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Original Article

The Downward Breaststroke Kick Technique: Does Increasing the Kick Angle Decrease Time?

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Abstract: Breaststroke kick pattern is different from elite breaststrokers to none elite breaststrokers. We analyzed breaststroke kick of knee angles and hip angles from FINA (Fédération internationale de natation) former world record holder, Olympians, World Championship, The International Swimming League (ISL) and NCAA (the National Collegiate Athletic Association) Division 1 championship qualifier. Previous study explored the 1990's breaststroke kick is very powerful because swimmers can push water back with the soles of their feet for a long period of time. We assess the effectiveness of utilizing a downward kick in the breaststroke with regard to the overall time, max speed, tempo, and velocity when using a downward breaststroke kick technique. We hypothesize that a significant proportion of the improvement is due to the downward breaststroke kick used in breaststroke competitions which resulted in a time improvement in the men's 100-yard record from 57.04s to 53.69s. Using a downward breaststroke kick in individual medley competition resulted in improvements from 1:15.42s to 1:13.50s in 100-m breaststroke split time men's 400-m individual medley. We find the introduction of the downward kick in the breaststroke kick is primarily responsible for this improvement in time.

Key words: Breaststroke, downward kick, velocity, Olympian.

1. Introduction

The purpose of the study was to determine the effects of the breaststroke kick on intra-cyclic velocity fluctuations. The breaststroke can be broken down into three phases: the kick, the pull, and the glide. We examined peak hip velocities of the breaststroke kick between elite, non-elite swimmers to estimate any significant velocity drop-offs and magnitude of velocity regained [1] when utilizing alternative breaststroke kicking techniques [2]. The focus of this study is to analyze the downward breaststroke kick and horizontally breaststroke kick and measure the resulting increase in velocity [3, 4]. We hypothesize that swimmers will gain additional propulsion and buoyancy when their feet travel directly down, after their feet have peaked, during the final portion of the kick phase. This downward breaststroke kick increases speed from water compared to the horizontally breaststroke kick (Fig. 1). The downward breaststroke kick exhibits a triangle shape and creates

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an aerodynamic buoyant force (Fig. 2).

When comparing the angle of the horizontally breaststroke kick to downward breaststroke kick in the 100-m or 100-yard breaststroke performance in the competition for 14 swimmers of the Olympians, FINA World Championship medalists, FINA world record

Fig. 1 Downward breaststroke kick (left) and horizontally breaststroke kick (right).

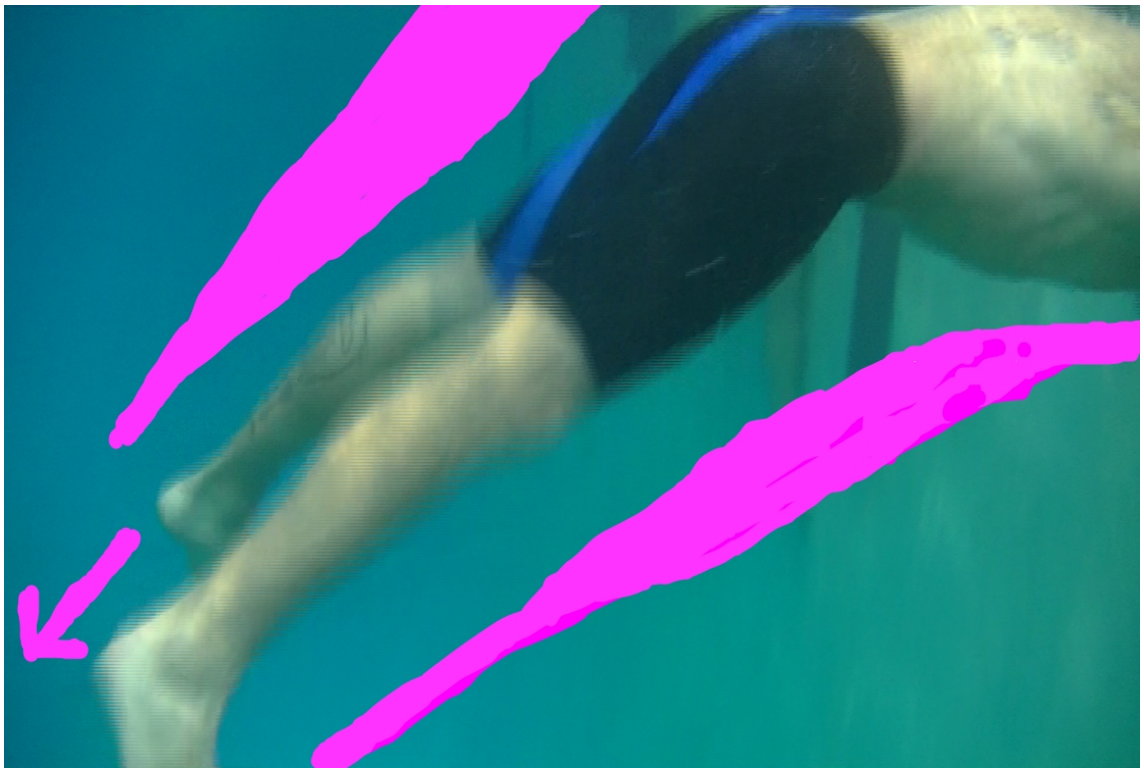

Fig. 2 The downward breaststroke kick showed triangle shape and aerodynamic buoyant force.

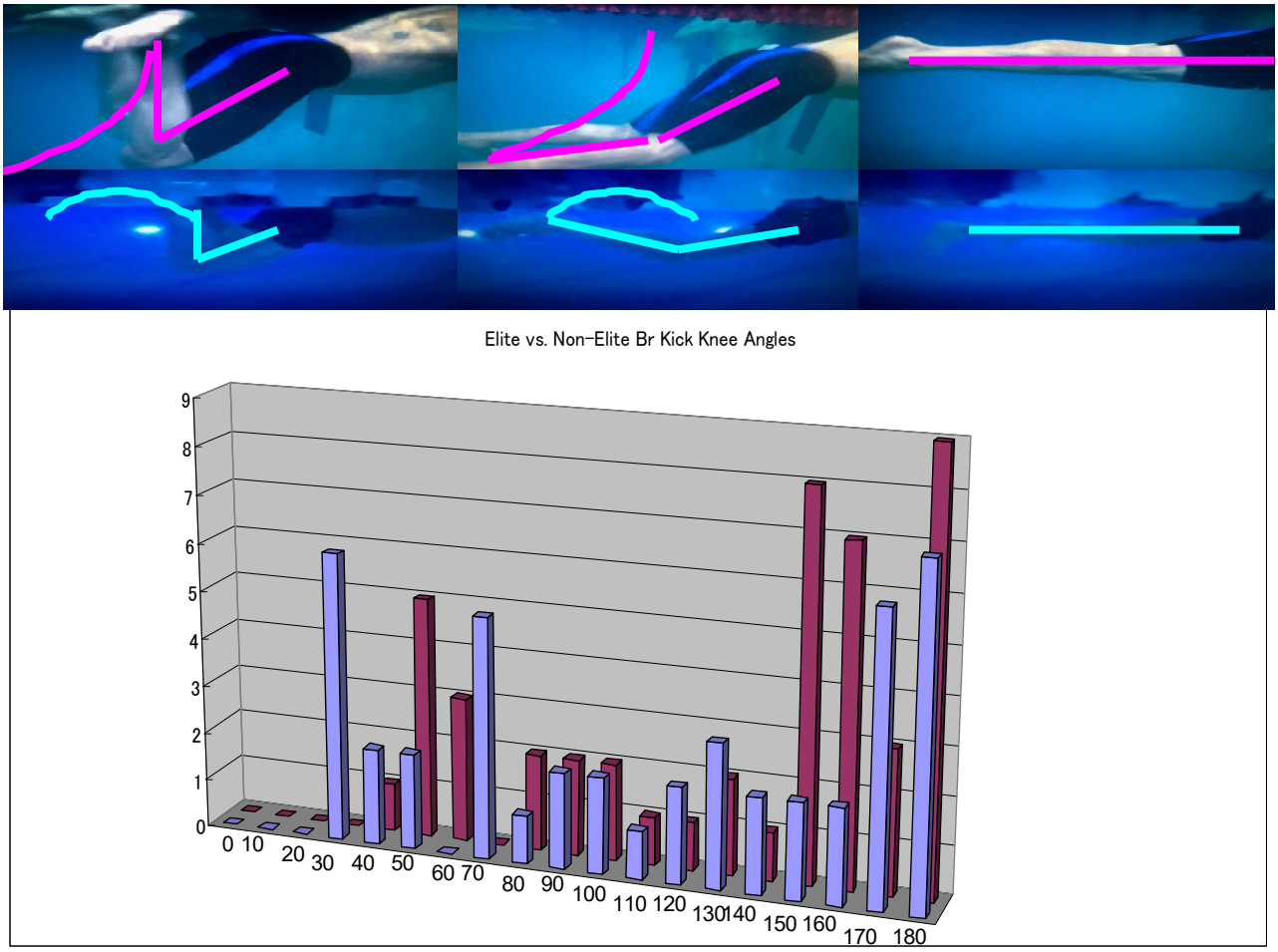

Fig. 3 Breaststroke knee angles (Elite—pink line vs. Non-Elite—blue line).

holders, we find the proportion of kicks knee angle average 119.4186° to 135.7843° (Fig. 3), competition 100-m or 100-yard breaststroke performance time improves from 65.10 ± 8.03 to 61.97 ± 8.28 s (Wilcoxon/Mann-Whitney: 1.608169, $p > 0.10$). The competition performance velocity improves form 1.39 ± 0.15 m^{-1} to 1.51 ± 0.18 m^{-1} (Wilcoxon/Mann-Whitney: 1.6431677, $p < 0.10$).

The breaststroke performance appears to be positively correlated to the degree of downward breaststroke kick in elite world class swimmers [5]. Breaststroke performances have improved dramatically and one potential explanation is that downward breaststroke kick in addition to generating more force [6] also increases aerodynamic lift, which is equal to increasing the velocity per cycle in the championship meet races [7].

2. Method

2.1 Participants

The subjects are all very accomplished international elite level swimmers. Subject #1 is a 2016 Rio Olympic Games 4th in Men's 200-m individual medley age of 24 years old (height 1.76 m, weight 72 kg). Subject #2 is FINA former master world record-holder in the Men's 50 & 100-m breaststroke. Subject #3 is 2016 Rio Olympic Games 5th in Men's 200-m breaststroke, and 2017 FINA world championship in Budapest 2nd in Men's 200-m breaststroke age of 24 years old (height 1.86 m, weight 82 kg). Subject #4 is in 2020 Tokyo Olympic Games Men's 200-m breaststroke (height 1.73 m, weight 70 kg). Subject #5 is 2015 FINA Kazan world championship (height 1.73 m, weight 70 kg). Subject #6 is 2018 NCAA division I

championship qualifier (height 1.80 m, weight 73 kg). Subject #7 is a three-time Olympian, current 50- & 100-m backstroke FINA master World record-holder, and the 2012 FINA World Cup champion in the 50-m backstroke at the age of 32 years old (height: 167 cm, body weight: 60 kg). Subject #8 is 2018 FINA world championship short course meter in Men's 200-m individual medley age of 23 (height 1.67 m, weight 62 kg). Subject #9 is 2018 FINA world championship short course meter in Women's 50-, 100-, & 200-m backstroke age of 24. Subject #10 is 2008 through 2012 NCAA division I championship finalist. Subject #11 is 2019 NCAA division I championship 3rd in Men's 100-yard backstroke. Subject #12 is 2017 through 2019 NCAA division I championship qualifier and 2013 European Youth Championship in Poznan 2nd in Men's 50-m freestyle. Subject #13 is 2016 Rio Olympic Games 8th in Women's 400-m individual medley. Subject #14 is 5th FINA World Junior Championship 2015 Singapore 3rd in Men's 100-m butterfly and 2016 through 2019 NCAA division I championship qualifier. .

2.2 Measures

2.2.1 Breaststroke Kick Angle Measures

We investigate the breaststroke kick knee angles and hip angles, kick phase, catch phase, outsweep phase, insweep phase, and wave propulsion phase. While swimming, the subjects were monitored from the side plane using an underwater video camera at a sampling frequency of GZ-R400T (DC 5.2 V, JVC, X00EJGTVB, 122A025B). Two angles of the breaststroke kick of the knee and hip bend movement were analyzed with the Kinovea (0.8.15, 1 GHz, 256Mo).

2.2.2 Breaststroke Performance Time Measures

The data of 100-m or 100-yard breaststroke performance time are collected during FINA and USA Swimming Rule Regulations Sanction Swim Meet. The race time collections by Colorado Timing System (12 V DC at 750 mA, 5 V at 3.5 mA, RS-232, ±12 V, RS232, ±12 V, 12 V DC at 0.5 A, 5 V DC) meet manager (S2015-001-007), touchpads (CTS AquaGrip®, TP-195GF), and start system (SS.S, 110-240 VAC, 6-watt/45-ohm, WSS, VDCA 18-1.2, TXR, JQR003).

2.3 Data Analysis

The breaststroke swimming performance breakout time, breakout distant, split, drop-off, cycles, time, tempo/rate, distance per cycle (meter/cycle), velocity (m/s) and turn time were recorded by Parametrix Race Analyzer™ [8]. These signals are used to calculate breaststroke performance swimming speed with Microsoft Windows Excel and a Wilcoxon Signed Ranked Test.

2.4 Breaststroke Kick Speed Measures

Breaststroke kick speed was analyzed [9] by Kinovea, and the breaststroke downward kick and breaststroke horizontally kick 1/500 s frequency and underwater high-speed HD camera.

3. Results

We find compared breaststroke kick pattern [10] is different from elite breaststrokers to non-elite breaststrokers where elite breaststrokes utilize a significantly wider vertical range while non-elite breaststrokers utilize a much more horizontal kick. We analyzed the knee angles of the breaststroke kick which is 119.4186° to 135.7843° (Wilcoxon/Mann-Whitney: -4.3875054) and hip angles 160.0233° to 162.0392° (Wilcoxon/Mann-Whitney: -0.8804718, $p > 0.05$, Fig. 4. We find that world class elite breaststrokers performed 100-yard or 100-m breaststroke with downward breaststroke kick or horizontally breaststroke kick. We find proportion of swim performance greater than average of 100-yard or 100-m breaststroke from 1:01.97s to 1:05.10s, (Wilcoxon/Mann-Whitney: 1.608169, $p > 0.10$, Fig. 5), velocity from 1.51 m^{-1} to 1.39 m^{-1}, (Wilcoxon/Mann-Whitney: -1.6431677, $p > 0.10$), distance per cycle from 2.0425 M/cycle to

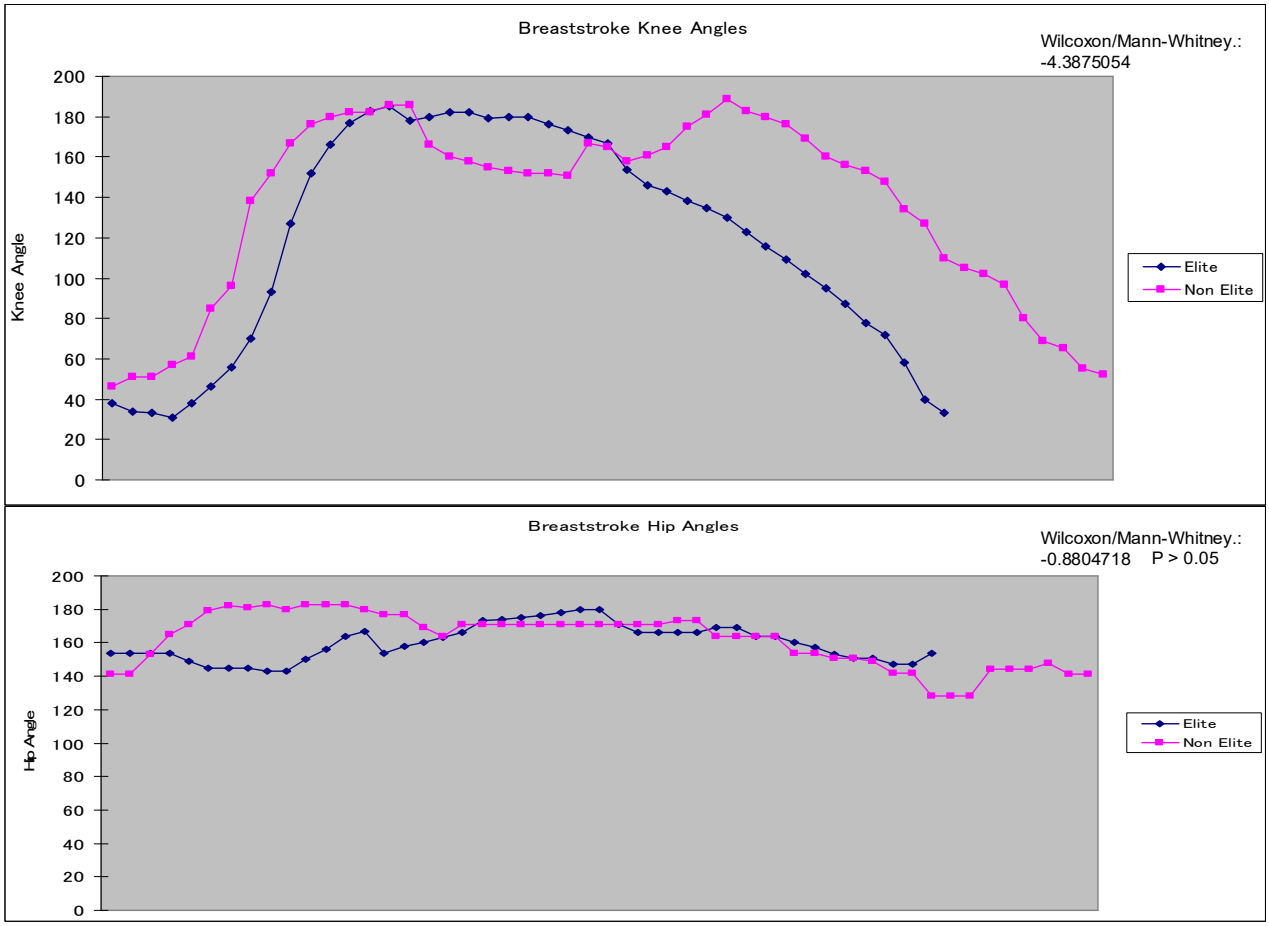

Fig. 4 Elite breaststrokers (blue) vs. non-elite breaststrokers (pink) knee angles and hip angles. Elite.

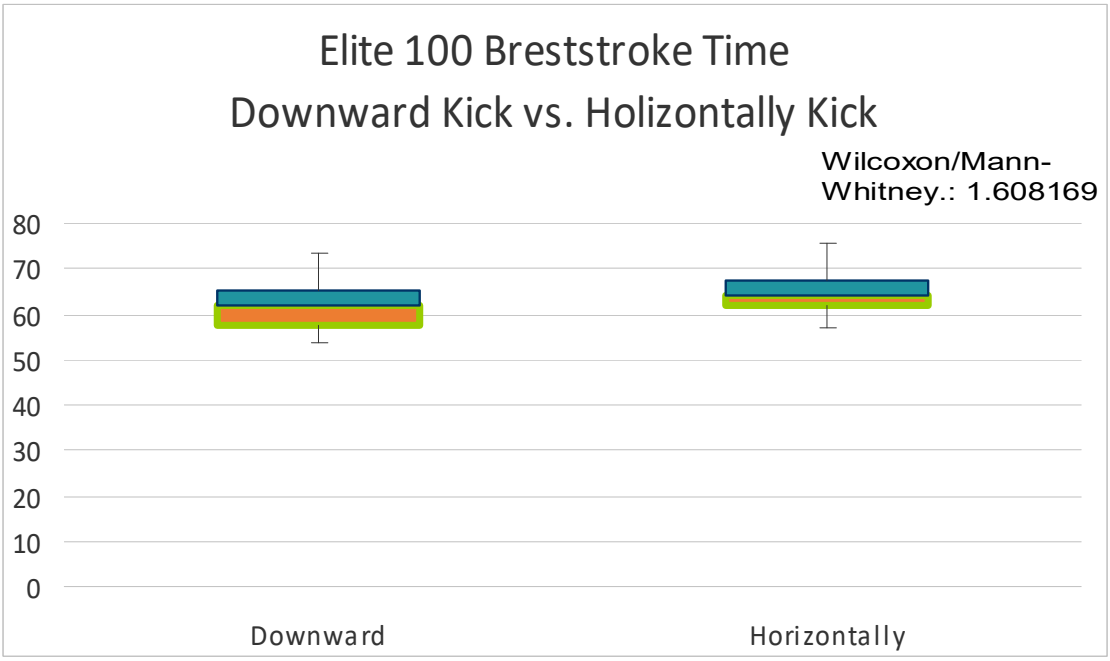

Fig. 5 Elite breaststrokers 100-m or 100-yard breaststroke performance time (downward vs. horizontally).

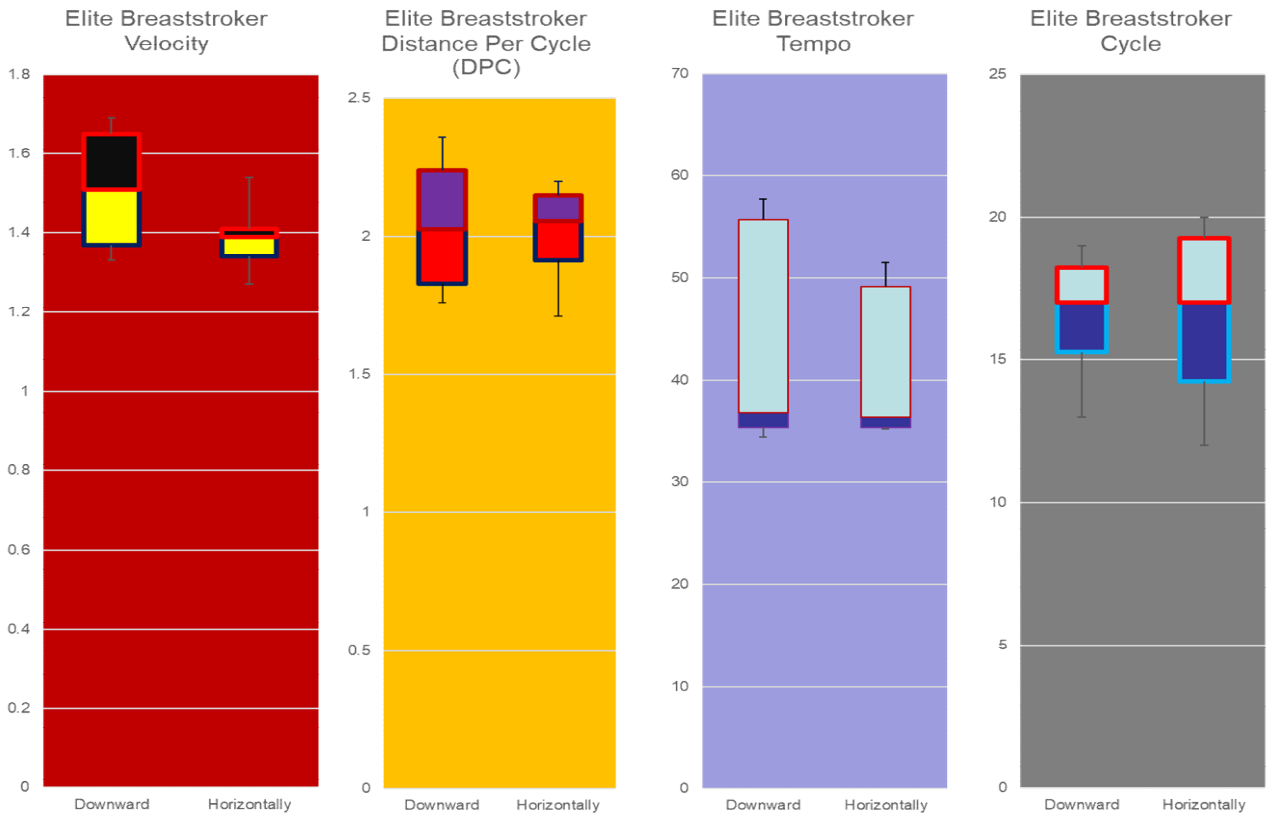

Fig. 6 Elite breaststroker velocity, distance per cycle, tempo, cycle.

2.005 M/cycle (Wilcoxon/Mann-Whitney: -0.5477226, $p > 0.10$); tempo from 43.95 strokes per minute to 41.33 strokes per minute (Wilcoxon/Mann-Whitney: -1.5414598, $p > 0.10$, Fig. 6).

4. Discussion

This study is to present empirical evidence to show that downward breaststroke kick will generate the most speed, faster 100-yard or 100-m breaststroke performance time, higher velocity, most efficient breaststroke, but also result in a high tempo stroke, shorter distance per cycle among elite world class breaststroke swimmers. We find same result: with proper technique the straight-knee butterfly kick and straight knee backstroke kick [11].

Since 2012, we employed a four-step training plan to improve the breaststroke technique in practice and competition. In the first step, we analyzed the downward breaststroke kick technique using underwater camera during training and Race Analyzer™ during swim meet. We calculate the breaststroke downward kick movement after training and utilize the technique in the Olympic Games, World Championship or NCAA. In the championship meet, we analyzed 100-yard or 100-m breaststroke performance by Race Analyzer™ to calculate time, velocity, distance per cycle, tempo and cycle.

The second step was that we employed a plane to implement the technique in practice and competition. After the 100-yard or 100-m breaststroke performance, swimmers are indicated to change their kick technique downward kick to horizontally kick in the last 25-yard or 25-m of the 100-yard or 100-m race. In training, we force to keep downward breaststroke kick in last 25-yard or 25-m in the 100 or 200-yard or meter training set.

The third step was to test the effectiveness of the breaststroke downward kick technique in non-championship meet. We focus downward kick in last 25-yard or 25-m in 100-yard or 100-m

breaststroke. We tried to input swimmers' body habit of downward breaststroke kick when they got tired of last 25-yard or 25-m in the 100-yard or 100-m breaststroke race.

The fourth step was to measure the effectiveness of the breaststroke downward kick during a major international competition during the Olympic Games, FINA World Championship, or NCAA Championship.

5. Conclusion

Positive breaststroke performance measured in a variety of elite swimmers is associated with both downward breaststroke kick and higher velocity. Breaststroke performance improved utilizing the downward breaststroke kick, and a mitigating factor [12] could be a reduction in resistance created by the alternative kick technique [13]. The results of the paper reveal that with proper training and technique, the downward breaststroke kick can result in much faster 100-yard or 100-m breaststroke times for all swimmers.

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