Load Estimation of the Musculoskeletal System of Formula Kitefoil Athletes in Laboratory Settings

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Summary

In this study, the loads acting on the body of a Kitefoil athlete were estimated. Four athletes took part in a laboratory testing, where body position, surface EMG of the back and lower limb muscles as well as the pressure of the feet on the board were measured. Two positions, the most comfortable (*habitual*) and with the highest loads on the trapeze line (*feedback*) were tested. The preliminary results show high loads acting on the leading leg (in the front of the board) and that the differences between the left and right sites might be detected with this type of testing, depending on the athlete's physical conditions.

Introduction

The loads acting on the body of a Kitefoil athlete are the result of many variables, including wind force, competitor's mass and body position. However, it can be assumed that these loads will be higher when the athlete has to counteract the strong wind force that is applied to their body through a line attached to the kite on one side and to the athlete's trapeze on the other. The athlete balances this force by appropriately leaning the body (mainly increasing the angle of flexion in the hip joints) and increasing the pressure of the feet on the board. This causes persistent isometric efforts of the lower and upper limb muscles, with an elevated position of the forearms to manipulate the kite [1]. Due to the fact, that measuring data crucial for the musculoskeletal analysis for this specific group of athletes is very difficult in real conditions (racing on the water), and due to very limited studies in the literature, we provided a laboratory study in order to estimate loads acting on the musculoskeletal system of the Kitefoil athlete.

Methods

Four Kitefoil athletes (one woman aged: 25, height: 164.5 cm, body weight: 71.2 kg and three men aged: 21.7 ± 3.1, height: 173.3 ± 2.1 cm, body weight: 83.3 ± 12.8 kg), competing at international level, took part in the study. Two body positions were tested, *habitual* and *feedback*. The *habitual* position was explained to the athlete as the position most similar to the natural one he or she adopts when swimming straight sections on the water. The *feedback* position was similar to the habitual position, but the athlete's task was to exert as high, as she or he can, force on the trapeze line. The force was measured by Smartlink Nano sailing dynamometer and was displayed for the athlete performing the *feedback* position. It was assumed, that the greatest loads on the athletes body correlate with the greatest load on the trapeze line. On the other hand, it was assumed that the *habitual* position is the most comfortable for the athlete, and therefore generates the least effort and load on the athlete's body. All trials were monitored with the use of BTS Smart motion capture system in order to record position of the body landmarks. Noraxon surface electromyography system was used to record the activation of biceps femoris, rectus femoris, gastrocnemius, and erector spinae muscles. Two small, portable Kinvent platforms were used to measure the pressure of the feet on the board, in the direction perpendicular to the board (Figure 1).

Figure 1: Laboratory setting and *feedback* position of the Kitefoil athlete.

Results and Discussion

Increased load on the leading leg was observed in both body positions. The mean difference between the front and rear leg was 14,8 ± 9,7% BW in *habitual* and 14,6 ± 9,2% BW in *feedback* position. A two-fold increase in muscle activity was noticeable in the *feedback* position, but only for two muscles: gastrocnemius and erector spinae muscles.

Conclusions

Our results suggests, that the load acting on the Kitesurfer body is asymmetrical and higher on the side of the leading leg. In order to increase the load transferred by the trapeze line, athletes activate more calf and back muscles, which should be given special attention during training and pre-season preparation. In the future studies, those data will be implemented for modelling of the loads in the joints and muscles with the use of inverse dynamics methods.

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References

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