Validation of the RobotiX Mentor Robotic Surgery Simulator

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Introduction

With robotic-assisted surgery becoming more common practice in urology, effective training remains a challange. There is a considerable learning curve associated with robotic training[1], though this has been reported as gentler than for laparoscopic training[2]. Simulation has gained widespread acceptance as a method of reducing the initial phase of the learning curve.

The RobotiX Mentor™ is a new virtual reality simulator which mimics the interface of the da Vinci® Surgical System, with integrated training modules including Fundamentals of Robotic Suturing (FRS) and Robotic Suturing. Face, content, and construct validity of the suturing module has been confirmed in a previous study[3], though this was performed on a different platform.

This study aims to assess construct, face, and content validity of the RobotiX Mentor virtual reality simulator. It also aims to asses its acceptabilty as a training tool and feasibility of its use in training.

Methods

This prospective, observational and comparative study recruited novice (n=20), intermediate (n=15), and expert (n=11) robotic surgeons as participants from institutions across the United Kingdom and Europe.

After a familiarisation task, each participant completed nine surgical tasks across two modules on the simulator, followed by a questionnaire to evaluate subjective realism (face validity), task importance (content validity), feasibility, and acceptability. Outcome measures of novice, intermediate, and expert groups were compared using Mann-Whitney U-tests to assess construct validity.

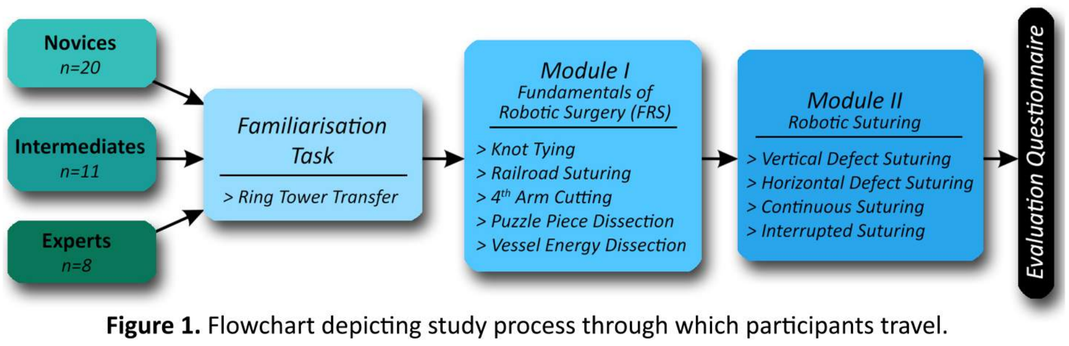

Figure 1. Flowchart depicting study process through which participants travel.

Results

Construct validity was demonstrated in a total of 17/25 performance evaluation metrics (p<0.001). Experts performed better than intermediates in regard to time taken to complete the first (p=0.002) and second (p=0.043) module, number of instrument collisions (p= 0.040), path length (p=0.049), number of cuts >2mm deep (p=0.033), average distance from suture target (p=0.015), and number of suture breakages (p=0.038). Participants determined both the simulator console and psychomotor tasks as highly realistic (mean: 3.7/5) and very important for surgical training (4.5/5), with simulator pedals (4.2/5) and knot tying task (4.6/5) scoring highest respectively. The simulator was also rated as an acceptable (4.3/5) tool for training and its use highly feasible (4.3/5).

Module & Performance Metric	Expert vs Novice	Expert vs Intermediate	Intermediate vs Novice
Fundamentals of Robotic Surgery (FRS)			
Generic			
Time to complete module (s)	***<0.001	**0.002	0.629
Total errors (n)	0.397	0.876	0.395
Instrument collisions (n)	**0.008	*0.040	0.177
Instruments out of view (n)	0.112	0.253	0.960
Clutch usage (n)	0.137	0.051	0.828
Distance by camera (mm)	**0.001	0.161	**0.004
Number of movements (n)	0.332	0.177	0.689
Path length (mm)	**0.002	*0.049	0.106
Task-specific			
Critical errors (n)	***<0.001	0.066	**0.001
Inaccurate punctures (n)	***<0.001	0.447	*0.011
Inaccurate targeting (mm)	***<0.001	0.876	**0.002
Precision (%)	**0.001	0.917	**0.004
Cuts outside marked line (n)	0.269	0.814	0.364
Cuts >2mm deep (n)	**0.005	*0.033	0.560
Robotic Suturing			
Time to complete module (s)	***<0.001	*0.043	*0.023
Unnecessary piercings (n)	*0.011	0.483	*0.020
Average distance from target (mm)	***<0.001	*0.015	**0.009
Suture breakage (n)	***<0.001	*0.038	*0.017
Needle drops (n)	0.770	0.591	0.813
Knot tail length deviation (mm)	**0.005	0.052	0.156
Time needle is out of view (s)	**0.001	0.837	***<0.001
Correct suturing angle (%)	0.690	0.649	0.262
Needle passage accuracy (%)	***<0.001	0.381	**0.005
Suture over-stretch (n)	*0.036	0.173	0.439
New suture requests (n)	0.118	0.089	0.877

*p <0.05; **p <0.01; ***p <0.001.

Table 1. Comparison of performance metrics between groups. *P* values are displayed.

Conclusions

Construct, face, and content validity were established for the RobotiX Mentor and feasibility and acceptability of incorporation into surgical training was ascertained. The RobotiX Mentor shows potential as a valuable tool for training and assessment of trainees in robotic skills and may reduce the initial learning curve if utilised as an adjunct to operating-room training.

Investigation of concurrent and predictive validity is necessary to complete validation and evaluation of learning curves would provide insight into its value for training.

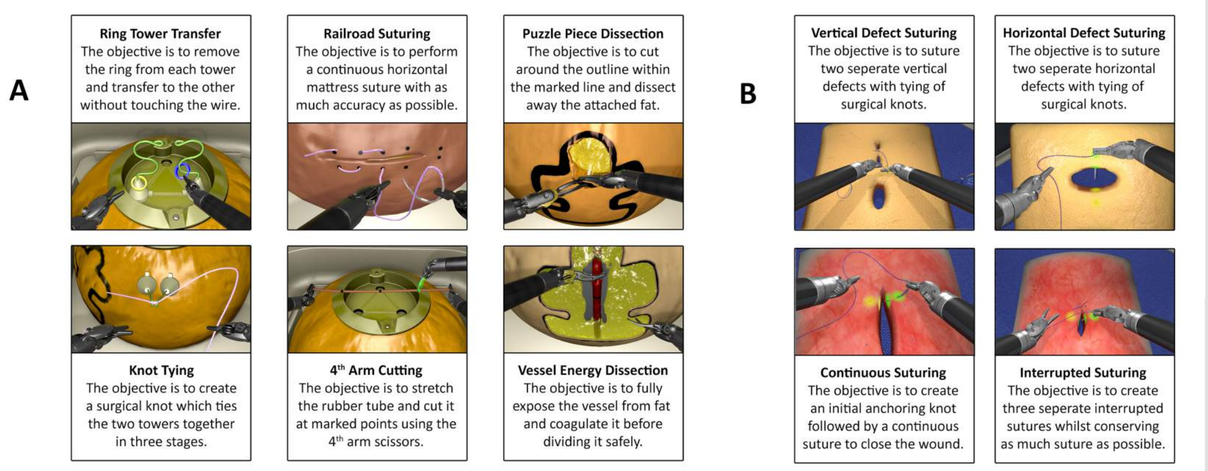

Figure 2. List of tasks included in the (A) Fundamentals of Robotic Surgery and (B) Robotic Suturing modules.

Figure 3. RobotiX Mentor surgical simulator in use.

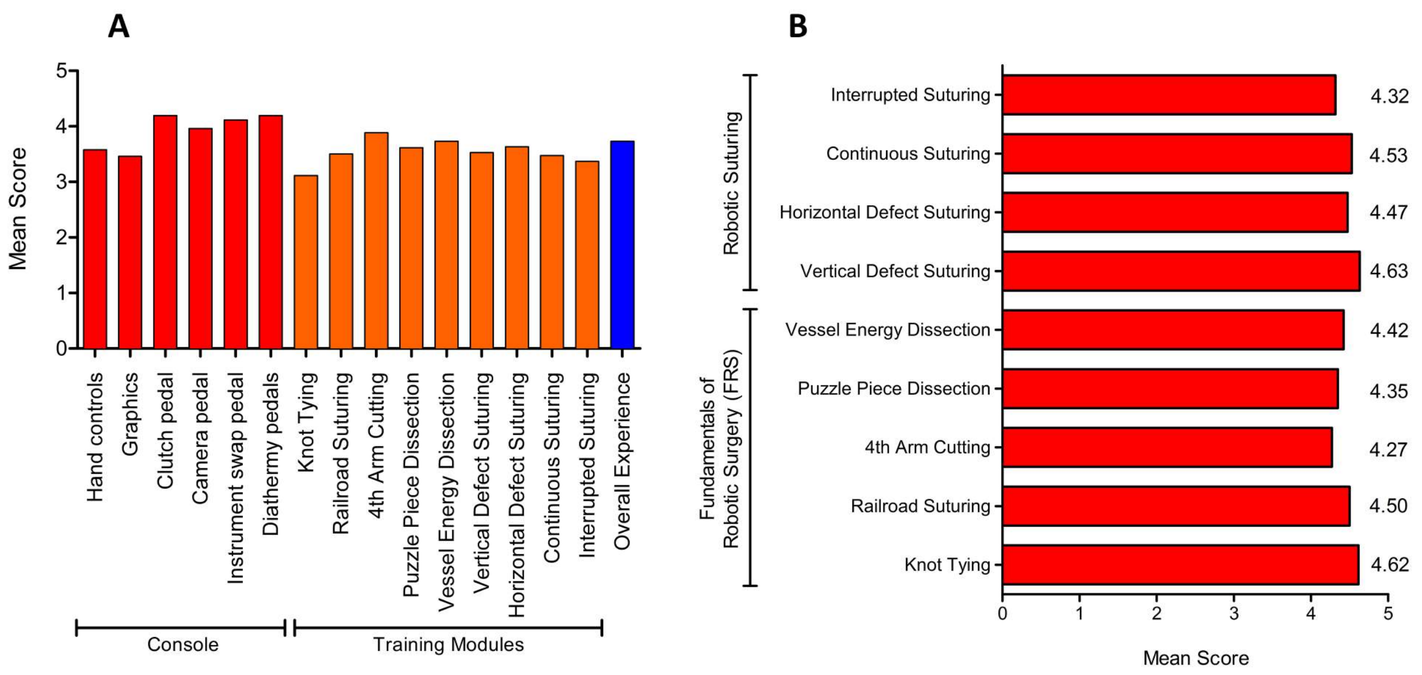

Figure 4. Assessment of (A) face and (B) content validity by novice, intermediate, and expert groups. Each element was scored on a Likert scale between 1 (not realistic/important) and 5 (very realistic/important).

References

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