ORIGINAL REPORTS

The Validation of a Novel Robot-Assisted Radical Prostatectomy Virtual Reality Module

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OBJECTIVE: To perform the first validation of a full procedural virtual reality robotic training module and analysis of novice surgeon's learning curves.

DESIGN: Participants completed the bladder neck dissection task and urethrovesical anastomosis task (UVA) as part of the prostatectomy module. Surgeons completed feedback questionnaires assessing the realism, content, acceptability and feasibility of the module. Novice surgeons completed a 5.5-hour training programme using both tasks.

SETTING: King's College London, London.

PARTICIPANTS: 13 novice, 24 intermediate and 8 expert surgeons completed the validation study.

RESULTS: Realism was scored highly for BDN (mean 3.4/5) and UVA (3.74/5), as was importance of BDN (4.32/5) and UVA (4.6/5) for training. It was rated as a feasible (3.95/5) and acceptable (4/5) tool for training. Experts performed significantly better than novice group in 6 metrics in the UVA including time ($p = 0.0005$), distance by camera ($p = 0.0010$) and instrument collisions ($p = 0.0033$), as well as task-specific metrics such as number of unnecessary needle piercing points ($p = 0.0463$). In novice surgeons, a significant improvement in performance after training was seen in many metrics for both tasks. For bladder neck dissection task, this included time ($p < 0.0001$), instrument collisions ($p = 0.0013$) and total time instruments are out of view ($p = 0.0251$). For UVA, this included time ($p = 0.0135$), instrument collisions ($p = 0.0066$) and task-specific metrics such as injury to the urethra ($p = 0.0032$) and bladder ($p = 0.0189$).

CONCLUSIONS: Surgeons found this full procedural VR training module to be a realistic, feasible and acceptable component for a robotic surgical training programme. Construct validity was proven between expert and novice surgeons. Novice surgeons have shown a significant learning curve over 5.5 hours of training, suggesting this module could be used in a surgical curriculum for acquisition of technical skills. Further implementation of this module into the curriculum and continued analysis would be beneficial to gauge how it can be fully utilised. (J Surg Ed ■:■■■-■■■. © 2017 Published by Elsevier Inc. on behalf of the Association of Program Directors in Surgery)

KEY WORDS: virtual reality, simulation, medical education, robotic surgery

COMPETENCIES: Practice-Based Learning and Improvement

INTRODUCTION

There are a number of virtual reality (VR) robotic simulators commercially available. Basic VR modules have been well validated for these simulators thus far. This current simulator, the RobotiX Mentor (3D systems; Simbionix Products, Cleveland, OH, USA) is a robotic surgery VR simulator that has been developed to train surgeons for robotic surgery performed using the da Vinci Surgical System. The simulator platform consists of a height adjustable headset containing stereoscopic visors, free floating

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hand controls and adjustable foot pedals integrated into a single console. It has been proven by Whittaker et al. to be effective for training using the Fundamentals of Robotic Surgery (FRS) curriculum, a basic VR module.[1] With continued validation of robotic VR simulators, it is becoming increasingly recognised that VR simulation is integral to the surgical curriculum.[1,2] Now, developments in VR technology have enabled production of full procedural VR training modules. Procedural modules can replicate a real-life environment with increasingly accurate anatomy. They have the potential to be used to develop cognitive skills, team and nontechnical skills and more advanced technical skills that may not offered in basic VR modules.

Before implementing procedural VR modules into robotic urological training curriculum, their usefulness and accuracy need to be established. The aim of this prospective study was to validate this novel full procedural "Robotic Radical Prostatectomy module" and to assess the feasibility and acceptability of the modules into a training curriculum.

MATERIAL AND METHODS

Study Design

This was a prospective, observational and comparative study that was conducted at King's College London, further with data collected at the European Association of Urology (EAU) hands-on-training (HOT) courses.

Participants

Subjects were categorised into 3 groups (novice, intermediate and expert). Opinion is divided on the number of procedures required to reach proficiency in robotic prostatectomy.[3,4] Experts were defined as having performed 50 cases or more independently. The intermediate group included subjects receiving surgical training who have performed up to 49 independent cases. The novice group was defined as having no previous operative experience.

Module

The Robotic Radical Prostatectomy module is composed of 3 tasks representing key steps during a robotic-assisted radical prostatectomy (RARP):

1. Bladder neck dissection
2. Neurovascular bundle dissection (nerve-sparing)
3. Urethrovesical anastomosis (UVA)

Successful completion of the neurovascular bundle dissection (nerve-sparing) required advanced surgical and anatomical knowledge beyond that of the novice group. Therefore, it was excluded from the preliminary validation.

Process

The novice surgeons initially underwent basic robotic training based on 3 FRS tasks:

1. Ring Tower Transfer
2. Railroad Track
3. Vessel Energy Dissection

The training consisted of guiding the participant through the controls and teaching basic robotic skills. Intermediates and experts were offered the opportunity to use the familiarisation tasks prior to use of the procedural modules. No data was collected from the familiarisation tasks. All participants then performed the guided bladder neck dissection task (BND) task followed by the guided UVA task. Postcompletion of these tasks, experts and intermediates were asked to fill in a questionnaire assessing their experience, opinion on realism, importance, acceptability and feasibility of the modules and simulator. Novice surgeons went on to complete a mean 5.5-hour supervised training programme over 5 weeks that consisted of 1-hour time slots. During each training session, participants performed each task in no particular order. The prostatectomy module was the only module participants were permitted to use during training. The study process is illustrated by Figure 1.

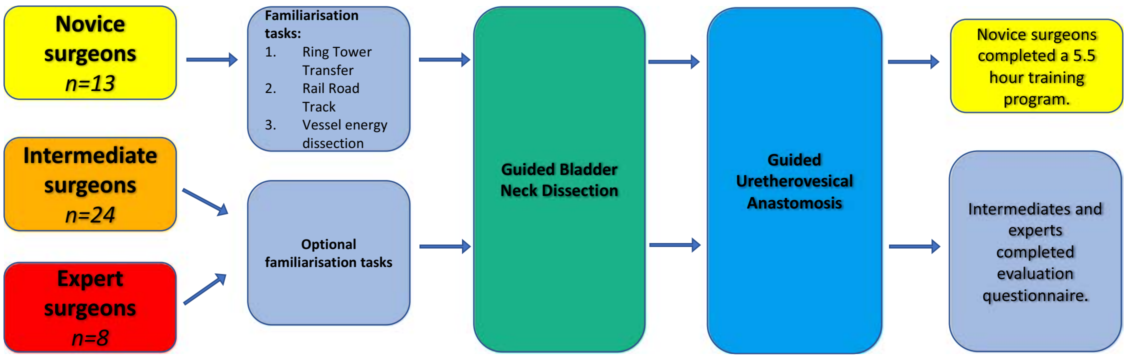

FIGURE 1. Flow chart illustrating the study process.