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

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INTRODUCTION

- 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.

METHODS

Step 1 - Cognitive conception
- Observation and analyses of surgeons in situ
- Inclusion of literatures’ recommendations

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

WHAT IS AFFINE VELOCITY

New power law for 3D movement:
\[ v = v_0 K^{\alpha} \]
- With the torsion \( \tau \)
- \( \alpha \) and \( \beta \) are exponents that depend on the studied movement

Logarithmic linearization to find \( \alpha \) and \( \beta \) for laparoscopic gesture:
\[ \log v = \log v_0 + \alpha \log K + \beta \]

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>Intermediate</th>
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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