THE EFFECT OF FUSION INSTRUMENTATION ON LUMBAR KINEMATICS AND INTRADISCAL PRESSURE

Methods: Nine cadaver lumbar spines were analyzed by applying nonconstraining nondestructive bending moments in a linear fashion (max = 13Nm; rate = 2 Nm/sec) while measuring global ROM, mechanical reaction at the sacrum, and segmental ROM at L1-L5. Pure moments applied to the top of the specimen created flexion, extension, lateral bending, and axial torsion. A 3-axis goniometer measured global ROM and a 6-axis load cell measured mechanical reaction. Segmental ROM was measured with an infrared motion analysis system. Intradiscal pressure transducers were inserted in L1/L2, L2/L3 and L3/L4 discs. Each specimen was tested in an intact and fused state (with L3/L4 instrumentation), while achieving a similar global ROM in the sagittal, frontal, and transverse planes. The instrumentation was removed and the specimens retested in an intact state to verify the experiment as nondestructive. Mean mechanical reaction, segmental ROM, and IDP data obtained during sagittal, frontal, and transverse plane testing were compared between intact, fused, and the second intact testing using repeat measures analysis of variance. Null hypotheses stated that the means during intact, fused, and the second intact testing would be similar, and contrary results were declared significant for a p-value < 0.05.

Results: All testing was verified as nondestructive, therefore results can be attributed to the instrumentation alone. A statistically significant increase in applied moment (at the top of the specimen) during fused testing when compared to intact values was recorded in flexion (27% ↑; p=0.0001), extension (7% ↑; p=0.035), left-right lateral bending (≈20% ↑; p=0.0001), and left torsion (7% ↑, p=0.012). These data correlated well with the reaction moments measured by the load cell (at the bottom of the specimen), thereby verifying a “pure” moment application. A statistically significant increase in segmental ROM during fused testing when compared to intact values was measured at all the remaining levels during sagittal (p=0.0031 - Figure 1) and frontal (p=0.044 - Figure 2) plane testing, and at L1/L2 and L4/L5 during transverse (p=0.03 - Figure 3) plane testing. Statistically significant decreases in segmental ROM were measured at the fused level (i.e., L3/L4) during sagittal (38% ↓; p=0.0001), frontal (25% ↓; p=0.0001), and transverse (17% ↓; p=0.0011) plane testing.

Discussion: This in vitro study quantified the effect of fusion instrumentation on the lumbar spine. Since no bony fusion was possible, this testing analyzed the effects of posterior instrumentation immediately following implantation. Clinically, these results suggest that patients who undergo lumbar fusion and require the same range of motion from their spine would impart increased loads on their spine, thereby increasing segmental ROM. If solid fusion was achieved in vivo, the increased fusion-site stiffness could result in greater increases in spinal loads and segmental ROM than values presented in this in vitro research. These results support the hypothesis that increased motion at levels surrounding a fusion mass may perpetuate postfusion degeneration of the spine. Disproportionate motion increases at levels adjacent to the fusion, indicating a predisposition at these levels only to degeneration, were not found. It could be hypothesized that over time, the increased loading would stimulate biological remodeling or failure of spinal structures. If increased loading exceeded the physiologic limit of these structures, cumulative damage may occur, possibly resulting in ligament laxity, disc degeneration, and osteophyte formation. In addition, significant alterations in intradiscal pressure within the fused disc may affect its physiology long-term and could be an impetus to discogenic low back pain following a successful bony fusion.