CHANGES IN LIFTING KINEMATICS RELATED TO PROLONGED ASYMMETRIC LIFTING

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INTRODUCTION

Manual materials handling is prevalent in many industries. Often the lifting envelope is asymmetrical due to inadequate work space or improper ergonomic work configuration. Muskuloskeletal injury has been associated with both trunk twist increasing spine torque and prolonged repetitive lifting tasks. Although frequency and duration of lifting has been shown to modulate the effects of repetitive lifting on the body [1] technique changes with prolonged asymmetrical lifting is limited. The aim of this study therefore was to examine kinematic changes to lifting technique related to prolonged asymmetric lifting.

METHODS

Eight male participants (age = 22 ± 1 yr., mass = 80.6 ± 6kg, height = 178 ± 4 cm) lifting a box weighing 10% of their maximum lifting capacity at a rate of 6 lifts per minute for 75 minutes. The lift envelope was from the floor directly anterior to the participant to a waist height shelf positioned 30 degrees to the right of the participant. Electromagnetic motion capture sensors (Polhemus Inc., Colchester, VT, USA) were placed on each lifter to define C7, T8, L5/S1, the hands, forearms, and upper arms bilaterally.

Motion capture data in concert with a static anatomical calibration for each participant was used to calculate joint angles using a kinematic model coded in MatLAB (The Mathworks, Natick, MA, USA). Joint range of motion (ROM), maximum joint angle, and maximum joint angular velocity were calculated about the elbow flexion/extension axis, and about all three anatomical axes for the shoulder and trunk.

Fatigue was quantified by comparing pre and post lifting maximal voluntary exertions (MVE) for the shoulder and trunk. During the lifting protocol ratings of perceived exertion (RPE) were obtained.

RESULTS

MVE and RPE. Both trunk and shoulder exertions decreased significantly (p < 0.05) after the 75 minute lifting protocol. Ratings of perceived exertion increased significantly from the first to the last five minutes within the 75 minute period.

Range of Motion. Lifting kinematics also changed from the beginning to the end of the 75 minute protocol. Right shoulder flexion, rotation and abduction ROM all increased significantly (Figure 1). Trunk flexion and lateral bend ROM increased while trunk rotation ROM decreased significantly.

Maximum Joint Angle. The maximum trunk twist increased significantly following the 75 minute lifting protocol.

Joint Angular Velocity. Shoulder ab/adduction, shoulder flexion/extension and trunk flexion, rotation and lateral bend all decreased over the 75 minutes of lifting.

DISCUSSION

The kinematic results suggest a modification to the lifting technique as the participant became fatigued. The significant decrease in MVE indicates that both the shoulder and the trunk were physiologically challenged. It appears that the participants migrated from ‘sQuaring’ themselves at load initiation and completing the lift by incorporating significant trunk rotation, to reducing the ROM of trunk rotation by becoming more ergonomic and positioning the upper body in a manner that was slight rotated to the box initiation. This results in the need to begin the lifted in with trunk rotation to the left and completing with less rotation to the right. Therefore increasing the spinal twist load at load initiation and reducing at box placement. This was coupled with an increase in shoulder motion which may result in a higher loading at the shoulder joint. The decrease in velocity may in part reflect a need to impose greater control over the motion and a result of tired muscles.

CONCLUSION

These results indicate that males change their lifting kinematics to compensate for the fatigue induced on both the shoulder and trunk during prolonged asymmetrical lifting.

REFERENCE


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