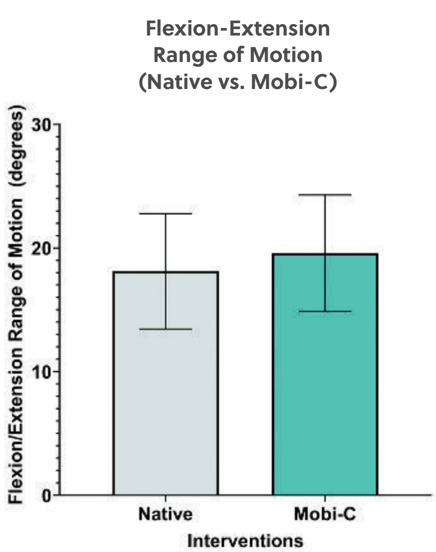

Fig. 5

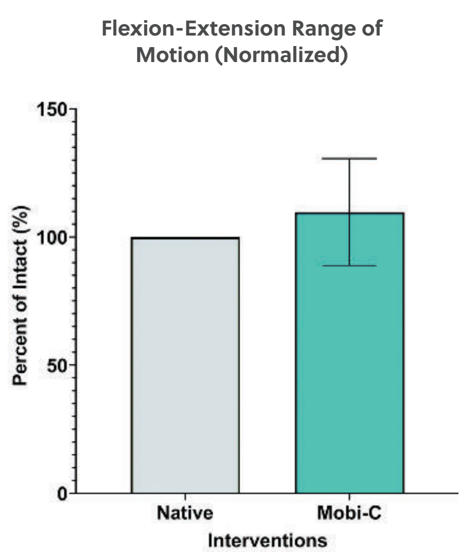

Fig. 6

Mobi-C has traditionally been thought to possess the ability to accommodate five degrees of freedom. This train of thought has led competitive discs to claim that they are the only disc to allow for compression similar to the native spine. This study disproves that claim. The results presented here indicate that Mobi-C possesses all six degrees of freedom present in the natural spine. In addition, the study results shown here reveal the true stiffness of the native disc. The stiffness of the native spine measured here, 341.3 N/mm or 1948.8 lbs/in, shows how little axial compression occurs during activities of daily living in the cervical spine. Furthermore, competitors whom claim their disc device possesses stiffness similar to the native spine and can also demonstrate visible deformation to small loads are most likely unable to back up their first claim with data.

CONCLUSION

Mobi-C demonstrated similar axial compression the native cervical disc. This finding indicates that Mobi-C enables motion in all six degrees of freedom, comparable to the natural spinal disc.

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