EFFECT OF THE REAR FOOT AND BACK PLATE IN THE SWIMMING START PERFORMANCE

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Summary

Introduction

1. Grab start and Kick Start: Differences and similarities
   1.1. Characteristics of the body position of the grab start and kick start
   1.2. Kinematic parameters
   1.3. Analysis of the temporal parameters

2. Angular momentum in the Kick Start
   2.1. Characteristics of the angular momentum in the block phase
   2.2. Angular momentum in the entry phase
Introduction

Three techniques are the most popular:

## Introduction

**Contradictory results**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>GRAB START</th>
<th>TRACK START</th>
<th>KICK START</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reaction time</td>
<td></td>
<td></td>
<td>&lt; reaction time</td>
</tr>
<tr>
<td>Block time</td>
<td></td>
<td></td>
<td>&lt; block time</td>
</tr>
<tr>
<td>Flight time</td>
<td></td>
<td></td>
<td>&gt; average horizontal force</td>
</tr>
<tr>
<td>Take-off angle</td>
<td></td>
<td></td>
<td>&gt; take-off velocity</td>
</tr>
<tr>
<td>Entry angle</td>
<td></td>
<td></td>
<td>&lt; T5m-7.5m</td>
</tr>
<tr>
<td>Flight distance</td>
<td></td>
<td></td>
<td>&lt; T10m-T15m</td>
</tr>
</tbody>
</table>

**Superiority of the Kick Start**

- Beretič, Durović & Okičić (2012);
- García-Hermoso et al. (2013);
- Honda et al. (2010);
- Nomura, Takeda & Takagi (2010);
- Ozeki, Sakurai, Taguchi & Takise (2012);
- Vint et al. (2009)
GRAB START vs KICK START

Biel, Fischer & Kibele (2010)

\[ \downarrow \]

< block time

> horizontal take-off velocity

< 7.5m time

Why do we have to compare them?

To know the differences due to the back plate and the feet position

\[ \downarrow \]

Key points of the kick start
Angular momentum = angular velocity x momentum of inertia

\[ H (\text{Kg.m}^2/\text{s}) = \omega \ (\text{rad/s}) \times I \ (\text{Kg.m}^2) \]
\[ I \ (kg.m^2) = m \ (kg) \times r^2 \ (m) \]

\[ \omega \ (\text{rad/s}) = d\Theta \ (\text{rad}) \times dt \ (s) \]

Smaller momentum of inertia
Higher angular velocity

Bigger momentum of inertia
Lower angular velocity
Introduction

To produce angular momentum is required an external force (torque/momentum of force)

\[ H = \int M \ (N \cdot m) \ . \ dt (s) \]

\[ H = (F \cdot d) \ dt \]
Introduction

AXIS OF ROTATION

Longitudinal axis

Transversal axis
Angular momentum determines the entry position into the water

Flat Start
↓
Smaller entry angle
↓
Flat Start technique with lower angular momentum

Pike Start
↓
Longer entry angle
↓

Vantorre et al. (2010)
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1.1. Characteristics of the body position of the grab start and kick start

9 swimmers of the Spanish National Swimming Team
1.1. Characteristics of the body position of the grab start and kick start

**Shoulder angle**
- **GS**: $105.75^\circ$
- **KS**: $103.85^\circ$

**Hip angle**
- **GS**: $26.91^\circ$
- **KS**: $24.42^\circ$

**Height CM**
- **GS**: $1.33 \pm 0.03$ m
- **KS**: $1.33 \pm 0.03$ m
1.1. Characteristics of the body position of the grab start and kick start

**Shoulder angle**

- **Height CM**
  - GS: 1.11 ± 0.08 m
  - KS: 1.16 ± 0.08 m

- **Shoulder angle**
  - GS: 130.31°
  - KS: 111.07°

**Hip-front leg angle**

- GS: 139.66°
- KS: 139.94°

**Hip-rear leg angle**

- GS: 139.66°
- KS: 172.16°
1.1. Characteristics of the body position of the grab start and kick start

**Shoulder angle**

- GS: 165.42°
- KS: 166.62°

**Height CM**

- GS: 0.67 ± 0.04 m
- KS: 0.71 ± 0.34 m

**Hip-front leg angle**

- GS: 154.24°
- KS: 165.16°

**Hip-rear leg angle**

- GS: 154.24°
- KS: 175.32°
1.2. Kinematic parameters

Kick start reaches the same distance regarding the grab start in 0.18s less.

<table>
<thead>
<tr>
<th>Flight Phase</th>
<th>Block Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS</td>
<td>KS</td>
</tr>
<tr>
<td>VyCM (m/s)</td>
<td>-1.77 ± 0.09</td>
</tr>
<tr>
<td>VxCM (m/s)</td>
<td>4.05 ± 0.21*</td>
</tr>
<tr>
<td>VrCM (m/s)</td>
<td>4.46 ± 0.33*</td>
</tr>
</tbody>
</table>

Kick start reaches the same distance regarding the grab start in 0.18s less.
1.2. Kinematic parameters

**1. GRAB START AND KICK START: DIFFERENCES AND SIMILARITIES**

- **Take-off hands off hands**
- **Horizontal Acceleration (m/s²)**
  - GS: 11.81 ± 2.05 m/s²
  - KS: 8.97 ± 1.02 m/s²

![Graph showing horizontal acceleration over time with GS and KS lines]
## 1.3. Analysis of the temporal variables

<table>
<thead>
<tr>
<th></th>
<th>Grab Start</th>
<th>Kick Start</th>
<th>5m Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Take-off Hands</strong></td>
<td>$0.51 \pm 0.04$ s</td>
<td>$0.38 \pm 0.07$ s</td>
<td>$1.71 \pm 0.13$ s</td>
</tr>
<tr>
<td><strong>Block Time</strong></td>
<td>$0.83 \pm 0.07$ s</td>
<td>$0.66 \pm 0.59$ s</td>
<td>$1.56 \pm 0.15$ s</td>
</tr>
<tr>
<td><strong>Flight Time</strong></td>
<td>$0.24 \pm 0.05$ s</td>
<td>$0.22 \pm 0.49$ s</td>
<td>$0.15$ s</td>
</tr>
<tr>
<td><strong>Entry Time</strong></td>
<td>$1.07 \pm 0.06$ s</td>
<td>$0.89 \pm 0.06$ s</td>
<td>$0.18$ s</td>
</tr>
<tr>
<td><strong>5m Time</strong></td>
<td>$1.71 \pm 0.13$ s</td>
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2.1. Characteristics of the angular momentum in the block phase

36 elite swimmers, Germany National Swimming Team and Spanish National Swimming Team.

**OBJECTIVE:** cluster analysis to identify the different profiles of angular momentum produced in the block phase.
2.1. Characteristics of the angular momentum in the block phase

Collaboration with Sebastian Fischer & Armin Kibele. Institute for Sports and Sport Science, University of Kassel.
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2.2. Angular momentum in the entry phase

OBJECTIVE: to analyze the characteristics of the entry phase regarding the different profiles obtained in the production of the angular momentum in the block phase.
2.2. Angular momentum in the entry phase

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2.2. Angular momentum in the entry phase

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THANK YOU FOR YOUR ATTENTION
References

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Ozeki, K., Sakurai, S., Taguchi, M., & Takise, S. (2012). Kicking the back plate of the starting block improves start phase performance in competitive swimming. In E. J. Bradshaw, A. Burnett & P. A. Hume (Eds.), 30th annual conference of the international society of biomechanics in sports (pp. 373-376). Melbourne, Australia.
