# A CASE STUDY: EVALUATING THE DIFFERENCE OF TECHNIQUE BY USING EFFICIENCY INDEX IN ELITE MALE FREESTYLE SWIMMERS

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The purpose of the study was to evaluating the difference of technique by using efficiency index in elite male freestyle swimmers during their training periods. Two swimmers were selected to take a 6 × 50 m freestyle descend set in a 50 m swimming pool. The mean velocity (MV), stroke length (SL), stroke cycle (SC), efficiency index (EI) and concentration of blood lactate (BL) were measured and compared to illuminate the difference of swimming technique and its impact on the performance level. According to previous and present studies, efficiency index is a useful measurement to evaluate the efficiency of the technique of swimmers. From limited number of subjects in the study, we speculated that the most effective intensity of improving efficiency of swimming technique is a little bit higher than anaerobic threshold.

**KEY WORDS:** swimming technique, efficiency index, blood lactate

**INTRODUCTION:** It's well known that race analysis is an important part of the application of science in swimming. At present, the analysis of race components during the international swimming competitions is a usual activity. Coaches and swimmers warmly accept the results. These analyses contain all the race components such as start time, swimming time, turning time, final time, mean velocity, stroke length and stroke frequency as well.
However, race analysis appeared to be less important in analyzing swimmer's training background, the improvement of training ability and current performance level, and these data is not available in daily training routine.
As a new concept, Efficiency Index (EI) was used to evaluate the training progress in recent years. The efficiency index was the product of the stroke length (SL) and mean velocity (MV) and was calculated in $m^2/s$. The equation is: EI=MV×SL. While this index included not only the stroke length, which is very important factor influencing the final performance of swimmers, but also the swimming velocity, it can reflect the change of the technique and muscle function of swimmers with the progress of training.
In this study, EI of two male swimmers was measured and compared to illuminate the difference of swimming technique and its impact on the performance level.

**METHODS:** Two male swimmers participated in this study after going informed consent. The information about two swimmers is shown in table 1. They undertook a 6 × 50 m freestyle descend set in a 50 m swimming pool. The subjects were required to increase the swimming velocity every repetition on 3 minutes, and the fastest speed was obtain at the maximal at the last repetition. Stopwatch and video are used together to time the start time for the first 5 meters when the head of the swimmer reach the 5 m line. Mean velocity was calculated by dividing the distance (45 m) by the time between 5 m(T5) to 50 m(T50) times. A stopwatch can record the time for 5 m (T5) and 50 m (T50) while a video can record the every repetition to measure a complete stroke cycle (SC: right hand entry to right hand entry in freestyle). Stroke length and efficiency index (EI) can be calculated as follows:
Mean Velocity (MV) = 45 / (T50-T5)
Stroke Length (SL) = 45 / (SC)
Efficiency Index (EI) = MV × SL
After one-year-training, Swimmer B was required to do the same test again to compare his change of EI. B (1) and B (2) were used to differ these two tests.

**Table 1 The background of two subjects.**

| Subject | Height (cm) | Weight (kg) | Age (year) | Result 100m FR(s) |
|---|---|---|---|---|
| Swimmer A | 185 | 87.0 | 28 | 51.58 |
| Swimmer B (1) | 189 | 89.0 | 18 | 53.12 |
| Swimmer B (2) | 189 | 89.5 | 19 | 51.97 |

**RESULTS:** The T5, T50, T45, mean velocity (MV), stroke length (SL), stroke cycle (SC), efficiency index (EI) and concentration of blood lactate (BL) are shown in table 2.

**Table 2 T5, T50, T45, MS, SL, SC, EI, BL of swimmer A and swimmer B in 6 × 50 m freestyle descend set.**

| Swimmer A | T5 | T50 | T45 | MV | SL | SC | EI | BL |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.49 | 33.96 | 32.47 | 1.386 | 3.333 | 13.5 | 4.6196 | |
| 2 | 1.51 | 33.1 | 31.59 | 1.425 | 3.214 | 14 | 4.5788 | |
| 3 | 1.46 | 31.8 | 30.34 | 1.483 | 3.214 | 14 | 4.7674 | 2.79 |
| 4 | 1.41 | 30.3 | 28.89 | 1.558 | 3.214 | 14 | 5.0067 | 3.39 |
| 5 | 1.3 | 28.3 | 27 | 1.667 | 3.103 | 14.5 | 5.1724 | 4.82 |
| 6 | 1.31 | 25.5 | 24.19 | 1.860 | 2.647 | 17 | 4.9243 | 8.51 |

| Swimmer B (1) | T5 | T50 | T45 | MV | SL | SC | EI | BL |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.13 | 30 | 28.87 | 1.559 | 2.647 | 17 | 4.1260 | 1.78 |
| 2 | 1.13 | 29.08 | 27.95 | 1.610 | 2.571 | 17.5 | 4.1390 | 1.88 |
| 3 | 1.13 | 28 | 26.87 | 1.675 | 2.571 | 17.5 | 4.3064 | 1.96 |
| 4 | 1.13 | 26.8 | 25.67 | 1.753 | 2.500 | 18 | 4.3825 | 3.06 |
| 5 | 1.13 | 26.2 | 24.9 | 1.807 | 2.434 | 18.5 | 4.3960 | 4.82 |
| 6 | 1.13 | 25.6 | 24.5 | 1.837 | 2.195 | 20.5 | 4.0324 | 7.9 |

| Swimmer B (2) | T5 | T50 | T45 | MV | SL | SC | EI | BL |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.05 | 30.88 | 29.83 | 1.509 | 2.727 | 16.5 | 4.1150 | 3.24 |
| 2 | 2 | 30.8 | 28.8 | 1.563 | 2.727 | 16.5 | 4.2601 | 3.39 |
| 3 | 1.05 | 28.9 | 27.85 | 1.616 | 2.647 | 17 | 4.2770 | 3.7 |
| 4 | 1.2 | 27.3 | 26.1 | 1.724 | 2.571 | 17.5 | 4.4334 | 3.9 |
| 5 | 1.17 | 25.8 | 24.63 | 1.827 | 2.500 | 18 | 4.5675 | 6.57 |
| 6 | 1.1 | 24.6 | 23.5 | 1.915 | 2.250 | 20 | 4.3085 | 13.62 |

**DISCUSSION:** A 6 × 50 m freestyle descend set measuring stroke count, distance per stroke and stroke rate was used to work out the most efficient way to swim originally by Australian. Recently, the efficiency index, as the product of the stroke length and mean velocity, was developed and measured in the training process. It doesn't only reveal the change of efficiency in swimming technique throughout a set, but also monitor the progress of the recovery in respect of the stroke rate versus the distance per stroke in the taper. Generally, the efficiency index or the distance per stroke with certain stroke rate will increase with the recovery of the muscle conditioning in the taper. When comparing different swimmers with different technique, the larger the index number is, the more efficient the swimmer swims.

In the study, efficiency index of two swimmers were compared. We found that swimmer A had significant longer stroke than swimmer B (3.214 m vs 2.647 m) at the similar velocity

(1.558 m/s vs 1.559 m/s), and it only took swimmer A 14 strokes to finish 45 m comparing with 17 strokes for swimmer B. Simultaneity, efficiency index of swimmer A was much higher than that of swimmer B (5.007 vs 4.126). Hence, we can speculate that swimmer A swam much efficiently than swimmer B at this velocity. As a matter of fact, swimmer A is a national level swimmer who has very good technique, and his best result in men's 100 m freestyle is 51.58 s. In contrary, swimmer B is 10 years younger than swimmer A, and his best is 53.12 s. After one year, we measured the efficiency index of swimmer B again. In this time, we found that his maximal value of EI increased significantly compared with one year before (4.567 vs. 4.396), and his BL concentration increased from 4.82 to 6.57 mmol/L at the same point as well. Hence, it suggested that the efficiency of the technique and anaerobic ability of swimmer B improved after one year training.

The concentration of blood lactate is considering as a valid indicator of metabolic intensity of muscle in the training process. In this study, concentrations of blood lactate were measured following every repetition. We found that the value of HL concentration, in which EI start to decrease, was about 1-2 mmol/L higher than that of anaerobic threshold. Hence, we can speculate that the best intensity of improving efficiency of swimming technique is a little bit higher than anaerobic threshold intensity, which is considered as the most effective intensity to improve aerobic capacity. However, due to the limited number of the subject in the study, we must draw this conclusion with caution.

**CONCLUSION:** Efficiency of the swimming technique is crucial factor to influence the final performance of swimmers. According to previous and present studies, efficiency index is a useful measurement to evaluate the efficiency of the technique of swimmers. From limited number of subject in the study, we speculated that the most effective intensity of improving efficiency of swimming technique is a little bit higher than anaerobic threshold intensity.