Difference of hydrodynamic force on foot between front crawl six-beat and flutter kicking.

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Background

Kick in Butterfly

Two kicks in one stroke

- 1st kick after arm entry
- 2nd kick on push phase

6-beat Front crawl swimming

6 kicks by both legs in one stroke

- 1st, 2nd and 3rd kick?
- Are they same?







To investigate the hydrodynamic differences

between 6-beat kicking in front crawl swimming

and flutter kicking without rolling of the whole body.



Subject

A well-trained male college swimmer

- 1.67 m, 60.0 kg, 22.1 yrs old, 14.1 yrs career
- Best record of 100m Fr. : 53.5 sec
- Specialty: 1500m Fr. and Open water swimming

Trials

25-m swimming under 2 conditions:

1) kicking holding a kickboard



2) front crawl swimming with 6-beat kicking

Measurements

Pressure on feet

- Small pressure sensors
- Both feet
- 3rd MP joint on dorsal and plantar sides

Swimming motion

- Under water camera from swimmer's right side
- 2-dimention DLT method
- Right leg motion on sagittal plane
- Right hand path on sagittal plane 2





Analysis

Difference of pressures on foot

- $\Delta P = P_{dorsal} P_{plantar}$
- To evaluate hydrodynamic force on the swimmer's foot.



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Motion analysis

- Horizontal position of hip
 -> Mean swimming velocity
- Vertical position of joints of right leg
- Hand path -> Stroke phases













6-beat trials



Mean swimming velocity





Results + $\Delta P = P_{dorsal} - P_{plantar}$ 15 trial: 1st kick 15 trial: 2nd kick 15 [trial: 3rd kick Right ... Left Right ... Left Right ... Left 10 10 10 APressure [kPa] APressure [kPa] ∆Pressure [kPa] 5 5 -5 -10^L____61 -10-1062 63 29 30 31 25 26 27 Time [sec] Time [sec] Time [sec] 15 trial: 1st 6beat 15 [trial: 2nd 6beat 15_[trial: 3rd 6beat] Right ... Left Right ... Left Right ... Left 10 10 10 APressure [kPa] APressure [kPa] APressure [kPa] 5 -10-10-1021 22 23 24 25 23 15 16 17 Time [sec] Time [sec] Time [sec]





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Conclusions

 There are suggested to be hydrodynamic differences between kicking without whole-body rolling and six-beat kicking with the rolling in front crawl swimming.

• The whole-body rolling would affect kicking motion and produce different hydrodynamic forces on the swimmer's feet in six-beat front crawl swimming.

Thank you for your kind attention.