THE PLAD REDUCES MUSCLE ACTIVITY OF THE POSTERIOR CHAIN WITHOUT A SUBSEQUENT CHANGE IN THE LUMBO-PELVIC ANGLE DURING A FREESTYLE LIFTING TASK

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INTRODUCTION

The lifetime prevalence of lower back pain is now close to 90%, resulting in billions of dollars lost due to absenteeism, disability and medical expenses (Cassidy et al., 1998). In the last decade, lifting belts were thought to be a solution for factory work both as a prevention tool and a rehabilitation strategy. However, with conflicting and negative research findings, advocacy for the lifting belt has started to decline. For example, a growing number of studies now show that belts do not significantly change active stability of the lumbar spine, and they do not reduce joint compression forces at L4/L5, and extended wear may actually weaken the lumbar musculature (Ivancic et al., 2002).

The PLAD (personal lift augmentation device) is a mechanical device designed to assist the musculature of the posterior chain (erector spinae, gluteus maximus, biceps femoris) during a lifting task, via band tension, thereby reducing the amount of work that the muscles are required to do (Abdoli-E et al. 2006). The purpose of this investigation was to examine the changes in muscle activity and the consequent lumbo-pelvic angle over a range of PLAD tensions while performing a symmetrical lifting task with a freestyle posture.

METHODS

Fifteen male subjects with no history of lower pack pain completed a total of 90 symmetrical lifts (15kg) using 6 different PLAD tensions (~260, 210, 160, 110, 60, 0 N) with a freestyle lifting posture. Single differential surface electrodes were placed at 8 designated sites to detect muscle activity (latissimus dorsi, thoracic erector spinae (T9), lumbar erector spinae (L4), rectus abdominis, external oblique, gluteus maximus, biceps femoris, and rectus femoris). Raw EMG data were normalized, filtered and ensemble averaged to allow for a trial-to-trial comparison, and the data were integrated to provide a representation of the total activity done during each lifting task. Fastrak sensors were placed on 8 landmarks (L1, L4, ASIS, right thigh, sternum, hand, head, PLAD) to compare the kinematics between band tensions and lifting styles. Mean integrated EMG (iEMG) and joint kinematics were statistically analyzed using a one way repeated measures ANOVA with Holm-Sidak comparisons.

RESULTS AND DISCUSSION

When adopting a freestyle lifting posture the highest PLAD tension prompted the most significant reductions in iEMG of the thoracic erector spinae (36.2%), lumbar erector spinae (37.3%) and biceps femoris (37.8%), however tension five elicited the most significance from gluteus maximus (26.1) (Table 1). A comparison of the cumulative mean of all five PLAD conditions with the no PLAD condition demonstrated significant reductions for thoracic and lumbar erector spinae (23.0% and 25.5%, respectively) and near significance for gluteus maximus (18.2%) and biceps femoris (28.9%) (Table 1). Analysis of the lumbo-pelvic angle for the freestyle lifting posture revealed non-significant differences between tension one and all other tensions (T2: -1.5°;p=0.791, T3: 3.5°;p=0.51, T4: -0.6°;p=0.923, T5; 0.5°;p=0.934, T6: 4.0°;p=0.482) and between PLAD and no PLAD conditions (1.18°;p=0.776).

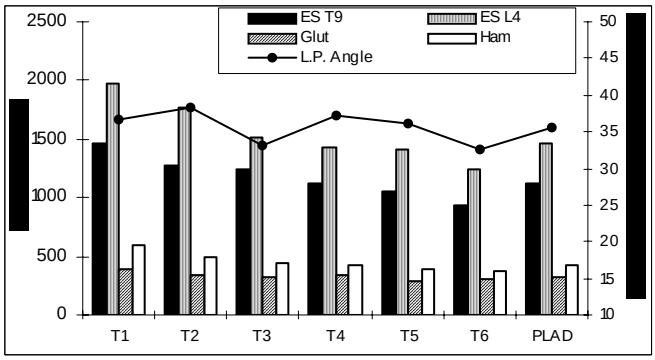

Figure 1. Tension-iEMG/Lumbo-Pelvic Angle Relationship.

SUMMARY

Although the largest changes were observed when the PLAD provided the most assistance, significant reductions in integrated EMG were seen across all tensions without subsequent changes in the lumbo-pelvic angle (Figure 1). Significance was also established by comparing the cumulative mean of the PLAD trials to the no PLAD condition, suggesting that the PLAD offers a means of reducing the prevalence of lower back pain in industry, with any tension, by reducing the total muscular work required to perform successive lifting tasks. However, such a contention needs further investigation.

REFERENCES

Cassidy et al. (1998). *Spine* 23(17): 1860-1866.
Ivancic et al. (2002). *Ergonomics* 45(7): 501-513.
Abdoli-E et al. (2006). *Clinical Biomechanics*, In Press.

Table 1. %iEMG Reduction from Tension 1/no PLAD condition. PLAD condition is combined mean iEMG of tensions 2 - 6. (ES – Erector Spinae, T – Tension).

Muscle	T2	p-val.	T3	p-val.	T4	p-val.	T5	p-val.	T6	p-val.	PLAD	p-val.
Thor. ES	12.8	*0.008*	14.8	*0.002*	23.5	*0.001*	27.4	*0.001*	36.2	*0.001*	23.0	*0.046*
Lumbar ES	10.3	*0.001*	23.6	*0.000*	27.6	*0.001*	28.9	*0.001*	37.3	*0.001*	25.5	*0.001*
Glut. Max.	13.6	*0.062*	17.5	*0.017*	13.0	*0.075*	26.1	*0.001*	20.8	*0.005*	18.2	*0.133*
Bicep. Fem.	17.8	*0.055*	25.9	*0.006*	29.0	*0.002*	34.2	*0.001*	37.8	*0.001*	28.9	*0.066*