LOWER EXTREMITY GAIT BIOMECHANICS AND THEIR ASSOCIATION WITH TRUNK FLEXION IN PATIENTS WITH LUMBAR SPINAL STENOSIS

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Introduction

Patients with symptomatic lumbar spinal stenosis (sLSS) have a narrowing of the spinal canal causing nerve decompression which often leads to pain and weakness in the back and legs while walking. Patients with sLSS walk slower and their gait patterns differ from healthy controls, yet little is known about joint kinetics during walking [1]. It is believed that one strategy to relieve pain is that patients with sLSS increase trunk flexion during walking [1,2] and it has been shown that in patients with sLSS, the maximum trunk flexion angle is affected by the maximum hip extension angle, maximum hip flexion moment and step length [2].
Hence, the aims of this pilot study were i) to investigate whether lower extremity gait kinematics and kinetics differ between patients with sLSS, asymptomatic elderly controls and young healthy controls and ii) to assess whether these parameters are related to maximum forward trunk flexion during walking.

Methods

Joint kinematics and kinetics during walking were assessed in 10 patients with sLSS (5m/5f; age, 70±10 years; body mass index (BMI), 29±5 kg/m^2), 10 asymptomatic elderly persons (5m/5f; 65±5 years; 25±6 kg/m^2) and 10 young healthy persons (5m/5f; 26±2 years; 22±2 kg/m^2) using a full body marker set and the Conventional Gait Model 2.3 (CGM 2.3) [3]. Data for four gait cycles per subject were extracted and time normalized to gait cycles (kinematics) or stance phases (kinetics). Differences in angle and external joint moment trajectories between groups were assessed using statistical parametric mapping (SPM, www.spm1d.ord) with analysis of variance (ANOVA) with posthoc t tests with Bonferroni correction. The influence of maximum thorax flexion during gait on lower extremity biomechanics trajectories was assessed using scalar linear regression tests. The significance level was set a priori to 0.05 for all tests.

Results

Walking speed was slower in patients (0.97±0.15 m/s) than elderly (1.17±0.17 m/s, P=0.037) and young controls (1.31±0.18 m/s, P<0.001) and the maximum trunk flexion was greater in patients (3.5±9.0°, P=0.014) and elderly (8.2±6.4°, P<0.001) than in young controls (-6.3±5.9°).
Figure 1 shows the kinematic and kinetic trajectories with significant differences between groups. At the hip, patients had lower flexion moments after heel strike than young controls (P=0.016) and lower adduction moments around 20% stance than elderly (P=0.003) and young controls (P=0.011). At the knee, patients and elderly had less extension in terminal stance than young controls (P=0.010 and P=0.013) and patients had lower extension moments after heel strike and in late stance than young controls (P=0.016 and P<0.002). At the ankle, patients had lower dorsiflexion moments during push-off than young controls (P=0.004).

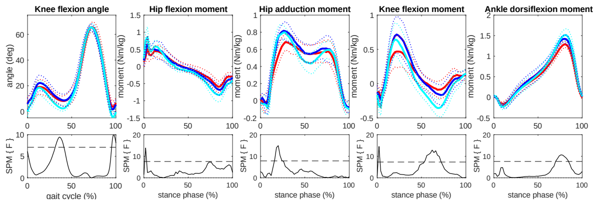

Figure 1. Top row: Mean (solid) ± standard deviation (dotted) trajectories of patients with sLSS (red), elderly (blue) and young (cyan) controls. Bottom row: Results of the ANOVA with grey shaded areas indicating time periods with significant differences between groups.

Greater maximum trunk flexion during gait was significantly associated with lower hip flexion angles in swing phase (63–83% gait cycle, P=0.009), greater knee flexion angles during midstance (20–39% gait cycle, P=0.013) and lower hip extension moments in the second half of stance (72–80% stance, P=0.018).

Discussion

Although forward trunk flexion in patients was comparable to elderly controls, joint moments differed mainly between patients and young controls but not between elderly and young controls, while joint angles differed between elderly and young controls. Despite methodological differences (patients and controls vs. only patients, and trajectories vs. peak values) to Igawa et al. [2], we found that hip angles and moments were related to maximum trunk flexion. These results indicate that elderly controls might use different strategies than patients with sLSS to adapt their gait to a more forward flexed trunk.

References

1. Wang et al, The Spine Journal, 22:157-167, 2021.
2. Igawa et al, PLoS ONE, 13(5):e0197228, 2018.
3. Leboeuf et al, Gait Posture, 69:235-241, 2019.

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