Psychology Research, August 2021, Vol. 11, No. 8, 363-368
doi:10.17265/2159-5542/2021.08.005

Original Article

The Effects of Breaststroke Kick Electromyography Muscle Activity

Takahisa Ide MA.,
Osaka University of Health and Sport Sciences, Osaka, Japan; Phoenix Swim Club, Paradise Valley, USA; Grand Canyon University, Phoenix, USA
William F. Johnson
TexasA & M University Corpus Christi, Corpus Christi, USA
Sadafumi Takise
Osaka University of Health and Sport Sciences, Osaka, Japan
Jan Konarzewski, Noriko Inada, Hiromasa Fujimori, Takeharu Fujimori, Emi Moronuki, Ken A. Barcinas, Yasuhiro Koseki, Kohei Kawamoto, Kazuki Watanabe

---

Takahisa Ide, M.A., Graduate School of Social and Cultural Studies, Nihon University, Graduate School of Sport and Exercise Sciences, Osaka University of Health and Sport Sciences, Osaka, Japan; Swimming Science, Phoenix Swim Club, Paradise Valley, USA; Athletic Department, Grand Canyon University, Phoenix, USA.

William F. Johnson, Assitant Professor of Finance in the Department of Finance, Texas A & M University Corpus Christi, Corpus Christi, USA.

Sadafumi Takise, Ph.D., Sport Science, Osaka University of Health and Sport Sciences, Osaka, Japan.

Jan Konarzewski, Masters Degree with the Distinction at the University of Edinburgh in Computer Science, B.A., in Informatics and Social Computing, University of Michigan, Swimming Scienc, Phoenix Swim Club, Paradise Valley, USA.

Noriko Inada, B.A., Department of Education, Waseda University, Swimming Science, Phoenix Swim Club, Paradise Valley, USA.

Hiromasa Fujimori, M.A., Faculty of Sport Science of Nippon Sports Science University, Swimming Science, Phoenix Swim Club, Paradise Valley, USA.

Takeharu Fujimori, M.A., Faculty of Sport Science of Nippon Sports Science University, Swimming Science, Phoenix Swim Club, Paradise Valley, USA.

Emi Moronuki, School of Health and Physical Education, Tsukuba University, Swimming Science, Phoenix Swim Club, Paradise Valley, USA.

Ken A. Barcinas, B.A. Faculty of Management Information of Yamanashi Gakuin University, Japan, Swimming Science, Phoenix Swim Club, Paradise Valley, USA.

Kohei Kawamoto, B.A., Department of Economics, Faculty of Economics, Chuo University, Swimming Sciences, Phoenix Swim Club, Paradise Valley, USA.

Kazuki Watanabe, Meiji University, School of Commerce, Phoenix Swim Club, Paradise Valley, USA.

Asahi Nagahata, Bachelor of Science, Business Administration with an Emphasis i Busiiness Intelligence, Grand CanyonUniversity, Phoenix, USA.

Iryna Glavnyk, Master of Bussiness Administration, Bachelor of Bussiness Management of Marketing and Enterpreneurship, Grand Canyon University, Phoenix, USA.

Daniil Antipov, Master of Business Administration, Bachelor of Arts in Goverment with an Emphasis in Legal Studies, Grand Canyon University, Phoenix, USA.

Mark Nikolaev, Master of Business Administration, Grand Canyon University, Phoenix, USA; Washington, D.C. Trident, Baar, Switzerland.

Bogdan Plavin, Bachelor of Science in Psychology, Grand Canyon University, Phoenix, USA; Masters of Science in Information Technology, Valparaiso University, Valparaiso, USA.

Phoenix Swim Club, Paradise Valley, USA
Asahi Nagahata, Iryna Glavnyk, Daniil Antipov
Grand CanyonUniversity, Phoenix, USA
Mark Nikolaev
Grand Canyon University, Phoenix, USA; Washington, D.C. Trident, Baar, Switzerland
Bogdan Plavin
Grand Canyon University, Phoenix, USA; Valparaiso University, Valparaiso, USA

This paper evaluates the efficiency of using a downward breaststroke kick in a sample of eight elite swimmers. Using a downward breaststroke kick increases the one stroke velocity and max speed but also increases production of lactate acid. Utilizing the downward breaststroke kick we find the 100-meter and 100-yard breaststroke times decrease from 1:05.10s to 1:01.97s and find the downward breaststroke kick increases muscle activity of the quadriceps, biceps, and calves. The increases in performance were observed from measuring the world class swimmers are highly correlated to duration of the kick aerodynamic buoyant force in breaststroke.

Keywords: swimming, breaststroke, electromyography, downward kick, Olympians, psychology

Introduction

The purpose of the study was to determine the effects of the breaststroke kick on intra-cycle lactate acid functions. The breaststroke can be broken down into three phases: the kick phase, the pull phase, and glide phase. We examined muscle activity of a swimmer's quadriceps, biceps, and calves of the breaststroke kick between downward breaststroke kick and horizontally breaststroke kick (Ide et al., 2021) when utilizing alterative breaststroke kicking technique. The focus of this is to analyze the downward breaststroke kick and horizontal breaststroke kick (Ide et al., 2017a) and measure the resulting increase in speed and velocity (Ide et al., 2021). We hypothesize that swimmers will gain additional propulsion and buoyancy (Ide et al., 2017b) 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. The downward breaststroke kick exhibits a triangle shape and creates and aerodynamic buoyant force. When comparing the angle of the horizontally breaststroke kick to downward breaststroke kick in the 100-meter or 100-yard breaststroke performance in the competition for eight swimmers of the Olympians, FINA (Federación Internacional de Natación) world championship medalists, FINA world record holders, NCAA (National Collegiate Athletic Association) Division I championship qualifiers, we cannot distinguish sprinter or distance swimmer by psychology test (Inada, Kawamoto, & Ide, 2008) but can distinguished muscle type (Ide et al., 2009) by fast-twitch muscle or slow-twitch muscle (Ide, 2007). We find the proportion of breaststroke kick muscle activity detection from noninvasive EMG (electromyography) signals (Ide et al., 2018a), compared average (Figure 1) of downward breaststroke kick 6.864648μV to horizontally breaststroke kick 2.448 μV (Wilcoxon/Mann-Whitney: 14.7495108).

The downward breaststroke kick (Ward, Prins, & Freemter, 2018) increases the stroke muscle activity and increases the velocity, max speed, and lactate acid production. Breaststroke performance seems to be associated to the downward breaststroke kick in elite world class swimmers' due to an increase in muscle activity.

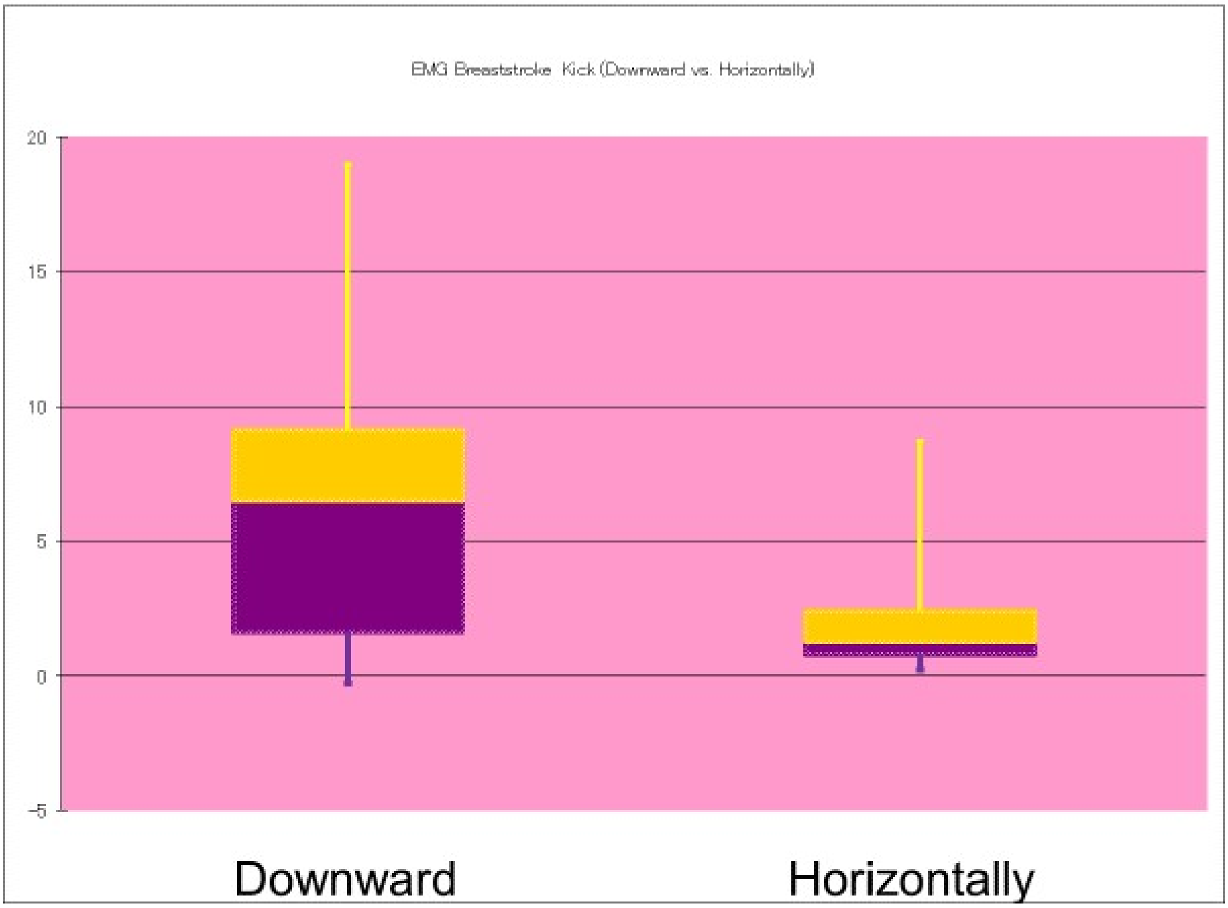

Figure 1. EMG breaststroke kick (downward average vs. horizontally average).

Methods

Electromyography

The EMG (electromyography) was generated by Muscle Link^{TM} (IWS940-DEV, TC-0168/5 V/1 kVrms/1,638.4 Hz/10 bit/5.375 mVp-p/4560457400458/20 μV/20.48Hz (49mm^{-1})/38,400bps) measure for on skin detection (Ide et al., 2018b) from noninvasive signals (Figure 2). The EMG test was wall breaststroke downward kick and horizontally kick tempo was 1.10-1.70 s/stroke by FINIS Tempo Pro/Underwater Metronome.

Measures

The breaststroke swimming performances for the 100-meter and 100-yard breaststroke times are collected from USA Swimming and FINA rule regulated sanctioned (Ide et al., 2010) swim meets. The race time collections by Colorado Timing System (5V at 3.5mA, RS-232 ± 12V, 12 V DC at 750mA, 12V DC at 0.5A, 5VDC), meet manager (S2015-001-007), touchpads (CTS AquaGrip®, TP-195GF), and start system (SS.S, 110240 VAC, 6W/45Ω, WSS, VDCA18-12, TXR, JQR003).

Participants

The subjects are all accomplished international elite swimmers. Subject #1 is the 4th place finisher form the 2016 Rio Olympic Games in Men’s 200-meter individual medley age of 24 years old (height: 1.76-meter, weight 72 kilogram). Subject #2 is NCAA Division I championship qualifier (height: 1.78-meter, weight: 72 kilogram). Subject #3 is the 2018 FINA short course champion in the Men's 200-meter individual medley age of 23 years old (height: 1.67-meter, weight 62 kilogram). Subject #4 is 2012 London Olympic finalist (height: 1.77-meter, weight: 72 kilogram). Subject #5 is 3 times Olympian (1992, 2000, & 2004, height: 1.67-meter, weight: 60 kilogram). Subject #6 is 2008 USA Swimming US open champion in 100-meter butterfly (height: 1.77-meter. weight: 71 kilogram). Subject #7 is USA Swimming National Championship finalist (height: 1.98-meter, weight: 89 kilogram). Subject #8 is 2018 FINA world championship short course meter qualifier (height: 1.65-meter, weight: 58 kilogram).

Data Analysis

The EMG (electromyography) measures the muscle activity of quadriceps, bicep, and calf (Ide et al., 2018c) during the downward and horizontal breaststroke kick. The breaststroke EMG downward kick and horizontal kick muscle activity test was wall breaststroke kick tempo 1.10-1.70 s/stroke by FINIS Tempo Pro/Underwater Metronome. These signals are used to calculate with Microsoft Windows Excel and Wilcoxon/Mann-Whitney Signed Ranked Test (Ide et al., 2012).

Figure 2. EMG breaststroke kick bicep (downward kick and horizontally kick).

Results

EMG muscle activity test shows the signals, average of downward breaststroke kick (Table 1) quadriceps 6.144444μV compared to breaststroke horizontally kick quadriceps 1.476724 μV (Wilcoxon/Mann-Whitney: 9.3379882), average of downward breaststroke kick bicep 6.446622μV compared to breaststroke horizontally kick bicep 3.607143 μV (Wilcoxon/Mann-Whitney: 7.3074297), average of downward breaststroke kick calf 8.100495μV to breaststroke horizontally kick calf 2.045783 μV (Wilcoxon/Mann-Whitney: 7.8705255).

Table 1

Elite 8 Swimmers EMG Muscle Activity (Quadriceps, Bicep, Calf)

	Quadriceps	Bicep	Calf
Downward	6.144444	6.446622	8.100495
Horizontally	1.476724	3.607143	2.045783

Discussion

Based on the above evidence it is clear the most preferred breaststroke technique is to use a downward breaststroke kick. The downward breaststroke kick (Maglischo, 2016) utilizes more muscle activity (Figure 3) 85.31± 7562% of quadriceps, 66.01±8692% of bicep, and 90.53±2478% of the calf. The downward breaststroke kick (Maglischo, 2013) generates the max speed and most efficient stroke. We analyzed the downward breaststroke kick lactate acid levels (Ide et al., 2012) and found that the increase was significant (citation from data) among elite level breaststroke swimmers, and also analyzed the downward breaststroke kick technique using the underwater camera during training and Paramerix Race Analyzer™ during training or swim meet. We calculate the knee degrees after training to utilize the technique in the championship meet; we analyzed performance by Parametrix Race Analyzer™ to split time, drop-off time, cycles, time, tempo, distance per cycle (meter/cycle or yard/cycle), velocity (meter/sec or yard/sec) and turn time.

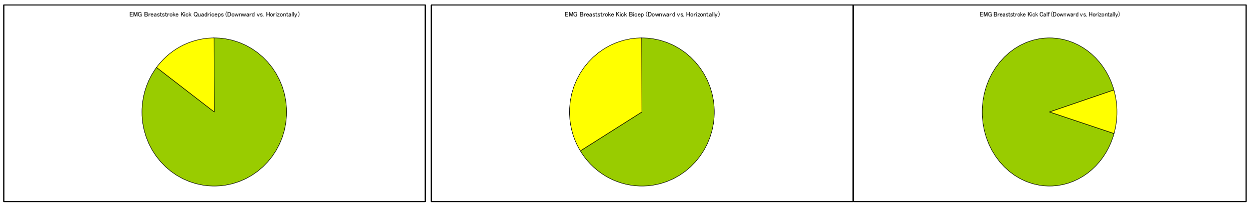

Figure 3. EMG breaststroke muscle activity of quadriceps, bicep, and calf.

Conclusion

Based on this analysis, positive breaststroke performance is associated with the downward breaststroke kick in elite world class swimmers. This study hypothesizes that improved breaststroke performance is partially due to an increase in propulsion and from a reduction is resistance equal to increasing the velocity and max speed in the championship meet races. The results of this paper reveal that with proper training and technique, the downward breaststroke kick can result in much faster 100-meter or 100-yard breaststroke times for elite swimmers, who are more adept at mitigating the increase in quadricep, bicep, and calf muscle activity during elite level competitions.

References

Ide, T. (2007). Men's 50-meter freestyle technique. Presented at the *7th International Swimming Research Symposium*. Tokyo, Japan.

Ide, T., Yoshimura, Y., Kawamoto, K., Takise, S., & Kawakami, T. (2009). *How to coaching butterfly.* Kanagawa, Japan: Japan Society of Sciences in Swimming and Water Exercise.

Ide, T., Yoshimura, Y., Kawamoto, K., Takise, S., & Kawakami, T. (2010). Effect of reduced knee-bend on 100 butterfly performance: A case study using the men's Asian and Japanese record holder.*Biomechanics and Medicine in Swimming XI,1*(1), 270-271.

Ide, T.,Takise, S., Yoshimura, Y., Kawamoto, K., Schaffer, S., Johnson, W. F.,&Kawakami, T. (2012). Straightness knee butterfly kick makes more lactate acid during butterfly swimming. A case study with a high-level swimmer. *International Journal of Swimming Kinetics, 1*(1), 51-59.

Ide, T., Takise, S., Schaffer, S., Kawamoto, K., & Yoshikawa, T. (2012). Effects of straightness knee kick makes more lactate in 100 fly performance: A case study using the men's Asian record holder.*2012 International Convention on Science, Education & Medicine in Sport. Glasgow, 1*(1), 48-49.

Ide, T., Johnson, W. F., Yoshimura, Y., Inada, N., & Takise, S. (2017a). The straightness backstroke kick makes fast speed and increased lactate acid: A case study using 3-times Olympian.*Journal of Sports Science, 5*, 89-95.

Ide, T., Johnson, W. F., Yoshimura, Y., Inada, N., & Takise, S. (2017b). The straightness backstroke kick makes fast speed and increased lactate acid.*Swimming Technique February, 44*(1), 34.

Ide, T., Johnson, W. F., Nikolaev, M., Glavnyk, I., Yoshimura, Y., Inada, N., & Takise, S. (2018a). Coaching Kohei Kawamoto—changing technique of an older swimmer. Japanese butterfly improve from 54.75 to 51.00. Presented at the *2018 World Aquatic Development Conference*. Lund, Sweden.

Ide, T., Johnson, W. F., Nikolaev, M., Glavnyk, I., Yoshimura, Y.,Inada, N., & Takise, S. (2018b). Elite swimmers using different muscles in the straightness backstroke kick movement. Presented at the *2018 World Aquatic Development Conference*. Lund, Sweden.

Ide, T., Johnson, W. F., Nikolaev, M., Glavnyk, I., Yoshimura, Y., Inada, N., & Takise, S. (2018c). Japanese swimming culture. Present at the *2018 World Aquatic Development Conference*. Lund, Sweden.

Ide, T., Johnson, W. F., Takise, S., Konarzewski, J., Inada, N., Fujimori, H., … Plavin, B. (2021). The downward breaststroke kick technique: Does increasing the kick angle decrease time.*Journal of US-China Medical Science, 18*, 30-36.

Ide, T., Johnson, W. F., Takise, S., Konarzewski, J., Inada, N., Fujimori, H., … Kawamoto, K. (2021). The downward breaststroke kick makes fast speed and increase lactate acid. *Journal of Sports Science, 9*.

Inada, N., Kawamoto, K., & Ide, T. (2008). Men's freestyle angle of catch point, finish point and kick point. Presented at the *1st International Scientific Conference of Aquatic Space Activities 2008*. Ibaraki, Japan.

Maglischo, E. W. (2013). Swimming propulsion.*Journal of the International Society of Swimming Coaching, 3*(1), 4-80.

Maglischo, E. W. (2016). *A primer for swimming coaches, biomechanical foundations. Vol. 2.*Hauppauge, New York: Nova Science Pub Inc.

Ward, S. M., Prins, J. H., & Freemter, B. G. (2018). Kinematic analysis of peak velocities in the breaststroke as a function of the timing of the kick.*Journal of Swimming Research, 26*(1), 42-55.