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COMPARING METHODS FOR SETTING SADDLE HEIGHT IN TRAINED CYCLISTS

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ABSTRACT

Peveler W, Bishop P, Smith J, Richardson M, Whitehorn E. Comparing Methods For Setting Saddle Height In Trained Cyclists. *JEPonline* 2005;8(1):51-55. Multiple methods exist for determining the optimal seat height for cycling. Prior research suggests that setting saddle height at 109% of inseam may be optimum when examining economy. A knee angle of between 25-35° has been recommended to help prevent overuse injuries. The purpose of this study was two-fold: 1) To compare the Greg LeMond method to the heel toe method and the Hamley method (109% of inseam). 2) To determine if The Hamely method, the Greg LeMond method and the heel toe method produced results that fall between the recommended angles of 25-35°. Nineteen (male (N=14) females (N=5)) cyclists were measured for inseam leg length (cm from the floor to ischium) and multiplied by 1.09 for the Hamley method and 0.883 for the LeMond method. Knee angle was measured for all three methods using a goniometer. There was no significant difference between the Hamley and the LeMond method ($p=0.917$). The heel toe method was significantly lower than the Hamley method ($p=0.004$). The heel toe method (70% accuracy) seemed to fall into the 25-35° range more often than the LeMond (65% accuracy). To ensure that the knee angle falls within a 25-35° knee angle it is recommended to use the Holmes method.

Key Words: Cycling, Performance, Knee Angle, Triathlon, Position

INTRODUCTION

It is biomechanically logical that there is an optimal saddle height for cyclists to maximize performance and minimize injury. Prior research suggests that 109% of the inseam distance (floor to ischium) for the distance between the pedal to the top of the saddle may be optimum when examining economy. (1,2,3). However, popular books on cycling recommend four methods for determining saddle height (4,5,6,7,8). The following three methods are recommended for economy:

- 1) Set saddle height at 109% of inseam in cm and measure from pedal axle to top of the seat height (1),
- 2) Set saddle height at 88.3% of inseam in cm and measure from center of the bottom bracket to top of the seat height (4), and
- 3) Set saddle height by placing the heel of the foot on the pedal and locking the knee with the pedal at the bottom of the stroke and the cyclist sitting on the seat.

Economy is extremely important in the sport of cycling. The more economical a cyclist is the better they will be able to perform while training or racing. While these three methods have been recommended, 109% of inseam (leg length) is the only method that has been tested in a lab for economy.

Cyclists usually keep their pedal strokes around 90 rev/min or greater while riding. Many rides, as well as races, last greater than 4 hours. This repetitive motion can lead to overuse injuries in cycling. Mellion (9) recommends that overuse injuries in cycling should not only be treated with rest and rehabilitation, but also with adjustments to bike setup. Patellar tendonitis is a common overuse injury in cyclists and is usually associated with a low saddle height. A saddle that is too low can cause over-compression of the knee, resulting in anterior knee pain. Due to this, it has been recommended that cyclists with patellar tendonitis move their saddle height closer to a knee angle of 25° at the bottom of the pedal stroke (5,6,10,11). Biceps tendonitis is another common over-use injury in cyclists and can be caused by a saddle height that is too high. If the saddle is too high it can cause posterior knee pain by over-extension in the dead spot at the bottom of the stroke, which puts a heavy strain on the biceps femoris. Due to this, it has been recommended that the saddle height be set between a 25-35° (5,6,10,11).

Of the four methods recommended in popular books only two have been scientifically tested and accepted: the Hamley method and a knee angle of 25-35°. Having four different commonly recommended methods for setting saddle height leads to the question of whether or not all four methods produce the same saddle height. The purpose of this study was two fold: 1) to compare the Greg LeMond method (88.3% of inseam) and the heel toe method with the Hamley method (109% of inseam) to determine if they produced the same saddle height; 2) to compare the Hamley method, the Greg LeMond method and the heel toe method to determine if they produced results that fell between the recommended knee angles of 25-35°.

METHODS

Subjects

Cyclists (male (N=14) females (N=5)) volunteered to participate in this study. All participants owned and trained on road bikes with clip-less pedals. All participants were tested on their own bikes and crank arm length was recorded for each subject. All the women in this study (n=5) used 170 mm cranks. Of the men, 4 used 170 mm, 7 used 172.5 mm, and 3 used 175 mm cranks. Cycling experience ranged from recreational to elite. Participants filled out an informed consent form as well as a physical activity readiness questionnaire (PAR-Q) and a health status questionnaire (HSQ) to

assess health status in accordance with the policies of the local Institutional Review Board for the Protection of Human Subjects.

Procedures

Leg inseam length (inseam) was measured in centimeters (cm) from the floor to ischium using a metal metric ruler (Mayes Brothers tool MFG, Johnson City Tennessee) ranging from 0-91.5 mm. The participants stood with their back against the wall with their feet about 5 cm apart. A one inch board was placed between the legs touching the wall and tight against their ischium. A level was used to ensure that the board was exactly horizontal and inseam was measured from the top of the board to the floor. Inseam was used to determine saddle height in both the Hamley and LeMond methods. The bike was placed in a stationary trainer (Trek fluid², Madison, WI) in order to hold it upright for measurements, and the riders were asked to pedal for a few seconds until they found their "comfortable spot" on the saddle.

For the Hamley method, saddle height was determined as inseam length x 1.09. In this method saddle height was measured from the center of the pedal axle to the top of saddle, with the pedal at the most distal end. The LeMond method multiplied inseam by 0.883 in order to get saddle height. Saddle height was then measured from the center of the bottom bracket to top of saddle. Distance from pedal axle to top of the saddle was also measured to compare with the Hamley method. During the heel-toe method the participants placed their heel on the pedal, while it was in the lowest portion of the stroke, and the saddle was adjusted up or down until the subject was just sitting strait on the saddle with their right leg knee locked in an extended position. The subject then placed the ball of the foot properly on the pedal and the distance from pedal axle to the top of the saddle was recorded to compare with the Hamley method. The measurement from pedal axle to top of saddle, on both the LeMond method and the heel-toe method, was divided to get percent of inseam in order to compare to Hamley's (109.0%) method.

Knee angles were measured using a goniometer (LeMond Fitness Inc.) during the LeMond and heel-toe methods. The axis of the goniometer was centered on the lateral femoral condyle and one end was pointed down towards the lateral malleolus of the ankle and the other end was pointed upward to the greater trochanter at the hip (10). These spots were found using palpation and tape was placed on these three spots to ensure measuring the same place during all three methods. Knee angle was also measured during the Hamley method.

Statistical Analyses

Knee angles of the Greg LeMond method and the heel-toe method were examined to determine if they fell with in the recommended 25-35° (5,10,6). Repeated measures Analysis of Variance was run to compare the means of all three methods for the percent of inseam. A priori alpha of $p < 0.05$ was used to test significance. Knee angle was analyzed by comparing the means and how often the angles fell within the recommended angles. Knee angle was also compared during the Hamley method.

RESULTS

Descriptive statistics of the subjects are presented in Table 1. By definition, the mean for the Hamley method was 109.0%. All means and standard deviations for inseam can be found in Table 2. There was no significant difference between the Hamley and LeMond method ($p=0.917$). There was a significant difference between the Hamley and heel-toe method ($p=0.004$).

When examining knee angle in each position, the mean for the Hamley method was 24.2°, for the LeMond method 24.3° and for the heel toe method 30.3°. Angles varied from 14°-43° using LeMond, and 21°-40° using heel-toe. Individual results can be found in Table 3. When comparing the percent

of time that the methods fell within the 25-35° specification, the following was found in tested subjects (n=19). The LeMond method was found to be 65% accurate, and heel-toe was found to be 70% accurate. In both methods combined the accuracy in falling in the 25-35° specification was 67.5%. The Hamley method fell within the 25-35° specification 55% of the time.

Table 1. Descriptive Statistics.

Variable	Male (n=14)		Female (n=5)	
	Range	Mean ? SD	Range	Mean ? SD
Age (yr)	19.0-37.0	26.8 ± 5.8	21.0-48.0	30.6 ± 7.0
Height (cm)	171.5-185.4	178.6 ± 4.6	165.1-180.3	173.2 ± 10.1
Weight (kg)	64.9-122.5	85.2 ± 18.4	53.5-69.4	61.0 ± 6.0

DISCUSSION

The purpose of this study was to determine if the four recommended methods for setting saddle height produced the same results. One purpose of this study was to compare the LeMond, heel-toe and Hamley methods to determine if they produced the same saddle height as represented in inseam. It appears that the Hamley method or the LeMond method yield almost the same results, but not the heel-toe method. Saddle height varied from individual to individual and there did not seem to be one measurement that worked for all cyclists. A potential problem with the LeMond method is that it measures from the bottom bracket to the top of the saddle and does not take into account crank arm length. Whereas the Hamley method takes into account crank arm lengths because it measures from the pedal spindle to the top of the saddle. Crank arm lengths can vary (normally 170.0, 172.5, or 175.0 mm) from bike to bike. The cyclists used their own bikes during this study. In this study there was no trend found between saddle heights when comparing the Hamley method and the LeMond method when looking at different crank arm lengths.

This study also determined if the LeMond method and the heel-toe method produce results that fell between the recommended angles of 25-35°, with the pedal at the bottom of the stroke.

Such an angle range could help avoid knee injury by avoiding excessive compression of the knee (when the saddle is too low) and excessive extension at the dead spot at the bottom of the stroke (when the saddle is too high) (5,6,10,11). Of the two methods examined, the heel-toe method seemed to fall into the 25-35° range more often than the LeMond method. The mean for the LeMond method (24.28°) fell slightly short of the recommended range. The mean of the heel-toe method (30.25°) fell right in the middle of the recommended

Table 2. Measurement of inseam percent for each method (n=19).

Variable	CT	
	Range	Mean ? SD
Hamley (%)	109.0 -109.0	109.0 ± 0.0
LeMond (%)	107.8 -111.1	109.2 ± .9
Heal Toe (%)	101.1 -111.2	106.7 ± 2.7

Table 3. Knee angles for each subject and method (n=19).

Subject	Hamley	LeMond	Heal Toe
1	28°	25°	42°
2	28°	25°	31°
3	14°	14°	21°
4	25°	25°	23°
3	25°	23°	34°
6	26°	26°	39°
7	30°	25°	27°
8	22°	26°	34°
9	26°	26°	28°
10	42°	42°	40°
11	31°	27°	27°
12	14°	18°	35°
13	18°	22°	35°
14	9°	18°	25°
15	28°	26°	32°
16	20°	19°	23°
17	17°	25°	26°
18	28°	24°	23°
19	20°	20°	24°

range and achieved the 25-35° knee angle for the greatest percent of participants (70%). The range of the heel-toe method was 21°- 40°, which is a wide range. Both methods only fell in the recommended range 67.5% of the time. The Hamley method fell within the recommended range only 55% of the time. It appears that approximately half of the time cyclists may fall into the recommended 25-35° while at their most efficient position (109%).

CONCLUSIONS

To ensure that the knee angle falls within the 25-35° angle, and to help prevent overuse injuries, it is recommended to use the Holmes method and a goniometer. For cyclists who are not prone to knee injury it may be feasible to be outside of the recommended 25-35° angle in order to be economical at 109%. For those prone to injury it may be beneficial to stay within the recommended knee angles of 25-35°.

This study only examined measurement techniques and compared them to established norms, the Hamley method and the Holmes method. Hamley and Thomas (1967) conducted their research in 1967 before clip-less pedals were invented, which could have an affect on actual measurement from pedal axle to top of saddle. It would be good to examine economy, in the Holmes method, at both ends of the spectrum (25°-35°) by comparing submaximal oxygen consumption.

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