

Effect of Treatment Table Height on Shoulder Muscles during Ultrasound Therapy Work

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Abstract. [Purpose] The purpose of this study was to propose a table height that can reduce shoulder muscle fatigue by analyzing and comparing median frequencies of shoulder muscles at different table heights when performing therapeutic ultrasounds work. [Subjects and Methods] The subjects were 63 healthy male adults who were equally and randomly assigned to a standard height group (SHG), a high height group (HHG), and a low height group (LHG). The standard table height was set at the level of the elbow joint when the subjects flexed their elbow while in a sitting position. High height and low height were set 10 cm higher and 10 cm lower, respectively, than the standard height. Muscle fatigue of the upper trapezius, middle deltoid, rhomboid, and infraspinatus of the subjects was measured during ultrasound treatment work at each table height. [Results] Median frequencies of the upper trapezius, middle deltoid, rhomboid, and infraspinatus muscles were significantly lower in the HHG than in the LHG. [Conclusion] When therapeutic ultrasound is performed using a table that has a height lower than that of the elbow joint, the median frequency of the shoulder muscle increases, hence decreasing muscle fatigue. This way, musculoskeletal pain as a result of performing therapeutic ultrasound can be prevented.

Key words: Therapeutic ultrasound, Work environment, Table height

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INTRODUCTION

Research on musculoskeletal pain has presented empirical grounds for improving working environments through the dose-response relationship¹⁾, and has prevented musculoskeletal problems by identifying factors that trigger such problems across a range of work-related activities²⁻⁷⁾. However, physical therapists' musculoskeletal system problems in physical therapists have been the subjects of limited investigation and research^{8, 9)}, and information is needed on the factors that cause such problems and on techniques for resolving them based on a dose-response relationship.

According to relevant research, 80% of physical therapists have pain in their musculoskeletal system, and 40% of these subjects complained of pain in the hands, wrists, and shoulders⁹⁾. Physical therapists perform a high amount of heavy work by since they lifting or move patients, and such heavy work is considered an etiology of pain and damage. However, short repetitive work may cause micro-injuries, and an accumulation of these injuries may lead to chronic musculoskeletal pain. Such work was also found to be a major cause of cumulative trauma disorders (CTDs)¹⁰⁾. There-

fore, among the diverse therapeutic actions performed by physical therapists, simple and repetitive low-intensity work as well as heavy work can cause musculoskeletal pain.

Hong et al.⁸⁾ reported that 50% of physical therapists in Korea who perform in therapeutic ultrasound work complained of musculoskeletal pain. Therapeutic ultrasound work is a representative physical therapy technique that requires repetitive motions of low-intensity muscle contraction for a short time and is considered to contribute to CTDs. Kang et al.¹¹⁾ asserted that repetitive therapeutic ultrasound work of low intensity for a short period may increase the work load on the spinal erectors, depending on the height of the treatment table. In addition, Lee et al.¹²⁾ stated that the muscle activity of shoulder muscles is affected by table height and that extensive use of the shoulder muscle causes muscle fatigue, which in turn can cause musculoskeletal pain. Accordingly, this study examined the effect of treatment table height during ultrasound work on shoulder muscle fatigue, and based on the results, we present an appropriate working environment, potentially contributing to the prevention of musculoskeletal pain of physical therapists.

SUBJECTS AND METHODS

The subjects were 63 male adults with no history of musculoskeletal or neurological system disorders. All the subjects listened to a detailed explanation about the study's methodology, safety matters concerned with the progression of the study, and bio-information protection before

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Table 1. Differences in median frequency of the different table heights (Unit: Hz)

Muscle	LHG	SHG	HHG
Upper Trapezius	84.2±51.2*#	56.8±19.1	53.6±15.1
Middle Deltoid	101.5±48.2#	78.5±19.3	74.7±18.7
Rhomboid	113.8±62#	81.4±39.1	65.2±35.5
Infraspinatus	86±32.1#	67.8±20.5	62.1±23

All data represent the mean ± SE. * indicate a significance different from the SHG.
indicate a significance different from the HHG.

voluntarily consenting to participate in the study. (This study was approved by the IRB of the Catholic University of Pusan (CUPIRB-2014-002). The average age, height, and weight of the subjects were 22.1±2.8 years, 170.8±5.5 cm, and 70.4±8.1 kg, respectively. All subjects were equally and randomly allocated to a standard height group (SHG), a high height group (HHG), and a low height group (LHG).

Therapeutic ultrasound work was performed as follows. Subjects sat on a stool with their foot, knee, and hip joints at 90°. The standard height was set from the ground to the olecranon process of the elbow when each subject flexed his elbow at 90°. High height and low height were established as 10 cm higher and 10 cm lower, respectively, than the standard height. When the subjects took a sitting position, the distance between each subject and the table was 20 cm. In order to maintain the same therapeutic ultrasound work, a circular air cushion, with a 12 cm diameter circle drawn on it, was placed at a corner of the treatment table in front of the subjects. Therapeutic ultrasound work was performed for five minutes along the circle drawn on the air cushion to the sound of a bell which rang once every three seconds¹⁾. Muscle fatigue of the subjects during the therapeutic ultrasound work was evaluated using electromyography (LXM3201, LAXTHA inc., Daejeon, Korea) and analysis software (Telescan, LAXTHA inc., Daejeon, Korea). The sampling rate was 1,024 Hz, and the root mean square was obtained. After completing a band pass filter processing between a frequency at 10 to 500 Hz with 60 Hz a notch filter process with a frequency at 60 Hz, the median frequency was calculated. In order to analyze the median frequencies of three groups, a post hoc test was conducted using a one-way analysis of variance and Sheffe's method using SPSS 18.0 for Windows, and a significance level was set of $\alpha=0.5$.

RESULTS

The median frequency of the shoulder muscles was lowest in the HHG and highest in the LHG. Post hoc analysis showed that the median frequency of the upper trapezius muscle of the LHG differed significantly from those of the SHG and HHG. The median frequencies of the middle deltoid muscle, rhomboid muscle, and infraspinatus muscle of the LHG and SHG differed significantly from those of the HHG (Table 1).

DISCUSSION

The dose-response relationship has been used to evaluate the risk factors during work¹⁾. Research on dose-response has been performed for diverse works, such as sewing⁶⁾, milking⁷⁾, looking through a microscope³⁾, and working on a computer^{4,5)}. It has helped to prevent musculoskeletal system diseases by analyzing the environmental factors that may trigger such diseases. However, in the field of physical therapy, such efforts have been confined to investigation and research, and therefore an analysis of the risk factors based on the dose-response relationship was needed.

One factor that influences muscle fatigue is working hours. The longer that therapists work on a table, the more they feel muscle fatigue¹³⁾. This study examined the effects of therapeutic ultrasound work on muscle fatigue and used five minutes work as the control. In general, the minimum time needed to effectively heat deep tissues with therapeutic ultrasound is more than 5 minutes.

For low-intensity ultrasound work, therapists move their upper limbs in different directions and work continuously, causing repetitive muscle contraction of the shoulder muscles that trigger such movements and the muscles that support the upper limbs. Repetitive low-intensity muscle contraction is related to induction of trigger points¹⁴⁾. The upper trapezius muscle that should continuously support the weight of the arms is the most representative muscle of where trigger points occur¹⁵⁾. The results of this study indicated that muscle fatigue of the upper trapezius muscle increased when the table height was high. In addition, muscle fatigue of the middle deltoid muscle and infraspinatus muscles, which engage in abduction and external rotation, increased, and muscle fatigue of the rhomboid muscle, which supports the shoulders, also increased. When a repetitive load applied on these muscles, it may possibly lead to trigger points¹⁶⁾. Hong et al.⁸⁾ observed that most physical therapists who conducted ultrasound therapy experience symptoms in the forearms and the wrists as well as the shoulders, suggesting that trigger points had influence.

Musculoskeletal pain during work mostly occurs through heavy work. However, the applicator used for therapeutic ultrasound work weighs about 500 g, indicating that use of this applicator, which is low-level light work, which does not greatly influence musculoskeletal pain. However, low-intensity muscle contraction, which is about 15% of maximal muscle contraction, may also increase muscle fatigue¹⁷⁾. Moreover, when recruitment of type II muscle fibers decreases as a result of repetitive muscle contrac-

tion, recruitment of type I muscle fibers increases¹⁸⁾ and the electromyography median frequency of electromyographic activity decreases, which may represent an increase muscle fatigue^{19, 20)}. In other words, low-intensity work, such as therapeutic ultrasound work, may increase muscle fatigue. In this study as well, muscle fatigue of the subjects increased in relation to table height during ultrasound work, suggesting that short repetitive therapeutic ultrasound work may be a cause of CTDs²¹⁾.

Laparoscopic surgery is recommended to be performed on an operating table at the height of the elbow, because this height does not increase muscle fatigue²⁾. In this study, table height was set using elbow height as the standard.

Yim et al.⁴⁾ asserted that muscle activity of the upper trapezius muscle, supraspinatus muscle, infraspinatus muscle, and rhomboid muscles increased, and research has suggested that computer table height is an etiology of neck and shoulder pain in computer users^{5, 21)}.

In the present study, the HHG experienced a higher level of muscle fatigue than the SHG in the upper trapezius, supraspinatus, infraspinatus, and rhomboid muscles, demonstrating that treatment table height contributes to pain in the neck and shoulders when physical therapists conduct therapeutic ultrasound work.

Kim et al.²²⁾ recommended working on a low computer table because computer work on a table whose height is lower than elbow height may reduce the muscle activity of the trapezius muscle. The results of the present study also demonstrated that shoulder muscle fatigue arising from therapeutic ultrasound work is lower when performed on a table lower than elbow height. Table height is a major cause of shoulder muscle fatigue, and when therapeutic ultrasound work is conducted on a table that is higher than the elbow, muscle fatigue of the upper trapezius muscle, middle deltoid muscle, infraspinatus muscle, and rhomboid muscles increases compared to when work is performed at a height lower than the elbow. Therefore, using a table that has a height lower than the elbow to carry out low-intensity ultrasound work will help prevent musculoskeletal pain.

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