INFLUENCE OF DIFFERENT BODY POSITION AND BICYCLE SETUP ON MUSCLES ACTIVITY AND JOINT KINEMATICS DURING CYCLING

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ABSTRACT

The current study investigated how saddle setup and body positions may influence muscle activity and joint kinematics. All 16 recreationally active participants have been tested in an upright and drop body positions. In each body positions tested, participants went through four different saddle setup for determination of which saddle setup influence the most of the muscle activity and cycling kinematics. The results showed that the changes during cycling from an upright position to drop position significantly influenced two out of eight muscles tested. The results also showed that five out of eight muscles tested were significantly different when compared to saddle setup position. As a conclusion, saddle setup is the most important factor that influence muscle activity. Results indicated that 10-degree saddle inclination setup influence more muscle activity than other saddle setup. This result was important to those who participated actively in this cycling sport to understand the behaviour of the muscle during cycling. Understanding the activity of the muscle during cycling will give advantages to coaches in designing a training programme. As a coach, finding a perfect saddle setup for the cyclist according to the need of the cycling will differentiate winning and losing in the competition.

PENGARUH PERBEZAAN POSISI BADAN DAN TEMPAT DUDUK KE ATAS AKTIVITI OTOT DAN KINEMATIK SENDI SEMASA KAYUHAN

ABSTRAK

Kajian ini mengkaji bagaimana kedudukan tempat duduk dan posisi badan mempengaruhi aktiviti otot dan kinematik sendi. Kesemua 16 peserta yang aktif secara rekreasi telah diuji pada posisi menegak dan menunduk. Pada setiap posisi badan yang diuji, peserta melalui empat kedudukan tempat duduk yang berlainan bagi menentukan posisi tempat duduk yang mana akan paling mempengaruhi aktiviti otot dan kinematik kayuhan. Dapatan menunjukkan perubahan yang signifikan sewaktu kayuhan daripada posisi menegak ke posisi menunduk bagi dua daripada lapan otot yang diuji. Dapatan juga menunjukkan perubahan signifikan bagi lima daripada lapan otot yang diuji bagi perbandingan antara posisi tempat duduk. Kesimpulannya, posisi tempat duduk adalah antara faktor paling penting yang mempengaruhi aktiviti otot. Dapatan menunjukkan peningkatan 10-darjah tempat duduk akan mempengaruhi lebih banyak aktiviti otot berbanding kedudukan lain tempat duduk. Dapatan ini penting bagi mereka yang terlibat secara aktif dala sukan berbasikal, bagi memahami lakuan otot sewaktu kayuhan. Memahami aktiviti otot sewaktu kayuhan akan memberikan kelebihan kepada jurulatih dalam membina program latihan. Sebagai jurulatih, mencari kedudukan tempat duduk terbaik untuk pengayuh mengikut keperluan kayuhan, akan menentukan antara menang atau kalah dalam pertandingan.

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CHAPTER 1

INTRODUCTION

1.1 Research background

With the increase in the number of cyclists nowadays, understanding and knowledge of the bicycle also need to be enhanced especially in terms of body position during cycling. Most people do not know the body position during cycling is greatly influenced by the position of the saddle (bicycle setup). The saddle that not in a proper setup such as too backward, too forward and too incline might cause injury to the cyclist (Bini, Hume, Lanferdini, & Vaz, 2013). Durability and strength of the muscles involved during cycling play an important role as a bicycle is a vehicle that uses human power to move. Seating position that is not in accordance with the cycling may result in failure to use muscular strength and endurance optimally in which later on will affect the cycling (So, Ng, & Ng, 2005).

While cycling, there are five parts of the body that touch the surface of the bike which is hands, buttocks, and legs. The position of these body parts plays an important role in determining the position of the body when cycling (Chapman et al., 2008b). Both hands holding the handle is not only used to control the bike but to support the body weight as well. Almost all the work is done by the hands. If the distance between the seat and the handle is too far, or if the seat height and handlebar were set up in different height, muscles in the hands need to work hard to accommodate the weight (Chiu, Wu, & Tsai, 2013). Hand position also plays a role in determining the position of the body during cycling. In road cycling, there are two different hand positions that usually used such as Upright position (hand grip at the top of the handlebar) and the drop position (hand grip at the drop of handlebar) where the position is more to aerodynamics. However, the position might cause the body weight to accommodate with more intense by the hand muscles as the body position exactly falling on the hands compared to the normal hand position where the weight is still accommodated balanced by the buttocks and hands (Chiu et al., 2013).

In addition to that, arms, buttock, and legs are the parts of the body that affect the cycling most (So et al., 2005). The dorsal position will affect the angular position of the foot while pedaling. In a previous study, dorsal position on the saddle too far backward will affect the angle of the pedaling (Bini et al., 2013). However, there are still no studies on the effects of the position of the dorsal that affects the leg muscles activity.

Foot position provided by Peveler, Pounders, & Bishop, (2007) states that, during the stroke, the angle of 25 to 35 degrees is the angle of the knee that is more

effective to produce a power stroke and at the same time to avoid possible injury to the knee. According to Peveler, Pounders, & Bishop, (2007), the state of the knee angle greater than 35 degrees will cause the leg had to be over extension to generate power and stroke but in these conditions will cause to posterior knee pain injury to the leg. When the leg angle is less than 25 degrees, it will cause increased compression to the knee to generate power and stroke. This situation would cause interior knee pain injury to the knee. If the seat is converted to forward and backward, at the same time maintaining the knee angle of 25 degrees, a significant difference in muscle use must be examined. The study conducted by Karl (2001) stated that change seating position forward can improve acceleration stroke while changing the seat back can maintain endurance cycling. However, in terms of the use of the muscles, there are still no studies conducted.

Back injury is another type of injury experienced by a cyclist (Little & Mansoor, 2008). It happens because the body position during the pedaling causes the back to accommodate excess weight, this usually occurs when the distance between the seat and the handle is too far which causes the orientation of the body is too broad. Back muscles which are not strong enough to accommodate the load of the body weight will ultimately lead to back pain (Srinivasan & Balasubramanian, 2007). In addition, the incline of the seat also able to cause back pain (Salai, Brosh, Blankstein, Oran, & Chechik, 1999). Based on the study conducted by Salai, Brosh, Blankstein, Oran, & Chechik, (1999), saddle angle of 10-15 degrees incline can reduce the load on the spine. However, this was a fluoroscopic study uses the image of the lumbosacral region in a lateral position of the cyclist to get the result and this should

be reinforced by the impact of the use of the back muscles. A study about it will be able to give a clear picture of the muscle.

1.2 Problem statement

Many studies have been done by previous researchers who study about body position and the position of the saddle. However, there are no studies on the effect of muscle activity when the seating position is changed and while cycling with different body positions. To understand more about the effects of hand position and seating position of the muscle activity, other measurements need to be taken as a measure of muscle (electromyography) in the future (Saori Hanaki-Martin, David R. Mullinaeux, Kyoungkyu Jeon, 2006). There is no scientific study done to see the upper body muscle activity pattern during cycling (So et al., 2005). Lack of information on this part prohibits a proper analysis when developing any physical fitness training program for the cyclist. Apart from that, it will be problematic for any pre-rehabilitation and rehabilitation program which need the muscle activity profiling of the cycling positions prior making any suggestions in relation to appropriate cycling posture and modifications.

1.3 Significant of study

Results from this study are expected to provide a clear picture of the use of the muscles in different body positions while pedaling in addition to the different seating positions. With a good understanding about the muscle used during normal pedalling,

sports physiotherapists, and coach can focus on a particular pedalling phase action to train a particular muscle group and also to optimal strength training program for cyclists (So et al., 2005). The results of this study can be used as basic reference charts for anyone interested in cycling activities regardless of an athlete or recreational cyclist because most of the tables muscle used during cycling previously are based on normal cycling and not include the body and saddle position. The result of this study will also be one of its kinds in providing a specific indication of specific muscle activity during cycling with regard to body and saddle position. Hopefully, the data of this study can provide comfort to the cyclist while cycling and thus expected to help reduce injuries. Therefore, this study will give preference in muscle activity during cycling in the diversification of the seating position and the position of the hand in order to lead the optimal cycling performance.

1.4 Objectives

In this objectives, research questions and hypothesis, the word mean Root Mean Square (mRMS) were used to reflect the muscle activity because mRMS can quantify the electric signal of the muscle that reflects the physiological activity during muscle contractions.

a) To measure mean Root Mean Square (mRMS) of trapezius muscle between body positions during cycling in different saddle setups.
b) To measure mean Root Mean Square (mRMS) of erector spinae muscle between body positions during cycling in different saddle setups.

c) To measure mean Root Mean Square (mRMS) biceps brachii muscle between body positions during cycling in different saddle setups.

d) To measure mean Root Mean Square (mRMS) triceps brachii muscle between body positions during cycling in different saddle setups.

e) To measure mean Root Mean Square (mRMS) gluteus muscle between body positions during cycling in different saddle setups.

f) To measure mean Root Mean Square (mRMS) ractus femoris muscle between body positions during cycling in different saddle setups.

g) To measure mean Root Mean Square (mRMS) vastus lateralis muscle between body positions during cycling in different saddle setups.

h) To measure mean Root Mean Square (mRMS) gastrocnemius muscle between body positions during cycling in different saddle setups.

i) To measure the hip angle between body positions during cycling in different saddle setups.

j) To measure knee angle between body positions during cycling in different saddle setups.

k) To measure ankle angle between body positions during cycling in different saddle setups.

1.5 Research questions

a) Is there a significant difference mean Root Mean Square (mRMS) trapezius muscle between body positions during cycling in different saddle setups?

b) Is there a significant difference mean Root Mean Square (mRMS) erector spinae muscle between body positions during cycling in different saddle setups?

c) Is there a significant difference mean Root Mean Square (mRMS) biceps brachii muscle between body positions during cycling in different saddle setups?

d) Is there a significant difference mean Root Mean Square (mRMS) triceps brachii muscle between body positions during cycling in different saddle setups?

e) Is there a significant difference mean Root Mean Square (mRMS) gluteus muscle between body positions during cycling in different saddle setups?

f) Is there a significant difference mean Root Mean Square (mRMS) vastus femoris muscle between body positions during cycling in different saddle setups?

g) Is there a significant difference mean Root Mean Square (mRMS) vastus lateralis muscle between body positions during cycling in different saddle setups?

h) Is there a significant difference mean Root Mean Square (mRMS) gastrocnemius muscle between body positions during cycling in different saddle setups?

i) Is there a significant difference hip angle between body positions during cycling in different saddle setups.

j) Is there a significant difference knee angle between body positions during cycling in different saddle setups.

k) Is there a significant difference ankle angle between body positions during cycling in different saddle setups.

1.6 Hypothesis

The null hypotheses are stated below:

a) There is no significant difference mean Root Mean Square (mRMS) trapezius muscle between body positions during cycling in different saddle setups.
b) There is no significant difference mean Root Mean Square (mRMS) erector spinae muscle between body positions during cycling in different saddle setups.
c) There is no significant difference mean Root Mean Square (mRMS) biceps brachii muscle between body positions during cycling in different saddle setups.
d) There is no significant difference mean Root Mean Square (mRMS) triceps brachii muscle between body positions during cycling in different saddle setups.
e) There is no significant difference mean Root Mean Square (mRMS) gluteus muscle between body positions during cycling in different saddle setups.
f) There is no significant difference mean Root Mean Square (mRMS) vastus femoris muscle between body positions during cycling in different saddle setups.
g) There is no significant difference mean Root Mean Square (mRMS) vastus lateralis muscle between body positions during cycling in different saddle setups.

h) There is no significant difference mean Root Mean Square (mRMS) gastrocnemius muscle between body positions during cycling in different saddle setups.

i) There is no significant difference hip angle between body positions during cycling in different saddle setups.

j) There is no significant difference knee angle between body positions during cycling in different saddle setups.

k) There is no significant difference ankle angle between body positions during cycling in different saddle setups.

1.7 Limitations

There are several limitations that limit the process and outcome of this study. The first limitation in this study was the participants involved. The recruited participants were from general populations that recreationally active. This is in line with the main objective of the study which was to see the outcome in the general population and thus helps them to improve cycling skill and avoid or reduce injury risk. Thus, the result might not be suitable to be applied to an elite cyclist or another group of populations.

The second limitation of this study is the buttock position on the saddle, due to the saddle setup forward, backward and incline, the participant was told to sit as normal as possible. The buttock position might be at the different position among the saddle positions in the test. Buttock location on the saddle was measured manually using one reflective marker that been attached at the right posterior superior iliac

spine (RPSIS). The buttock position might be more valid and reliable to be used to monitor the body position on the saddle using a pressure sensor on the surface of the saddle.

The third limitation is the study was conducted in the laboratory to control variable that will interfere with the results such as weather, temperature, etc. The result might be different if the study is conducted independently outside the laboratory

The fourth limitations are the bicycle was used in the study was attached to the trainer stand because the test was held in the laboratory. The trainer stand prevented the bicycle from swinging from side to side as cycling on the road. This situation might produce a different result is there is an equipment in the lab to allow the cyclist to do so to mimic the real situation during cycling.

1.8 Delimitation

This study has been delimited to several delimitations by the researcher, in order to provide a focus for the study that was done. The first delimitation is the participant in the research was selected only among male, 18 years old and above. They also must be physically healthy and free from any knee and back injury. The participant that not met the requirement was terminated from this study.

The second delimitation is the study was conducted in a short period of time to measure muscle activity among the saddle setup and body position. This procedure

was used in the study to avoid muscle fatigue because of the participant was not among elite cyclist. The result might be different if the participant was asked to run the test for a long cycling duration if muscle fatigue is part of the research variables.

The third delimitation is on the result's obtained, in which only one completed cycle of pedalling was analysed.

1.9 Operational definition

Body position:

In this study, body position is categorized by the position where the hand will be placed on the handlebar. Two hand position will be used in this study, 1. Hand placing at the top of the handlebar (upright position) and 2. Hand placing at the drop of the handlebar (drop position).

Saddle setup:

In this study, there are only four different saddle setup will be used.

a) Normal :

Saddle setup in normal position is where the front edge of the saddle falling above the central crank with the saddle angle 0 degrees. The height of the

saddle is according to 25 to 35 degree of the knee angle recommended by Paveler et al (2007).

b) 1 cm forward:

Saddle setup in 1 cm forward position is where the front edge of the saddle is moved 1 cm forward from a normal position with the saddle angle 0 degrees. The height of the saddle is according to 25 to 35 degree of the knee angle recommended by Paveler et al (2007).

c) 2 cm backward:

Saddle setup in 2 cm backward position is where the front edge of the saddle is moved 2 cm backward from a normal position with the saddle angle 0 degrees. The height of the saddle is according to 25 to 35 degree of the knee angle recommended by Paveler et al (2007).

d) 10^{o} incline:

Saddle setup in 10 degrees inclines position is where the front edge of the saddle falling above the central crank with the saddle angle 10 degrees. The height of the saddle is according to 25 to 35 degree of the knee angle recommended by Paveler et al (2007).