The effect of on-body lift assist device on the lumbar 3D dynamic moments and EMG during asymmetric lifting

Mohammad Abdoli E.*, Joan M. Stevenson
Biomechanics Laboratory, Queen's University, Kingston, Ontario, Canada*0ema@qlink.queensu.ca

Introduction

An on-body personal lift assistive device (PLAD) was developed that reduces lumbar moments[1] as well as the EMG of the erector spinae without interfering with the abdominal muscles and kinematics of the lumbar spine[2] in symmetrical lift. The purpose of this study was to show the effect of this device on the 3D dynamic moments about L4/L5 joint as well as the EMG activity of the back and abdominal muscles during stoop, squat, and free lifting across three load magnitudes (5, 15, 25kg) in asymmetrical conditions.

Methods

Nine male subjects lifted three loads from 45 degrees on the left and the right side in stoop, squat, and free style with and without the PLAD. EMG activity was monitored at four bilateral locations; lumbar (L4) and thoracic (T9) erector spianae muscle group (LES and TES), rectus abdominus (RA), as well as external obliques (EO). Synchro-switches attached to the box and 3 Fastrak® units were used to quantify the box and body motions during the lifting tasks. 3D dynamic moments were estimated about each axis. EMG data from each muscle were measured and normalized to each muscle's isometric MVC. The integrated moments about three axes as well as the integrated EMG's of the muscles were compared through repeated measures ANOVAs to assess the effects of PLAD across each lifting condition.

Results and Discussion

The ANOVA indicated that use of the PLAD system significantly reduced the ipsi- and contra-lateral muscles of LES and TES activity for 5 kg, 15 kg, and 25kg loads ($p < 0.001$). Significant reduction was observed in contra-lateral muscles of EO, but not the ipsi-lateral one (Fig 1-a). No significant differences were found in RA muscles' activity. No main effect of the direction (left and right) was observed. A significant reduction was observed for all of the moments about the three axes (Fig 1-b). These results confirm that the PLAD, with its elastic elements, does reduce the 3D moments as well as the EMG force requirements during asymmetrical different lifting techniques and loads. The magnitudes of the reduction in iEMG averaged to 20% and for integrated moments 15% for all of the loads.

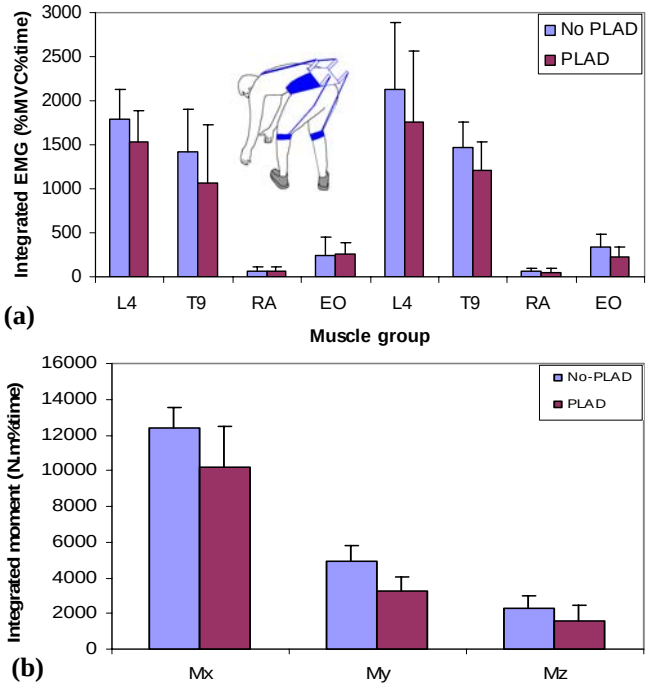

Figure 1. (a) Mean+SD integrated EMG of 8 right and left muscles as well as (b) The Mean+SD integrated moments in 3D while lifting 15Kg load from the left side (45degrees).

References

1- Abdoli-E, M., (2005). Design and instrumentation of a dynamic mechanical personal lift augmentation device (PLAD) for manual lifting tasks.Thesis/Dissertation, Queen's University.
2- Abdoli-E, M., Agnew M.J., Stevenson, J. M., (2006). An on-body Personal Lift Augmentation Device (PLAD) reduces EMG amplitude of erector spinae during lifting tasks. Accepted by Clinical Biomechanics.