Persistent Lumbar Foraminal Stenosis in Spite of Direct Decompression

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Introduction: Foraminal stenosis is a common condition in degenerative spines. While traditional posterior decompression strategies have been shown to be effective in neutral positioning [1,2], they have not been tested in flexion and extension of the spine, which can cause a change in foraminal space [3,4]. Consequently, a true assessment of these techniques' effectiveness has not been quantified. The purpose of this study is to use 3D X-ray reconstructions to compare the effects of a posterior foraminal decompression on intervertebral foraminal area with respect to flexion and extension of the spine.

Methods: Eight cadaveric specimens (L5-S1) were used for this study. The edge of the superior vertebrae and approximately half of the sacrum were cast in quick-set resin (Smooth Cast 300). Intact Testing: Each specimen was placed into a X-ray compatible pure moment jig modeled after a previously validated pure moment apparatus (Figure 1A) [5]. To ensure minimal image distortion, all parts of the jig directly in the line of sight of the C-arm were made out of plastic. 3D-scans (Philips BV Pulsera) of each specimen were taken under no load, 3.5Nm of flexion, and 3.5 Nm of extension.

Foraminal Area Measurements: The 3D scans were used to create 3D models of the left and right foraminal spaces through segmentation software (Mimics Innovation Suite 13.1) The models of the foraminal space were cut into lateral cross sections 1mm thick (Figure 2), and the lowest cross-sectional area of the foramen was recorded.
Foraminotomy: After intact testing, the left side of each specimen was subject to a direct, posterior approach decompression. After the foraminotomy, the specimen were once again tested and scanned under no load, 3.5Nm of flexion, and 3.5 Nm of extension.

Results: Across all treatment groups, specimens showed a statistically significant (p< 0.05) increase in foraminal area under flexion and a decrease under extension. Additionally, there was a significant difference in relative change of foraminal area after decompression. Specifically, there was a significant difference between the two groups (decompression versus no decompression) in the neutral (178 versus 167mm²) and flexed (200 versus 189mm²) positions, but not in extension (158 versus 155mm²).

Discussion: The lack of an increase in foraminal area under extension (where foraminal area is already the smallest) following posterior decompression suggests that this approach may not be completely successful in treating foraminal stenosis. Further research will entail a comparative study of the anterior and posterior approaches to foraminal decompression with respect to flexion and extension.