PhD Thesis: Virtual Reality Simulation in Laparoscopic Gynaecology

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Aim: To investigate, on novice and experienced gynaecological surgeons:

1. The *construct validity* of the LapSim®Gyn Virtual reality Simulator, and to determine the learning curves of novice gynaecologists. To establish the expert performance level in the simulator.
2. To develop and validate a global and a procedure-specific rating scale for assessment of technical skills in laparoscopic gynaecology.
3. To investigate if skills obtained by simulator training can be transferred to human operation

Background: Laparoscopic surgery requires proficiency with sophisticated technical skills. Reports of complications caused by impaired technical surgical skills have highlighted the importance of teaching surgical technical skills in a safe, realistic and efficient environment. The traditional approach of 'see one do one, teach one' is no longer acceptable to either the surgical profession or to the well-informed and demanding patient There is also a need for unbiased structured objective assessment of technical skills during the surgical education. Virtual Reality Simulators might possess the capacities needed for future basic training in laparoscopic surgery, however, there is little research evidence of their efficiency and little is known on of the transferability of skills beyond the artificial environment of the setting of the training facility

Research Strategy: For the investigation we choose the Virtual Reality Simulator LapSimGyn, in which both basic skills and complete operative procedures can bee trained. The evaluation was executed in three stages:

1. Evaluation of the construct and discriminative validity of the simulator, generating learning curves for novice gynaecologists and determine the expert performance level in the simulator. Design: Prospective cohort.
2. Developing and validating a general and procedure specific rating scale for evaluation performance in laparoscopic gynaecology. Furthermore, to investigate the Inter-Rater Agreement, the gamma coefficient (Kendall's rank correlation) which is a measure of the strength of dependence between observations, and the Kappa value for each of the ten individual items included in the rating scale. Design: Prospective cohort, observer blinded study
3. Establishing the effect of procedural Virtual Reality Simulator training on a human laparoscopic operation. Training was criterion based and the novices in the intervention group had to train until they reached the expert performance level defined in the first study. Outcome was operative performance assessed by observers blinded to subject and group status, using the rating scale validated in the second study. Design: Prospective Randomised Controlled and blinded trial

Results: Data form the first study showed that expert gynaecologists performed significantly and consistently better than intermediate and novice gynaecologists. Learning curves differed significantly between the groups, showing that experts start at a higher level and more rapidly reach the plateau of their learning curve when compared to intermediate and novice groups of surgeons. The second study

demonstrated significant differences in surgical performance between the three groups, hence the rating scale was both construct and discriminative valid. The Inter-rater agreement, kappa value and gamma coefficient was sufficiently high. Finally, in the intervention study, the simulator trained group reached a mean total score as intermediate experienced gynaecologists while the controls performed as true novices. The mean total operating time was reduced with 50% in the simulator trained group, both findings highly significant.

Conclusion The LapSimGyn VR simulator demonstrates construct validity, both on Basic Skills module and on the procedural gynecological module, hence the simulator can be used for both training an assessment. The procedure-specific rating scale for laparoscopic salpingectomy is a valid and reliable tool for assessment of technical skills in gynecologic laparoscopy. Skills in laparoscopic surgery can be clinically relevant increased by proficiency based procedural virtual reality simulator training. The performance level of novices is increased to the level of intermediately experienced laparoscopists and the operation time is reduced substantially. Mandatory simulator training should be considered before trainees perform laparoscopically on humans.