Wheelchair tennis skill development, court movement and physiological cost: effects of organised practice

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Wheelchair tennis: characteristics...

Adequate court mobility is required

- Poor movement
- Poor court positioning
- Timing and shot execution
- Errors and/or reduced rally duration

Dyrbus (2012).
Wheelchair tennis: the racket as a constraint...
Wheelchair tennis: the racket as a constraint...

Negative impact on speed and acceleration

Goosey-Tolfrey and Moss (2005)

Without a racket:

More effective hand rim contact = more effective force production = higher speeds

de Groot et al. (2016)
Wheelchair tennis: characteristics...

Elite players are more capable of navigating the court surface...

- Distance
- Speed

Figure 4 — Rank-by-result interaction of tennis match-play speed ($V_{\text{max}}$, $V_{\text{avg}}$). *Significant main effect for rank ($P < .05$).
Wheelchair tennis: characteristics...

Elite players are more capable of navigating the court surface...

- **Distance**
- **Speed**

  ... increasing propulsion speed should enable enhanced court-movement and positioning

  ... more able to cope with the challenges of match-play

Sindall et al. (2013).
Wheelchair tennis: characteristics...

Self efficacy (SE) is a function of skill level

- SE is higher in elite AB tennis players than low-skill counterparts

Neil et al. (2006)
Wheelchair tennis: characteristics...

Self efficacy (SE) is a function of skill level

- SE is higher in elite AB tennis players than low-skill counterparts

Neil et al. (2006)

- Positive perceptions of anxiety control
- Positive performance outlook

Hanton et al. (2003)
Wheelchair tennis: characteristics…

Self efficacy (SE) is a function of skill level

- SE is higher in elite AB tennis players than low-skill counterparts

  Neil et al. (2006)

  - Decreased perceptions of anxiety control
  - Problems with focus and concentration
  - Debilitating performance effects

  Hanton et al. (2003)
Wheelchair tennis: characteristics...

Novel approaches for increasing SE are merited

- Improved mechanical efficiency in short periods of practice
  - Vegter et al. (2013)
- Improvements in chair use and problem-solving
  - Sakakibara et al. (2013)

Low skill groups

PRACTICE

- Specific to tennis
- Considers the effects of racket holding
- Can court-movement and self efficacy be increased using R / NR practice?
Purpose of the study

Determine possible differences in court-movement, physiological cost and self-efficacy in match-play following practice and racket-holding.
Methodology

Participants

- n = 16 (M = 12, F = 4) able-bodied participants
- No prior wheelchair propulsion experience
- No prior wheelchair tennis playing experience
- Allocated match-play opponent
- Random assignment to racket (R) or no racket (NR) practice
# Methodology

## Testing procedure

<table>
<thead>
<tr>
<th>Duration</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-min</td>
<td>Warm up - on court (no racket)</td>
</tr>
<tr>
<td>60-min</td>
<td>Match-play (1)</td>
</tr>
<tr>
<td>40-min</td>
<td>Organised Practice (R)</td>
</tr>
<tr>
<td></td>
<td>Organised Practice (NR)</td>
</tr>
<tr>
<td>60-min</td>
<td>Match-play (2)</td>
</tr>
</tbody>
</table>
Methodology

Testing procedure – Physiological profiling

Graded Exercise Test

- 4 to 6 bouts submaximal exercise
  3-min @ 15 to 20W increments

5-min Rest

Peak Exercise Test

- Bouts of exercise to volitional exhaustion
  1-min @ 15 to 20W increments

Measures: HR, expired air for oxygen uptake, blood lactate and differentiated RPE
Methodology

Testing procedure – Match-play bouts (1) & (2)

- Likely recreational conditions
- Continuous, competitive play
- Green LCB

Measures:
- Court movement variables
- Physiological variables
- Self efficacy
Methodology

Testing procedure – Organised practice

1. **Down-the-mountain.** 
   Bout 1: Gentle push from A to B. Increase speed gradually from B to C. Turn at C, sprint to A (2 mins 45 secs). 
   Bout 2: Start at B. Gentle push to A. Increase speed to D. Sprint to B (2 mins 45 secs).

2. **Park-the-car.** 
   Bouts 1 & 2: Start at A. Sprint behind the baseline. Turn 90 degrees and stop at P (brake sharply). Reverse out of marked area beyond the baseline, turn 90 degrees, and sprint along the baseline before turning 90 degrees and parking in Q. Reverse out of Q, turn 90 degrees and sprint back along baseline to P.

3. **Through-the-gate.** 
   Bouts 1 & 2: Start at S. Push through G, then through any marker (A, B, C or D). Back to G, then to any other marker, but not one directly in a straight line (ie. a push to A cannot be followed by a push to C). Finish at S.

4. **Agility.** 
   Bouts 1 and 2: Begin at P facing the net. Coach shouts positions (1 to 8). Player must react, turn and sprint to the number marker, returning to P at speed.

5. **Sprint-salmon-reverse.** 
   Bout 1: Start at A. Sprint to B. Turn and sprint to C. Slalom through markers to D. Reverse the chair back to E. Turn and sprint to A. 
   Bout 2: Repeat in the opposite direction.

6. **Two-push-salmon.** 
   Bout 1: Start at A. Sprint to B (only two pushes permitted between cones). 
   Bout 2: Repeat, starting at B.

7. **Half-court-map.** 
   Bout 1: Begin at the Start position facing the net. Tennis court markings outline the course to be taken. 
   Bout 2: Repeat starting at the End position.

8. **Box-command.** 
   Bouts 1 & 2: Begin at P, facing the coach. Coach shouts shot type (volley, backhand, forehand, lob). Player turns towards the command and makes one powerful push to leave P. On leaving P, player brakes to stop dead, and reverses back to P. Player should now remain facing the same way as the direction he / she reversed from. Player is ready for the next command.

Newbery et al. (2010)
Methodology

Data analysis

1. Combined effect of organised practice and racket strategy on match-play:
   • Separate 2 x 2 (practice by racket) mixed measures ANOVAs
   • $\eta^2_p$ for effect size

2. Effect of racket holding during practice:
   • Independent t-tests
   • Cohen’s $d$ for effect size
Results

1. Combined effect of practice and racket strategy on match-play

No significant *practice* by *racket* interaction effects

Main effects for *practice* were significant

Main effects for *racket* were not significant
Results

1. Combined effect of practice and racket strategy on match-play

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**Main effects for practice were significant**

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## Results

### 1. Combined effect of practice and racket strategy on match-play

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<th><em>P</em></th>
<th>η² partial</th>
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<tr>
<td>Overall distance (m·min⁻¹)</td>
<td>34.5 (6.9)</td>
<td>37.5 (6.9)</td>
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<td>Forwards distance (m·min⁻¹)</td>
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<td>12.6 (1.4)</td>
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<td>Peak speed (m·s⁻¹)</td>
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Results

2. Effect of racket holding during practice

Court-movement and physiological variables

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<thead>
<tr>
<th>Variable</th>
<th>t</th>
<th>P</th>
<th>d</th>
<th>ES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total distance</td>
<td>-2.957</td>
<td>0.010</td>
<td>1.48</td>
<td>Very large</td>
</tr>
<tr>
<td>Average speed</td>
<td>-2.956</td>
<td>0.010</td>
<td>1.46</td>
<td>Very large</td>
</tr>
<tr>
<td>Forwards distance</td>
<td>-2.862</td>
<td>0.013</td>
<td>1.43</td>
<td>Very large</td>
</tr>
<tr>
<td>%HR_L</td>
<td>-2.430</td>
<td>0.029</td>
<td>1.22</td>
<td>Large</td>
</tr>
<tr>
<td>Peak speed</td>
<td>-2.391</td>
<td>0.031</td>
<td>1.19</td>
<td>Large</td>
</tr>
<tr>
<td>Reverse distance</td>
<td>-2.262</td>
<td>0.040</td>
<td>1.13</td>
<td>Large</td>
</tr>
</tbody>
</table>

Higher values attained during NR practice
## Results

### 2. Effect of racket holding during practice

#### Energy expenditure (EE)

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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>R</td>
<td>NR</td>
<td>t</td>
<td>P</td>
<td>d</td>
</tr>
<tr>
<td><strong>Total kcal</strong></td>
<td>kcal</td>
<td>95 (38)</td>
<td>141 (63)</td>
<td>1.770</td>
<td>0.098</td>
<td>0.88</td>
</tr>
<tr>
<td><strong>Relative kcal·min⁻¹</strong></td>
<td>kcal·min⁻¹</td>
<td>4.0 (1.6)</td>
<td>5.9 (2.6)</td>
<td>-1.770</td>
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</table>

*Higher values attained during NR practice*

*Target duration: 76 to 88 min (R) vs. 51 to 60 min (NR)*
Results

2. Effect of racket holding during practice

Time spent in individual speed zones
Discussion

• Increased court movement, but no change in physiological variables

Practice-induced changes in chair skills increasing mechanical efficiency...

• Racket strategy not a factor...

... offset likely physiological consequences of increased movement activity

• Ball to racket contact

Characteristics of R and NR practice

NR - EE & health outcomes

The racket as a constraint
Acknowledgements

John P. Lenton¹, Barry S. Mason¹, Keith Tolfrey¹, Rory A. Cooper², Kathleen A. Martin Ginis³ and Victoria L. Goosey-Tolfrey¹

¹The Peter Harrison Centre for Disability Sport, School of Sport, Exercise, and Health Sciences; Loughborough University; Loughborough; UK

²Human Engineering Research Laboratories, Rehabilitation Research and Development Service, Department of Veterans Affairs, and Departments of Rehabilitation Science and Technology and Physical Medicine & Rehabilitation; University of Pittsburgh; USA.

³University of British Columbia, ICORD; Canada.