Validation of a Novel Hip Arthroscopy Simulator

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DISCLOSURE

• Robert Westermann MD is an unpaid consultant for Smith & Nephew
• No other conflict of interests to disclose
INTRODUCTION

Hip arthroscopy is a technically challenging procedure with a prolonged learning curve. On average, residents only assist with or perform five hip arthroscopies during their training.\(^1\)

With limited opportunity for in vivo skill development, the use of virtual reality arthroscopic simulators has become increasingly popular in recent years.

While shoulder and knee simulators have been extensively validated in the literature for construct validity, there is a paucity of literature regarding the validation of novel hip arthroscopy simulation.
The purpose of this study was to establish construct validity of a virtual reality arthroscopy simulator system by VirtaMed ArthroS™ (Zurich, Switzerland) for hip arthroscopy.

**Hypothesis:**

Experienced arthroscopists will perform significantly better than intermediate or novice arthroscopists on all measured metrics including camera path length, time, cartilage injury, and composite score.
PARTICIPANTS

20 trainees and one fellowship trained sports medicine surgeon without experience in virtual reality hip arthroscopy were prospectively enrolled.

Participants who performed <25 arthroscopies, 25-74 arthroscopies, and >75 arthroscopies prior to the study were stratified as novice (n=8), intermediate (n=9), and expert (n=4), respectively. Previous number of arthroscopic hip procedures performed was also obtained at the time of enrollment.
## PARTICIPANTS

<table>
<thead>
<tr>
<th>Participant Experience and Characteristics</th>
<th>Novice (n=8)</th>
<th>Intermediate (n=9)</th>
<th>Expert (n=4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Arthroscopic Experience, (range)</td>
<td>0.25 (0-2)</td>
<td>36 (28-50)</td>
<td>395 (80-1200)</td>
</tr>
<tr>
<td>Mean Hip Arthroscopy Experience, (range)</td>
<td>0 (0)</td>
<td>4 (0-15)</td>
<td>52 (1-200)</td>
</tr>
<tr>
<td>Handedness (Right: Left)</td>
<td>7:1</td>
<td>7:2</td>
<td>4:0</td>
</tr>
<tr>
<td>Year in training *</td>
<td>4:4 (MS4: PGY-1)</td>
<td>8:1 (PGY2/3: PGY4/5)</td>
<td>3:1 (PGY4/5: Prof.)</td>
</tr>
</tbody>
</table>

*MS4=Fourth-year medical student; PGY-1=Orthopedic Intern; PGY2/3=Junior orthopaedic resident; PGY4/5=Senior orthopedic resident; Prof.=Fellowship trained sports medicine surgeon
METHODS- Simulation

Participants were introduced and oriented to the simulator by an individual not affiliated with the study. Pre-established anterolateral and mid-anterior portals were utilized.

Anatomic objectives for visualization during arthroscopy included: acetabular fossa, ligamentum teres, posteromedial acetabulum and labrum, anterior acetabulum and labrum, anterolateral acetabulum and labrum, ligamentum teres, posterior transverse ligament, anterior transverse ligament, superior articular cartilage, and lateral labrum.

Composite score, procedure time, camera path length, iatrogenic femoral head cartilage injury, acetabular cartilage injury, and number of fluoroscopic images taken was automatically recorded by the simulator.
METHODS- Statistical Analysis

One-way ANOVA tests were used to compare the metrics measured by the simulator between the three cohorts with significance set at $p<0.05$. Pearson’s correlation coefficients were utilized to assess correlation between measured metrics and participant characteristics.
## RESULTS

<table>
<thead>
<tr>
<th>Measured Metrics</th>
<th>Novice</th>
<th>Intermediate</th>
<th>Expert</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite Performance Score (score, ± SD)</td>
<td>114.5 ± 14.91</td>
<td>146.44 ± 17.17</td>
<td>151.5 ± 17.18</td>
<td>&lt;0.002*</td>
</tr>
<tr>
<td>Time to Simulation Completion (seconds, ± SD)</td>
<td>321.75 ± 67</td>
<td>202.44 ± 36.3</td>
<td>181.69 ± 24.5</td>
<td>&lt;0.002*</td>
</tr>
<tr>
<td>Camera Path Length (cm, ± SD)</td>
<td>202.63 ± 42.21</td>
<td>172.26 ± 74.51</td>
<td>147.36 ± 59.41</td>
<td>0.3804</td>
</tr>
<tr>
<td>Safety Score (score, ± SD)</td>
<td>78.75 ± 10.44</td>
<td>82.11 ± 9.81</td>
<td>82 ± 6.52</td>
<td>0.7749</td>
</tr>
</tbody>
</table>

*significant finding (P<0.05)

Participants with more experience performed significantly better in composite performance score and procedure time, but not camera path length or safety.
## RESULTS

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</thead>
<tbody>
<tr>
<td>Composite Performance Score</td>
<td>0.65*</td>
<td>0.40</td>
<td>0.38</td>
<td>0.65*</td>
</tr>
<tr>
<td>Time to Simulation Completion</td>
<td>-0.72*</td>
<td>-0.33</td>
<td>-0.28</td>
<td>-0.70*</td>
</tr>
<tr>
<td>Camera Path Length</td>
<td>-0.32</td>
<td>-0.39</td>
<td>-0.39</td>
<td>-0.38</td>
</tr>
<tr>
<td>Safety Score</td>
<td>0.14</td>
<td>0.21</td>
<td>0.18</td>
<td>0.15</td>
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</table>

*strong correlation (r ≥0.65)

Composite performance score had a strong positive correlation with categorical arthroscopic experience and year of training. Similarly, time to simulation completion had a strong negative correlation with categorical arthroscopic experience and year of training.
CONCLUSION

• The VirtaMed ArthroS hip simulator demonstrates good construct validity with composite performance score and time to completion showing strong correlation with reported experience with arthroscopy.
  • Iatrogenic cartilage damage during simulation does not show a high degree of correlation with experience or skill level

• Limitations of this study include lack of a control group and simulation is unable to account for key components of in vivo arthroscopy such as hip distraction, bleeding/visibility intraoperatively, and portal establishment
REFERENCES

