The efficiency of lower extremity movement in different seat positions during cycling

[1*]Chia-Hsiang Chen, [2]Po-Ling Chang and [2]Tzyy-Yuang Shiang
[1]Department of Physical Education, National Taiwan Normal University, Taiwan
[2] Department of Athletic Performance, National Taiwan Normal University, Taiwan
*e-mail: doof75125@hotmail.com

SUMMARY

Purpose: The purpose of this study is to investigate the efficiency of lower extremity movement in different seat positions during cycling. **Methods:** Eleven healthy college students (age 25.3 ± 1.3 years old; height 174.5 ± 6.1 cm; weight 70.8 ± 6.2 kg) were recruited in this study. We tested nine different seat positions including 3 different saddle heights (90%, 95%, 100% of trochanter length) and 3 different forward/backward position (interval 5 cm). Both muscle activation and riding performance were evaluated by EMG and pedaling force transducer (sampling frequency at 1000 Hz). Statistical analysis was processed by analysis of variance (ANOVA) in repeated measures. The significant level was set at $\alpha = .05$. **Results:** The force output increased accompanied by forward and higher saddle position. The muscle activation of the lower extremity decreased accompanied by forward and lower saddle position. The efficiency increased accompanied by forward and lower saddle position. **Conclusions:** The efficiency of cycling was greater when the seat moved forward and lower. It was not only increased force output, but also decreased muscle activation.

INTRODUCTION

Proper riding posture can reduce the cycling injuries and enhance the performance [3.7]. However, the instructions of riding posture only provided by the coaches or riders on self-experience nowadays. There are still lacks of scientific evidences to clarify bike fitting methods for enhancing performance and riding comfort.

Poor riding postures may be caused by the wrong setting of seat height and further causing riding injuries [2]. Most of the riders do not pay much attention on these details. The major factor among all the poor riding posture is the setting of seat position. In the biomechanical point of view, too high or low seat position might affect the force output and riding efficiency. Therefore, the purpose of this study was to investigate the efficiency of lower extremity movement in different seat positions during cycling.

METHODS

Eleven healthy college students (age 25.3 ± 1.3 years old; height 174.5 ± 6.1 cm; weight 70.8 ± 6.2 kg) were recruited in this study. We tested nine different seat positions including 3 different heights (90%, 95%, 100% of trochanter length) and 3 different sagittal positions (interval with 5 cm).

Muscle activities of RF, BF, TA and GM were collected (sampling frequency at 1000 Hz). The EMG signal in this study were filtered and smoothed by Butterworth filter. EMG signals were band pass filtered with frequency 10-500 Hz and full-wave rectified with 6 Hz low pass filter to get the linear envelope. Normalization were used with signal of maximal voluntary contraction (MVC) in the 3 sec. Multi-axial force transducer (Bioforcen Inc, China.) was used to detect the force and torque during pedaling. The signal was filtered by low-pass in 6 Hz. Data of the different saddle positions in the pedaling were compared.

Participants of this study were given informed consent before attending. Participants were ask to perform 10 min warm up on the bike and EMG signal will be collected as the normalization standard in the following 10 sec of maximal exertion pedaling under 200 watt workload [1]. The main experiment was conducted after 5 min rest. Counterbalance order will be arranged to eliminate the error from adaptation or learning effect. Every cycling posture was tested in 30 sec pedaling for twice and 1 min rest between testing. And also there was a 5 min rest between different cycling postures. Neuromuscular efficiency was calculated as maximum isometric force/EMG amplitude [4]. Statistical analysis was processed by analysis of variance (ANOVA) in repeated measures.

RESULTS AND DISCUSSION

The forces on different seat positions are shown in Figure 1-a. The force output increased accompanied by forward and higher saddle position. Total muscle activities on different seat positions are shown in Figure 1-b. The muscle activation of the lower extremity decreased accompanied by forward and lower saddle position. The efficiency on different seat positions is shown in Figure 1-c. The efficiency increased accompanied by forward and lower saddle position. The most efficiency position is in 90% height and 5 cm forward.

In previous studies of different seat position, it appears that increasing the angle seat tube angle can improve the efficiency of cycling [5]. And the other study focused on different sagittal seat positions had found the cyclists tend to lean the body forward on the bicycle or even sit on the most forward position of saddle for racing with maximum effort [6].

CONCLUSIONS

The efficiency of cycling was greater when the seat moved forward and lower. It was not only increased force output, but also decreased muscle activation. The future studies should determine more thoroughly how saddle positions can be optimized to improve cycling performance and reduce lower limb injury risk.

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REFERENCES

1. Albertus-Kajee, Y., et al. *Journal of Electromyography and Kinesiology*, **20(6)**:1036-1043, 2010
2. Asplund, C., et al. *Phys Sports med*, **32(4):** 23-30. 2004

3. De Vey Mestdagh, K. *Applied Ergonomics*, **29(5)**: 325-334. 1998
4. Deschenes MR., et al. *Medicine and science in sports and exercise*, **40(5)**: 856, 2008
5. Price D., et al. *Journal of sports sciences*, **15(4)**: 395-402, 1997
6. Ricard MD., et al. *Journal of Sports Science and Medicine*, **5(1)**: 25-32, 2006
7. Silberman MR., et al. *Journal of Sport Medicine*, **15(4)**: 271, 2005

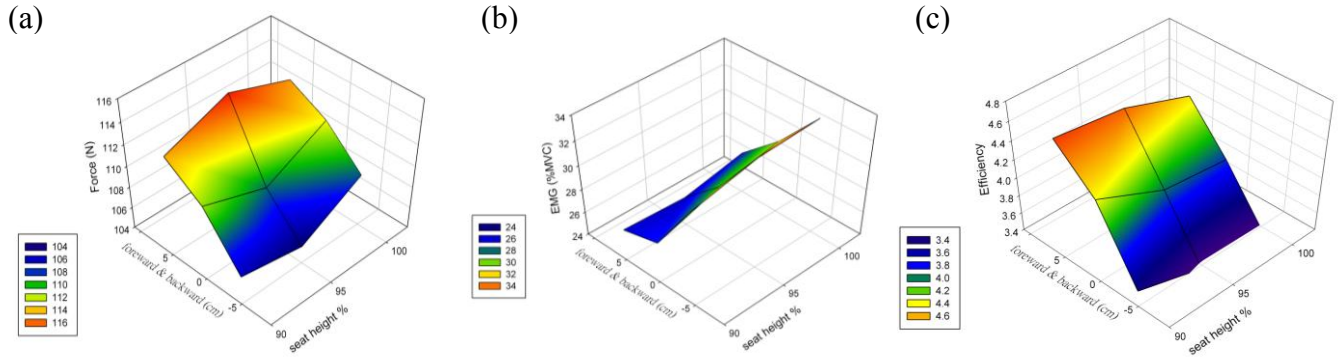

Figure 1: (a) The forces on different seat positions; (b) Total muscle activities on different seat positions and (c) The efficiency on different seat positions. The seat positions including 3 different heights (90%, 95%, 100% of trochanter length) and 3 different forward and backward positions (0 cm stands for standard position, 5cm is most forward position and the -5cm is most backward positions).