EFFECTS OF LUMBAR EXTENSOR FATIGUE AND CIRCUMFERENTIAL ANKLE PRESSURE ON ANKLE JOINT MOTION SENSE

Kevin Pline, Michael Madigan
Musculoskeletal Biomechanics Lab, Virginia Polytechnic Institute and State University; Blacksburg, VA
email: kmpline@vt.edu, web: www.biomechanics.esm.vt.edu

INTRODUCTION

Falls from heights are one of the three leading causes of occupational deaths in the United States, accounting for approximately 700 deaths annually [1]. Increases in postural sway, which suggests a degradation of balance, have been shown following lumbar extensor fatigue [2]. This could conceivably contribute to fall accidents because it is common in many occupational tasks. However it is unclear how lumbar extensor fatigue affects balance. Proprioception at the ankle is critical in maintaining balance and any loss of proprioception could cause increases in sway and contribute to falls. Therefore, the first objective of this study was to evaluate the effect of lumbar extensor fatigue on ankle proprioceptive acuity.

Circumferential Ankle Pressure (CAP) has been shown to improve ankle proprioceptive acuity in individuals with below average proprioceptive acuity [3]. If lumbar extensor fatigue degrades proprioceptive acuity at the ankle, it is possible that the application of circumferential ankle pressure could mitigate the deleterious effects of fatigue on ankle proprioceptive acuity. Therefore, the second objective of this study was to investigate the effect of CAP on ankle proprioceptive acuity both with and without lumbar extensor fatigue.

Proprioceptive acuity in this study was quantified as ankle joint motion sense (JMS) which is the angular displacement at a joint necessary to detect joint motion.

METHODS

Fourteen healthy male subjects participated in the experiment with a mean (SD) age of 23.6 (2.9) years. To measure JMS, subjects were seated on a Biodex System 3 Pro, and the ankle was passively moved at 0.25 deg/sec in either plantar flexion or dorsiflexion until motion was detected by the subject and a hand held stop button pushed. During testing, subjects had their eyes closed and listened to music to prevent ancillary sensory cues of ankle motion. All subjects were tested with and without CAP both before and after a lumbar fatiguing protocol.

JMS was quantified as the angular displacement of the Biodex arm (in degrees) between the initial position and the final position after the subject stopped movement. Both directions were averaged together to give one JMS score for each condition. A square root transformation was used to obtain a normal distribution in the data. A two-way repeated measures ANOVA was used to test for the effect of fatigue on CAP on ankle JMS.

CAP was applied using a pediatric blood pressure cuff placed just above the talocrural joint and inflated to a pressure of 60 mmHg. Subjects were fatigued to 75% of their unfatigued maximum voluntary exertion (MVE) of the lumbar extensors by performing multiple sets of back extensions on a Roman Chair over 14 minutes [2].

RESULTS AND DISCUSSION

Subjects were fatigued to 68.3 (7.2)% of their unfatigued lumbar extensor MVE. Both fatigue and CAP impaired JMS scores (Figure 1). Fatigue induced a 6 (10) % increase in the JMS scores

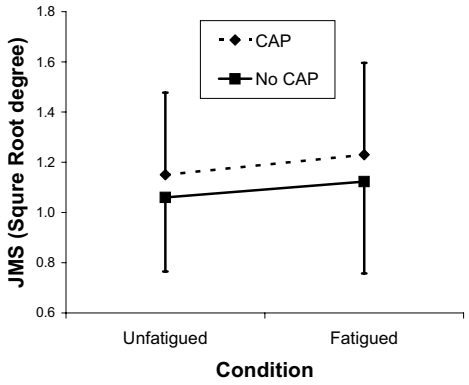

Figure 1: Mean (SD) averaged JMS scores (deg) after square root transformation for unfatigued and fatigued condition with and without CAP

(p=0.031). CAP induced a 7.7 (10) % increase in the JMS scores (p=0.016). The ANOVA performed on the JMS scores revealed no significant interaction between fatigue and CAP (p=0.868).

The explanation for lumbar extensor fatigue impairing proprioception at the ankle joint is not intuitive. One possible explanation is that the general body fatigue, induced by the lumbar extensor fatiguing protocol, hindered joint proprioception at the ankle due to the deficiency of central processing of proprioceptive signals. A number of central changes occur during fatigue and affect, among other things, proprioception [5]. Contrary to previous reports, CAP had a negative effect on ankle proprioception, which may be explained by difference in experimental methods.

CONCLUSIONS

Muscle fatigue of the lumbar extensors decreased ankle JMS. Our results also indicated that the application of CAP decreased ankle JMS. Although this provides a convenient explanation for the previously reported increase in postural sway with lumbar extensor fatigue, this is likely only one contributing factor. Future studies are needed to further understand the relationship between muscle fatigue, JMS, and balance.

REFERENCES

1. BLS, National census of fatal occupational injuries in 2003 US Department of Labor, *Bureau of Labor Statistics* (2004)
2. Davidson BS, et al.. *Eur J Appl Physiol.* **93,** 183-9, 2004.
3. You SH, et al. *J Orthop Sports Phys Ther*. **34,** 449-60, 2004.
4. Matre D et al., *Eur J Pain*. **6,** 245-60, 2002.
5. Gandevia, *Physiol. Rev*. **81,** 1725-1789, 2001.

ACKNOWLEDGEMENTS

This work was supported by grant # J-689 from the Jeffress Memorial Trust, Richmond, VA (to MLM) and grant # R01 OH007882 from the Centers for Disease Control and Prevention (to MAN). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the sponsor.