The 8th TSME International Conference on Mechanical Engineering
12-15 December 2017
Bangkok, Thailand


BME0007

# Performance study of knee supports by electromyography (EMG) testing

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**Abstract**. Knee supports are used for people who are injured or not injured, but want to prevent injury to the knee from sport and exercise activities by supporting nearby knee muscles. The purpose of this work was to compare the EMG signals reduction of three cases of no knee support (A), the brand-named knee support (B) and the natural rubber (NR) knee support (C). The EMG testing was performed using Isokinetic machine and obtaining the EMG signal by controlling a leg movement. It was found that the measured EMG signals from A, B and C cases were 0.0339, 0.0135 and 0.0156 mV from Vestus medialis oblique muscle and 0.0376, 0.0232 and 0.0310 mV from Rectus femoris muscle, respectively. Results from EMG signals differ very little and the result from C case showed better performance than A case. Both knee supports of B and C can reduce EMG signal referred to reducing of muscle activity in the same way. Thus, further knee support developing from natural rubber can be conducted from this work depending on theoretical biomechanics and anatomy.

## 1. Introduction

Knee injuries from sports or exercises are common problems. Knee support can be used for reducing risk of injury. Everyone can use knee support without assistance from expert [1, 2]. There are many reasons causing of knee injuries such as rapid changing of direction or jump landing. Knee injury cases were rapidly increased over the past decade [3, 4, 5]. Anterior cruciate ligament (ACL) tearing is a common problem. In the USA, there are 100,000 to 250,000 new cases each year [6]. Knee supports are external devices which can be normally utilized during the day and during sport tasks [2, 4, 7].

There are many types of knee brace that provide different levels of support and be attached to the knee in a number of different ways. They also were made of different materials and varied in price. Type of knee brace can be classified by levels of support such as basic level, advance level, elite level and knee pad. This research aimed to study knee supports of the basic level type only because they can snugly fit and provide some compression to the knee which helps supporting the soft tissues (muscles and ligaments) [8, 9].

Electromyography (EMG) is a diagnostic procedure to assess the health of muscles for evaluating and recording the electrical activity produced by muscles. The purpose of this study was to determine the effect of knee braces to muscles. There were previous studies solely used surfaced EMG to observe different responses from dynamic muscle activities such as running and side-step cutting [10,

11]. This study will focus on testing of different types of knee supports on the same activities instead. Research has focused on Vestus medialis oblique muscle and Rectus femoris muscle during movement and rotation of knees.

## 2. Material and Methods

### *2.1. Material for knee supports and sampling*

There are two types of knee supports in this study: one is a durable neoprene-blend from brand-named (figure 1a) and the other is a custom made NR (figure 1b). The design of the custom knee support is similar in concept of the commercial one but different materials. The NR has more stiffness than neoprene-blend. Standard test method of ASTM D412-98 is used for testing mechanical property of knee support with tensile testing machine (Zwick Roell, Germany). The custom knee support has a strap that it can be tightly adjusted or loosen for everybody. The samplings or participants comprised of healthy adult male volunteers, 23 year old, height 165 cm, weight 60 kg, without experiencing ligament tear.

a.

b.

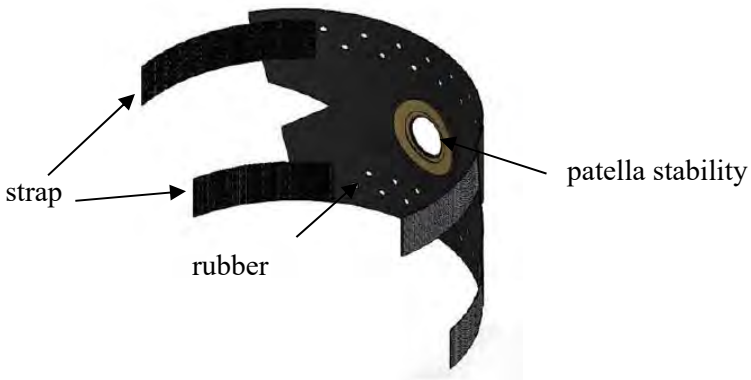


**Figure 1.** Two types of knee brace, a) brand-named knee brace and b) NR knee brace

### *2.2. EMG testing and equipment*

The testing apparatus was developed by the department of electrical engineering, Prince of Songkla University (figure 2). The apparatus have 2 components; the isokinetic machine used to control velocity and force of leg, and the PSU_Beatlab_1 used to amplifier EMG signal that it made from Stainless Steel for noise reduction. The amplifier EMG has 5 signal channels input. The EMG signals were sampled at 1000 Hz and a low-pass filtered of 50 Hz. The amplifier received EMG signal from electrode of TYCO Healthcare model Kendall/Tyco ARBO and recorded into computer. The use of isokinetic machine may improve muscular strength of healthy adults. This machine is a reliable tool for isokinetic muscle performance measurement and able to assess muscle strength more objectively.

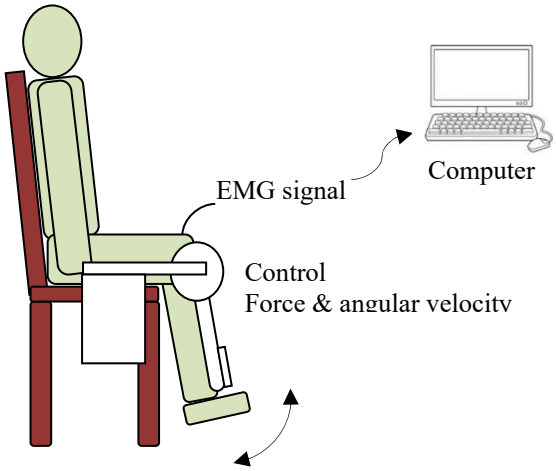


**Figure 2**. testing apparatus

Two muscles, Vestusmedialis oblique and Rectus femoris, were used to record signal of EMG because they are large muscles and provide good signals than other muscles. The electrodes were setup on leg positions as shown in figure 3. Vestusmedialis oblique muscle and Rectus femoris muscle were activated when knee joint turned up and down.

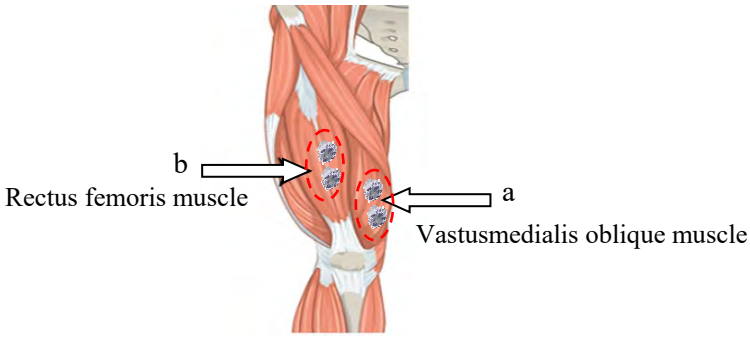


**Figure 3.** Positions of electrode attachment a) Vastusmedialis oblique and b) Rectus femoris.

*2.3. Procedure*

Each subject was tested in all three proposed conditions of A, B and C as mentioned earlier. The experiment was conducted in Center of Excellence for Rehabilitation Engineering. The isokinetic was set at a speed of 20 degree/minutes with a load of 3 kg. The participant turned leg 3 times for finding of noise and turned leg 10 time continuously for recording EMG signal (figure 4).

a b

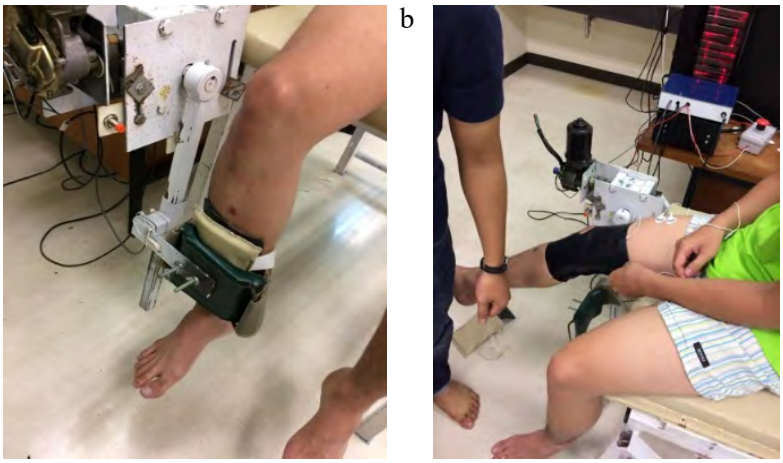

**Figure 4.** Experimental setup for obtaining EMG signal a) no knee support and b) custom knee support from natural rubber

## 3. Results

There are four data obtained from testing which are EMG signals from two muscle of Vestusmedialis oblique and Rectus femoris, force, and angular velocity (figure 5). Force and angular velocity affect the value of EMG signal. According to the EMG signal related to force and angular velocity, when participants exert a lot of force or move fast, it will be large too. However, EMG signal was analyzed at the same force and angular velocity.

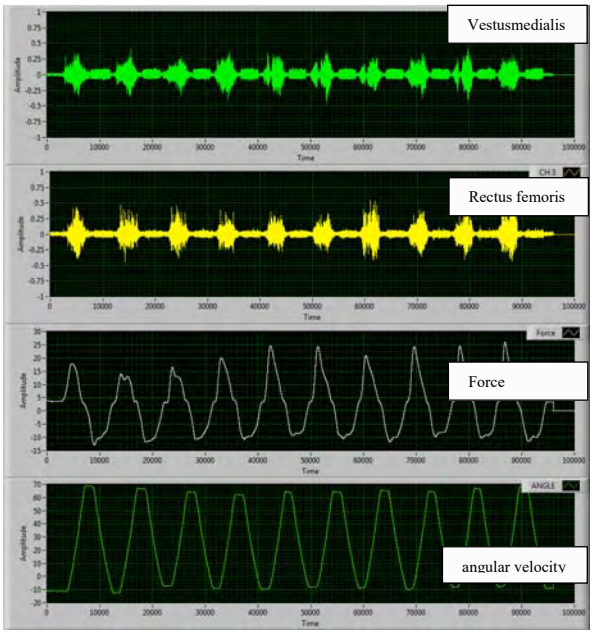


**Figure. 5** Shown data from testing apparatus

EMG signals were calculated from average amplitudes subtracted of noises. The result showed that EMG signals from wearing of knee braces have less value than without one. This is because knee braces can absorb force and support muscles. The EMG signals were presented in table 1.

**Table 1.** Results of EMG signals from each case

| Testing case | EMG signal (mV) | |
|---|---|---|
| | Vastusmedialis oblique | Rectus femoris |
| Case A (no knee support) | 0.0339 | 0.0376 |
| Case B (Brand-named knee support) | 0.0135 | 0.0232 |
| Case C (custom NR knee support) | 0.0156 | 0.0310 |

The result of EMG signal from case B was less than case C which can be concluded that commercial knee support can support muscles better than custom NR support but with a few differences. However, wearing knee supports can be reducing EMG signals of both muscles than no knee support in case A.

## 4. Conclusions

This research was conducted to study the effect of different knee braces to EMG signal of muscles. The result showed that EMG signal can be reduced when participants wore knee braces. The commercial or brand-named knee support performed better than the custom NR knee support. However, this was a preliminary research and study and the quantity of the study is too small because it was used only in one person. Therefore, the future study should be tested with more volunteers for reliability of research and the well-developed NR knee support can be possible but need more research work and further development.


## Acknowledgement

This study was supported by Department of Mechanical Engineering and Department of Electrical Engineering Faculty of Engineering, Prince of Songkla University. Special thanks to Thongruang W. Professor of Department of Mechanical Engineering and Jindapetch N. Professor of Department of Electrical Engineering. Thank you to the Department of Mechanical Engineering, Faculty of Engineering, Chulalongkorn University for organizing hosted conference. And thanks all people in my life.


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