CHAPTER I
INTRODUCTION

1. Research rationale and background

A productive population spends much time in a sitting posture which is claimed to be one of the common risk factors for low back pain (LBP) (Williams et al., 1991; Hoogendoorn et al., 2000). Epidemiologic research has shown that prolonged sitting occupations have a high incidence of LBP (Wilder et al., 1988). Moreover, low back pain during a sitting period is one of the most common causes to stop working and to lose income in agricultural and industrial countries (Patenaude and Somer, 1987).

Sitting postures can easily provoke the LBP symptom (Dankaerts et al., 2006) because these postures are related to the biomechanics of the lumbo-pelvic region and trunk muscle activation. The sitting postures are semi-flexion postures in which there are less lumbar lordosis and pelvic anterior tilting than in a standing posture (Al-Eisa et al., 2006). Previous studies proposed that the back semi-flexed or flexed posture results in increment substantial activity of the trunk extensors to counterbalance upper compression forces on the motion lumbar segments (Nachemson, 1981; Schultz et al., 1982). Thus working in a semi-flexed or flexed posture, such as a sitting posture, has been shown to be a cause of LBP (Stubbs et al., 1983). If people are in a prolonged sitting position, they may experience LBP at some stages in their life because this posture can increase intradiscal pressure and local muscle system fatigue (Harrison et al., 1999). These muscles, lumbar multifidus (LM) muscles and internal oblique (IO) muscles, act as lumbo-pelvic stabilizers (Dankaerts et al., 2006; O'Sullivan et al., 2006), maintain the lumbar segmental stability and directly control the lumbar segmental movement (O'Sullivan, 2000). The fatigability of these muscles is the alteration of physiological mechanisms that have decreased muscle fiber conduction velocity, which results from the accumulation of several metabolites such as proton (H^+), extracellular potassium (extracellular K^+), phosphate (P_i) and adenosine diphosphate (ADP). In addition, these affect the reduction of motor unit activities and sacrolemmal excitability which could induce occurrence of muscle fatigue (Clark et al., 2003; Allen, 2008).

Not only do Asian women spend their time sitting on the floor due to their life-style (Nag et al., 1986; Callaghan et al., 2001), but Asian men often sit on the floor to work in their workplaces. In Thailand, there is a mixture of Buddhist and Thai culture which is reflected in cultural sitting postures; the crossed sitting and heel sitting postures. These two sitting postures are the most common postures for Thai men that can be observed in Thai ceremonies, the work place, meditation and even in daily lives (Nag et al., 1986). Nevertheless, these two postures may result in trunk muscle fatigue, especially of LM and IO muscles, because these muscles must continuously contract for prolonged periods. The difference in unsupported sitting postures leads to difference activation of LM and IO muscles (O'Sullivan et al., 2006). Thus, non-equivalent LM and IO activation may be implied difference in muscle fatigue and may change of the translation of oxygen within muscles (Callaghan and Dunk, 2002; Callaghan et al., 2010), and finally lead to spinal pain.

Nowadays, there are numerous non-invasive methods to investigate the fatigability of muscles, such as mechanomyography (MMG), near infrared spectroscopy (NIRS) and surface electromyography (sEMG) (Yoshitake et al., 2001; Pereira et al., 2007; Kankaapää et al., 1998; Lariviere et al., 2002). However, the sEMG is a non-invasive method which is widely used to investigate muscle fatigue (De Luca, 1993; Dankaerts et al., 2004), and this device can measure fatigue rates of trunk muscles. The sEMG has been demonstrated to provide a high reliability (r = 0.75-0.82) (Ng et al., 1997; Ali et al., 2006). The median frequency (MF) value is an outcome measurement of sEMG to investigate the fatigability of muscles. MF value is a common outcome measurement of sEMG that has a high accuracy to detect muscle fatigue in an early stage. It is a basic outcome of sEMG (De Luca, 1997; Mannion et al., 1997; Roy et al., 1997; Sparto et al., 1997). Therefore, the MF value reflects muscle fatigue in fatiguing tasks and has been widely used to predict and investigate muscle fatigue.

Additionally, the visual analogue scale (VAS) is an instrument that has been used to measure localized muscle fatigue. It uses a 10 cm horizontal line with anchors at the two ends reading "no fatigue/discomfort at all" and "worst imaginable fatigue/discomfort" (Kumer, 2006). VAS is an acceptable instrument to consider task-related fatigue (van Dieën et al., 1997; Iwakiri et al., 2008). A previous study proposed that the discomfort assessment tool VAS has been validated and has poor

correlation with objective assessment when they assessed discomfort by using VAS and near-infrared spectroscopy (NIRS) (r = 0.07-0.47) (Crane et al., 2005). However, there is no study to evaluate the correlation between normalized MF and VAS. Therefore, the unknown correlation between normalized MF and VAS is very interesting.

Previous study reported that sitting on the floor for 30 minutes could cause differences in trunk muscle activities (Nag et al., 1986). Thirty minutes in the previous study may have been speculated to induce fatigability of LM and IO muscles. To date, no study has evaluated the effect of crossed sitting and heel sitting postures on the fatigability of LM and IO muscles. In addition, there is a lack of information in terms of a subjective assessment tool for lower trunk discomfort. Furthermore, there is no study to evaluate the correlation between normalized MF and VAS. Therefore, the aims of the current study are; 1) to investigate the fatigue caused by the crossed sitting and heel sitting postures of LM and IO muscles using the normalized MF slope, 2) to investigate subjective assessment of lower trunk discomfort using the VAS in healthy Thai men, and 3) to assess the correlation between the normalized MF and VAS concerning lower trunk muscle fatigue.

2. Research questions

2.1 Do the sitting postures, crossed sitting and heel sitting, affect the normalized MF slope?

2.2 Do the sitting postures, crossed sitting and heel sitting, affect the VAS?

2.3 Is there a significant correlation between the normalized MF and VAS?

3. Objectives of the study

General objective

To study the effect of sitting posture on the fatigability of LM and IO muscles including lower trunk discomfort in healthy Thai men. Additionally, the correlation between the normalized MF and VAS is investigated.

Specific objectives

1. To compare the normalized MF slope of LM muscles and IO muscles between the crossed sitting and heel sitting postures throughout 30 minutes.

2. To compare the VAS of lower trunk throughout 30 minutes between the crossed sitting and heel sitting postures.

3. To investigate the correlation between the normalized MF and VAS.

4. Parameters

4.1 Normalized median frequency slope (normalized MF slope; %/second)

4.2 Normalized median frequency (normalized MF; %)

4.3 Visual analogue scale (VAS)

5. Hypothesis of the study

5.1 The normalized MF slope of LM muscles provided from the crossed sitting posture for 30 minutes will be significantly different from the heel sitting posture.

5.2 The normalized MF slope of IO muscles provided from the crossed sitting posture for 30 minutes will be significantly different from the heel sitting posture.

5.3 The VAS of trunk provided from the crossed sitting posture every five minutes throughout 30 minutes will be significantly different from the heel sitting posture.

5.4 There is a significant correlation between the normalized MF and VAS.

6. Scope of the study

This is a study of the normalized MF slope of LM muscles and IO muscles including an investigation of lower trunk discomfort using the VAS provided from the crossed sitting and heel sitting postures in healthy Thai men, aged 20-30 years. All subjects were recruited form Khon Kaen University. The sEMG was used to define the fatigability of LM and IO muscles. The fatigability from sEMG had been recorded during the two sitting postures for 30 minutes. The VAS was used to determine the subjective discomfort of the lower trunk every five minutes throughout 30 minutes. The normalized MF slope and VAS provided from the crossed sitting and heel sitting postures were compared. In addition, the normalized MF were assessed to find the correlation with VAS.

7. Benefits from the study

7.1 Suggesting a suitable floor sitting postures; the crossed sitting and heel sitting postures, for healthy Thai men aged 20-30 years when they need to work at ground level.

7.2 Providing new evidence concerning a substitute method to assess lower trunk muscle fatigue.

7.3 Providing new evidence for further studies in the areas of lower trunk muscle fatigue and lower trunk discomfort.

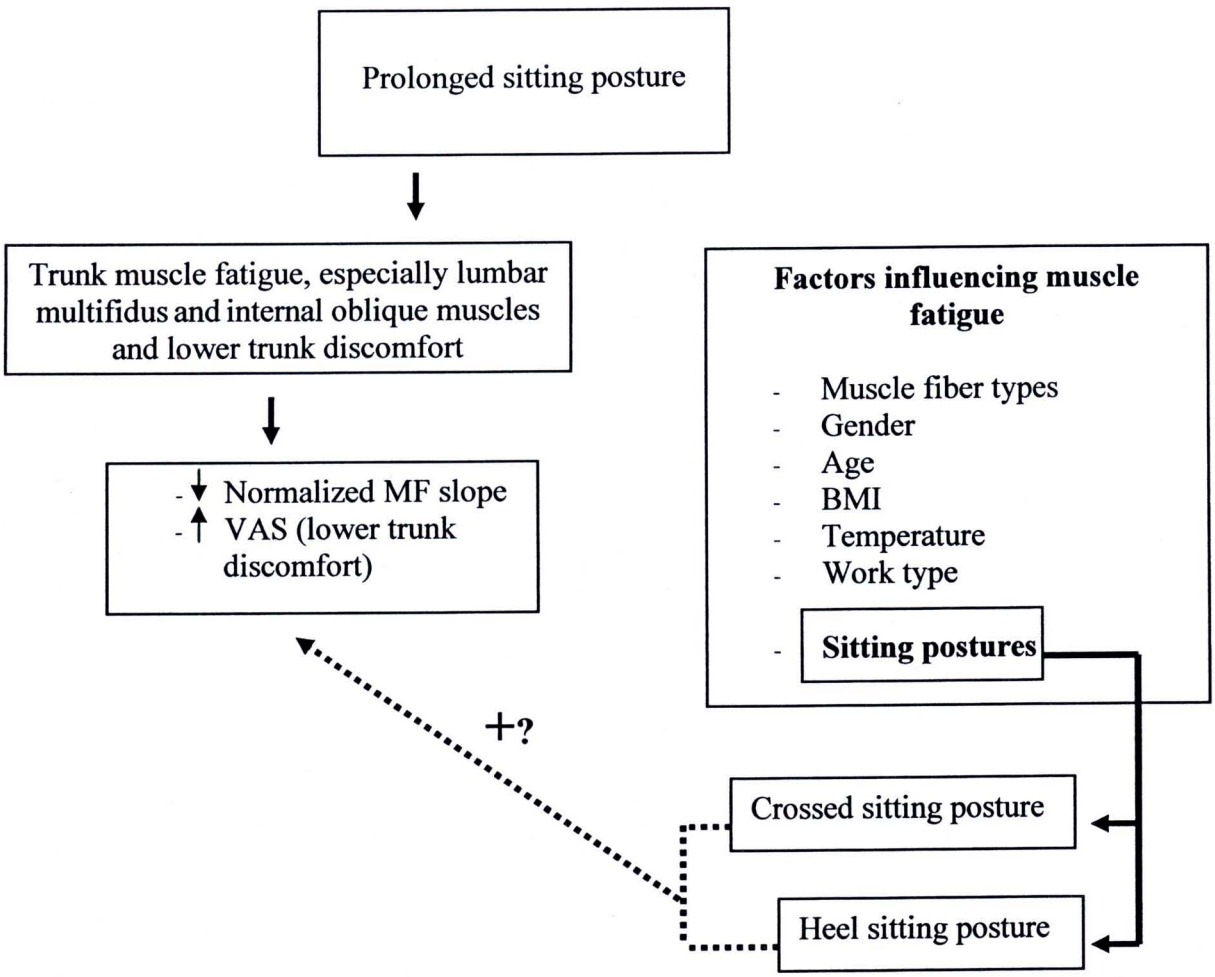

Figure 1 Conceptual framework of the current study