On-Body Lift Assist reduces back moments and EMG during asymmetric stoop and squat styles lifting

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Introduction

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

Methods

Nine male subjects participated in this study. Using a psychophysical test, each subject selected a specific tension for the elastic bands of the PLAD. Subjects then lifted three loads from 45 degrees on the left and the right side in stoop and squat 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). EMG data from each muscle were measured and normalized to each muscle's isometric MVC. 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 the lumbar spine. The integrated moments about three axes as well as the integrated EMG's of the muscles were compared through a repeated measures analysis of variance to assess the effects of PLAD across each lifting condition.

Results and Discussion

The ANOVA test 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 ($p < 0.01$). Significant reduction was observed on contralateral muscle of EO, but not the ipsilateral one. No significant difference was found in RA muscles activity (Table 1). No main effect of the direction (left and right) was observed. Significan reduction was observed for all of the moments about the three axes (Table 2). These results confirm that the PLAD with its elastic elements does reduce the 3D moments as well as the EMG force requirements during free style lifting technique and different loads.

References

a- 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.

b- 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. Clinical Biomechanics 2006 (in press).

Table 1. Summary of 3-way repeated measure ANOVA showing the main effects that were significant for at least one of the dependent variables of IEMG.

Dependant variables		Direction	Load	Device
L4	Ipsilateral	NS	***.001***	***.001***
	Cotralateral	NS	***.001***	***.001***
T9	Ipsilateral	NS	***.001***	***.001***
	Cotralateral	NS	***.003***	***.005***
EO	Ipsilateral	NS	***.002***	NS
	Cotralateral	NS	***.002***	***.001***
RA	Ipsilateral	NS	***.001***	NS
	Cotralateral	NS	***0.01***	NS

Table 2. Summary of 3-way repeated measure ANOVA showing the main effects that were significant for at least one of the dependent variables of 3D moments.

Dependant variables	Direction	Load	Device
M_x	NS	***.001***	***.001***
M_y	NS	***.001***	***.001***
M_z	NS	***.001***	***.001***