Mass centre speed fluctuations of single arm amputee front crawl swimmers at sprint and distance pace

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Introduction

- To swim effectively, swimmers must coordinate complex body movements to maximise propulsion and minimise resistance (drag).
- Propulsion and resistance will both fluctuate within the stroke cycle (but not easily measured).
- The resulting intra-cyclic speed (ICS) fluctuations can be assessed using, e.g., a velocity meter or 3-D motion analysis.

Taken from Payton and Wilcox (2006)
Introduction

• At or below 1.1 m·s⁻¹, single arm amputees can use their affected-arm to generate propulsion and increase intra-cyclic speed.
• Above 1.2 m·s⁻¹, single-arm amputees might not be able to rotate their affected-arm fast enough to generate propulsion.

PURPOSE
To determine the influence of the backward speed of the hand (unaffected-limb) and stump (affected-limb) on ICS and whether ICS fluctuations differ between sprint and distance pace.

Taken from Lecrivain et al. (2008)
Methods

Participants

• Ten (2 ♂, 8 ♀) highly-trained swimmers (16.8 ± 3.3 yrs; 1.68 ± 0.09 m; 63.9 ± 14.2 kg; 50 m PB: 33.1 ± 3.1 s).

• Elbow level single-arm amputees.

• IPC S9 class for front crawl.

Trials

• Two 25 m front crawl trials.

• One at 50 m pace, one at 400 m pace.

• No breathing within a 10 m test section.
Methods

Data Collection

• Calibrated performance volume.
• Two above-water and four below-water video cameras (50 Hz).

Data Processing

• One complete stroke cycle.
• Thirteen-segment full body model.
• Manually digitised 18 landmarks to obtain 3-D coordinates.
Data Processing

Individualised body segment parameters determined using Elliptical Zone Method.

Photographs of participant’s frontal and sagittal planes for use with the “eZone” software programme.
**Methods**

**Dependent Variables**
- Mass centre speed.
- Intra-cyclic speed fluctuation
- Backward speed of hand and stump.

**Data Analysis**
- Means and standard deviations.
- Inter-individual analysis.
- ANOVA ($p < .05$) to compare each dependent variable (between pace and between arm).
Backward speed of hand and stump

Fig 1. Mean (± SD) backward speed of the hand (unaffected-arm) and stump (affected-arm) during the Pull and Push phases, at 50 m and 400 m pace.

a Denotes significant differences ($p < .01$) between phases.

b Denotes significant difference ($p < .05$) between 50 m and 400 m pace.
Fig 2. Mean (± SD) mass centre speed, expressed as a percentage of mean swimming speed at the end of the Glide, Pull and Push phases of the unaffected- and affected-arm at 50 m and 400 m pace.

a Denotes significant differences ($p < .01$) between phases.
b Denotes significant difference ($p < .05$) between 50 m and 400 m pace.
Intra-cyclic speed fluctuation

ICS Fluctuation

• ICS changed more during pull of unaffected arm compared to pull of affected arm.

• ICS Fluctuation: \( \frac{(\text{max-min})}{\text{mean}} \times 100\% \)
  19.3% (400 m Pace)
  19.7% (50 m Pace)

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Fig 3. Intra-cyclic speed fluctuations, as a percentage of mean swimming speed, for eight female (♀) and two male (♂) arm amputee front crawl swimmers swimming at 50 m and 400 m pace. G.M. = Group Mean (± SD).

\(^a\) Denotes significant difference \((p < .01)\) between affected- and unaffected-side.
Summary and Conclusion

- Amputees’ mean intra-cyclic speed fluctuation (~19%) did not differ between sprint and distance pace.
- Amputees were effective at increasing their swimming speed with their unaffected-arm, but not so with their affected-arm.
- The final backward push of the hand should be executed at high speed to successfully generate propulsion.
- The affected-arm appears not be able to generate effective propulsion, particularly when swimming at high speed.
Thank you for your attention

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