CHAPTER IV
RESULTS

The current study investigated the fatigability of lumbar multifidus (LM) and internal oblique (IO) muscles which were measured by normalized median frequency slope (normalized MF slope), the lower trunk discomfort using visual analogue scale (VAS) between the crossed sitting and heel sitting postures, and the correlation between normalized MF and VAS.

Part 1: Reliability of the current study

The reliability of sEMG measuring on LM and IO fatigue was performed in 10 subjects. This reliability tests consisted of two tests; LM test and IO test. Each subject performed three trials for three seconds in each trial and rested for three minutes between each trial. The reliability tests of the EMG data were recorded at middle second in the three seconds of sustained contraction period of each muscle. The reliability protocol of the current study was described by Dankaerts et al (2004). ICC (3,1) was employed to test the reliability in the current study. The result of the reliability of sEMG in all muscles of the current study and the raw data of each subject were in Appendix D.

Part 2: The fatigability of lumbar multifidus and internal oblique muscles, lower trunk discomfort and the correlation between normalized median frequency and visual analogue scale

1. Calculation of sample size

Base on data collection from 10 subjects, the variance for visual analogue scale (VAS) in centimeters (σ^2) at 30 minutes was calculated. The largest variability among subjects was 1.76 centimeters which was used as the variance to calculate the sample size in the current study. One centimeter of VAS (Chatchawan et al., 2005) was used as the magnitude of the minimum significant difference between groups. Then, the sample size in the current study would be calculated as following:

$$n/group > \frac{\sigma^2\{Z_{\alpha/2} + Z_\beta\}^2}{\delta^2}$$

$$n/group > \frac{1.76}{1}(1.96 + 1.28)^2$$

$$n/group > 18.49 \approx 19$$

$$n/group > 23 \text{ (drop out 20\%)}$$

Thus, the appropriate number of subjects for the current study was 23 subjects for each group of sitting posture. The raw data was in Appendix C.

2. Characteristics of the subjects

Twenty-four healthy Thai men subjects were recruited for the current study. Each subject was assigned to undertake two sitting postures, namely the crossed sitting and heel sitting postures. Each subject was randomly assigned into two groups using a card in order to assign the sequence of the crossed sitting posture or the heel sitting posture on two consecutive days. One of the subjects was excluded because he was unable to complete the measurement processes. Therefore, the total subjects for the current study were 23 subjects. The mean characteristic data of the subjects were shown in Table 1.

Table 1 Characteristic data of the subjects in the current study

Sources	**Total sample (N=23)**		
	Mean	**SD**	**Range**
Age (yrs)	21.61	2.55	20-30
Weight (kg)	58.16	5.38	50-68
Height (cm)	168.57	4.57	161-180
BMI (kg/m^2)	20.45	1.85	17.92-24.26

Key: BMI = body mass index, **yrs** = years, **kg** = kilogram, **cm** = centimeter, **m** = meter

3. Comparisons of the fatigability between the crossed sitting and heel sitting postures

Table 2 represented the significant differences of normalized MF slope between the crossed sitting and heel sitting postures in both LM and IO muscles. These results showed that the normalized MF slope of right LM, left LM, right IO and left IO muscles in the crossed sitting posture decreased significantly greater than the heel sitting posture ($p = 0.014$, $p = 0.044$, $p = 0.041$ and $p = 0.044$, respectively) (Figure 8). Therefore, the crossed sitting posture leaded to LM and IO muscle fatigue greater than the heel sitting posture performed. The raw data for normalized MF of each subject were presented in Appendix E.3-E.25 and example EMG signals and normalized MF slope were shown in Figure E.1-E.3.

Table 2 Comparisons of normalized median frequency slope between crossed sitting and heel sitting postures in both lumbar multifidus and internal oblique muscles

Muscles/sitting postures	**Normalized median frequency slope (%/second) (N = 23)**		**p-value** [a]
	Crossed sitting	**Heel sitting**	
Right Lumbar multifidus	-0.144 ± 0.07	-0.105 ± 0.05	0.014*
Left lumbar multifidus	-0.138 ± 0.07	-0.106 ± 0.05	0.044*
Right Internal oblique	-0.166 ± 0.10	-0.117 ± 0.05	0.041*
Left internal oblique	-0.165 ± 0.10	-0.119 ± 0.05	0.044*

[a] = Paired T-test

[c] = normalized to initial values

* = Significantly different (p-value < 0.05)

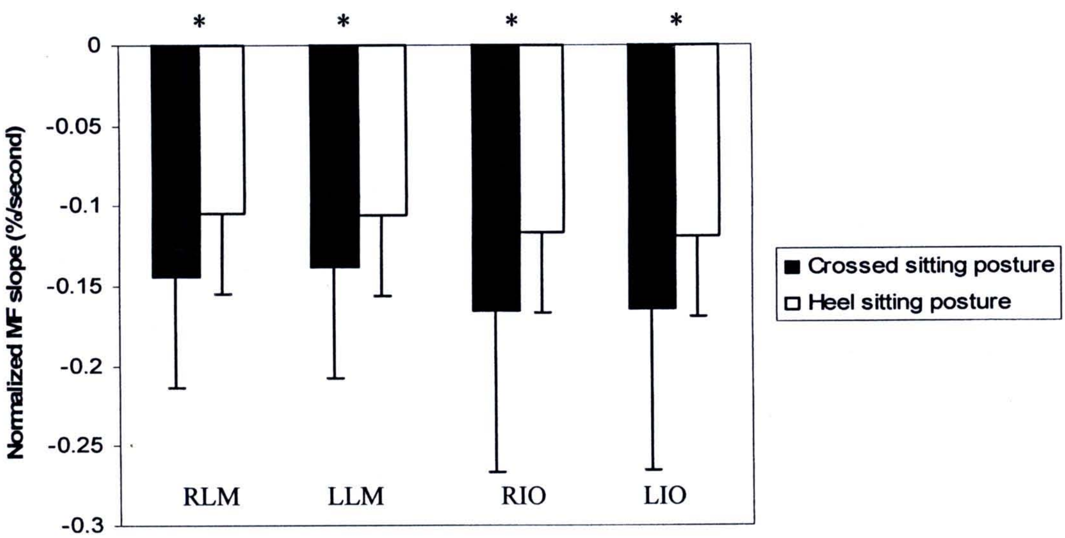


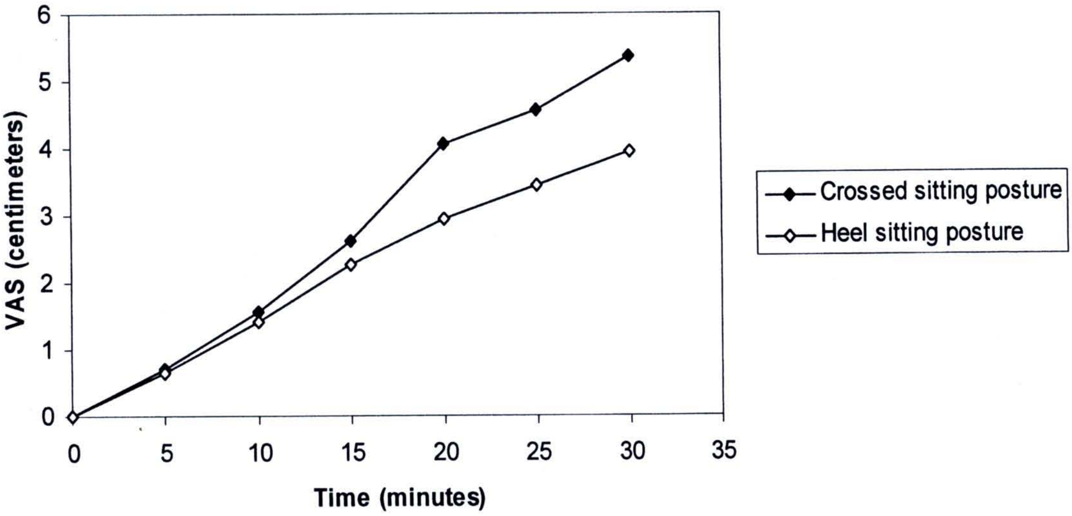
Figure 8 Means and standard deviation (SD) of normalized median frequency slope (normalized MF slope) of right lumbar multifidus (RLM), left lumbar multifidus (LLM), right internal oblique (RIO) and left internal oblique (LIO) between the crossed sitting and heel sitting postures (* denote statistically significant difference between groups; $p < 0.05$)

4. Comparisons of lower trunk discomfort between the crossed sitting and heel sitting postures

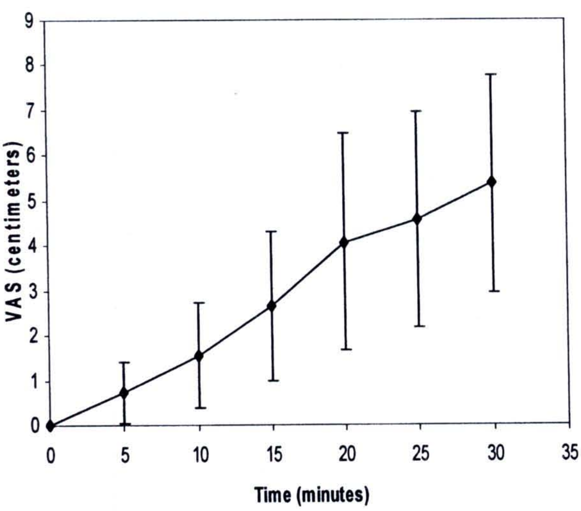
Means and standard deviations of lower trunk discomfort using visual analogue scale (VAS) between the crossed sitting and heel sitting postures every five minutes throughout 30 minutes were shown in Table 3 and Figure 9. The raw data for VAS of each subject were presented in Appendix E.2. The mean of VAS provided from the crossed sitting posture was greater than that from the heel sitting posture at all time points and the magnitude of VAS increased from zero to 30 minutes for both sitting postures.

Table 3 Mean and standard deviation (SD) of lower trunk discomfort using visual analogue scale (VAS) between the crossed sitting and the heel sitting postures (N=23)

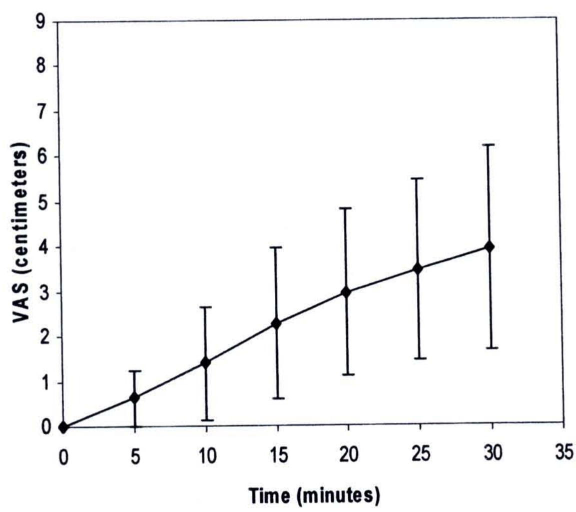
	VAS (Mean ± SD) in centimeters					
Sitting posture	**5 minutes**	**10 minutes**	**15 minutes**	**20 minutes**	**25 minutes**	**30 minutes**
Crossed sitting	0.71 ± 0.68	1.55 ± 1.18	2.63 ± 1.67	4.07 ± 2.40	4.57 ± 2.39	5.36 ± 2.41
Heel sitting	0.64 ± 0.62	1.40 ± 1.26	2.27 ± 1.68	2.95 ± 1.86	3.44 ± 2.00	3.94 ± 2.26



(A) Magnitude of mean visual analogue scale (VAS) at every five minutes between crossed sitting and heel sitting postures



(B) Mean and standard deviation for VAS from crossed sitting posture



(C) Mean and standard deviation for VAS from heel sitting posture

Figure 9 Magnitude of mean VAS every five minutes between crossed sitting and heel sitting postures (A), mean and standard deviation for VAS from crossed sitting posture (B) and mean and standard deviation for VAS from heel sitting posture (C)

The analysis using repeated-measured general linear model was applied to test the effects of study factors on the mean magnitude of VAS. The independent variables in the model included two sitting postures as directed by the protocol, the duration of time of sitting, and the sequences of these two sitting postures that were randomly assigned for each subject. The model was set to test the main effects of factors and the two-way interaction effects of all pair-wise of factors. The results were illustrated in Table 4. Only the effect of duration time showed a significant main effect on VAS ($p \leq 0.001$), while other main effects revealed the non-significance results. In addition, there were no any significant effects of all pair-wise interaction effects. It should be noticed that the effect of sitting postures was nearly significance ($p = 0.146$) and the interaction effect of duration time and sitting postures was also quite close to significance level ($p = 0.052$). Figure 9(A) shows the effect of sitting postures that resulted in a greater effect of the crossed sitting posture on VAS score, and this result suggested the effect of sitting postures that was the protocol of this study should not be neglected.

Table 4 A repeated measures general linear model testing the effects of time, sitting postures and sequence on visual analogue scale (VAS) between the crossed sitting and heel sitting postures (N=23)

Effect	df	F-value	P-value	Sig.
Time	1.52	119.608	< 0.001	*
Sitting postures	1.00	2.196	0.146	
Sequence	1.00	0.208	0.651	
Time*Sitting postures	1.52	3.398	0.052	
Time*Sequence	1.52	0.503	0.557	
Sitting postures*Sequence	1.00	0.371	0.546	
Time*Sitting postures*Sequence	1.52	0.804	0.422	

5. The correlation between normalized median frequency (normalized MF) and visual analogue scale (VAS)

Pearson correlation coefficient demonstrated that there was significant negative correlation between the normalized MF and VAS for all muscles in the crossed sitting posture and in heel sitting posture as described in Table 5 and Figure 10. Therefore, decreasing of normalized MF related to increasing VAS over the times that indicated the development of the fatigability of muscles.

Table 5 Pearson correlation coefficient for the normalized median frequency (normalized MF) and visual analogue scale (VAS) between crossed sitting and heel sitting postures

Muscle/correlation	Pearson correlation coefficient (N=23)	
	Crossed sitting	Heel sitting
Right lumbar multifidus	-0.98**	-0.99**
Left lumbar multifidus	-0.94**	-0.99**
Right internal oblique	-0.99**	-0.98**
Left internal oblique	- 0.88*	-0.96**

* = Significantly different (p-value < 0.05)

** = Significantly different (p-value < 0.01)

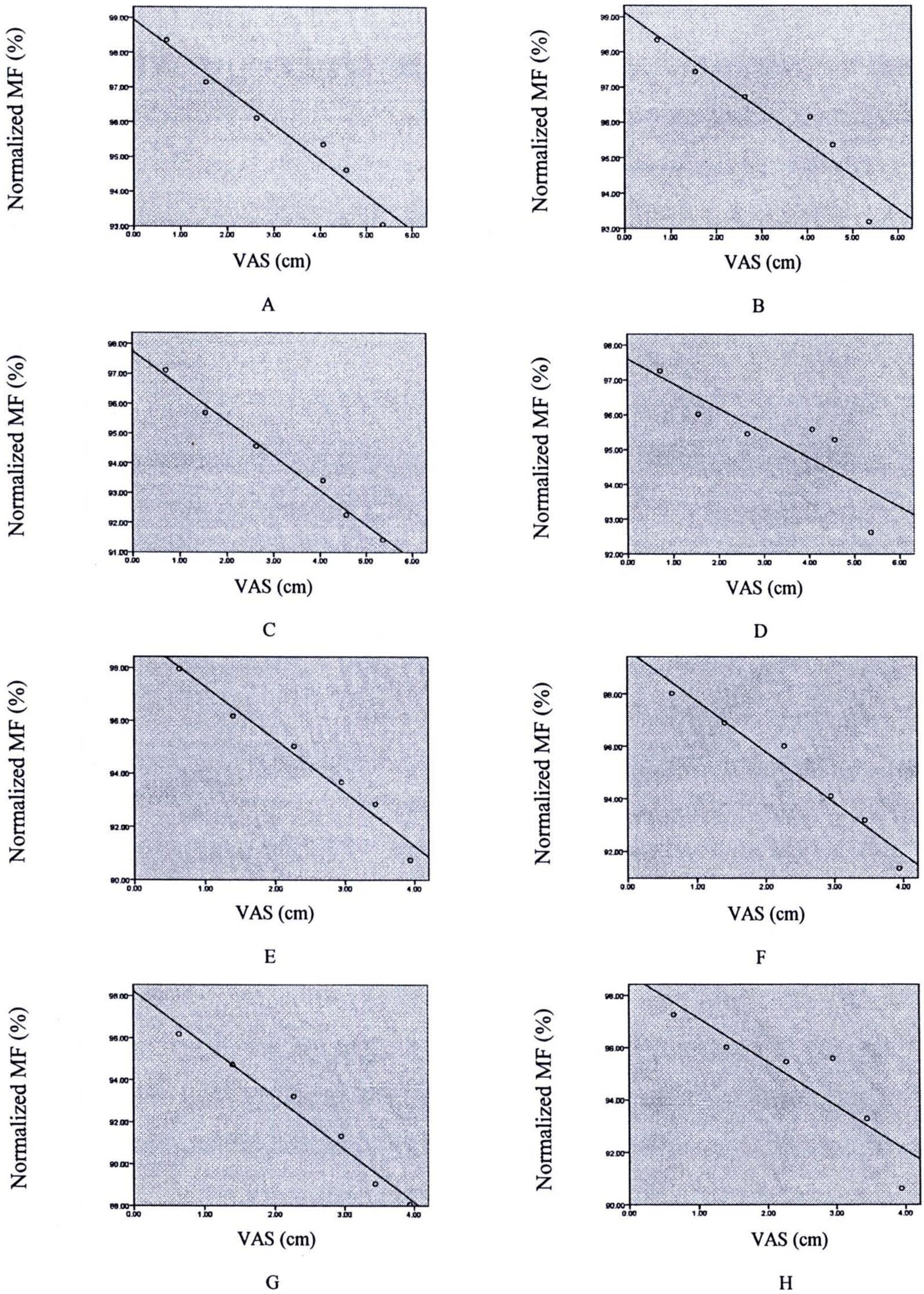


Figure 10 Correlation between normalized median frequency (normalized MF) and visual analogue scale (VAS) in the crossed sitting posture [right lumbar multifidus muscle (A), left lumbar multifidus muscle (B), right internal oblique muscle (C), left internal oblique muscle (D)] and in the heel sitting posture [right lumbar multifidus muscle (A), left lumbar multifidus muscle (B), right internal oblique muscle (C), left internal oblique muscle (D)]