Altered Sit-to-Stand Mechanics in Lumbar Spinal Stenosis with Neurogenic Claudication: Insights from Advanced Motion Analysis

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INTRODUCTION: Lumbar Stenosis with Neurogenic Claudication (LSNC) is a common condition defined as a narrowing of the lumbar spinal canal. Patients with LSNC often suffer from weakness and paresthesias with prolonged standing or walking. These symptoms can inhibit patients' abilities to carry out activities of daily living where even simple tasks such as moving from a sitting to standing (StS) position can be difficult and sometimes dangerous. Therefore, the aim of this study is to utilize novel analysis methodology to characterize StS movements in patients with LSNC and compare it to healthy controls.

METHODS:

In a prospective, single-center, concurrent cohort study, 42 patients with LSNC with bilateral symptoms and 45 controls. Patients were enrolled in the study. Functional balance tests were performed and recorded by 3D motion capture in both the standing (Romberg) and seated positions. Balance effort and CoE dimensions were calculated. Outcome measures included 3D lumbar, pelvis, hip, and knee range of motion (RoM).

RESULTS: During the sit-to-stand task, patients with LSNC demonstrated significantly greater lumbar and pelvic range of motion compared to controls. Specifically, LSNC patients showed increased lumbar spine flexion (58.4° vs 31.8°), side flexion (3.6° vs 2.3°), and rotation (3.7° vs 2.6°), as well as greater pelvic anterior tilt (57.2° vs 34.3°), obliquity (4.5° vs 2.8°), and rotation (14° vs 3.3°) (all $p<0.05$). Conversely, NSLC patients exhibited decreased hip (55.6°/54.3° vs 64.1°/64.2°) and knee flexion (69.2°/67.5° vs 75.9°/75.3°) ranges of motion ($p<0.05$). At the transition point from sitting to standing, NSLC patients also demonstrated a significantly greater pelvic anterior tilt (47.2° vs 35.3°) and reduced knee flexion angles (74.1°/72.6° vs 84.7°/86.1°, $p<0.05$), highlighting altered biomechanical strategies in this population.

DISCUSSION AND CONCLUSION: This study is the first to present objective biomechanical metrics from a validated sit-to-stand task to evaluate patients with LSNC. Our findings demonstrate that LSNC patients exhibit reduced hip and knee flexion, compensating with increased lumbar spine flexion and pelvic tilt during the transition from sitting to standing. As a fundamental movement performed over 60 times daily, sit-to-stand is a clinically relevant indicator of health, functional independence, and fall risk, especially in older adults. While previous literature has focused on five-repetition sit-to-stand assessments, our single-trial analysis using motion capture provides precise, quantifiable data that eliminates the subjectivity and variability of observational scoring. These results align with prior kinematic studies and support the growing utility of sit-to-stand power as a predictor of mobility, surgical outcomes, and rehabilitation needs in spine pathology.