TURNING TECHNIQUE OF ELITE SWIMMERS IN BUTTERFLY AND BREASTSTROKE

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The objective of this study was to determine the kinematic differences of the turning technique in butterfly and breaststroke between elite Hong Kong swimmers and the finalists of British Commonwealth Games (BCG) in 1982 during 100m butterfly and breaststroke events. A video head was fixed into a water-resistance box which was put underwater and mounted on the side of the pool. The motion of the butterfly and breaststroke swimmers were filmed in the sagittal plane. Then the video materials were processed using a PEAK Performance System. The kinematic parameters included distance out, time out, and average horizontal speed out. The results showed that the average horizontal speed out for most of the subjects were smaller than the average horizontal speed out in BCG (1982).

KEY WORDS: swimming, turn, kinematics

INTRODUCTION: The performance improvements in elite level swimmers are relatively restricted. So coaches will try to determine all possible methods or gather information to improve the performance of swimmers. The time that a swimmer takes to complete the distance of a given race can be considered as the summation of the times the swimmer spends starting, stroking and turning. One possible area is to improve turning efficiency throughout the push-off, glide and stroke resumption phases. During turning a swimmer's body is in contact with a solid object, and there are great gains to be made during that instant by the most efficient use of a wall. The turns can mean the fraction of a second between winning and losing. There is a great similarity between the turns for butterfly and breaststroke, mostly because they are both made with two hands. In this study, the kinematic parameters of turn technique in butterfly and breaststroke were revealed and a comparison between the Hong Kong elite swimmers and the international swimmers of British Commonwealth Games (BCG) in 1982 was made.

METHODS: Nine elite swimmers took part in this study. Figure 1 shows a water resistant transparent box equipped with a video head (Panasonic F-15) mounted on the side of the swimming pool by a tailor-made metal frame. The video head with water resistance box was submerged about 10cm below the water level and about 2.5 m away from the turning wall. A video cable passed from the top of the box and connected to the video recorder (Panasonic AG-S745) and monitor. The underwater motions of the swimmers were filmed in the sagittal plane about 6m away from the video head. Two 100 m trials were performed by the swimmers in the 25 m swimming pool. Therefore, four turns per swimmer were captured. The floating buoys 1m in length with alternated colour served as calibration markers for distance measurements. The recording rate of the video camera was 25 frames per second. This frame rate was considered adequate for this investigation, since the motion of the swimmers was relatively slow and only below-water performance was recorded. A PEAK Performance Technologies Motion Analysis System was used to sequentially encode every frame and the kinematic parameters were calculated.

Distance out (D_{out}) was defined as the horizontal distance between the vertex of the head of the swimmer and the wall at the instant the swimmer completed the first stroke cycle following the turn. In the butterfly event, this coincided with the instant the swimmer's hand or hands entered the water during the first stroke after turning. In the breaststroke events, this coincided with the instant the swimmer's arms were fully stretched forward at the end of the first regular stroke after turning.

Time out (T_{out}) was defined as the time elapsed between the moment the swimmer's foot, or feet, made first contact with the wall and the instant the swimmer completed the first stroke following the turn.

Average horizontal speed out (AV_{out}) was defined as the D_{out} divided by the corresponding T_{out}. Hand touch time (H_t) was defined as the time of hand touching the wall.
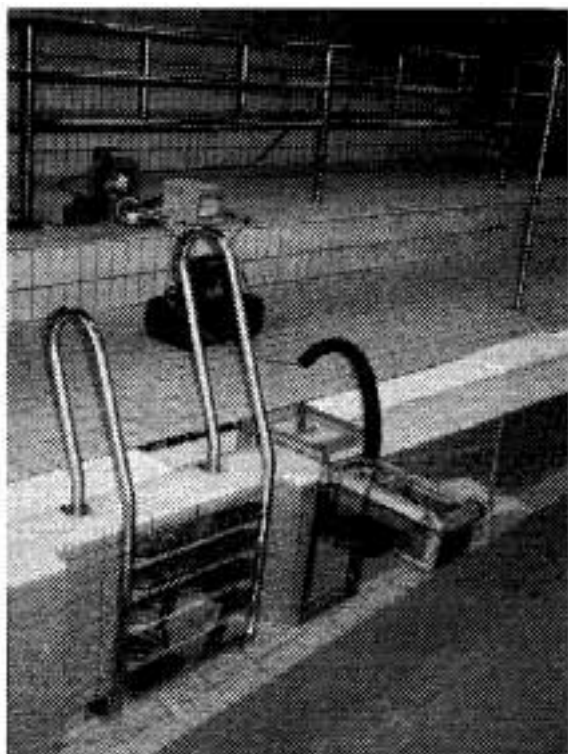Foot touch time (F_t) was defined as the time of the foot touching the wall.

Figure 1 - Photograph shows the video camera head was fixed in a water resistance box and mounted at the side of the wall of the swimming pool.

RESULTS:

Table 1   Kinematic parameters in swimming turn of elite swimmers

Subject	Sex	Stroke	H_t (s)	F_t (s)	D_{out} (m)	T_{out} (s)	AV_{out} (m/s)
1	M	Butterfly	0.57 k0.13	0.29 k0.042	7.25 k0.29	3.37 k0.28	2.16 k0.13
2	M	Butterfly	0.66 k0.091	0.33 k0.06	6.38 k0.14	2.94 k0.093	2.18 k0.079
3	F	Butterfly	0.79 ±0.16	0.43 k0.058	5.44 k0.13	2.59 k0.17	2.10 k0.10
4	F	Butterfly	0.78 k0.08	0.43 k0.070	7.06 k0.24	3.69 k0.17	1.92 k0.033
5	F	Butterfly	0.74 k0.14	0.37 k0.091	5.63 k0.25	2.88 ±0.40	1.97 k0.17
6	M	Breast	0.62 k0.016	0.28 k0.016	8.00 k0.00	4.14 k0.13	1.93 k0.059
7	M	Breast	0.79 k0.23	0.39 k0.044	8.83 k0.29	5.29 k0.28	1.67 k0.093
8	F	Breast	0.69 k0.082	0.41 k0.038	8.38 ±0.48	5.32 k0.15	1.58 k0.087
9	F	Breast	0.48 k0.11	0.35 k0.15	8.00 k0.00	4.82 k0.087	1.66 k0.030

Table 1 shows the distance out (D_{out}), time out (T_{out}), average horizontal speed out (AV_{out}). hand touch time (H_t) and foot touch time (F_t). The average horizontal speed out of male butterfly and breaststroke swimmers ranged from 2.16 rnls to 2.18 rnls and from 1.93 rnls to 1.67 rnls respectively. The average horizontal speed out of female butterfly and breaststroke swimmers ranged from 2.10 rnls to 1.92 m/s and 1.66 m/s to 1.58 rnls respectively.

Table 2   Kinematic parameters in swimming turn of the butterfly and breaststroke finalists in BCG (1982).

Sex	Stroke	D_{out} (m)	T_{out} (s)	AV_{out} (m/s)
M	Butterfly	6.03	2.44	2.48
		k0.51	k0.27	±0.10
F	Butterfly	5.47	2.37	2.32
		k0.37	k0.25	kO.ll
M	Breast	8.39	4.43	1.90
		k0.75	k0.55	kO.ll
F	Breast	7.47	4.00	1.87
		±0.55	k0.40	k0.08

Table 2 shows the average kinematic values of the turning technique employed by the finalists of 100 m butterfly and breaststroke events in 1982 BCG at Brisbane. The average horizontal speed out of the male butterfly and breaststroke BCG swimmers were found to be 2.48 rnls and 1.90 rnls respectively. The average horizontal speed out of the female butterfly and breaststroke swimmers were found to be 2.32 rnls and 1.87 m/s respectively.

DISCUSSION: Compared to BCG, the average horizontal speed out in subject 1 was small (2.16m/s). This may due to the short foot contact time (0.29 s). This will reduce the propulsion power after push-off. To increase the foot contact time, the body should be positioned so that the knee flexion could be increased before push-off. Also, the distance out is relatively large (7.25m) when compared with the BCG result (6.03m). The reduction of the distance out could decrease the deceleration period after turning. This can be achieved by emerging earlier and immediately starting the arm stroke.
Subject 2 could extend the foot touch time (0.33 s) by increasing the flexion of the knee so that propulsion can be improved. As a result, the average horizontal speed out could be increased. Moreover, by observation from the video materials, a lot of air bubbles were generated during the swimming motion. This may be due to a non-streamline form of motion.
The average horizontal speed out of subject 3 was fairly comparable to the BCG. The average horizontal speed out of subject 3 and finalists in BCG were found to be 2.10 rnls and 2.32 rnls respectively.
The average horizontal speed would be increase if the distance out and time out could be reduced in subject 4.
The foot touch time of subject 5 was 0.37 s and should be increased to provide greater impulse so that the average horizontal speed out could be comparable to the BCG result.
The average horizontal speed out of subject 6 was comparable to the result from the BCG. The average horizontal speed out of subject 6 and finalists in BCG were found to be 1.93 rnls and 1.90 rnls respectively.
In subject 7, the hand touch time was 0.79 s and should be reduced. So that the time out could be decreased by early body rotation. Also, a lot of air bubbles were generated during their swimming motion. This may be due to non-streamline form of motion.
The distance out (8.38 m) and time out (5.32 s) were relatively large in subject 8 when compared with the BCG results which were 7.47 m in distance out and 4.00 s in time out. Furthermore, the average horizontal speed out of subject 8 was relatively small. The

reduction of the time out could be decreased by earlier start of the first regular stroke after turning.

The average horizontal speed out of subject 9 was found to be 1.66 m/s which was smaller than the BCG result (1.87 m/s).

CONCLUSIONS: In general, the horizontal speed out in butterfly and breaststroke in BCG swimmers were higher than Hong Kong. Moreover, the time out and distance out of Hong Kong swimmer were longer than BCG swimmers.

The distance out should relate to the speed of swimmer at the moment of emerging and the clean swimming speed. The average horizontal speed out should be comparable to the clean swimming speed so that a smooth transition can be obtained.

The turning motion of swimmer takes place between the moment of first hand contact with the wall and the start of the push-off. The time needed to execute the movement should be reduced to a minimum, while at the same time the swimmer should prepare for the subsequent push-off.

REFERENCES
Arellano, R., Brown, P., Cappaert, J., and Nelson, R. C. (1994). Analysis of 50-, 100-, and 200m freestyle swimmers at the 1992 Olympic Games. *Journal* of Applied Biomechanics, **10,** 189-199.
Chow, J. W., Hay, J. G., Wilson, B. D., and Imel, C. (1984). Turning techniques of elite swimmers. *Journal* of Sports Sciences, **2,** 241-255.
Cross, R. and Wilson, C. (1993). Swimming Teaching and Coaching - Level 2. England: ASA Swimming Enterprises Ltd.
Huellhorst, U, Ungerechts, B. E. and Willimczik, Klaus (1988). Displacement and speed characteristics of the breaststroke turn - a cinematographic analysis. In, Ungerechts, B.E. et al (ed.), Swimming Science *V*, Champaign, I11., Human Kinetics Publishers, p93-98.
Lyttle, A. D., Blanksby, B. A., Elliott, B. C. and Lloyd, D. G. (1998). Optimising Kinetics in the freestyle flip turn push-off. In, Riehle, H. J. and Vieten, M. M. *ISBS* '98 XVI International Symposium on Biomechanics in Sports July *1998*, University of Konstanz, Germany, p. 71-73.
Wilkie, D. and Juba, K. (1996). The Handbook of Swimming. England: Penguin Group.