

Abstract of Doctoral Thesis

Title : Contribution of trunk movement for horizontal velocity during underwater undulatory swimming: analysis of foot kinematics and vortex generation

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Introduction and purpose

Trunk movement contributes to increasing the horizontal body velocity during underwater undulatory swimming (UUS). This doctoral thesis aimed to investigate the contribution of trunk movement on UUS performance by analyzing kinematics and hydrodynamics.

Characteristics of foot and trunk kinematics on fast swimmers

Kinematic data during UUS was collected for analyzing the trunk kinematics. This study revealed that fast swimmers performed the UUS with greater trunk angular velocity and increased the toes vertical velocity.

The vortex structure is related with the great horizontal UUS velocity

The area and circulation of the generated vortex during UUS was obtained using computational fluid dynamics (CFD), and correlation coefficients between vortex parameters and horizontal UUS velocity were determined. This study showed that the generation of a large vortex with great circulation around the trunk and behind the swimmer is related with great horizontal UUS velocity.

The vortex generation is effective in increasing UUS velocity by trunk movement

The whole-body movement was exchanged between a fast and a slow swimmer using CFD to investigate whether the vortex related with horizontal UUS velocity is generated by the trunk movement, which is in turn related with UUS performance. The large vortex with great circulation around the trunk and the strong vortex behind the fast swimmer were assigned to the slow swimmer. This indicates that the trunk movement during UUS generates a vortex that is related with improved UUS performance.

Conclusion

This doctoral thesis showed that a greater trunk angular velocity during UUS induces an increase in the toe vertical velocity and generates a large and strong vortex around the trunk and behind the swimmer. This indicates that trunk movement indirectly and directly contributes to increasing the horizontal UUS velocity, and improving the trunk movement skills may have the potential to shorten the race time.