ASSESSMENT OF MUSCLE ACTIVITY AND SPINE COMPRESSION DURING CONSTRICTED AXIAL LOADING

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INTRODUCTION

Occupational-related low back disorders are the leading cause of lost work days as well as the most costly occupational safety and health problem facing industry today. Twisting has been found to be associated with lower back pain (Frymoyer, 1983). Previous biomechanical measures of twisting allowed ancillary moments and forces in addition to the twisting exertion. This confounding makes it difficult to assess twisting. However, pure twisting adds neuromuscular constraints. Research suggests optimal control strategy allows variability in redundant or task-irrelevant directions (Todorov, 2002). This suggests control of ancillary degrees of freedom (sagittal and lateral moment during twist exertion) may require increase motor control effort and muscle co-contraction. Therefore, the goal of this study was to compare muscle activity of the lumbar spine during pure twisting with less constricted twisting. The term pure twisting refers to a situation where the lateral and sagittal forces are no more than 20% of the axial torque. We hypothesize that muscle activity will be greater during constrictive twisting when compared to less constrained twisting.

METHODS

Nine subjects were requested to perform isometric twisting exertions of ± 20%, ± 40%, and ± 60 of their maximum voluntary contraction (MVC) against a load cell placed an arms length away while standing on a ground-reaction force plate. Throughout the experiment EMG signals were collected on the left and right rectus abdominus (RA), external obliques (EO), internal obliques (IO), and erector spinae (ES) as described in Granata (1995).

Data collection consisted of two parts. First, the subjects were simply required to match the above mention percentages of their MVC. Second, the subjects were asked to match the torques as before, but with an added constraint requirement. This constraint required subjects to minimize forces in the non-axial directions (less than 20% of twist). This was achieved by displaying a real-time two dimensional graph which had the maximum allowed non-axial forces graphed as a box. The subjects were required to keep the forces inside the box while the desired twisting force was achieved. The protocol was performed while the subjects stood parallel to the wall and while standing with 30º left trunk rotation.

RESULTS AND DISCUSSION

Muscle activity increased for all muscle groups during constraint twisting exertions. This was statistical significance for RA, EO, and ES (Table 1).
During the twisting exertions there was a significant \( (p<.0356) \) difference between right and left EO. The EO were the only muscle group to display statistical significance under this relationship. This agrees with past research which has indicated that the EO are the primary muscles responsible for creating a twisting exertion (Pope 1986).

![Figure 1. Muscle activity as a function of constriction.](image)

**SUMMARY**

Muscle activity increased as constraints were added to twisting. As a result, stiffness and subsequently stability of the trunk are increased when muscle activity of the trunk increases. However, increased cocontraction has been associated with greater levels of spinal compression (Granata 95, Marras 1997). Recent evidence from motor control research suggests that neuromuscular variability can be mapped into task-irrelevant directions thereby improving performance in the critical task dimension (Todorov, 2002). Eliminating task-irrelevant dimensions by constraining ancillary degrees-of-freedom requires greater control effort from the neuromuscular system with potential influences in spinal load and risk of overload injury.

Future analysis will evaluate spinal compression during constrained twisting. The ground force plate data will be used to perform a bottom-up analysis to find the forces and moments at the S5/L1 region of the lumbar spine. Along with kinetic data, kinematic, and EMG data will be used to run an EMG-Assisted Model of Trunk Loading\(^3\) which will output spine compression.

**REFERENCES**


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<th>Muscle Group</th>
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