

The Straightness Backstroke Kick Makes Fast Speed and Increased Lactate Acid. A Case Study Using 3-Times Olympian

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Abstract: In this study, we assess the effectiveness of utilizing a straight knee kick in the backstroke with regard to the overall time, max speed, and distance per stroke when using a straight knee butterfly technique. We analyzed freestyle kick of knee angles from 7-Olympic medalists, 1970's S-shaped pulling pattern stroke was used with a bending knee freestyle kick. The straight knee kick used in butterfly competitions resulted in improvements from 54.74 to 51.00 in Men's 100-meter butterfly and from 23.43 to 23.02 in Men's 50-meter butterfly. Using a straight knee kick in backstroke competitions resulted in improvements from 1:01.74 to 1:00.55 in the 100-meter backstroke event. Increases in performance speed, max speed and distance per stroke among three elite level swimmers are highly correlated to duration of the kick resistance, and straight knee kick in backstroke. The straight knee kick also resulted in an increase in lactate acid.

Key words: Backstroke, straightness kick, lactate acid, Olympian.

1. Introduction

The focus of this study is to analyze the straightness of the knee (Fig. 1) [1, 2] for the backstroke kick [3] and measure the resulting increase in lactate acid [4]. We hypothesize that swimmers will gain additional propulsion when their feet [5] by traveling directly down, after their legs have extended at the knee, during the final portion of their upkick [6]. Previous studies explored the effectiveness of the straight knee kick during freestyle and butterfly strokes during competitions [7]. This straightness backstroke kick reduced the resistance speed [8] from water compared to the bending knee backstroke kick (Fig. 2).

When comparing the angle of the backstroke kick [9] and lactate acid for three swimmers of the FINA world

champions, we find the proportion of kicks greater than 170 degrees knee-bending increase from 12.5% to 67.4% and knee angle average 151.15 degree to 171.06 degrees, distance per cycle (DPC) improved from 2.12 ± 9 M/C to 1.93 ± 12 M/C, Wilcoxon/Mann-Whitney.: 4.766278, $P \leq 0.01$. The elbow angles of > 170 degrees elbow-bending from 25.3% to 60.3%, Wilcoxon/Mann-Whitney.: 4.776403, $P \leq 0.01$, but the straightness knee backstroke kick increased lactate acid 6.1 mmol/l compared to the bending knee backstroke kick 4.3 mmol/l.

The duration of the speed test and the lactate test 60seconds was measured during a wall kick with a tempo of 1.10-1.20 sec/stroke by FINIS tempo machine and the one stroke velocity, distance per stroke, and max speed performed twice during a 25-meter backstroke while being filmed from a race start. The first 15 meters were completed under water

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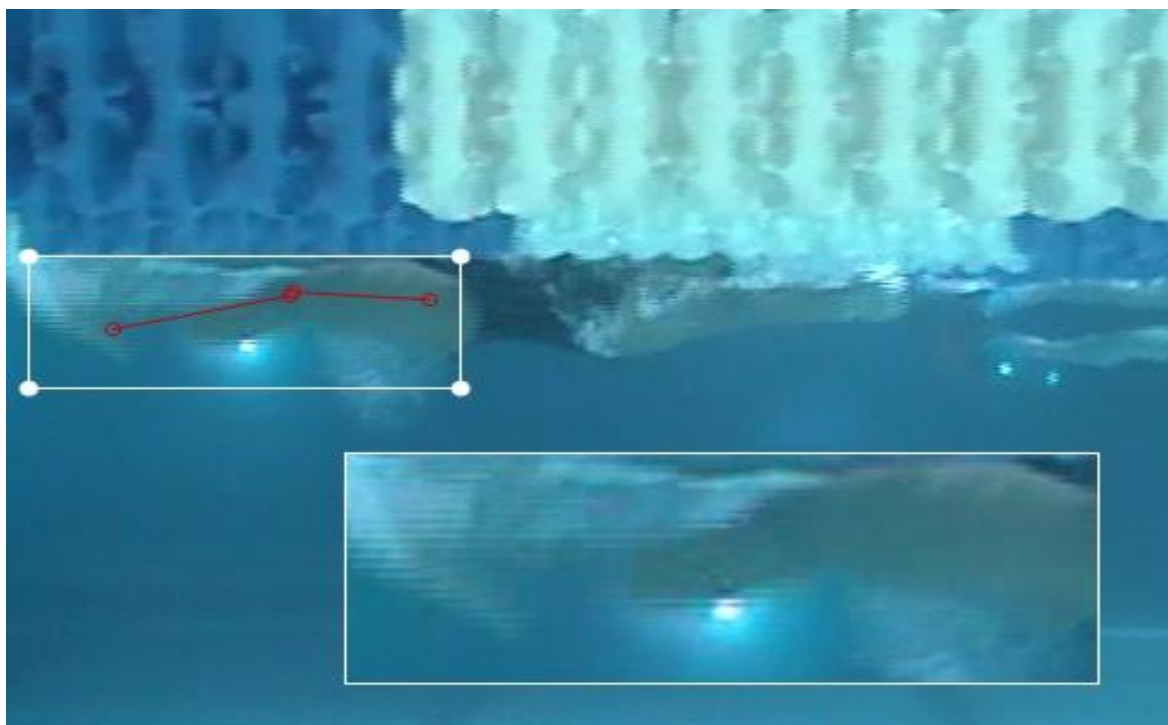


Fig. 1 Straightness backstroke kick.

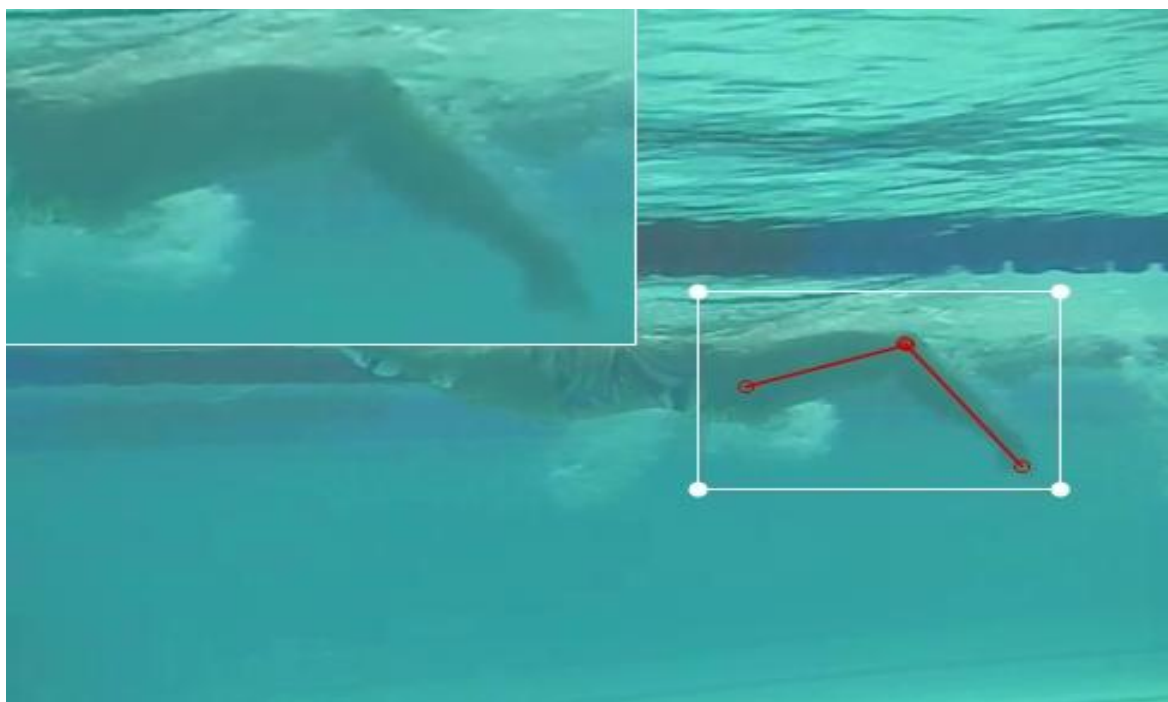


Fig. 2 Bending backstroke kick.

using the dolphin kick and the final 10 meters swimming all out backstroke stroke [10]. The straight knee backstroke kick increase the stroke velocity [11] by one, distance per stroke but max speed also creates

too much lactic acid for the swimmer to hold the form for more than 30 seconds under current conditions. The results of this paper reveal that with proper training and technique, the straight knee backstroke kick can result

in much faster 100 meter backstroke times for swimmer able to mitigate the increase in lactic acid [12] production during competition.

Backstroke performance appears to be positively correlated to the degree of straight knee kick in elite world class swimmers. Backstroke performances have improved dramatically and one potential explanation is that straight knee kick in addition to generating more force also reduces resistance equal to increase the distance per cycle in the championship meet races. Using results from Lactate ProTM [12], we find (Result) with proper technique the straight-knee butterfly kick can increase speed and proper training will be able to mitigate the excess production of lactate acid.

2. Methods

2.1 Participants

The subjects are all very accomplished international elite level swimmers. Subject #1 is a three-time Olympian, current 50 & 100-meter backstroke FINA masters World record-holder, and the 2012 FINA World Cup champion in the 50-meter backstroke at the age of 36 years old (height; 167 cm, body weight; 60). Subject #2 is the NCAA (National College Athletic Association) 200 yards backstroke finalist and former Polish National team member, 25 years old FINA world champion (height; 190 cm, body weight; 83kg). Subject #3 is a FINA World champion team member 25-year-old, Japanese National Team member.

2.2 Measures

2.2.1 Backstroke Kick Speed Measures

Kick speed is analyzed by Kinovea (0.8.15, 1GHz, 256Mo) the butterfly kick with a 1/500sec frequency and underwater high-speed HD camera (Panasonic HDM:1080i 720p 480pHX-WA30). The lactate test was administered after a 50seconds wall kick with a tempo of 1.10sec/stroke measured by a FINIS tempo machine. The subjects lactate data is generated by the

Lactate ProTM LT-1710 (Arkray, 5µl, Kyoto, Japan) meter for determination of the blood lactate. Blood lactate was below detection limits of the meter (< 0.8 mM), and confirmed by laboratory assay as 0.459 ± 0.037 mM (mean \pm SEM, $n = 34$).

2.2.2 Backstroke Lactate Measures

The data for the straightness knee backstroke kick speed and the lactate test [16] are collected during a 60second wall kick, where tempo is 1.10-1.20 sec/stroke measured by the FINIS tempo machine. The one stroke velocity, distance per stroke, and max speed data is collected from two 25 meter backstroke swims after a race start. The first 15 meters were completed under water using the dolphin kick and the final 10 meters are completed at maximum effort.

2.3 Data Analysis

The straight knee backstroke kick increases the stroke velocity by one stroke, distance per stroke and max speed and creates excess lactic acid unlikely to allow for normal swimming condition for more than 30 seconds. The subject was filmed during four 25 meter butterfly swims from a push start. The first 15 meters were completed under water using the butterfly kick and the final 10 meters swimming maximum effort butterfly stroke. A Swimming Speed Meter (Vine, VMS-003, AC100V, 1/500sec, 0.2mm/pulse) is attached to the swimmer and data is exported as analog signals via an RS232C. These signals are used to calculate swimming speed with Microsoft Windows Excel and a Wilcoxon Signed Ranked Test.

2.4 Procedure

The wire line of the speed meter was attached to the swimmer by a belt and intracyclic velocity changes are recorded precisely for several stroke cycles while swimming at maximum speed. The average velocity changes for one stroke cycle are calculated with data from all successive stroke curves. The average number of stroke cycles was compared for the 2009 stroke and 2005 stroke. A Swimming Speed Meter, registered

velocity when the subject achieved maximum speed within one stroke cycle, which is during the second kick phase.

2.5 Backstroke Angle Measures

We then investigate the wave phase of the butterfly stroke, first kick phase, and in-sweep phase. While swimming, the subject was monitored from the side plane using an underwater video camera at a sampling frequency of 60Hz (Underwater monitor system 2, YAMAHA, Shizuoka, Japan). Three angles of the knee bend, toe to surface, and upper body movement were analyzed with the DartTrainer and Kinovea.

3. Results

We find when the proportion of kicks greater than 170 degrees knee-bending increases from 12.5% to 67.4% (average angle increased from 151.15 degree to 171.06 degrees) (Fig. 3), distance per cycle (DPC) improves from $2.12 \pm 9M/C$ to $1.93 \pm 12M/C$, Wilcoxon/Mann-Whitney.: 4.766278, $P \leq 0.01$ (Table 1). The elbow angles of > 170 degrees elbow-bending from 25.3% to 60.3% (Fig. 4), Wilcoxon/Mann-Whitney.: 4.776403, $P \leq 0.01$, but the straightness knee backstroke kick increased lactate acid 6.1 mmol/l compared to the bending knee backstroke kick 4.3 mmol/l (Fig. 5).

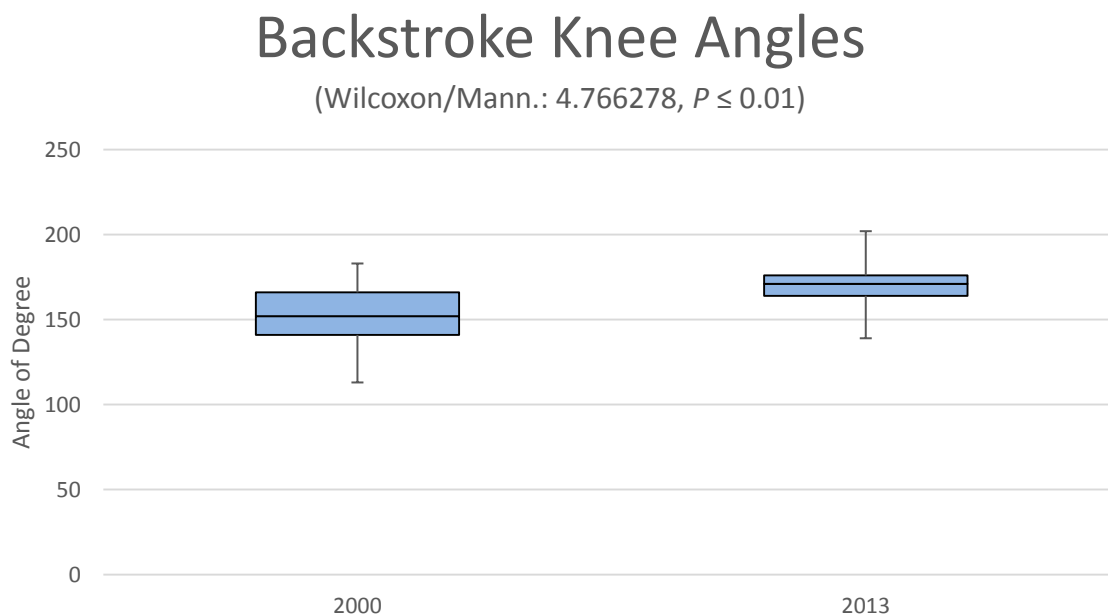


Fig. 3 Backstroke Knee Angles (Straightness-2013 vs. Bending-2000).

Table 1 Wilcoxin Signed Rank test of distance per stroke when comparing when backstroke kick angle is greater than or equal to 170 degrees to less than 170 degrees.

	df	Value	P-value
Wilcoxon/Mann-Whitney		4.7663	***0.00
Wilcoxon/Mann-Whitney (tie-adj.)		4.7690	***0.00
Med. Chi-square	1	15.1435	***0.0001
Adj. Med. Chi-square	1	13.5076	***0.0002
Kruskal-Wallis	1	22.7587	***0.00
Kruskal-Wallis (tie-adj.)	1	22.7849	***0.00
van der Waerden	1	22.3969	***0.00

Significance at the 1% level is denoted by ***.

Backstroke Elbow Angles

(Wilcoxon/Mann-Whitney.: 4.776403, $P \leq 0.01$)

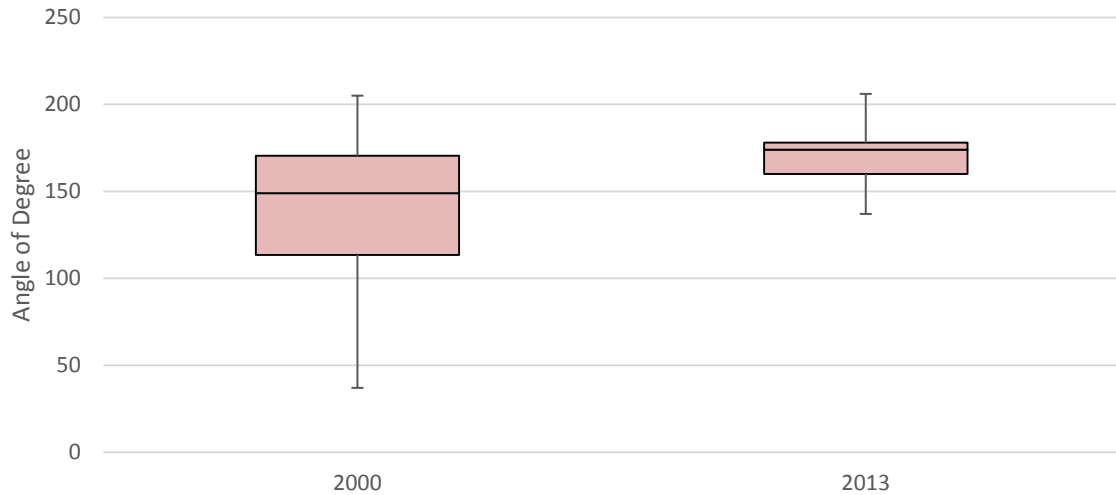


Fig. 4 Backstroke Elbow Angles.

Backstroke Kick Lactate Acid

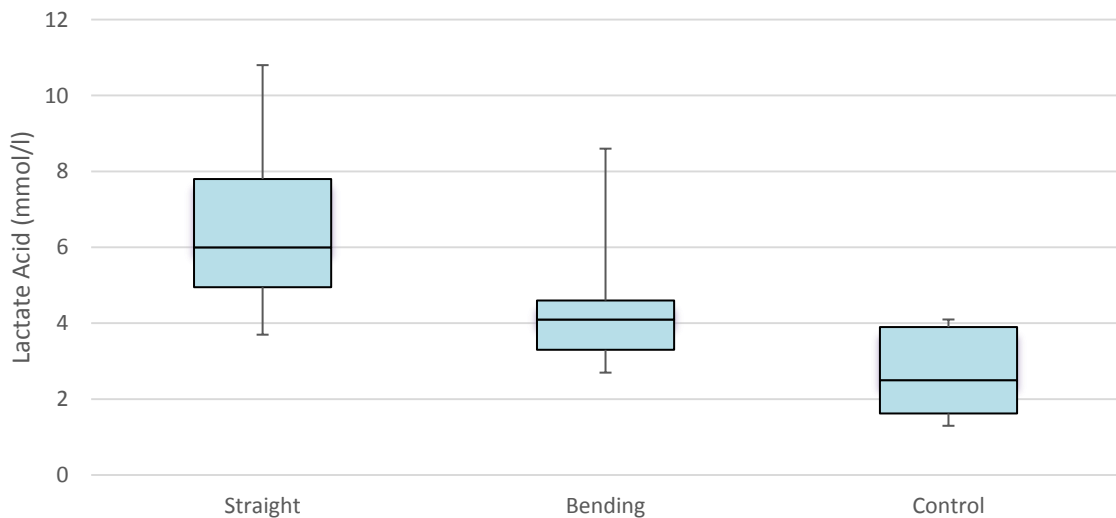


Fig. 5 Backstroke Kick Lactate Acid (Straightness vs. Bending vs. Control).

4. Discussion

The aim of this study is to present empirical evidence to show that straight knee backstroke kick will generate the most speed, most efficient stroke, but also result in a higher level of lactic acid among elite level backstroke swimmers [14]. Since 2008, we

analyzed the straight-knee kick technique using the underwater camera during training and Race Analyzer during swim meet. We calculate the knee degrees after training to utilize the technique in the championship meet. In the championship meet, we analyzed performance by Race Analyzer to time, velocity, and distance per cycle.

Since 2008, we employed a four step training plan to implement the technique in practice and competition [8]. In the first step, we imagined the straighter backstroke kick on land. On the land, we focused on the backstroke straightness leg kick, stretching the tendon of the tibialis anterior muscle rather than using the quadriceps muscles [15]. When Noriko Inada used this stretched tendon in a similar way in the backstroke straightness leg kick, the kick frequency was much more rapid [16].

The second step was to utilize the straightness leg kick in the pool, and this involved slow speed drills during training. We changed his technique during training, so these drills involved swimming no more than 3500-meter training session. We find that training in excess of 3500 meters will result in a tendency to increase the knee bending angle. Also, these training sessions were performed just once a day to stress the importance of utilizing the proper straight-knee technique.

The third step was to test the effectiveness of the straight-knee kick technique in a minor meet. After the race, we compared the results by the video camera and Race Analyzer. Our goal was to determine if these techniques were an improvement compared to traditional backstroke kind and provide a benchmark for future comparison. The fourth step was to measure the effectiveness of the straight knee kick during a major international competition during the Olympic Trials, World Championship Trials, Japan Nationals, World Championship, FINA World Cup or US Nationals. Her Training partner won FINA World Championship Masters in Montreal, Canada.

5. Conclusion

Positive backstroke performance measured by final time is associated with both a straight elbow and a straight knee in elite world class swimmers. Backstroke performance improved, although a possible explanation is not only increased propulsion, but also due to less resistance equal to increase the distance per

cycle in the championship meet races. The results of this paper reveal that with proper training and technique, the straight knee backstroke kick can result in much faster 100 meter backstroke times for swimmer able to mitigate the increase in lactic acid production during competition.

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