CONTROLLING CENTRE OF MASS MOMENTUM IN SIT-TO-STAND AFTER EPIDURAL ANALGESIA INFUSION

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INTRODUCTION

Epidural analgesia is used post-operatively following chest, abdominal and lower extremity surgery (Brown *et al*., 1990) with significantly shorter hospital stays and earlier mobilization occurring after epidural use. (Ilahi *et al*., 1994) Despite the potential benefit of epidural analgesia, decreased somatosensory input and varying degrees of neuromuscular inhibition may increase falling risk during out-of-bed activities. Although the goal of epidural analgesia is pain relief, some motor dysfunction can occur. The purpose of this study was to assess motor tasks in subjects during epidural analgesia to qualitatively determine ambulation safety and thus, we examined the effects of epidural analgesia on total body centre of mass momentum during a sit-to-stand task. The time to rise from sitting has been correlated with fall incidence; persons at increased risk of falling tend to minimize vertical and horizontal momentum compared to lower risk individuals. In the current study, the speed of rising was uncontrolled, allowing adaptations in momentum generation to be quantified.

METHODS

This study design was prospective, randomized, double blind and was comprised of five normal adult volunteers. (38 $\pm$ 2 yr; mean $\pm$ sd) An experienced anesthesiologist inserted a multi-orifice catheter into the L2,3 or L3,4 epidural space. An initial 15 ml dose of 0.1% Ropivacaine and 5 µg/ml fentanyl was administered to establish a T10 block. The block was maintained with a constant infusion of a 0.08% Ropivacaine and 2 µg/ml fentanyl solution. Block height was assessed every 30 min (modified Bromberg test) in which skin sensitivity to cold was documented. The sit-to-stand task was completed at five intervals throughout the experiment. A baseline measure (b1) was taken when the catheter was in place, but prior to any drug administration. Drug infusions were performed at 30 min (i1), 2 hr (i2), and 4 hr (i3) after the initial drug dose was administered. Drug effects on task completion were collected and a final baseline data set (b2) was collected 2 hr later.

Three-dimensional kinematic data were acquired using a four-camera high-speed video based system (Motion Analysis Corp., Santa Rosa, CA). Reflective markers (3/segment) were placed on the head, upper arm, forearm, trunk, pelvis, thigh, shank and foot bilaterally. During each trial, the subject was seated with knees at 90º on a stool placed on a force platform (Kistler, model 9286, Winterthur, Switzerland). Participants rose from sitting to standing using a self-selected strategy. Three trials were collected from each side (3 s, 120 Hz video, 1200 Hz force). Ground reaction forces were used to determine the time at which the subject lost contact with the stool, defining the beginning of the sit-to-stand manoeuvre; any movement prior to this was designated as pre-take-off. The end of the weight transference movement was defined as the time at which knee extension velocity became zero. The 3D segmental displacements were used to calculate segmental velocities, the maximum horizontal momentum, (MHM) maximum vertical momentum, (MVM) and maximum resultant momentum (MRM) with a customised algorithm. Multivariate analysis of variance with repeated measures (SPSS, v. 10) was used to determine significant within subject differences in MHM, MVM, and MRM, among the baseline and infusion trials.

RESULTS AND DISCUSSION

Normal volunteers under the influence of epidural analgesia used different weight transference strategies during the sit-to-stand task. Significant differences were found in both MVM and MRM, ($p < 0.025$) but no significant difference in MHM was observed between baseline epidural-no drug trials and epidural-drug trials. Consistent with the current literature, MHM occurs temporally prior to time of take off from the stool, followed by MVM. (Fig. 1).

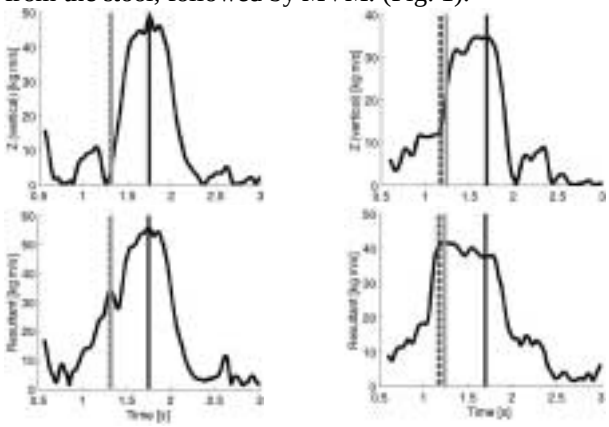

Figure 1. Exemplar plot of vertical (top) and resultant (bottom) centre of mass momentum vs. time graphs, illustrating MHM (red dotted), MVM (blue) and take-off (green) for baseline (left) and infusion 1 (right) trials.

SUMMARY

Normal stability relies heavily upon sensory input, thus it is intuitive that the post-anesthesia trials involve alternative centre of mass momentum control strategies. With no incidence of falling observed in this study, the strategies adopted by the volunteers were effective in maintaining safe postural control during the functional sit-to-stand task. This suggests that patients may continue similar rehabilitation activities following lower extremity injury with minimal risk, allowing for more rapid recovery.

REFERENCES

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ACKNOWLEDGEMENTS

C. Good, M. Baker, CHR, Obstetric Research Fund, NSERC