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USING EMG TO EVALUATE MUSCLE FUNCTIONS IN PATIENTS WITH LOW BACK PAIN (LBP) SYNDROMES.

W.W. Lu, K.D.K. Luk, K.M.C. Cheung, J.C.Y. Leong
Department of Orthopaedic Surgery, The University of Hong Kong
e-mail: wwlu@hkusua.hku.hk

Abstract: Muscle function is relevant to the effective diagnosis and treatment of LBP, although the qualitative and quantitative measurement of muscle function remains problematic. The aims of this study is to evaluate the spinal musculature function and contraction profiles for patients with low back pain (LBP) syndromes both pre and post treatment, and to compare these results to those obtained from normal subjects. 20 normal subjects and 10 patients with LBP were asked to perform symmetrical and asymmetrical loading activities which simulated common industrial tasks. Surface EMG electrodes and video cameras were used to record muscular activity and spinal kinematics. In comparison with the normal group, subjects with LBP showed different muscle activation profiles. No change in the EMG patterns was seen pre and post-treatment.

Key words: electromyography (EMG), spine biomechanics, trunk muscles.

INTRODUCTION

Low back pain (LBP) has an enormous influence on industry. More people are off work because of back pain than because of any other disease or injury[1]. Back muscle assessment is a critical part of the evaluation process for identifying physical impairment in patients with low back pain syndromes. Muscle function impairment is a common finding associated with LBP and is typically described in terms of strength, fatigue, or muscle activity. The reasons of these impairments in patients with LBP are still unknown and have been speculatively associated with abnormal fibre type composition, spasm, or protective inhibition of muscles[1,2]. Even though clinicians believe that muscle function is relevant to rehabilitation outcome, effective measurement of muscle function remains puzzling. Therefore, the purpose of this study is to evaluate the functions of the spinal musculature as well as the contraction profiles for patients with LBP syndromes pre and post treatment, and to compare these results to results obtained normal subjects.

METHODS

20 normal subjects and 10 patients with LBP were used in this study. All the subjects were ask to slowly perform symmetrical and asymmetrical tasks. The tasks include "carrying" weights up / down and "carrying" weights up and down with 45 degree left rotation. The maximum voluntary contraction (MVC) was measured prior to testing by asking subjects to produce maximum contraction of the back muscles. The MVC results were used for EMG normalization.

Eight channel of surface EMG electrodes were applied to the prepared skin on the muscles over the lumbar region including the trapezius, longissimus dorsi, erector spinae, and serratus posterior. The EMG signals were pre-amplified and pre-filtered using a band-width of 20 to 1000 Hz to produce signals of approximately ± 5 V. In order to identify the relationship or interdependence of EMG profiles, the cross-correlation coefficients for Linear Envelope (LE) EMG from each channel was calculated.

Kinematic data was recorded using a video camera synchronised to the EMG signal. The video data was used to observe the proportions of time spent in a given range of motion and to define postures.

RESULTS

Balanced muscle EMG activities are found in most of the normal subjects during symmetrical tasks, and the typical muscular reaction EMG profiles are displayed in Figure 1. The mean cross-correlation values between the left and right side linear envelope EMG was 0.84 and ranged from 0.66-0.96 (sd= 0.11). The maximum normalised EMG ranged from 5-25%MVC (Table1), suggesting that the load used in this study (50N) was within the light or medium weight level for all normal subjects. In comparison, the peak linear envelope EMG profiles showed quite large differences between LBP patients (Table1). More than 50% of the patients showed unbalanced EMG activities between the left and right side spinal muscles. The mean cross-correlation was 0.63 and the range was from 0.34-0.93 (sd=0.21).

Examination of the LE EMG profiles for the asymmetrical tasks demonstrated that the patterns of muscle myoelectric activity were much higher on the left side than the other side (Fig.2). For most subjects, the latissimus dorsi (Ch2) showed highest EMG activity followed by the trapezius (Ch1) and erector spinae (Ch3). The erratus posterior showed minimal activity throughout the whole task. In addition, no significant differences were found for the peak myoelectric signals between the normal subjects and the LBP patients. The results also showed that inter-subject EMG profiles have large variations, suggesting that each subject may have his own reaction synergy.

Finally, similar EMG patterns were found pre and post treatment in both symmetric and asymmetric tasks intra-subjects, suggesting that the fixed movement patterns may exist within the subjects.

DISCUSSION AND CONCLUSION

Biomechanical and epidemiological studies have identified work intensity, static work postures, frequent bending and twisting, lifting and repetition as occupational risk factors associated with LBP [1,5]. During last decades, many lumbar spine studies have been conducted allowing overall loads applied to the spine to be well-defined [1,4,5] However, these studies focused mainly on the acute injury risk factors. In reality, occupational low back injury is more likely the result of cumulative microtrauma associated with repeated and prolonged loading[3]. It is assumed that repetitive stress or sustained microtrauma will endanger the integrity or functioning of the tissues[2]. Such cumulative trauma disorders of the back have not been well described in the literature. Work related chronic LBP patients were therefore selected as subjects in this study.

The raw, unprocessed form of the electromyographic signal has little informational content. Therefore, the LE EMG normalized as percentage of maximum voluntary contraction (MVC) was used. While voluntary efforts that produce maximum EMG from some muscles have been published[2], an appropriate method to achieve maximum voluntary contraction signals for normalization from LBP patients remains to be established. This is a critical issue for those studies that use EMG signals for clinical evaluation of muscle functions or to predict muscle forces. In this study isometric restraint extension and right/left twisting of low back strategies were used to produce maximum muscle activity. Based on our experiences, it was difficult to find a method that consistently produced maximum muscle activity for all subjects. However, the right and left twisting strategies provided MVC data for most muscles across the subjects.

In this study, the tasks were familiar to most of the subjects and no learning period was needed. We assumed that for the familiar tasks, muscles contracted in their fixed patterns (synergies). If so, the EMG profile was valuable not only for understanding the functions of each spinal muscle, but also for explore the relationship between the EMG profiles and LBP. Patterns of muscle activity did not change much pre and post treatment within subjects, which might be related to the treatment methods or the nature of the muscle reaction pattern, which may not be easy to change. This observation is in agreement with the findings of other studies[2,3]. In this study it is found that for the same task there are different motor patterns between subjects. The inter-subject variations may explain why, under the same work conditions, some people may suffer tissue injuries and others may not.

In the lumbar spine, there are more than 30 muscles that are paired and symmetric to the midsagittal plane. These muscles played an important role in increasing stability or sharing loads for the lumbar spine under different loading conditions. Thus, further studies have to be conducted for providing more data to understand LBP.

In summary, LE EMG profiles and the cross-correlation coefficients for spinal muscles have shown very reproducible intro-subject muscle contraction synergies, which were not sensitive to the treatment. Between normal subjects and LBP patients, muscle activity patterns varied, which may be related to different nature behavioural of CNS motor programs.

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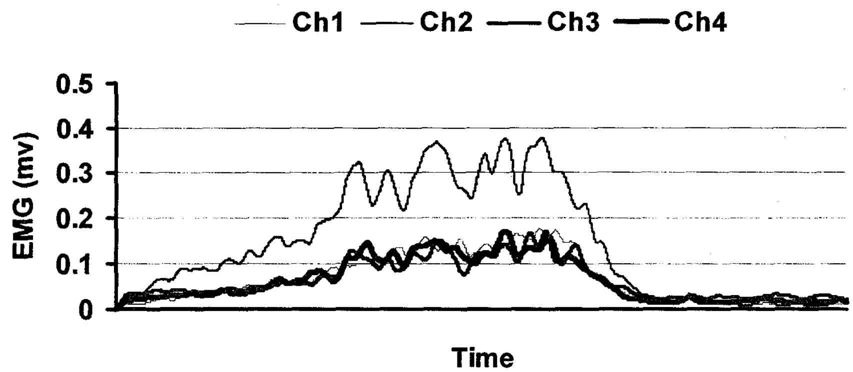
Table 1. The average peak LEEMG (as a % of MVC) for normal and LBP subjects performing symmetrical tasks. EMG electrode Ch1-Ch4 placed on left side and Ch6-Ch8 for right side.

Sub.	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Mean
Normal	7.5	22.2	11.5	19.5	4.8	25.1	9.8	17.5	14.7(7.4)
Patient	23.4	34.6	29.7	38.9	23.9	28.9	38.9	26.6	30.6(6.2)



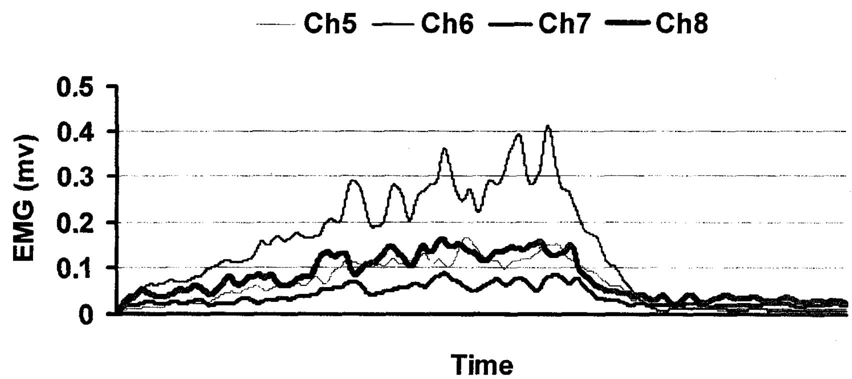


Fig. 1. Typical EMG profile from normal subject showing the left (Top) and right side muscle activity for a symmetrical task.

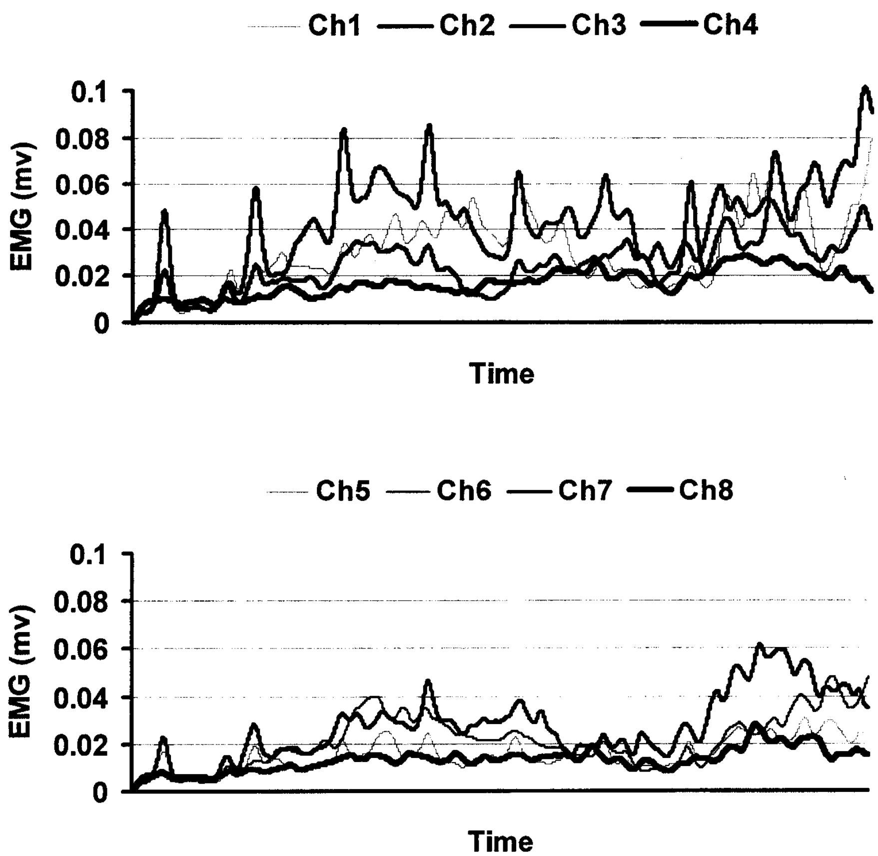


Fig. 2. Typical EMG profile from a patient showing the left (Top) and right side muscle activity for an asymmetrical task.