The importance of sagittal kick symmetry for underwater dolphin kick performance

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Basic Mechanics

• Cyclic motion
  – Up-peak
  – Down-peak

• 2 Distinct Phases
  – Downkick (DK)
  – Upkick (UK)
Rationale

• Experienced swimmers shed large vortices during DK & smaller vortices in UK phases; inexperienced swimmers shed small vortices during DK phase and none during UK (Arellano, 1999; Arellano et al., 2000)

• Dolphins/cetaceans perform symmetrical DK & UK phases (Ungerechts, 1983; Von Loebbecke et al., 2009a; Von Loebbecke et al., 2009b)
Purpose

To evaluate the kinematics of DK and UK phases and how symmetry between DK and UK is related to performance
Methods

- 15 male swimmers from University and Club
  Age = 21.5±3.2 yrs,
  Experience = 11.4 ± 5.6 yrs

- Filmed 3 trials of 15m UDK at max effort

- Digitized 12 landmarks
Methods

Measured & Calculated:
• vertical joint amplitudes & velocities,
• horizontal CM displacements & velocities,
• joint angles, & kicking frequencies

Each variable determined for whole kick cycle, DK & UK

Symmetry ratios determined for each variable (DK/UK)

Correlated mean horizontal velocity ($V_x$) with all DK & UK values, and with symmetry ratios
Results

![Graph showing the z-position vs. x-position for different swimmers. The graph includes three curves: the slowest swimmer, the median swimmer, and the fastest swimmer. The slowest swimmer curve is the farthest to the right, the median swimmer is in the middle, and the fastest swimmer is the closest to the left.]
Fastest: $V_x = 1.84 \text{ m/s}$  

Median: $V_x = 1.67 \text{ m/s}$  

Slowest: $V_x = 1.30 \text{ m/s}$
Additional Findings
Limitations
Conclusions

• Kick symmetry highly related to UDK performance
  – Those who perform UK well tend to be faster at UDK

• Factors contributing to UK performance...
  – Peak vertical toe velocity
  – Hyperextended knees and ankles at start of UK, less knee flexion at end of UK
Further Study

• Low hand amplitudes related to performance
  – Importance of thoracic mobility
  – Drag reduction?

• Bilateral asymmetries

• Evidence of trunk undulation
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