

CHAPTER III

MATERIALS AND METHODS

The current study comprised two main parts. The first part of the current study was to test the reliability of surface electromyography (sEMG). The second part was to investigate 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 crossed sitting and heel sitting postures. In addition, the correlation between normalized MF and VAS were assessed.

1. Design and setting

The current study was conducted at a laboratory room and the room temperature was set up at 25°C, Faculty of Associated Medical Sciences, Khon Kaen University, Thailand.

2. Subjects

The subjects in the current study could be divided to two parts as the following:

2.1 The first part: Reliability of sEMG

Ten healthy men, aged 20-30 years, were screened by the principal investigator using a screening questionnaire (Appendix I). Each subject was required to give a written informed consent. The inclusion and exclusion criteria for the experiment were as the follows:

Inclusion criteria

Subjects were included if their age were between 20-37 years and their BMI were 18.5-24.9 kg/m² (National Heart Lung and Blood Institute, 2009).

Exclusion criteria (O'Sullivan et al., 2006)

Subjects were excluded if they:

1. Had experienced their low back pain which had required any medication or consultation with health professional and/or had days off work within the last six months caused by low back pain.

2. Were diagnosed with a medical condition that affected musculoskeletal system, such as, lumbar spondylosis, spondylolisthesis, lumbar herniated nucleus pulposus, ankylosing spondylitis, rheumatoid arthritis.

3. Had recent lumbo-pelvic and/or abdominal surgery.

4. Had any symptoms; such as recent back pain, leg pain or numbness on their back or legs during the experimental period.

2.2 The second part: Investigation of the fatigability, lower trunk discomfort and the correlation between fatigability and lower trunk discomfort

Twenty-three healthy men, aged 20-30 years, were screened by the principal investigator using a screening questionnaire (Appendix B). Each subject was required to give a written informed consent. The inclusion and exclusion criteria as be described before in part 2.1

3. Sample size

The sample size was limited to the main effect of the crossed sitting and heel sitting postures on the VAS. The formula of Armitage and Berry (1994) was used to estimate the sample size as follow:

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

Sample size calculation: n = sample size needed in each comparison group

$Z_{\alpha/2}$ = area under the normal curve in significant level at 0.05; $Z_{\alpha/2} = 1.96$

Z_{β} = area under the normal curve in probability of failing to reject a false null hypothesis; $Z_{\beta} = 1.28$

σ^2 = variability among subjects or pooled variance estimation; $\sigma^2 = 1.76$

δ^2 = magnitude of the minimum significant difference between group means; $\delta^2 = 1$
(Chatchawan et al., 2005)

4. Randomization

As the current study was a cross-over design study, each subject was assigned into two groups (crossed sitting posture and heel sitting posture) using a simple randomization.

5. Instrumentation

5.1 Surface electromyography (sEMG) (MP 35, BIOPAC Systems, California, USA), which had four channels, was used to continuously record EMG signal. The raw EMG signal was recorded at the sampling rate of 1,000 Hz and a frequency band-pass filter was set up at high-pass frequency 30 Hz and low-pass frequency 500 Hz, amplified (gain \times 1,000) and common mode rejection ratio (CMRR) as 85 dB. In the EMG data analysis, the EMG fast Fourier transform algorithms (Stulen et al., 1981), where a 1-sec data epoch window (1024 data points), was used to calculate the single spectrum. The MF is defined as the value dividing the spectrum area into two equal parts (Kankaapää et al., 1998).

5.2 Snap leads

5.3 Silver/silver chloride (Ag-AgCl) surface EMG electrodes

5.4 Casio stopwatch

5.5 Cushion (100 \times 200 \times 3 cm³)

5.6 Fine sandpaper

5.7 Alcohol

5.8 Balance

5.9 Height

6. Procedures

The current procedure was to evaluate the fatigability of LM and IO muscles and lower trunk discomfort between crossed sitting and heel sitting postures. Additionally, the correlation between the fatigability and lower trunk discomfort were assessed.



6.1 To investigate the fatigability of lumbar multifidus and internal oblique muscles, lower trunk discomfort and the correlation of the fatigability and lower trunk discomfort between crossed sitting and heel sitting postures

All subjects were explained about the purpose, experimental procedures and advantage of this study. A screening questionnaire (Appendix B) was applied to ensure that they met the inclusion and exclusion criteria. Then, all subjects signed the informed consent. As the current study was a cross-over design study, each subject was randomly assigned into two groups using a card. In order to assign the sequence of the two sitting postures, the principal investigator prepared a separate card for each subject. The sequence of the two sitting postures was written on each card. Half of the cards were written with the sequence of the crossed sitting posture on the first day and with the sequence of the heel sitting posture on the second day. The other half of the cards were written with the sequence of the heel sitting posture on the first day and with the sequence of the crossed sitting posture on the second day. Each subject was asked to draw one of the cards from a hat on the first visit. After that, all subjects changed their shirt and pants to put on the sleeveless waistcoat and shorts which allowed visualization of the spine for marking the points to attach the surface electrodes. Before starting data collection, the principal investigator instructed the experimental procedures again and gave an outline of all sitting postures to all subjects. On the familiarization session, all subjects practiced all testing procedures until they could readily perform all sitting postures. If they had any questions regarding the study, the principal investigator explained many doubts that they asked.

6.1.1 Skin preparation and electrode attachment

Before electromyographic (EMG) measurement, the skin over boundaries of both LM muscles and IO muscles was prepared to reduce skin impedance less than 5 k Ω by shaving electrode sites, cleaning these sites with alcohol and abrading the skin with fine sandpaper. After that, the principal investigator attached pairs of adhesive disposable Ag-AgCl surface electrodes (EL 503) with electrical contact surface area one cm² on unilaterally 2.5 cm apart and parallel to muscles of both sides (O'Sullivan et al., 2006): LM muscle (level of L5, parallel to a line connecting the posterior superior iliac spine and L1-L2 interspinous space) (O'Sullivan et al., 2006) (Figure 4) and IO muscle (1-cm medial to the anterior

superior iliac spine) (Ng et al., 2002) (Figure 5). The four ground electrodes were placed over both anterior superior iliac spines and both iliac crests. Snap leads were connected between surface electrodes and amplifiers to transfer EMG signals and all electrodes were taped securely to avoid excessive movement of leads.

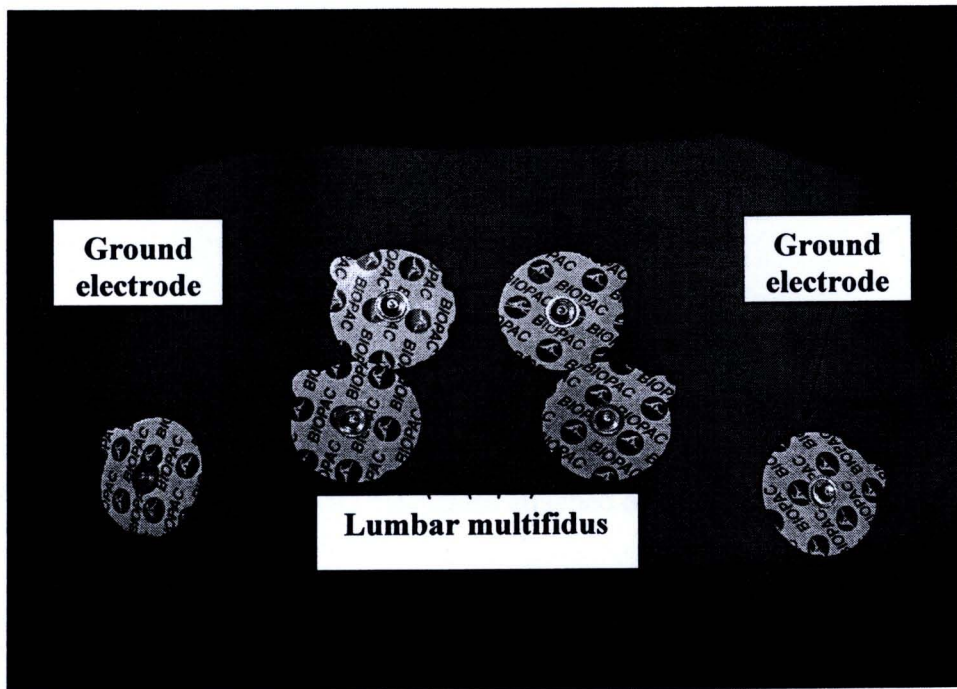


Figure 4 Location of sEMG electrodes attached on lumbar multifidus muscles

6.2.2 Testing procedures

6.2.2.1 Crossed sitting posture

Before sitting, each subject was asked to rest in a supine lying position for 10 minutes (Jones et al., 2004), to eliminate fatigability of testing muscles (LM muscles and IO muscles) and was asked the lower trunk discomfort using VAS for ensuring no discomfort at all in the baseline. After that, they performed the crossed sitting posture on a cushion for 30 minutes. The marker of horizontal stand was adjusted to contact to L3 spinous process level in order to maintained position in neutral position during testing. Each subject was instructed to

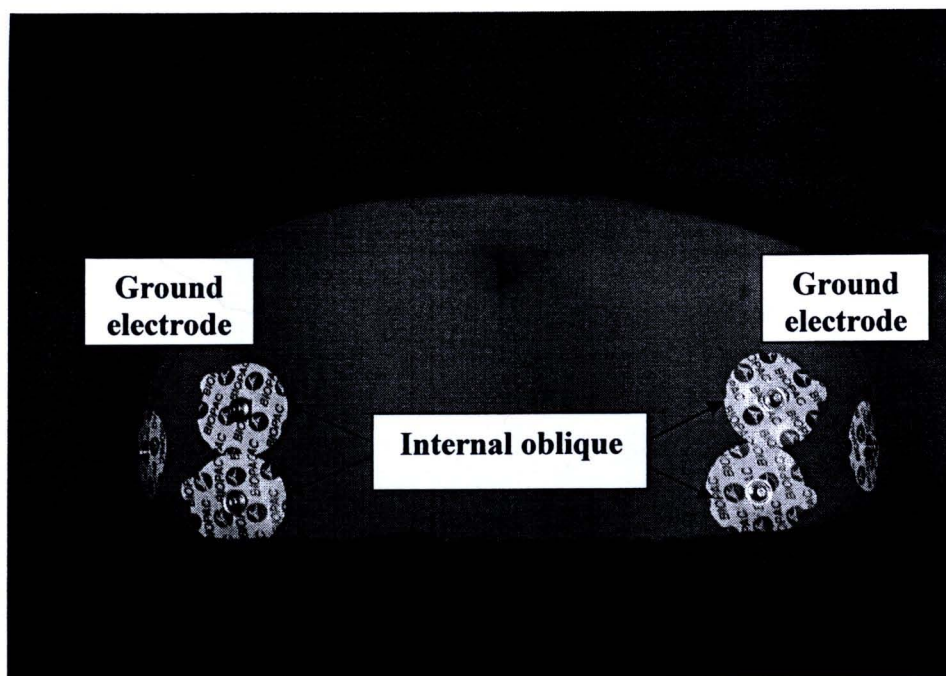


Figure 5 Location of sEMG electrodes attached on internal oblique muscles

view a designed point 1.5 m. ahead at their eye level. This posture consisted of the relaxation of thorax, the pelvic anterior rotation to obtain a neutral lumbar lordosis, both hips flexion, both of knees flexion that crosses each leg to place the calf of same leg being on the top of the opposite foot. The opposite leg places on the cushion (Office of the National Culture Commission, 2009) (Figure 6). In the same time, the principal investigator started the electromyographic recording throughout 30 minutes and the VAS was asked every five minutes throughout 30 minutes to measuring the lower trunk discomfort.



Figure 6 Crossed sitting posture

6.2.2.2 Heel sitting posture

Before sitting, each subject was asked to rest in a supine lying position for 10 minutes (Jones et al., 2004), to eliminate fatigability of testing muscles (lumbar multifidus muscles and internal oblique muscles) and was asked lower trunk discomfort using VAS for ensuring no discomfort at all in the baseline. After that, they performed the heel sitting posture on a cushion for 30 minutes. The marker of horizontal stand was adjusted to contact to L3 spinous process level in order to maintained position in neutral position during testing. Each subject was instructed to view a designed point 1.5 m. ahead at their eye level. This posture consisted of the relaxation of thorax, the pelvic anterior rotation to obtain a neutral lumbar lordosis, both hips flexion, both knees flexion and contacted to a cushion, both feet dorsiflexion and both ischial tuberosities rest on the heels (Office of the National Culture Commission, 2009) (Figure 7). In the same time, the principal investigator started the electromyographic recording throughout 30 minutes and the VAS was asked every five minutes throughout 30 minutes to measuring the lower trunk discomfort.

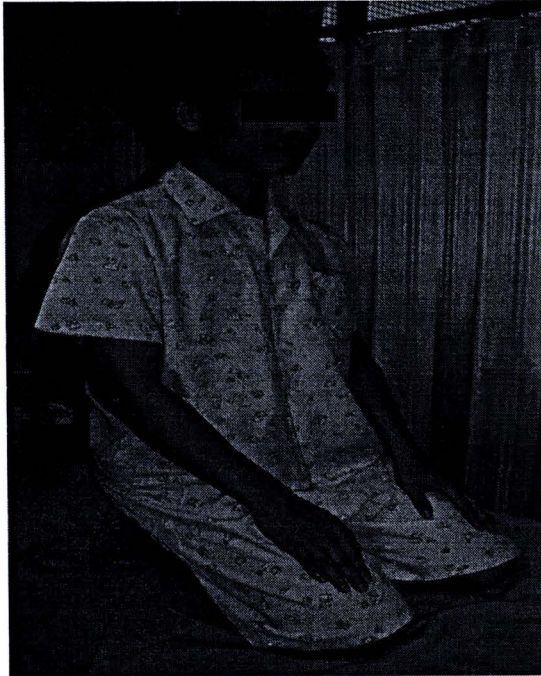


Figure 7 Heel sitting posture

7. Variables in the study

7.1 The difference of the normalized MF slope provided from the crossed sitting posture was compared to that provided from the heel sitting posture.

7.2 The difference of the VAS every five minutes throughout 30 minutes of lower trunk discomfort provided from the crossed sitting posture was compared to that provided from the heel sitting posture.

7.3 The correlation between normalized MF and VAS in crossed sitting and heel sitting postures.

8. Data processing

8.1 Normalized median frequency slope (normalized MF slope)

The MF data using fast Fourier transforms (FFT) were investigated every one minute throughout 30 minutes in crossed sitting and heel sitting postures. After that, all MF data were normalized to their initial MF values. The least square linear regression analysis was applied to analyze the normalized MF data. The normalized MF slopes were derived using linear regression and MF slope were compared between the crossed sitting and heel sitting postures.

8.2 Visual analogue scale (VAS)

The mean of VAS every five minutes throughout 30 minutes were compared to evaluate the difference between the crossed sitting and heel sitting postures.

8.3 The correlation between normalized median frequency and visual analogue scale

The mean of normalized MF and VAS every five minutes were assessed the correlation in the crossed sitting and heel sitting postures.

9. Data analysis

The normalized MF slope of LM and IO muscles throughout 30 minutes and the VAS measuring lower trunk discomfort every five minutes throughout 30 minutes were examined to compare between the crossed sitting and heel sitting postures. Additionally, the correlation between normalized MF and VAS were assessed. The Kolmogorov-Smirnov Goodness of fit-test was used to test assumption of normal distribution of the data. The paired sample t-test was employed to calculate the difference of any changes of the normalized MF slopes of LM and IO muscles throughout 30 minutes. A repeated measures general linear model was employed to calculate the difference of any change of VAS every five minutes throughout 30 minutes between the two sitting postures. In addition, Pearson correlation coefficient was used to assess the correlation between the normalized MF and VAS.

