Electromyographic Evaluation of the Sound and Involved Knee During Gait of Hemiplegic Cerebral Palsy Patients

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Introduction

Cerebral palsy patients exhibit several variations from the normal gait pattern, when the kinematic and kinetic information is analyzed [1]. Electromyography (EMG) is frequently applied in such patients during gait, in order to supply information about the activation patterns of the involved muscles. In normal gait, the co-contraction of the knee extensor and flexor muscles is increased during the loading response in order to stabilize the knee joint when absorbing the body-weight load, whereas the same muscle group remains silent during the terminal stance phase [2]. However, it is still unknown whether the same behavior exist for hemiplegic cerebral palsy patients as well. The purpose of this study was to compare the level of activation of the thigh muscles during the above mentioned phases of the gait cycle.

Statement of Clinical Significance

This study provides information about the function of the central nervous system of hemiplegic patients, during two phases of the gait cycle: when co-contraction (loading response) or no activity (terminal stance) of the thigh muscles is required [2]. Moreover, the comparison of the sound and the involved side of hemiplegic patients may help us to understand and distinguish in more detail the compensatory and pathologic neuromuscular adaptations that occur in such cases. In this sense, the EMG examination can be a supporting interpretation tool for the clinical decision making.

Methodology

The EMG measurements were assessed on nine hemiplegic children during gait with an age ranging from 5.4 to 11.7 years (7.78±2.27) and classified to Group I (1 case), Group II (2 cases), Group III (4 cases) and Group IV (2 cases) [3]. The Noraxon EMG device was used and four thigh muscles were selected for evaluation with surface electrodes: the vastus lateralis (VL), rectus femoris (RF), semimembranosus (SM) and biceps femoris (BF). The EMG signal was rectified and the linear envelope was calculated with the cut-off frequency set at 9 Hz. The linear envelope values were normalized to the maximal measured EMG of each subject during gait. The EMG values of the involved knee were compared to the values of the sound knee, during the loading response and the terminal stance, which were determined as the 0-10% and 30-50% of the gait cycle, respectively. For the statistical analysis a paired t-test between the involved and the sound knee was used with significance level $p<0.05$.

Results

As shown in Figure 1A, during the loading response the activity of the knee extensors and knee flexors of the sound side is enhanced. The statistical analysis did not show any significant differences when the sound knee was compared to the involved ($p>0.05$). During the terminal stance phase (Figure 1B) all the examined muscles (sound and involved limb) had a decreased level of activation. The comparison of the involved knee with the sound one revealed, that only the SM muscle had a statistically significant increased level of activation (34.1±18.2 vs. 13.3±9.2, respectively).

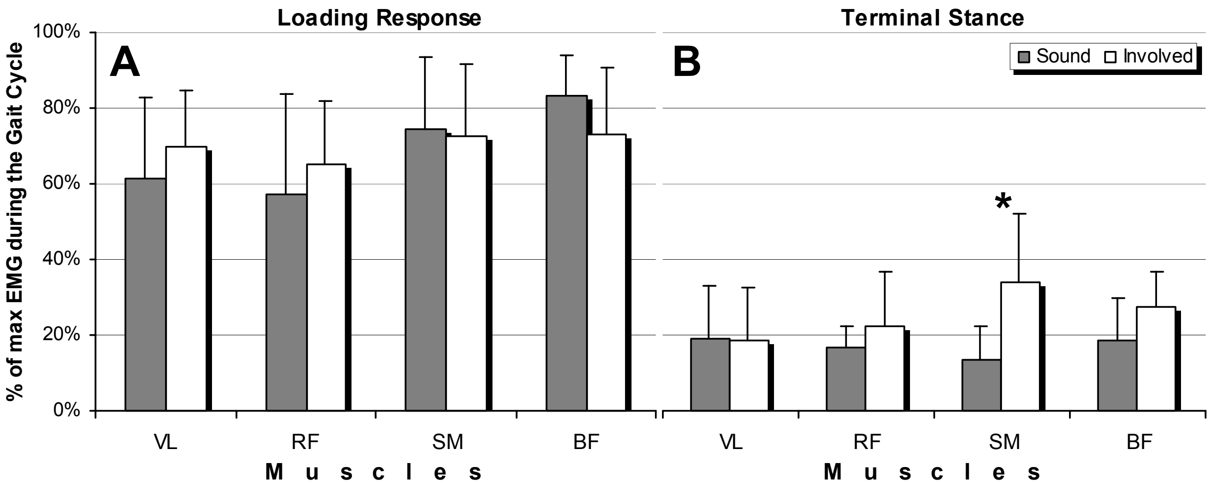

Figure 1. Mean values of the normalized EMG during the loading response (A) and the terminal stance phase (B) for the examined muscles. Satisticaly significant differences ($p<0.05$) between the involved and sound knee are marked with an asterisk.

Discussion

According to the analyzed data it seems that the knee stabilization through the activation of the knee extensor and flexor muscles, during the loading response, is preserved in hemiplegic children both for the intact and impaired knee, despite their different dysfunctional severity. However, the magnitude of the co-contraction level between the extensors and the flexors varies. Interestingly, during the terminal stance phase only the SM of the involved knee showed statistically increased activity in comparison to the sound knee, whereas this was not the case for the BF. The increased activity of the SM may be due to the increased muscle tone that the spastic patients have [4]. This implies, that differentiation in the activation pattern might exist between different knee flexors in the involved knee. Knowing which muscle is acting abnormally during the gait cycle is probably useful piece of information, when conservative or surgical treatment [muscle lengthening(s) or tendon transfer(s)] has to be made. However, more accurate measurements might be required (e.g. indwelling electrodes) in order to limit the effect of cross-talk (distinction between the medial hamstrings muscle group) and extrapolate which muscle is performing an impaired function.

References

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Acknowledgments

The authors would like to thank Waltraud Schuster, technical assistant in the gait analysis laboratory, for collecting and processing the data from the gait analysis.