4D Micro Neurosurgical Aneurysm Clipping Simulator for Training Medical Residents

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Disclosure

> The authors disclose no financial interest related to the topic discussed.

> The patient data used for this study was approved by the Ethics committee in the State of Bern, Switzerland under the approval number KEK Bern-2019-01335
Background: Introduction

> Residents are less exposed to realistic intracranial aneurysm clipping

> VR and other static simulation training miss realistic patient-specific exercises and haptic properties

Aneurysm

Aneurysm remnant?

Normal vessel patent?

Aneurysm occluded?
Materials

3D Patient-Specific Anatomy

> The Simulator consists of true scale 3D printed soft and hard tissue structure of Patient head with pathology (wall patency, thickness, and elasticity)

> Time-series pathological pulsatile blood-flow is felt while clipping aneurysm (additional dimension in simulator)
Methods

> Totally 25 questions were asked to the participants after each clipped an aneurysm using 4D simulator and analysed using descriptive statistics

> Clipping Quality was reviewed by a blinded expert

<table>
<thead>
<tr>
<th>No. of Participants n=16</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Years. of Neurosurgical Experience</strong></td>
</tr>
<tr>
<td>Group A: &lt;4 years Early residency</td>
</tr>
<tr>
<td>No. of Participants in each group</td>
</tr>
<tr>
<td>Background</td>
</tr>
<tr>
<td>No. of Aneurysm clipped as main surgeon</td>
</tr>
</tbody>
</table>
4D Simulator- Surgical Anatomy

<table>
<thead>
<tr>
<th>Understanding the Vascular Structures</th>
<th>4.62 (0.72)</th>
<th>0.0%</th>
<th>0.0%</th>
<th>12.5%</th>
<th>12.5%</th>
<th>75.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding the Morphology</td>
<td>4.69 (0.69)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>6.2%</td>
<td>18.0%</td>
<td>75.0%</td>
</tr>
<tr>
<td>Realizing spatial relation with respect to the nearby surgical field</td>
<td>4.62 (0.62)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>6.2%</td>
<td>25.0%</td>
<td>68.8%</td>
</tr>
<tr>
<td>Pateyny and gathering idea in Clipping</td>
<td>4.81 (0.40)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>18.8%</td>
<td>81.2%</td>
</tr>
<tr>
<td>Help in preparing for surgery</td>
<td>4.69 (0.48)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>31.2%</td>
<td>68.8%</td>
</tr>
<tr>
<td>Did it improve your understanding of the surgical view</td>
<td>4.81 (0.40)</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>18.8%</td>
<td>81.2%</td>
</tr>
</tbody>
</table>
General Usage Feedback for 4D clipping Simulator

Not Required and Not Helpful (1)
Not Sure (2)
Required (3)
Helpful and Required (4)
Helpful and Very much required (5)
Tactility, Haptics and Clipping Similarity in 4D Simulator

**Tactility Feedback**

- Percentage: 80%
- Response: Very realistic

**Haptics Feedback**

- Percentage: 92%
- Response: Excellent Haptics

**Clipping Simulation - Similarity**

- Percentage: 76%
- Response: Highly Similar to real clipping
Summary of Clip Training

Summary of Clipping Status between participants of different level of experience after 1st Trail

![Graph showing the summary of clipping status between participants of different levels of experience after the 1st trail. The graph compares the success rates of clipping tasks based on years of experience, indicating higher success rates among participants with more years of experience.](image_url)
Discussion

> 93.8% found the necessity of pulsation for Clipping Training.

> 87.5% of the participants felt the simulation anatomy can be a very good alternative than the theoretical and conventional learning approaches.

> Only 1 of 16 from early-residency group successfully clipped the aneurysm and rest failed, this shows need of extensive training.

> The aneurysm clipping simulator carries the potential to improve the surgical skills in cerebrovascular procedures and should be considered as an armamentarium in future cerebrovascular training programs and educational settings.