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Effects of Change in the Height of Therapy Tables on the Fatigue of Splenius Capitis Muscle and Trapezius Muscle

The purpose of this study is to analysis of muscle fatigue in the upper trapezius and splenius capitis muscles according to therapy table height variation. The subjects were consisted of 15 healthy adults(10 males, 5 females) who had no medical history of neurological and musculoskeletal problems. In experiment, wireless electrode EMG system was measured for each the upper trapezius and splenius capitis muscles during the treatment performed on table. the differences in the muscle fatigue was compared for 4 types of table height(-6cm, -3cm, 0, +3cm from elbow in 90° flexion position). Muscle fatigue according to therapy table height were significant difference except for left upper trapezius. And muscle fatigue of right upper trapezius and splenius capitis showed significant decrease in +3cm table height compared to -6cm table height($p<.05$). Muscle fatigue of right upper trapezius and splenius capitis were the highest in -6cm table height, but those were the lowest in +3cm table height. This study propose to change therapy table height higher than +3cm from elbow in 90° flexion position, if you hope to reduce muscle fatigue.

Key words: *Table Height; EMG; Muscle Fatigue*

Young Hoon Kim, Ji Bin Noh, Sung Hoon Joo, Jung Hyun Choi, Jung Gyu Yoon, Sang Bin Lee

Namseoul University, Cheonan, Korea

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Address for correspondence
Sang Bin Lee, PT, Ph.D
Department of Physical Therapy, Namseoul University, 21 Maeju-ri, Sunghwan-eup, Cheonan, Korea
Tel: 82-41-580-2532
E-mail: sblee@nsu.ac.kr

INTRODUCTION

Work related musculoskeletal disorders(WRMSD) have recently been increasing at a notable rate(1). According to World Health Organization(WHO), WRMSD is defined as 'painful disorders of muscle, tendon, peripheral nerve, and vascular system' that can be attributed to repeated or continuous use of the body and can deteriorate over a period of time(2).

There is an agreement in human engineering that force, posture, and repetition are the 3 main causes for work related musculoskeletal disorder(3). Grieco et al. puts it, work related musculoskeletal disorder gradually develops through accumulation of constant stress on a specific body part over a period of time(4).

To take an example, there are more than 100,000 people working in health related occupations in the United Sates of America, and this group shows higher work related damage rate compared to people working in other service related occupations. Musculoskeletal disorder seems to be more common to health related occupations as well, particularly a high rate in the nurses. Physical therapists are also exposed to work related musculoskeletal disorders such as low back pain(5)

Normally, the weight of the head should be 1/7 of the body, and muscles in neck and shoulders must efficiently work in order to maintain an ideal upright posture. The flexion position of cervical spine increases the load to the cervical spine, which puts about 3.6 times the load on the cervical spine compared to a standing posture(6). The forward head posture involves flexion of the lower cervical vertebra and extension of upper cervical vertebra, and can be commonly seen in white collared workers. This posture can especially be seen in the patients with neck and shoulder pain in the clinical field(7). Constant forward flexion of the cervical vertebra increases the load to tissues in the neck area(6), and it lead to the increasing activity of electromyogram, EMG in muscles in the cervical vertebra(8). Particularly, increased danger on trapezius muscle is obvious while working on the jobs that require visual demands or precision(8). Eventually, increasing the-load on the muscle and joint on the neck from a forward head posture will be the main cause of work-related musculoskeletal disorder(9).

As seen in the past research results, musculoskeletal disorder can be caused by the wrong posture that might result from inappropriate height of work station and chairs. Physical therapists also need to maintain an appropriate height of the therapy table and a proper distance between the patient and the therapist for a proper posture. The height of the table is the first determinant in efficiently delivering full force of the therapist to the patient. The height of the table should be determined by a combination of various factors, such as the height of the therapists, the size of the patient, the posture of patient on the table, and applied techniques. The table must be set with a lower height when delivering pressure and force to the patient with less power(10).

The myofascial release technique is a technique that helps create a more comfortable and stable posture by trying to lead an imbalanced body to a balanced state, and it is one of the highly individualized orthopedic physical therapy techniques based on the request of the patients and skilled experience of the therapists. Although there are multiple methods and corresponding postures for myofascial release technique, a generally used technique is to start with symmetric positions of both hands and apply direct and/or indirect power along fascial planes on the locations where contraction and relaxation of muscles are perceived: one applies traction after waiting for relaxation of muscles(11).

Accordingly, in order to conduct research on how the height of therapy table affects muscle fatigue during physical therapy, we chose myofascial release technique for an experimental activity and upper trapezius and splenius capitis muscle for muscles under analysis to measure the effect of the height of therapy tables.

METHODS

Subjects

This research was conducted toward 15 male and female college students in the 20's currently attending N University located in Chungnam Providence of Korea. The subjects did not have any lesion or any history of lesion on nervous system, muscular system and skeletal system. Those who had external injury or pain in the back muscle were excluded from the subject group. Each subject was asked to read the content and procedures of research, and sign a consent form to agree to voluntarily participate in this research. The subjects participated in 4 rounds of experiments with each session using a different height of the table.

Table 1. Characteristics of subjects

	Mean±SD
Age(yrs)	24.2±2.00
Weight(kg)	61.13±9.41
Height(cm)	169.33±8.69

Measurement Equipment

Research was conducted by applying myofascial release technique and using an orthopedic physical therapy table with varying heights. Muscle activity was measured by attaching wireless surface electrodes(Ag/AgCI Monitoring Electrode 2225, 3M, South Korea) with 4 channels. sampling rate of EMG signal was set at 1,000Hz(1,000 samples/second), and amplified wave was filtered by band pass filter of 20~500Hz.

Procedure

The subjects were well informed and oriented before conducting the research, and the 15 subjects who have agreed to participate in the research were selected. The orthopedic physical therapy table with an automatic height-adjuster was selected for the research. A fixed chair of 55cm without arm supports was used for the research. Also, the posture while sitting on the chair was standardized as maintaining up right waist with the hip on the back of the chair. Four different heights of the table were set as 6cm below the elbow, 3cm below the elbow, as high as the elbow, and 3cm above the elbow, respectively. The test sequence was identical for all the subjects, and EMG surface electrodes were attached to the agreed subjects to measure muscle fatigue of upper trapezius and splenius capitis muscle(Table 1).

In order to relax the occipital region, we let the patients lie flat on the back and let the subjects sit at their bedside and solidly support the elbow on the bed. The subjects were, then,asked to place spinous process of cervical vertebra in between their fingers and move along the head until they reached the hard occipital ridge so that the fingers of the subjects

Table 2. Position of attaching electrode

Muscle	Electrode position
Trapezius muscle	In between 7th spinous process and acromion
Splenius capitis muscle	2cm outside C_4 interspine

were positioned in between the line of occipitial ridge and spinous process of C_2. After adjusting the height of the table based on the physical condition of the subjects, 2 minutes of myofascial release technique was applied to the identical patient of each group. In order to eliminate fatigue effect, 1 minute of static rest was given after delivering myofascial release technique at each given height. Muscle fatigue of back muscle was measured using RMS values of EMG's while conducting myofascial release technique.

Attaching Electrode

In order to measure muscle vitality, electrodes were attached to trapezius muscle and splenius capitis muscle. Eleanor were referred for the actual positions to attach the electrodes(12). In order to decrease the skin resistance of table electrodes, any hair on the attachment position was shaved off, and corneum was rubbed off by rubbing soft sand paper 3~4 times. Finally after rubbing off excessive oil with antiseptic alcohol, surface electrodes were attached.

Data Analysis

The SPSS version 18.0 program for WINDOW was used for data analysis, and K-S test(Kolomogorov-Smirnov test)was used to confirm its normal distribution. Descriptive statistics was used to identify the general characteristics of the research subjects. The statistical method used to analyze muscle fatigue based on changing heights was one way ANOVA for related designs. Also, when any significant difference was found as the result of one way ANOVA analysis for related design, we appealed to the Scheffe test as a posteriori test, and the level of significance was set at a=.05.

RESULTS

Comparison of Muscle Fatigue Based on the Height

Statistically significant differences were found in muscle fatigue while conducting myofascial release technique based on the changing height on the right trapezius muscle, right splenius capitis muscle, and left splenius capitis muscle(Table 3)($p<.05$).

Table 3. Comparison of muscle fatigue based on the height

Target muscle	Height	Mean	SD	F	p
Right trapezius muscle	-6	60.93	13.78	3.463	.022*
	-3	53.91	11.95		
	0	47.45	18.12		
	+3	43.64	188.36		
Left trapezius muscle	-6	55.72	14.89	2.120	.108
	-3	58.19	11.11		
	0	49.86	12.86		
	+3	47.64	13.26		
Right splenius capitis muscle	-6	60.55	12.70	4.159	.010*
	-3	50.16	10.16		
	0	53.72	7.68		
	+3	48.08	10.36		
Left splenius capitis muscle	-6	58.12	12.33	2.853	.045*
	-3	44.70	15.36		
	0	48.72	15.68		
	3	44.60	14.66		

* $p<.05$

Multiple Comparison Analysis on Muscle Fatigue Based on the Height

When conducting therapy on the right trapezius muscle we found significantly decreased muscle fatigue when the elbow was 3㎝ above the table compared to the elbow 6㎝ below the table($p<.05$).

Also, the right splenius capitis muscle showed significantly decreased muscle fatigue when the elbow was 3㎝ above the table compared to the elbow 6cm below the table(table 4~7)($p<.05$).

Table 4. Multiple comparison analysis on muscle fatigue based on the height – Right splenius capitis muscle

Muscle	Height I (I)	Height II (J)	Mean difference (I–J)	Table std. dev	Significance
Right splenius capitis muscle	−6	−3	10.28	3.79	.069
		0	6.82	3.79	.365
		+3	12.46	3.79	.019*
	−3	−6	−10.38	3.79	.069
		0	+3.56	3.79	.829
		+3	2.07	3.79	.959
	0	−6	−6.82	3.79	.365
		−3	3.56	3.79	.829
		+3	5.64	3.79	.534
	+3	−6	−12.46	3.79	.019*
		−3	−2.07	3.79	.959
		0	−5.64	3.79	.534

*p<.05

Table 5. Multiple comparison analysis on muscle fatigue based on the height – Right trapezius muscle

Muscle	Height I (I)	Height II (J)	Mean difference (I–J)	Table std. dev	Significance
Right trapezius muscle	−6	−3	7.01	5.77	.689
		0	12.48	5.77	.154
		+3	17.29	5.77	.038*
	−3	−6	−7.01	5.77	.689
		0	6.46	5.77	.740
		+3	10.27	5.77	.375
	0	−6	−13.48	5.77	.154
		−3	−6.46	5.77	.740
		+3	3.80	5.77	.932
	+3	−6	−17.29	5.77	.038*
		−3	−10.27	5.77	.375
		0	−3.8	5.77	.932

*p<.05

Table 6. Multiple comparison analysis on muscle fatigue based on the height – Left splenius capitis muscle

Muscle	Height I (I)	Height II (J)	Mean difference (I–J)	Table std. dev	Significance
Left splenius capitis muscle	−6	−3	13.42	5.32	.108
		0	9.40	5.32	.381
		+3	13.52	5.32	.104
	−3	−6	−13.42	5.32	.108
		0	−4.01	5.32	.903
		+3	.099	5.32	1.00
	0	−6	−9.40	5.32	.381
		−3	4.01	5.32	.903
		+3	4.11	5.32	.896
	+3	−6	−13.52	5.32	.104
		−3	−.099	5.32	1.00
		0	−4.11	5.32	.896

*p<.05

Table 7. Left trapezius muscle

Muscle	Height I (I)	Height II (J)	Mean difference (I–J)	Table std. dev	Significance
Right trapezius muscle	−6	−3	−2.46	4.78	.966
		0	5.85	4.78	.684
		+3	8.07	4.78	.423
	−3	−6	2.46	4.78	.966
		0	8.32	4.78	.395
		+3	10.54	4.78	.195
	0	−6	−5.85	4.78	.684
		−3	−8.32	4.78	.395
		+3	2.21	4.78	.975
	+3	−6	−1−8.07	4.78	.423
		−3	−10.54	4.78	.195
		0	−2.21	4.78	.975

*p<.05

DISCUSSION

There are many therapy postures for physical therapists. Physical therapists are very much vulnerable to work related musculoskeletal disorders, since they tend to use a lot of physical movement and, as a consequence, increase the load on musculoskeletal system, by assisting, lifting, transferring, pushing and pulling, bending and twisting their lower backs while making physical contact with patients. Thus, in order to increase the efficiency of therapy and decrease the load and muscle fatigue, they must find an intelligent and efficient way to conduct therapy to the patients(10). The studies on work related musculoskeletal disorders are insufficient, especially for physical therapists in Korea, and the seriousness of the problem has not been recognized. Also, methods to prevent or treat musculoskeletal disorders have not been reported as much as necessary. Thus, we aim to identify the effect that the height of the table has on muscle fatigue of splenius capitis muscle and trapezius muscle while conducting mysofascial release technique with an expectation to provide the base data for an efficient and ideal physical therapy posture while preventing muscle fatigues by adjusting the height of the table.

According to Ji, the height of the work station is very closely related to the height of the chair, thickness of the work station, the space for thigh, and etc(13). He claimed that the optimal height of a work station varies depending on the nature of the work; higher for more precise work such as assembling micro parts and lower for rough work. Also, Jung's research on the height of work station reported that the most optimal height of a work station for light intensity of labor is 5~10㎝ below the elbow(14). Bendix recommended that be 3㎝ above the elbow with 90 degree of angle of the elbow joint(15). And Kim reported that when the height of the keyboard is the same as or lower than the elbow, it resulted in lower vitality of trapezius muscle(16).

Karlqvist et al. reported that lower electrode activity of trapezius and deltoid muscles was found when the work station is less than 3㎝ above the elbow compared to 3~9㎝ above while working with a mouse(17). Ahn et al. also found a similar result: the most optimal height decreasing tension on trapezius muscle is 3㎝ over or the same height as the elbow(18). The current research showed a significant decrease in muscle fatigue when the table was 3㎝ above the elbow than it was 6㎝ below the elbow($p<.05$). This difference in muscle fatigue perhaps indicates that if the table is lower than the elbow, a therapist needs to bend forward, which comparatively increases activity of splenius capitis muscle and trapezius muscle.

Kim et al. reported, after comparing muscles in the left and right, that the muscle fatigue of the right arm tends to increase more than the left one, as the weight increases(19). And T. Kim et al. reported, as expected, that lesser load was given to the back muscle if the subject had stronger arm muscles(20). They also reported a similar result in comparison between a dominant and a non-dominant hand: one carrying weight with a dominant hand showed lesser load on the back muscle than the other using a non-dominant hand. This contrast can be easily attributed to the differences in muscle power. The present research also supports the same line of contrast: right muscles influenced by the dominance of a dominant hand show larger muscle fatigue than left muscles.

The subjects of this research were limited to a group of 15 people mostly in the early 20's, and, furthermore, it was not conducted in a real clinical condition. Thus, we can not claim that genuine physical therapy was applied to the research. Thus, further research is in order that is applied in real clinical situations and utilizes various kinds of therapy techniques.

CONCLUSION

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This research was conducted to find how change in the height of therapy table affects muscle fatigue of splenius capitis muscle and trapezius muscle. The research subjects were 15 healthy adults in the 20's, and therapy was given for each subject for 2 minutes at each of the 4 different height of the table: 6㎝ below the elbow, 3㎝ the below the elbow, the same height as the elbow, and 3㎝ above the elbow. The findings can be summarized as follows:

1. While comparing the muscle fatigue based on different heights, there were significant differences in trapezius muscle, right splenius capitis muscle, and left splenius capitis muscle($p<.05$).

2. A multiple comparison analysis on muscle fatigue based on varying heights exhibited that muscle fatigue of right trapezius muscle and right splenius capitis muscle significantly decreased when the table was 3㎝ above the elbow than it was 6㎝ below the elbow($p<.05$).

With the results above, it was found that muscle fatigue of therapists is the least when the height of the table is 3㎝ above the elbow.

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