THE EFFECT OF HEIGHT AND FEET POSITION WHEN LIFTING ITH RODS ON EMG

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INTRODUCTION

Lifting and manual material handling account for a large proportion of back injuries. To date, the majority of studies have focused on the lifting of rectangular shaped objects or irregular shaped objects such as shopping bags or sacs. However, there is a paucity of studies focusing on the lifting of rods or long awkward heavy objects. In-The-Hole (ITH) drilling is a heavy repetitive mining task, which has been identified as having a relatively high incidence and severity rate of ergonomic-related injuries.

The purpose of the study was to examine how the load experienced by ITH operators changed when lifting a vertical drilling rod (1.61 m, 35 kg) using four different feet positions and two rod heights. In addition, a symmetrical lift with a lifting index (LI) of 1 also served as a comparison to the asymmetrical foot positions (0° and freestyle) when lifting from the ground and the rack. Faster lifting resulted in higher EMG peak than slow lifting for the ES_L. The worse lifting condition (90°/ground) had a higher EMG peak (83% MVC) than the NIOSH lift (63% MVC), while the best condition (56% MVC for freestyle/rack) was not significantly different. However, large standard deviations of EMG peak were observed among subjects.

METHOD

Eleven experienced ITH operators participated in the study. All subjects had no history of serious back injury or any recent discomfort. Each subject was required to lift a vertical drilling rod until the upper body was in an erect posture (0° = subject facing the rod, 45° = subject oblique to the rod, 90° = subject right side to the rod; and freestyle). In addition two rod height conditions were studied where the base of the vertical rod was supported either (1) at the ground level (height of rod CG = 0.83 m) or (2) on a rack of 20 cm (height of rod CG = 1.03 m). All lifts were performed toward the right side of the subject and in a randomized order. In addition, each subject lifted a box of 21.5 kg in the sagittal plane which corresponded to a LI of 1 in the NIOSH lifting equation (Waters et al., 1993). A LI of 1 indicates that the weight of the load lifted corresponds to the recommended weight limit that will be acceptable for 75% of female workers and 90% of male workers. Reflective markers were placed on the subjects and three video cameras were used to record their displacement. In addition, two surface electrodes were applied on the right and left erector spinae (ES) at the level of L3. To determine the percentage of maximal ES electromyography (EMG) activity during the lifting tasks, the subjects performed a maximum voluntary contraction (MVC) (standing prone back extension).

RESULTS

In the first phase of the study only the peak EMG (EMG peak) data was analysed. Lifting from a rack reduced the EMG peak for both the left (ES_L) and right (ES_R) erector spinae, compared to lifting from the ground (Figure 1). The EMG peak of ES_L was consistently higher than ES_R when lifting off the rack, however the differences were not statistically significant. When subjects lifted from the ground no significant trends involving the ES_L and ES_R were observed. Most of the subjects (9 out of 11) adopted the 0° foot position as the freestyle. The EMG of ES_L revealed that the 90° feet position resulted in higher EMG peak than the freestyle and 0° position from the ground. Asymmetrical foot positions (90° and 45°) had higher EMG peak values compared to the symmetrical foot positions (0° and freestyle) when lifting from the ground and the rack. Faster lifting resulted in higher EMG peak than slow lifting for the ES_L. The worse lifting condition (90°/ground) had a higher EMG peak (83% MVC) than the NIOSH lift (63% MVC), while the best condition (56% MVC for freestyle/rack) was not significantly different. However, large standard deviations of EMG peak were observed among subjects.

DISCUSSION AND CONCLUSION

Initial feet position and vertical height had a significant effect on EMG peak. Waters et al (1993) has defined heavy workload as muscular exertion greater than 70% of MVC. Although, most of the tasks had mean values that were below 70%, almost all were in the range of 50-70%. Even the NIOSH lifting and the best ITH task (freestyle/rack) had a mean MVC value of approximately 60%. The current study found that 38 trials were less than 50% of MVC, 27 trials were between 50-70%, and 34 trials were above 70%. Nevertheless, further detailed analysis with a three-dimensional multisegment model that will support the EMG data will follow to improve the validity of the results. Research in this area will help to better understand the load on the back during complex 3D tasks leading to better workplace lifting recommendations.

REFERENCES


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