

INCREASED VENTILATION AND INJURY HISTORY APPEAR TO MODULATE SPINE STABILITY

S.G. Grenier, R.A. Preuss and S.M. McGill

Spine Biomechanics Lab, Dept. of Kinesiology, University of Waterloo, Waterloo, Ontario

Email: sggrenie@ahsmaail.uwaterloo.ca

INTRODUCTION

Spine stiffness, and subsequent stability, during isometric holds is dependent upon symmetric and stable muscle activation levels (Cholewicki & McGill, 1996). In addition, during challenged breathing, the same muscles that create stability are used to assist in lung ventilation (McGill et al. 1995). A related phenomenon has been reported in monitor lizards, where the same muscles used to breathe, assist in lateral movement of the spine for running (Owerkowicz et al., 1999). Ventilation takes precedence over running speed and therefore is a limiting factor. Humans use the diaphragm to breathe together with the abdominals if necessary, but does ventilation take precedence over spine stability? It was hypothesized that those subjects with a prior history of spine troubles would be more likely to exhibit anomalous motor patterns in those muscles involved in achieving both spine stability and ventilation.

METHODS

Workers from physically demanding jobs (n=51) volunteered for this study. Their current spine health was documented together with their prior history for disabling spine troubles (sufficient for work absence).

EMG was recorded bilaterally at three different sites. Pairs of Ag Ag-Cl surface electrodes were placed 3 cm apart, center to center, over rectus abdominis (RA, 3 cm lateral to the umbilicus), external oblique (EO, 15 cm lateral to the umbilicus), and internal oblique (IO, halfway between the anterior iliac spine and the midline, just superior to the inguinal ligament. The EMG

signals were A/D converted via a 12 bit, 16 channel A/D board, full wave rectified and low pass filtered (Butterworth - cutoff at 2.5 Hz). Signals were normalized to the subject's MVC effort at each muscle site. An ultrasonic flow meter, in-line with the mouthpiece, recorded ventilation variables.

Subjects performed two weight holding trials (22 kg); one of 60 sec duration while breathing ambient air and the other of 70 sec while breathing 10% CO₂. Their flexed trunks were held at 30° from vertical and their feet were stationary, shoulder width apart. On average this resulted in a compressive load on the L4/L5 joint of 2730N, well below the NIOSH action limit. The linear enveloped EMG from the abdominal muscles were evaluated for anomalous patterns.

RESULTS

Of 51 subjects, 11 showed an anomalous abdominal motor pattern. Of those eleven, eight reported having had work disabling back pain. Fisher's exact test confirmed a link between prior injury history and anomalous motor patterns in the back stabilizing musculature (P=0.056). One of the 3 that had not reported any pain was a 21 year old apprentice with six months experience. Another is a 25 year veteran who had reported back pain but which was not work disabling.

Motor anomalies were only observed in either the external or internal oblique muscles. Most showed a pattern of entrainment with ventilation but some showed dramatic asymmetries between right and left muscle pairs while others instead

showed evidence of panicked breathing and erratic abdominal activation.

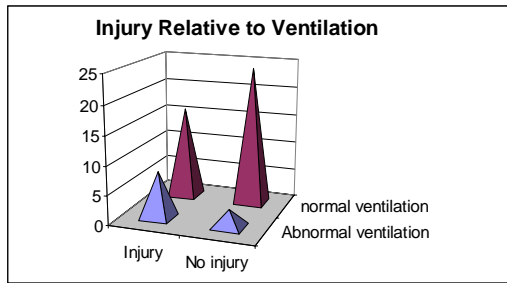


Figure 1: Those who exhibited motor anomalies were more likely to have a history of disabling low back troubles.

DISCUSSION

Although this initial investigation was not designed for statistical rigor, it appears that those with a previous injury history are more prone to experiencing inappropriate muscle activation to maintain sufficient spine stability. Cholewicki and McGill's (1996) analysis leads us to suspect that these anomalous motor patterns increase the risk of spine instability along with risk of injury. It is interesting to note that these anomalous motor patterns emerge even with light loads, as this phenomenon has been reported before with much heavier hand held loads (McGill et al. 1995).

Abdominal muscles appear to be important for achieving sufficient spine stability. Gardner-Morse and Stokes (1998) report that abdominal antagonistic co-activation increases spine stability. EO has the greatest effect but at the expense of increased muscle fatigue. IO was a more efficient stabilizer in their model. However, our data suggests that IO and/or EO also assist ventilation in abnormal subjects (even during light tasks), leading to increased risk due to muscle fatigue. In normal individuals IO and EO were activated at levels of 3% of MVC, or less, for the task. Cholewicki and McGill (1996) suggest this may be enough to stabilize the spine.

Hodges et al. (1997) report that the latency response of the abdominal muscles is affected by their respiratory activity. The response time is less when the muscle is prepared for expiration. This implies that in people who must use this muscle to breathe the risk of injury increases while inspiring, when the muscle may not be active.

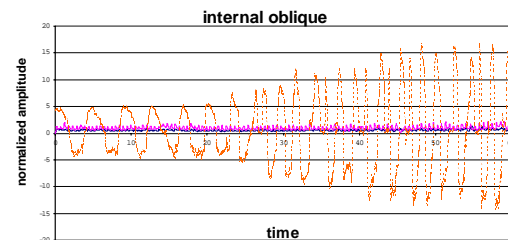


Figure 2: Despite the obvious increase in ventilation amplitude and frequency there is no evidence of entrainment in this normal subject's internal oblique.

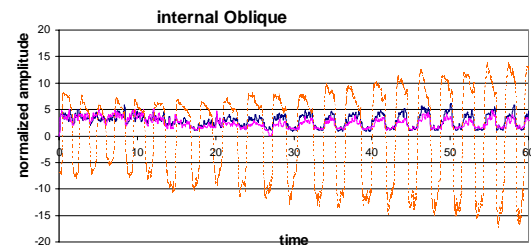


Figure 3: The entrainment of internal oblique with the ventilation is evident following the transition from normal to challenged breathing. Anomalous patterns are seen during the transition.

Given that 73% of those with anomalous abdominal recruitment had a history of back troubles, the question arises; does the motor control anomaly lead to injury or does the compromised motor response result from injury? A longitudinal is underway to assess this question.

Acknowledgement: Funding for this project was provided by the Worker Safety and Insurance Board of Ontario.

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