Low-Velocity Whiplash-like Perturbations Influence Head Motion During Gait: A Novel Use of Detrended Fluctuation Analysis

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Motor deficits such as muscle inhibition and loss of joint control arising from altered patterns of muscle recruitment have been recognized in cervical spine disorders. Recent work in our laboratory has shown that neck pain causes a disturbance in the rhythmical motion of the head relative to the upper trunk during gait. The strength of the head-upper trunk rhythmical disturbance is quantified using a measure we developed - the Spine Walk Index (SWI). The SWI quantifies uncertainty in the estimate of the long-range power law correlation (alpha), which is calculated from a series of event times using detrended flucutation analysis (DFA). However, it is difficult to reliably identify events within a head motion signal. Our approach will be discussed. To investigate the sensitivity of the SWI to detect coordination changes in head motion during gait, we subjected three groups of healthy volunteers (n=6+9+8) to a series of 9, 49 or 100 mild (peak velocity change of 3.0 km/h) whiplash-like perturbations. This type of perturbation experiment has been previously used to elicit reflex-like neck muscle activation in healthy volunteers and has the potential to cause mild neck muscle soreness similar to that experienced following mild whiplash. The SWI was derived from 3D head and upper trunk motion data collected during a 5 minute treadmill walk prior {0h} and following the perturbations {1h, 1d, 2d, 6d}. Our results clearly demonstrate that the SWI increased 1d and 2d post-perturbation for both the 49 and 100 groups and as expected, the 100 group had a greater change. Unexpectedly, the 9 group presented with a small decreased SWI 1d post-perturbation. These findings demonstrate that the SWI is sensitive to detect a change in head coordination during gait following a series of mild whiplash-like perturbations. These data suggest that the SWI may be a useful clinical tool to examine the effectiveness of interventions used to treat patients with mild whiplash injuries.

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