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Original Article

Electrophysiological characteristics according to activity level of myofascial trigger points

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Abstract. [Purpose] This study compared the differences in electrophysiological characteristics of normal muscles versus muscles with latent or active myofascial trigger points, and identified the neuromuscular physiological characteristics of muscles with active myofascial trigger points, thereby providing a quantitative evaluation of myofascial pain syndrome and clinical foundational data for its diagnosis. [Subjects] Ninety adults in their 20s participated in this study. Subjects were equally divided into three groups: the active myofascial trigger point group, the latent myofascial trigger point group, and the control group. [Methods] Maximum voluntary isometric contraction (MVIC), endurance, median frequency (MDF), and muscle fatigue index were measured in all subjects. [Results] No significant differences in MVIC or endurance were revealed among the three groups. However, the active trigger point group had significantly different MDF and muscle fatigue index compared with the control group. [Conclusion] Given that muscles with active myofascial trigger points had an increased MDF and suffered muscle fatigue more easily, increased recruitment of motor unit action potential of type II fibers was evident. Therefore, electrophysiological analysis of these myofascial trigger points can be applied to evaluate the effect of physical therapy and provide a quantitative diagnosis of myofascial pain syndrome.
Key words: Electromyography, Electrophysiological characteristics, Myofascial trigger point

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INTRODUCTION

Myofascial pain syndrome (MPS) can be caused by frequent muscle or fascial stiffness as a result of prolonged tension and muscle fatigue due to repetitive stress of muscles or overuse of particular muscles[1, 2)]. Most individuals experience MPS at least once in their lifetime. MPS activates trigger points in 54% of women and 45% of men, and is regarded as the most common cause of pain in the musculoskeletal system[3)]. In particular, the upper trapezius requires head movement according to the direction of view, but it can be vulnerable to damage when the hands and arms are used repetitively in work that requires precise control[4–6)]. Once myofascial trigger points are activated, changes in the structural characteristics and contraction function of the muscle will occur. The most distinctive changes are taut bands, tender nodules, referred pain, local twitch response, muscle weakness, and restricted range of motion[3)].

To evaluate the contraction function of skeletal muscle, various methods can be used. Among them, surface electromyography (EMG) analyzes functional changes in muscle by measuring quantitative changes in motor unit action potential that is activated by muscle contraction[7, 8)]. Surface EMG is widely used in kinetic analysis to diagnose normal or abnormal function in muscles and nerves according to amplitude and frequency[9)]. It has several advantages, as it is noninvasive and convenient, and can perform measurement even during dynamic motion[10, 11)].

Although a number of clinical reports on the pathologic mechanisms or clinical diagnosis and treatment of MPS can be found, few studies have been conducted on the changes in contraction function in myofascial trigger point areas or on the electrophysiological characteristics and neuromuscular physiological information. This study aimed to compare the electrophysiological characteristics of normal muscles versus muscles with latent or active myofascial trigger points, and to identify their neuromuscular physiological characteristics, in order to provide a quantitative evaluation of MPS and clinical foundational data for its diagnosis.

SUBJECTS AND METHODS

Ninety adults in their 20s participated in this study. This study was approved by the research agency, and all participants provided written informed consent. Subjects were selected among those with no known neurologic disease, no regular exercise habit, and no drug use that could affect the experimental result. Subjects were equally divided into three groups. Subjects in the active myofascial trigger point group were those diagnosed with MPS by a physician and whose

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Table 1. Comparison of MVIC, ET, MDF, and FI among the three groups

	Group A (n = 30)	Group B (n = 30)	Group C (n = 30)	Post hoc
MVIC, kg	19.8±11.5*	22.1±9.4	23.5±10.2	/
ET, s	48.5±9.7	49.5±10.2	51.2±8.8	/
MDF, Hz	102.5±21.4	88.5±23.1	84.5±17.4†	a<c
MFI	0.15±0.07	0.08±0.04	0.06±0.04†	a<c

Data are presented as mean ± SD.
*Significant difference among the three groups ($p < 0.05$).
Group A: active myofascial trigger points; Group B: latent myofascial trigger points; Group C: control.
ET: endurance time; MDF: median frequency; MFI: muscle fatigue index; MVIC: maximal voluntary isometric contraction

clinical characteristics were pain in the upper trapezius during rest, taut bands, tender nodules, referred pain, local twitch response, and muscle weakness. Subjects in the latent myofascial trigger point group were those not diagnosed with MPS but who felt tenderness when the upper trapezius was stimulated. Subjects in the control group had no voluntary pain or tenderness. Mean age, height, and weight, respectively, were 23.27 ± 4.21 years, 172.32 ± 8.44 cm, and 64.14 ± 6.54 kg in the active trigger point group; 23.74 ± 6.47 years, 174.76 ± 6.22 cm, and 66.74 ± 5.74 kg in the latent trigger point group; and 24.17 ± 3.14 years, 171.21 ± 9.64 cm, and 63.44 ± 7.51 kg in the control group.

To measure maximum voluntary isometric contraction (MVIC), the shoulders and heads of the subjects were firmly fixed and pulled as the dynamometer as maximum power, thereby measuring MVIC against the upper trapezius. Endurance time was measured from the start of MVIC to a 50% reduction in contraction force. Median frequency (MDF) was measured by using EMG at the muscle belly of the upper trapezius during MVIC. Muscle fatigue index was calculated by obtaining the MDF at a section where the MVIC force was reduced from 100% to 50%, and remove the 50% MDF from 100% MDF was divided into 100% MDF. The sampling rate for the surface EMG signal was set at 1,000 Hz, and the frequency band filter was set at 20 to 450 Hz, using one channel. Storage and analysis of the EMG signals was performed using Acqknowledge 3.8.1 (Biopac Systems, Goleta, CA, USA). The average of three measurements was calculated and used in the analyses; 10 minutes of rest was given between measurements to prevent muscle fatigue.

Statistical analyses were performed using SPSS version 18.0 for Windows (SPSS, Inc. Chicago, IL, USA). One-way analysis of variance was conducted to examine differences among groups with respect to the measured items, while the Tukey test was conducted for post hoc analysis. The statistical significance level of α was set at 0.05.

RESULTS

There were no significant differences in MVIC or endurance time among the three groups. However, MDF was significantly different among all three groups ($p < 0.05$) (Table 1). Tukey post hoc results showed that the active myofascial trigger point group was significantly different from the control group. Muscle fatigue index also was significantly different among all three groups ($p < 0.05$) (Table 1). Tukey post hoc results showed that the active myofascial trigger point group was significantly different from the control group.

DISCUSSION

This study aimed to measure MVIC, endurance, MDF, and muscle fatigue index of normal muscles versus muscles with latent or active myofascial trigger points, thereby identifying the neuromuscular physiological characteristics of muscles with active myofascial trigger points and providing clinical foundational data that are applicable for the quantitative evaluation and diagnosis of MPS.

Surface EMG, which was used to evaluate the functionality of trigger points in this study, is nonintrusive and convenient; thus, it is widely used in studies on the functional characteristics of muscle, by analyzing the electrical activity of muscle. The results of MDF according to surface EMG show changes in recruitment of fast-twitch muscle fibers and conduction velocity of motor unit action potential[12]. In addition, increases in MDF reflect recruitment of type II fibers, and muscle fatigue index can be analyzed according to the relationship between type II fibers and MDF[13, 14]. In the present experiment, MDF was significantly higher in the active trigger point muscles than in normal muscles. The above results indicate that as trigger points were activated, recruitment of motor unit action potential of type II fibers also increased. In addition, muscle fatigue index also increased due to the increased distribution of type II fibers. However, MVIC was lower in active trigger point muscles than in normal muscles. Although a high correlation between muscle strength and MDF has been reported[15, 16], the same correlation was not found in this study. This result was due to increased recruitment of motor unit action potential of type II fibers in active trigger point muscles, which more easily induced muscle fatigue as a physiological phenomenon, thereby reducing muscle strength. In other words, the greater the fatigue, the weaker the muscle strength[17]; endurance also was decreased due to muscle weakening.

Therefore, this study's results will be effective in complementing the physical therapy diagnosis of MPS—which, until now, has focused on physical examination only—by understanding not only the usefulness of electrophysiological analysis in MPS diagnosis, but also the neuromuscular physiological characteristics of active trigger point muscles.

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