

IMPACT OF LIFT ASSISTIVE DEVICE ON LUMBAR COMPRESSIVE FORCE
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INTRODUCTION

The goal of this research is to develop a strategy to reduce the lifting force requirements of back muscles and thus allow provide some support to returning injured workers to their jobs more quickly. To accomplish this goal, a personal lift assistive device (PLAD) was developed using elastic elements and attachment points at the shoulders, waist and knees. The PLAD acts parallel to the back muscles and can be thought of as an external force generator that provides additional elastic energy for lifting tasks, thus allowing the user to accomplish a lift using less of his/her own muscle force. During a lift, these internal forces are transferred by the PLAD to the shoulders, pelvis and lower legs during the down phase of lift and energy returned to the worker during the up phase of the lift. The purpose of this study is to demonstrate the effectiveness of the PLAD on the compressive force on the L4/L5 disc during a variety of lifting tasks.

METHODS

To validate these findings, nine male subjects with no history of back pain executed a variety of lifting tasks (symmetric/asymmetric, light/medium/heavy, free/stoop/squat) under the PLAD and No-PLAD conditions. Three Fastraks® were synchronized into one computer in order to provide 12 electromagnetic sensors with 6 dof. Simultaneous data were acquired at 30 Hz. On a slave computer, sampling at 1000 Hz, six custom strain gauges and eight EMG channels were recorded with all data synchronized using a hand switch. Fastrak® sensors were positioned at the centre of gravity of the hands, forearms, arms, thighs, as well as on the head, C7, T9 and L5. The fully dynamic 3D moments at L4/L5 were calculated using the Hof [1] validated model. A polynomial model [2] was used to predict the lumbar compressive force by the 3D estimated moments. Two approaches were used to determine the impact of the PLAD on back moments. When there is no PLAD, conventional LSM 3D dynamic calculations were used. When PLAD was worn two strategies were employed: first, the force contributions of the elastic elements were subtracted from the total L4/L5 moments so that the contribution due to the PLAD could be calculated. Second, the PLAD force contributions were ignored to see if postural effects alone influenced the results. Results of peak lumbar compressions were compared in symmetrical lifting for 3 different loads (5kg, 15kg, 25 kg) with 3 different styles (stooped, squat, free) under 2 conditions of PLAD/No-PLAD. Two 3-way repeated measure ANOVAs were used to examine the impact of peak compression under various conditions.

RESULTS AND DISCUSSION

Figure 1 shows that regardless of load or style, the PLAD conditions were less than the no PLAD conditions by 5% to 20% ($p < 0.001$). This difference was greatest for stoop conditions and least for freestyle lifts. Future designs could correct this problem. It also shows the ability of PLAD across different lifting styles ($p < 0.05$) as well as for various loads

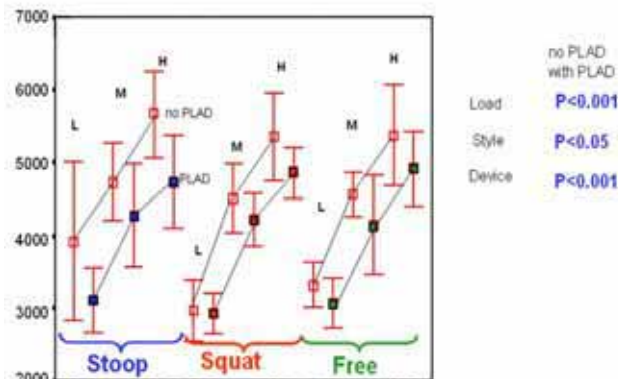


Figure 1: PLAD/no-PLAD comparison of 3 styles of lifting at 3 different types of loads.

($p < 0.001$). Hence, regardless of the comparison, the PLAD proved to be effective at reducing the L4/L5 moments and compressive forces.

In Figure 2, when the impact of PLAD was removed mathematically, results revealed that there was no significant

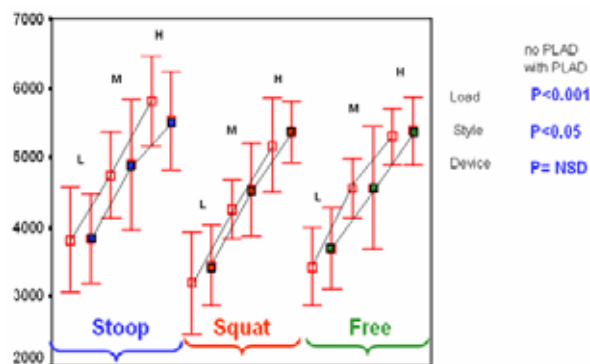


Figure 2: Influence of posture on PLAD/no-PLAD comparison of 3 styles of lifting at 3 different types of loads.effect.

different in peak compressive force across all conditions.

CONCLUSIONS

These results prove that the PLAD does reduce the compressive force on the L4/L5 disc across a number of lifting conditions. Hence, it could be considered as a good device to increase the margin of safety for tissue tolerances in the spine during lifting tasks. Further research is needed to confirm its effectiveness in terms of electromyography and spinal stability as well as examining the impact of the PLAD over extended user trials.

REFERENCES

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