Introduction

- Clinical goniometry is important longitudinal assessment tool used by hand surgeons and therapists.
- Carter, et al previously reported most reliable manual goniometric techniques for measuring wrist ROM.
- Objective: Assess reliability of clinical goniometry as compared to measurements based on photographs taken by subjects at home.
- Hypothesis: Patient-performed photography-based wrist goniometry would be as reliable as traditional physician-performed goniometry.

Materials and Methods

- Approved by the HSS IRB (2013-129)
- Six (6) healthy, adult volunteer subjects
- ROM measurements using 1º goniometer
  - Active & passive wrist flexion/extension, active wrist radial/ulnar deviation, active forearm pronation/supination
- Subjects given instruction sheet (Figure 3) → digital photographs taken at home
- Blinded photograph-based ROM measurements
- Clinical vs. radiographic measurement agreement calculated via intraclass correlation coefficient (ICC)
  - “Good” agreement defined as 0.70 to 0.79 and “Excellent” as 0.80 to 0.99.

Results

- Photograph-based measurements for active wrist radial/ulnar deviation and flexion/extension were accurate and had 8° or less difference compared to clinical measurements (Figure 1).
- Passive wrist flexion/extension measurements displayed slightly greater variability, but were still reliable.
- Pronation and supination measurements poorly correlated with clinical measurements.
- ICC demonstrated “Good” and “Excellent” agreement for all measurements except pronation and supination (Figure 2).
- Statistically significant agreement (p < 0.05) was achieved for ulnar deviation and active/passive wrist flexion, whereas trend towards significance (p 0.05 to 0.10) was achieved for radial deviation and active/passive wrist extension.

Figure 1: Photograph-based vs. clinical ROM measurements

Mean of absolute value differences between clinical and photograph-based ROM measurements (boxes) + two standard deviations

Figure 2: Reliability analysis

<table>
<thead>
<tr>
<th>Measurement</th>
<th>ICC</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radial deviation</td>
<td>0.790</td>
<td>0.056</td>
</tr>
<tr>
<td>Ulnar deviation</td>
<td>0.956</td>
<td>0.002*</td>
</tr>
<tr>
<td>Pronation</td>
<td>0.460</td>
<td>0.258</td>
</tr>
<tr>
<td>Supination</td>
<td>0.278</td>
<td>0.365</td>
</tr>
<tr>
<td>Wrist flexion (active)</td>
<td>0.911</td>
<td>0.009*</td>
</tr>
<tr>
<td>Wrist extension (active)</td>
<td>0.763</td>
<td>0.070</td>
</tr>
<tr>
<td>Wrist flexion (passive)</td>
<td>0.930</td>
<td>0.006*</td>
</tr>
<tr>
<td>Wrist extension (passive)</td>
<td>0.724</td>
<td>0.092</td>
</tr>
</tbody>
</table>

Figure 3: Pictures from instruction sheet provided to subjects

Active wrist flexion (left) & extension (right)

Passive wrist flexion (left) & extension (right)

Forearm pronation (left) & supination (right)

Ulnar (left) & radial (right) deviation

Conclusions

- First study to evaluate photography-based goniometry in joint with biaxial plane of motion (versus previous studies in knee or elbow)
- First study in which subjects take the photographs used for measurements
- Key findings:
  - Patient-performed photography-based goniometry is accurate and reliable for active/passive wrist flexion/extension and active radial/ulnar deviation
  - Pronation and supination not accurately measured
- Establishes protocol allowing accurate and reliable wrist ROM measurements without direct physician contact
  - Cost & convenience implications
- Limited by small sample size
- Next steps:
  - Ongoing patient study (n = 50) based on power analysis

References


Acknowledgments

Joe Nguyen (Department of Biostatistics, HSS) for statistical support.