COMPARISON OF SOME BIOMECHANICS PARAMETERS OF BREASTSTROKE SWIMMERS IN FLUME AND SWIMMING POOL

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The purpose of this study was to compare some parameters of breaststroke swimmers in a swimming pool with those for breaststroke swimming in the flume, to search whether there is some difference between two test circumstances of swimming pool and flume in technical parameters. Four male breaststroke swimmers aged between16 and 18 years were studied. Subjects were required to swim in a 25m pool for best or familiar stroke length and tried to decrease stroke rate, and performed at three minute intervals at speeds ranging from 70% to 100% of the best performance of individuals. Subjects were familiarized to flume swimming on the day prior to be tested, then swam at the same speed based upon conversion from pool in swimming flume. According to testing we found that stroke rate, stroke length and efficiency index for pool and swimming flume at corresponding speeds were similar. Of course, there was as expected significant difference in the stroke rate and stroke length used between subjects to swim at the various speeds.

KEY WORDS: stroke rate, stroke length, aerobic speed, efficiency index.

INTRODUCTION: Shanghai swimming flume (see figure 1) of China provides a controlled environment for in-depth study of swimming. Multiple cameras and “3-line” system placed around the subject provide an environment for technique analysis, Gas analysis equipment can be attached to a swimmer for physiological assessment of extended effort swims. However, the usefulness of the flume is dependent on the study environment providing swimming conditions that are essentially the same as in a pool environment. So the purpose of this study was to compare some technique parameters in breaststroke swimming in the flume with those for swimming in a pool.

Figure 1: Shanghai swimming flume

As we all know the ability to achieve and maintain a velocity over the distance of a race is related to biomechanical factors. Among the important biomechanical factors are stroke rate (SR) :number of stroke cycles per minute and stroke length (SL):distance per stroke cycle. Efficiency index (EI) evaluates the training progress in recent years, which is a very important factor influencing the final performance of swimmers, and the equation is EI=V SL. The main work of this paper is to research some technique difference between swimming pool and flume based upon SR, SL and EI and so on. At present there are 13 swimming flumes in the world. But there is a dearth of reported studies which compare flume with swimming pool. The early study found there is one paper which compared swimming flume to paced swimming pool and found that swimmers used higher SR in swimming flume than in the swimming pool at the same speeds (Hay and do Carmo1995). The swimmers were able to adopt a swimming technique in the flume which exhibited similar SR at the same swim speeds as for swimming pool（Barry Wilson, Hideki Takagi and David Pease）. However, this result is equivocal for the highest speed of flume swimming (1.6 m/s). So it is significant to compare technique parameter in pool with swimming flume.

METHOD:

Subjects:
The subjects for this study were four male breaststroke swimmers. Mean height, body mass and age were 181.25 ± 1.50cm, 72.00 ± 3.60kg, 17.25 ± 0.50 years respectively. They were informed of the nature of the experiments and gave written consent to participate in this study. During the testing period, the subjects completed their daily training programs with reduced intensity and total volume of training.m the reviewers' checklist of the Journal of Science and Medicine in Sport. These items were.

Testing procedure:
Within a 4 weeks training period, requiring swimmers to train in swimming flume two times per week, subjects swam in a 25m pool for best or familiar SL and tried to decrease SR. Swimmers performed at three minutes intervals at speeds ranging from 70% to 100% in 5% increments of the best performance of each person. Subjects were familiarized to flume swimming on the day prior to be tested, then they swim at same speed in swimming flume based on conversion from pool (see table 1).
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Before testing subjects should worm-up in 25m pool for 5 minutes, two cameras were set at 10m and 20m of pool, based upon the time from 10m and 20m situation, we can get average speed, SR and SL and so on. In the flume subjects were required to worm-up at 1.2 m/s for 5 minutes, and lasting time for more than 60 seconds.

Table 1: mean value of each subject in swimming pool

	Swimmer 1	Swimmer 2	Swimmer 3	Swimmer 4
Performance of 100m (s)	73.13	73.31	75.01	74.14
Mean SR (cycle/min)	35.80	32.36	34.09	35.05
Mean SL (m/cycle)	2.04	2.34	2.03	1.97
Mean V（m/s)	1.219	1.262	1.156	1.149
EI (m2/s)	2.487	2.953	2.347	2.458

According to testing we found that SR, SL and EI were not too much different between pool and swimming flume at corresponding speed (see table 2). Now cooperating SR and SL have reached resonance in swimming sports. Some studies (Capelli, Pendergast & Termin,1998;Termin & David,2004; Dekerle et al ,2004) have shown that at maximal V beyond which further increase in SR leads to considerable decrease in SL. In my study this viewpoint was validated, but when V of swimming flume exceeds to 100%, subjects will withdraw from the maintain-point in the flume, or they cannot keep up at the maintain-point exceed to 10 seconds. It means increasing in SR in swimming flume however with decreasing in SL, and the V of subject falls slowly and slowly, on this condition the V is not the maximal velocity. Based upon this parameter we can see that swimmer 2 and 3 are superior to swimmer 1 and 4, because their EI is higher than swimmer 1 and 4. Short stroke rate and longer stroke length will be the main point in training, at the same time keep up the flat time of propulsion.

Table 2 some parameters of each subject in swimming flume and pool

Subject	**V（m/s）**	**Test condition**	**SR （cycle/min）**	**SL （m/cycle）**	**EI （m2/s）**
Swimmer1	42736	Pool	28.19	2.49	2.91
	85%MAS	flume	27.8	2.53	2.95
	46753	Pool	33.84	2.27	2.9
	90%MAS	flume	34.52	2.22	2.85
	14246	Pool	37.88	2.2	3.06
	95%MAS	flume	36.23	2.3	3.2
Swimmer2	43831	Pool	26.53	2.71	3.26
	85%MAS	flume	25.7	2.8	3.36
	46753	Pool	30.77	2.5	3.19
	90%MAS	flume	30	2.56	3.28
	13516	Pool	37.5	2.19	3
	95%MAS	flume	36	2.13	3.13
Swimmer3	42736	Pool	26.17	2.68	3.14
	85%MAS	flume	24.4	2.88	3.37
	46388	Pool	28.36	2.69	3.41
	90%MAS	flume	28.8	2.65	3.36
	13150	Pool	32.56	2.51	3.41
	95%MAS	flume	32	2.55	3.47
Swimmer4	44197	Pool	31.14	2.33	2.82
	85%MAS	flume	33.8	2.18	2.6
	46753	Pool	35.04	2.19	2.81
	90%MAS	flume	32.9	2.33	2.99
	13150	Pool	41.86	1.95	2.65
	95%MAS	flume	37.41	2.18	2.97

It is well know that breaststroke swimmers obtain optimal SL, based on shape, technique and strength of individual. So at a constants SL with each subsequent swim, the SR was increased while trying to maintain the maximal SL. Thereafter the subject was encouraged to increase his SR and not concentrate on his SL, repeat swims with higher SR until there was no further increase in V with increase in SR, under this condition the performance would be heightened. With increasing in SL, leads to considerable increasing in V, when V of the swimming reached the maximal velocity, there will appear some condition: one is fast SR and slow SL, when SR arrives to max. the swimmer will stop or slow down; two is fast SL and slow SR, when SL arrives to max. the swimmer will slow down; three is optimal SR and optimal SL, this situation is the best. Some investigators (Dekerle. et al ,2004; Capelli, Pendergast & Termin,1998) have shown that faster swimmers swim with a longer SL at both slow and fast velocity, but slower SR would demand a greater force for each stroke, endangering a greater local muscular fatigue.

CONCLUSION: According to testing we found that SR, SL and EI were similar for poll and swimming flume at corresponding speeds. But the speed of swimmers is dynamic changed in pool and swimming flume, even speed is controlled in swimming flume, it only shows approximate speed of swimmers. As a whole the technique parameter of pool and swimming flume is conform. Because of lack of subjects, T-testing with SPSS was undertaken.

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