
Biomechanical Study of Fin-swimming and Fins

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The purpose of this study was to determine the biomechanical parameters of elite single-fin fin-swimmers, and to explore the optimum match of body and fin.

The Chinese fin-swimming team is one of the most successful teams in the world. Six male and five female world and national level fin-swimmers served as subjects in the study. In the experiment period (about one year), four tests were made. In every test, each subject performed 3 trials of the activity using his or her maximum effort for swimming 50 or 100 meters in a swimming pool. Only the swims in the section between the 25- and 35-meter marks were analyzed.

Underwater photography was used (60-100 fps) to record all actions of every fin-swimmer. The film was analyzed using a JTK-2 Motion Analyzer, and the raw data was smoothed by digital filtering. The fluid and material mechanical characteristics of fins were determined. Among the 35 parameters determined were fin frequency (FF), fin amplitude (FA), angles of hip and knee (AH, AK), position and velocity of body center (VBC), fin transfiguration ration (FTR), body streamline index (BSI), fin dynamical elastic modulus (FDEM), fin thrust coefficient (FTC), etc. Furthermore, three types of new fin were produced.

TABLE 1

	Male Mean	(SD)	Female Mean	(SD)
FF(hz)	2.25	(0.67)	2.08	(0.05)
FA(m)	0.34	(0.05)	0.31	(0.05)
AH (deg)	155.8	-184.0	156.7	-183.6
AK (deg)	125.5	-181.8	125.7	-181.8
VBC (m/s)	2.56	(0.45)	2.39	(0.04)
FTR (%)	19.2	(6.1)	15.8	(7.2)
FTS (ds)	2.51	(0.65)	2.27	(0.47)

It was found that the fin frequency played a major role in swimming velocity. According to the anatomical analysis, energy analysis and film analysis, it was concluded that it was best to take the waist as the initiating force point. The results revealed differences between men and women. Static flexure and transfiguration in the water of the fins were directly proportional and basic frequency of fins and static flexure or transfiguration ratio in the water were inversely proportional. **During** the 6th Chinese National Games, the majority of fin-swimmers who used the new fins (especially the 3rd form) broke their own records. When the 100 meter swim was used as the standard of achievement, the average decrease in time was 1.52 seconds, and the maximum decrease was 3.31 seconds. The new fins, therefore, were effective. The theoretical calculation based on the mathematical model developed by **Lighthill** for elongated-body locomotion (e.g. fish locomotion) was in accord with the experimental results.