Feasibility of using the Leap Motion hand gesture sensor for tracking wrist fracture physiotherapy

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Background

• Patients want to be in control of their health
• The NHS needs patients to self-manage their health and recovery
• Requires:
  ▪ Education
  ▪ Information
  ▪ Support in the community

Empowering patients:
...we will do more to support people to manage their own health...
Background

• Physiotherapy and Rehabilitation
  ▪ Relies on self-management of exercises
  ▪ Outside of the clinic

Can technology be used to educate, inform and support self-management of physiotherapy and rehabilitation?
Distal radius [Wrist] fracture physiotherapy

- Most common type of fracture in adults
- Regaining mobility important

Physiotherapy

- Outpatient and self directed
- Relies on patient compliance
- Understanding of exercises “fear of pushing it”
- Poor compliance associated with stiffness and failure to regain full function

‘Low cost’ consumer technologies

Accelerometer based tracking

Optical tracking

Virtual/Augmented Realities
Leap Motion: Hand gesture tracking

Accurately track hand movements

Very low cost: £30

Plug and play

Programmable

Research Question: Can Leap Motion be used to accurately track wrist fracture physiotherapy exercises?
Experimental setup

Hand and forearm orientation data stream from Polhemus Liberty sensors

Hand position and orientation data stream from Leap Motion IR depth sensor

Liberty sensors on forearm and back of hand

Leap Motion visual field

Leap Motion sensor
Methods

- 11 Healthy participants (5 analysed)
- Six wrist movements
- Five reps of each movement
- Four trials per movement pair
- Left and right hands

- Tracked with Leap Motion and Polhemus Liberty
- Finger movements (and grip force) not tested
Example data

**Ulnar** (negative) and **Radial** (positive) Movements

**Leap measure**: Blue, Red peak markers

**Liberty measure**: Black, Green peak markers
Results: Mean peak angle

<table>
<thead>
<tr>
<th>Movement</th>
<th>Leap</th>
<th>Liberty</th>
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<tbody>
<tr>
<td>Extension</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>Flexion</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>Radial</td>
<td>40</td>
<td>*</td>
</tr>
<tr>
<td>Ulnar</td>
<td>30</td>
<td>*</td>
</tr>
<tr>
<td>Pronation</td>
<td>50</td>
<td>*</td>
</tr>
<tr>
<td>Supination</td>
<td>120</td>
<td>*</td>
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</tbody>
</table>

* p<0.05
Results: Consistency of peak angle measure

<table>
<thead>
<tr>
<th></th>
<th>Leap</th>
<th>Liberty</th>
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<tbody>
<tr>
<td>Mean</td>
<td></td>
<td></td>
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<tr>
<td>Angle (deg)</td>
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<tr>
<td>Extension</td>
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<tr>
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<tr>
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<td>Supination</td>
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</table>

p<0.05
Discussion

• Leap Motion can track 5 out of 6 wrist exercise pairs with reasonable success:
  ▪ Supination movement not successfully tracked
  ▪ Average of 28% error (exc. supination) relative to Polhemus Liberty
  ▪ Much larger variability in measurements

• Fine for basic home based tracking:
  ▪ Provide feedback on approx ROM
  ▪ Count repetitions
  ▪ Could be linked to diary, time history etc.
Future work

• Combine with other sensors to improve function:
  ▪ Finger
  ▪ Grip force

• Improved hand models? Bespoke or software updates

• Develop software: patient evaluation
Thank you

Any Questions