Cost-Efficient Laparoscopic Haptic Trainer based on Affine Velocity Analysis.

Charles Barnouin, Benjamin de Witte, Richard Moreau, Arnaud Lelevé, Xavier Martin

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Learning minimal invasive surgery (MIS) skills is young surgeons’ major concern. Cognitive load elicited by simulators’ use and trainees’ spatial abilities seem to impact efficient learning process(1). Objectives: design a basic skill training simulator which objectively evaluate trainees’ level. Use of Affine velocity(2–3) as assessment variable.

**INTRODUCTION**

- Observation and analyses of surgeons in situ
- Inclusion of literatures’ recommendations

**METHODS**

**Step 1 - Cognitive conception**
- Spatial Abilities
- Fundamentals of Laparoscopic Surgery
- Cognitive Load

**Step 2 - Simulator conception**
- Use of materials enabling haptic feedback and developing a VR environment (Phantom Omni, CHAID, laparoscopic devices…)

**WHAT IS AFFINE VELOCITY**

Relationship between geometry and kinematic:

\[ v = v_0 K^{-1/3} \]

- With the curvature \( K \)

- New power law for 3D movement:

\[ v = v_0 K^\alpha |\tau|^{\beta} \]

- With the torsion \( \tau \)
- \( \alpha \) and \( \beta \) are exponents that depend on the studied movement

**RESULTS**

Panel of 77 subjects separated initially into 4 groups:
- Expert surgeon: more than 100 interventions
- Intermediate: between 5 and 20
- Unexperienced intern (BSS): witnessed but never performed
- Novice

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<th>Intern</th>
<th>Expert</th>
<th>Intermediate</th>
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<tr>
<td>Expert</td>
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Statistical test Kruskal and Wallis on affine velocity (above) can separate every groups but Experts and Intermediates, whereas collision alone could also not separate Novices from Unexperience Interns.

**CONCLUSION**

- A cognitive analysis of MIS enables to design a reliable and valid simulator.
- Affine velocity is a valid tool and another objective variable to evaluate a trainee skill on his trajectory.
- Once a certain level of skill is reached, it becomes harder to differentiate individuals.
- As feedback about skill level is displayed, the simulator should be effective in learning, this needs however to be confirmed by future investigations.

**REFERENCES**