ELECTROMYOGRAPHIC RESPONSE OF TRUNK MUSCLES DURING LOAD CARRIAGE WALKING IN CHILDREN

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INTRODUCTION

Previous studies investigated the effects of load carriage on electromyographic response of three selected trunk muscle of children aged between nine and ten during treadmill walking. (Hong and Cheung, 2002). In this study, similar experimental setup was used to investigate the muscle activities during prolonged load carrying walking on younger children aged six. One more muscle, the rectus abdominis, was also investigated.

METHODS

Fifteen Chinese children (Age = 6) participated in this study. Electromyographic (EMG) signals from the trapezius 1 (T1), trapezius 4 (T4), lumbar erector spinae and rectus abdominis were recorded during walking on a treadmill with a speed of 1.22 ms^{-1} and with backpack loads of 0%, 10%, 15% and 20% of their body weight. The electromyographic signals of trunk muscles were recorded by the use of BTS electromyography system (Bioenginerring Technology & Systems, Italy) with a sampling rate of 2000 Hz. Electromyographic signals of the muscles during maximum voluntary contraction (MVC) were recorded at the beginning of the test. After the MVC test, the subjects were required to stand for one minute with the testing load in a two straps backpack. The subject then completed a 20 minutes walking on the treadmill. The EMG signals were collected at the stand, and during the walking at different time point (1, 5, 10, 15 and 20 minutes). The duration of the EMG signals collection at each time point is one minute.

LabVIEW (National Instruments, USA) and BioProc Data Processing System (University of Ottawa, Canada) were used to process the EMG signals. A two-second EMG sample was extracted from each recording time. The extracted EMG signals were band pass filtered with 300 Hz low pass and 20 Hz high pass, and were full-wave rectified. The EMG signals were integrated (IEMG), and were normalized to the corresponding values recorded from the maximum voluntary contraction. The root mean squares of the EMG signals (RMS) ere also calculated for comparison. The EMG signals were further processed for power spectral frequency analysis by Fourier Transform method with regression and with harmonics at 1000 Hz. Mean (MPF) and median (MDF) power frequencies were recorded to evaluate muscle fatigue by the relative changes in same muscles normalized to that at the time point at the start. A shift of MPF and MDF frequency of the EMG signal to the low range indicated muscle fatigue.

Two-way multivariate analysis of variance (MANOVA) was applied on electromyographic activity at all the four channels to see significant influence on the muscle activities by load and time. The EMG activity was composed of IEMG, RMS, MPF and MDF. A two-way univariate analysis of variance (ANOVA) was performed on each of the four components of EMG activity to determine the components contribution on significance variance. Tukey post hoc tests were applied to see the trend of the changes of each component against load and time. Statistical significance was accepted at the 95% level of confidence.

RESULTS AND DISCUSSION

The data collected from lumbar erector spinae was with bad quality. A lot of noise appeared and a two-second sample without noise cannot be extracted. The data failed to indicate the muscle activity and were therefore discarded.

MANOVA showed that significant differences in EMG activity were introduced by the load effect to all muscles ($p<0.05$). Time effect was significant to the T1 and T4 ($p<0.05$) but not to rectus abdominis ($p>0.05$). The interaction load-by-time effect was not significant to all three muscles ($p>0.05$). Two-way univariate ANOVA showed that the load effect was significant in IEMG, RMS, MPF and MDF on T1 and T4. Despite MANOVA showed significant load effect on rectus abdominis, no significant effect was found in each of the four muscle activity components. Time effect was significant in MPF on T1, and IEMG, RMS and MPF on T4. Post-hoc test showed that a 20% load significant increased muscle activity on T1. Muscle fatigue was found at 10 minutes. 15% load significant increased muscle activity on T4. However muscle fatigue was not found within the 20 minutes duration. With a 20% load, muscle fatigue was found at 15 minutes.

SUMMARY

Load carriage significantly increased the muscle activity in T1 what the load is 20% and in T4 when the load is 15% of the body weight. Walking time significantly induced muscle fatigue in trapezius 1 and 4 at the time point of 10 and 20 minutes. The load carriage and walking time had no significant effects on muscle activity and muscle fatigue to the rectus abdominis within the 20% load range and 20 minutes time period. No conclusion on the effects to lumbar erector spinae can be drawn. Future study on other muscles, with heavier loads and longer walking duration is suggested.

REFERENCES

Hong, Y. and Cheung, C.K. (2002). *Proceedings of XXth ISBS*, 405-408.

ACKNOWLEDGEMENTS

The work described in this paper was fully supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region. (Project no. CUHK4122/99M).