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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
- Spatial abilities 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...)

Step 3 - Simulator validation
- Define assessment variables to evaluate the trajectory:
  - Time taken to complete the level
  - Number of errors (collisions)
  - Affine Velocity

WHAT IS AFFINE VELOCITY

Relationship between geometry and kinematics first shown in 2D drawing:

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

- With the curvature \( K \)

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:

\[ \alpha = -0.048, \beta = -0.0026 \]

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

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