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World Class Elite Breaststrokers Downward Kick EMG Muscle Activity of the Gluteus Maximus, Quadriceps Femoris, Hamstring, Gastrocnemius Medialis, Rectus Abdominal, and Erector Spinae

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This study analyzed the difference between using a downward breaststroke kick and a horizontal breaststroke kick in a sample of world class elite swimmers. We compared average muscle activity of the gluteus maximus, quadriceps femoris (vastus medialis and rectus femoris), hamstring/long head of the biceps femoris, gastrocnemius medialis, rectus abdominal, and erector spinae when using the downward breaststroke kick technique. We find that when this sample of swimmers utilized the downward breaststroke kick, max speed and velocity per stroke increased, measured by 12,788 EMG samples, where the results are highly correlated to duration of the aerodynamic buoyant force in breaststroke kick technique. The increases in performance observed from measuring the world class elite swimmers is highly correlated to the duration of the kick aerodynamic buoyant force. Among this sample of elite swimmers, the longer a swimmer demonstrates a buoyant force breaststroke kick, the lower the time in a 100 breaststroke.

Keywords: swimming, breaststroke downward kick, EMG, imagination, world class elite swimmers

Introduction

This study isolates the effects of a downward breaststroke kick presented in "A Primer for Swimming Coaches" (Maglischo, 2016). The breaststroke kick can be broken down into three phases: the kick phase, the pull phase, and glide phase (Ide et al., 2021). We examined muscle activity of a swimmer's (Ide et al., 2018a) quadriceps, hamstrings, calf gastrocnemius, gluteus, abdominal, and latissimus of the breaststroke kick between downward kick and horizontally breaststroke kick when utilizing alternative breaststroke kicking technique presented in Ide et al. (2021). We hypothesize that swimmers will gain additional propulsion (Ide, 2007; Inada, Kawamoto, & Ide, 2008) and buoyancy (Maglischo, 2013) when their feet travel directly down, after their feet have peaked, during the final portion of the kick phase. This downward breaststroke kick increases the foot speed in the water compared to a horizontal breaststroke kick. Utilizing the downward breaststroke kick we find the 100-meter and 100-yard breaststroke time performance improved from 1:05.10 s to 1:01.97 s. We find the

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proportion of breaststroke kick muscle activity detection from noninvasive EMG signals (Takise & Masuhara, 1981) compared average of downward breaststroke kick increases muscle activity of the quadriceps femoris (QF) (vastus medialis (VM) and rectus femoris (RF)), hamstring/long head of the biceps femoris (BF), gastrocnemius medialis (GM), gluteus femoris (GF), rectus abdominal (RA), and erector spinae (ES). The downward breaststroke kick increases the stroke muscle activity of the quadriceps femoris (QF), biceps femoris (BF), gastrocnemius medialis (GM) (Ide et al., 2023) and increases the velocity, max speed, and lactate acid production. The breaststroke performance seems to be associated to the downward breaststroke kick in world class elite swimmers.

Method

Participants

The subjects are all very accomplished international elite swimmers 10 males and 12 females from FINA (Federation Internationale de Natation) former world record holders, Olympic Champions, Olympic medalists, Olympians, Olympic finalists, World Championship medalists, World Championship finalists, US Nationals champions, US Open champions, The International Swimming League (ISL) and NCAA (the National Collegiate Athletic Association) Division 1 championship qualifiers.

Procedures

A telemetry EMG system was generated by Muscle Link™ (TWS940-DEV, TC-0168/5V/1.638.4 Hz/10bit/5.375mVp-p/4560457400458/20μV/20.48Hz (49mm^{-1})/38,400bps (Ide et al., 2018c) measure for on skin detection from signals on the following muscles: quadriceps femoris (QF) (vastus medialis (VM) and rectus femoris (RF)), hamstring/long head of the biceps femoris (BF), gastrocnemius medialis (GM), gluteus femoris (GF), rectus abdominal (RA), and erector spinae (ES). For each muscle, three disposable adhesive circular Ag—AgCl electrodes were on the muscle in line of the muscle fibers. The breaststroke EMG downward kick and horizontal kick muscle activity test was a wall breaststroke kick tempo exercise of 1.10-1.70 s/stroke by FINIS Tempo Pro/Underwater Metronome. The results of these teste were measured using a Wilcoxon/Mann-Whitney Signed Ranked Test in Microsoft Excel. The breaststroke swimming performances for the 100-meter and 100-yard breaststroke times were collected from USA Swimming and FINA rule regulation sanctioned swim meets. These race time collected by Colorado Timing System (5V at 3.5mA, RS-232 ±12V, 12V DC at 750mA, 12V DC at 0.5A, 5V DC), Colorado Timing System meet manager (S2015-001-007), Colorado Timing System touchpads (CTS Aqua Grip®, TP-195GF), and start system (SS. S, 110240VAC, 6W/45Ω, WSS, VDCA18-12, TXR, JQR0033) (Ide et al., 2010).

Data Analysis

We investigate the muscle activity of kick phase of the breaststroke stroke, catch phase, insweep phase, outsweep phase, and wave propulsion phase. The EMG measures the muscle activity of quadriceps femoris (QF) (vastus medialis (VM) and rectus femoris (RF)), hamstring/long head of the biceps femoris (BF), gastrocnemius medialis (GM), gluteus femoris (GF), rectus abdominal (RA), and erector spinae (ES) (Ide et al., 2023) during the downward and horizontally breaststroke kick. The breaststroke EMG downward kick and horizontally kick muscle activity test was wall breaststroke kick tempo 1.10-1.70 s/stroke by FINIS Tempo Pro/Underwater Metronome (Ide et al., 2018b). These signals were used to calculate (Ide et al., 2009) with Microsoft Windows Excel and Wilcoxon/Mann-Whitney Signed Ranked Test.

Results

The EMG muscle activity test measures the average signal of the quadriceps femoris (QF) (vastus medialis (VM) and rectus femoris (RF)) downward breaststroke kick 4.9277726μV compared to horizontally breaststroke kick 2.37772243μV (Wilcoxon/Mann-Whitney: 9.7209, $p < 0.05$), hamstring/long head of the biceps femoris (BF) downward breaststroke kick 6.283735μV compared to horizontally breaststroke kick 3.506154μV (Wilcoxson/Mann-Whitney: 5.8778, $p < 0.05$), gastrocnemius medialis (GM) downward breaststroke kick 7.948011μV compared to horizontally breaststroke kick 2.434μV (Wilcoxon/Mann-Whitney: 10.5735, $p < 0.05$), gluteus maximus (GF) downward breaststroke kick 5.855612245μV compared horizontally kick 5.36703297μV (Wilcoxon/Mann-Whitney: 2.409, $p < 0.05$), rectus abdominal (RA) downward breaststroke kick 3.005040268μV compared to horizontally breaststroke kick 3.02231405μV (Wilcoxson/Mann-Whitney: 0.7644, $p < 0.05$), and erector spinae (ES) downward breaststroke kick 3.302272727μV compared to horizontally breaststroke kick 3.183606557μV (Wilcoxon/Mann-Whitney: 5.0582, $p < 0.05$).

Discussion

The purpose of this study was to analyze the performance results of swimmers using two different breaststroke kick techniques and the muscle activation of quadriceps femoris, hamstring/long head of the biceps femoris, and gastrocnemius medialis (Hosokawa et al., 2009) were using different downward breaststroke kick to horizontally breaststroke kick. The downward breaststroke kick utilizes more muscle activity 207.291024% of quadriceps femoris, 179.220165% of hamstring/long head of the biceps femoris, 326.541126% of gastrocnemius medialis; examples of EMG muscle activity at three different averages are presented in Figure 1. The downward breaststroke equal to muscle activity 99.401277% of rectus abdominal, 103.727413% of erector spinae, 109.10334% of gluteus maximus are presented in Figure 2. We hypothesize that world class elite swimmers gain additional propulsion and buoyancy when their feet have peaked, during the final portion of the kick phase.

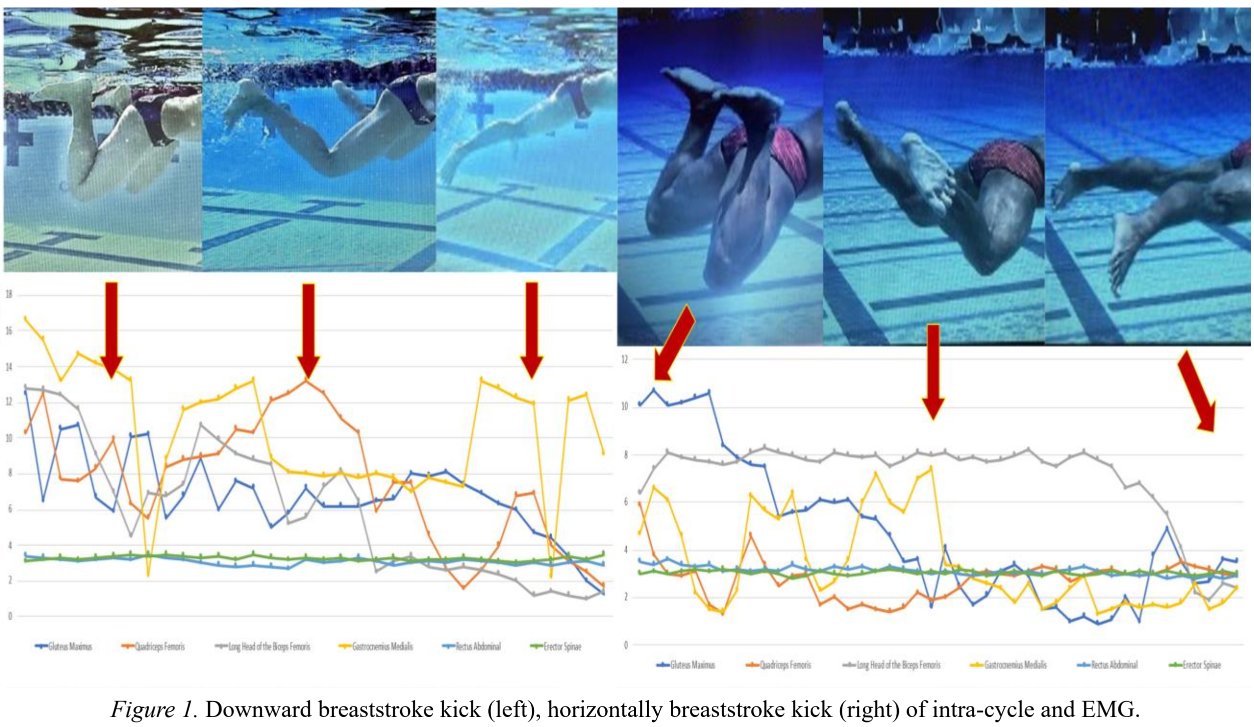

Figure 1. Downward breaststroke kick (left), horizontally breaststroke kick (right) of intra-cycle and EMG.

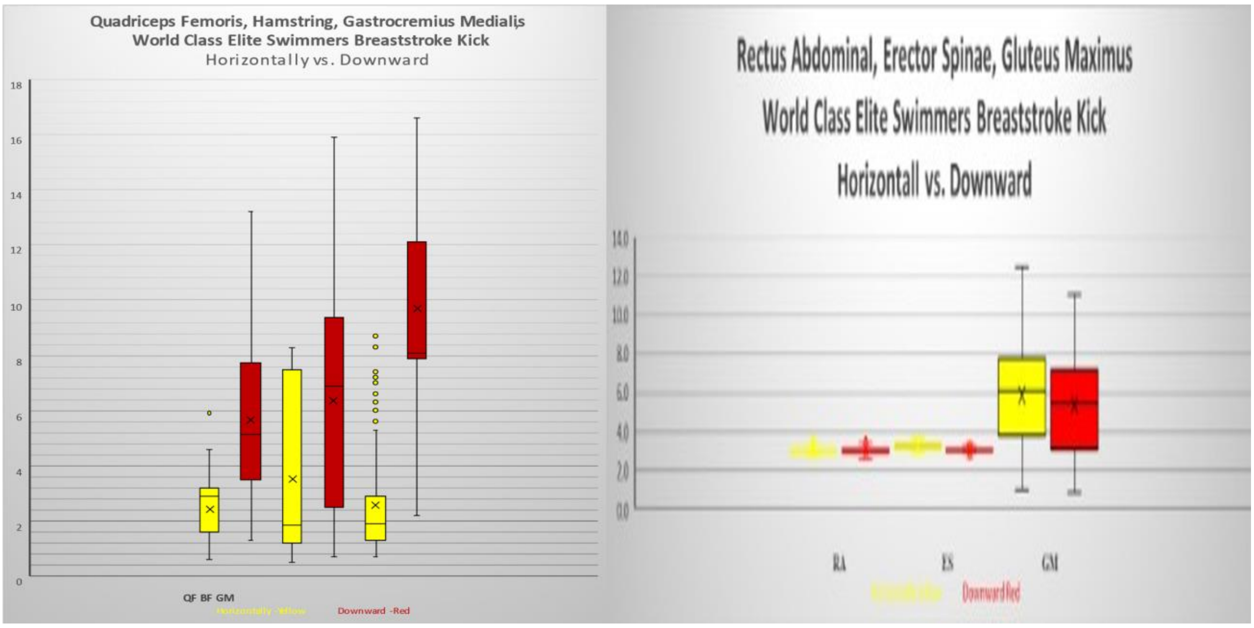

Figure 2. EMG test world class elite swimmers horizontally breaststroke kick vs. downward breaststroke kick average (quadriceps femoris, hamstring, and gastrocnemius—left, rectus abdominal, erector spinae, glutes maximus—right).

Conclusion

In conclusion, analysis provides significant evidence that breaststroke performance is associated with swimmers who utilize a downward breaststroke kick compared to a horizontal breaststroke kick among world class elite swimmers. The breaststroke performance improved, although a possible explanation is not only increase equal to increase lactate acid (Ide et al., 2012; Ide et al., 2021; Ide et al., 2017a; 2017b; Ide et al., 2012), velocity (Wakayoshi, Shiraki, Ogita, & Kitajima, 2010), and max speed (Yoshimura et al., 2007; Ide, 2010) in championship performance. Breaststroke performance improved utilizing the downward breaststroke kick which is attributed to a reduction in resistance created by the alternative kick technique. The result of this paper reveals that with proper training and technique, the downward breaststroke kick can result significantly faster 100-meter and 100-yard breaststroke times for world class elite swimmers.

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