

Use of virtual reality simulator in the training of postgraduated surgical residents



Ann. Ital. Chir., 2006; 77: 465-468

Pietro Petrin*, Elda Baggio**, Roberto Spisni***, Francesco Rulli****



University of Padua*, Verona**, Pisa***, Roma-Tor Vergata****, all in Italy.

Use of virtual reality simulator in the training of postgraduated surgical residents

AIM OF THE STUDY: *The purpose of this research project, granted by the Italian University and Scientific Research Ministry (MIUR) and carried on among four Surgical Departments in Padua, Verona, Pisa and Rome-Tor Vergata Universities, is to study the effectiveness of a virtual reality simulator as a tool for surgical residents training and as a method for measuring the surgical skills.*

MATERIALS AND METHODS: *The residents performances on the computer were compared with those obtained by other training groups: medical students with no surgical background, senior surgeons with experience in the laparoscopy field and non medical students with referred ability in videogames. The residents were also sent to a well certified live animal laboratory where they could perform a cholecystectomy in a pig. Their operation was assessed by two independent observers using a new scoring methods for assessing the operative errors.*

RESULTS: *Statistically significant differences among the groups could be seen only after several tasks sessions and in the more surgical specific tasks. The first data analysis shows a fair correlation between the residents rank positions after the training tasks on the simulator and those obtained in the surgical operation.*

CONCLUSION: *Even if the data are not conclusive and the surgical simulators must develop greater levels of fidelity and operational diversity, the potential value of simulation in the educational surgical field appears to be impressive.*

KEY WORDS: Educational measurement, Laparoscopy, Virtual reality.

Introduction

The method of teaching surgeons has undergone little change during the last century: the surgeon develops his skill through textbooks, literature, lectures, medical conferences and congresses, clinical observation and ultimately by performing the procedure under the supervision of an experienced surgeon¹. However exponential growth in scientific knowledge, development of new technology and introduction of novel surgical procedures are changing the practice of surgery and surgical residents have greater difficulty in finding time and proper teachers to acquire all the professional competences². Aside from patients safety and required costs, there is support from the educational literature for training sur-

geons in a structured environment other than the operating room³.

At least in the laparoscopic field the virtual reality simulators can help the educators in shortening learning curves in surgery and reduce the complications that can occur in the early stage of apprenticeship. They can also provide good objective tool for evaluating the technical skills and possibly predict future operating room performance.

An experimental teaching project granted by the Italian University and Scientific Research Ministry (MIUR) is being carried on among four Surgical Departments in Padua, Verona, Pisa and Rome-Tor Vergata Universities for evaluating the virtual reality system value as new training tool in surgery. Preliminary results of the project are presented.

Material and methods

A LapSim virtual reality simulator (Surgical Science Ltd.,

Manuscript received December 2005. Accepted for publication January 2006.

For correspondence: Prof. Pietro Petrin, Dipartimento di Scienze Chirurgiche e Gastroenterologiche dell'Università, Clinica Chirurgica IV, Azienda - Ospedale Università, Via Giustiniani 2, 35128 Padova

Göteborg, Sweden) has been utilized during the current research program. The system includes a computer (dual-processor Pentium III using Windows 2000 operative system) and a laparoscopic interface module with two instruments and a footswitch. The software package (LapSim Basic Skills) offers eight surgical tasks with increasing complexity: 1) *camera navigation* where appearing balls have to be centered in the camera view; 2) *instrument navigation* where the balls have to be pointed by instruments in turns with the right and the left hand no touching the surrounding virtual tissue; 3) *coordination* where one hand controls the camera and the other points the balls; 4) *grasping* where tubular objects have to be manipulated using grasper instruments and put in a box; 5) *lifting and grasping* where an object has to be lifted in order to grasp and remove a needle and put it in a box; 6) *cutting* where a tubular structure has to be stretched and cut using ultrasonic scissor (controlled by a foot pedal); 7) *clip applying* where a vessel must be cut between two clips and bleeding may occur if overstretched calling for prompt response by means of a suction device and new clip position; 8) *suturing* where a precise suture must be carried on in a realistic intraabdominal environment. The computer system registers performance parameters for each task (time, error, badly placed clips, blood loss...) and economy of motion parameters (path length, angular path and drift). The degree of difficulty in each task can varied according with the tutoring teacher's choice.

In the first step of the program four training groups were enrolled: 1) 10 medical students with no experience at all; 2) 30 postgraduated surgical residents (4-5th year in training) with poor laparoscopic experience; 3) 10 well qualified surgeons with large experience in the laparoscopic field; 4) 10 non medical students with reported practice in video games as control group. All were first-time users of virtual reality simulator.

After initial introduction and tutorial examples of the different tasks, they underwent several training sessions with only one final increase in basal difficulties.

In the second step, surgical residents already trained and evaluated were send to perform a cholecystectomy in a well certified live animal laboratory (UCCS Center of CNR in San Piero a Grado, near Pisa). Their technical skills in the porcine model were assessed by two independent observers using a new scoring methods for assessing the operative errors⁴.

On the ground of the obtained scores the residents were ranked by the blind observers from the best to the worst and their positions were compared with the ones obtained in the simulator during the basic task sessions so that statistical correlation could be evaluated.

Results

During the first two sessions of training no statistical differences were found among the groups (Fig. 1). Only

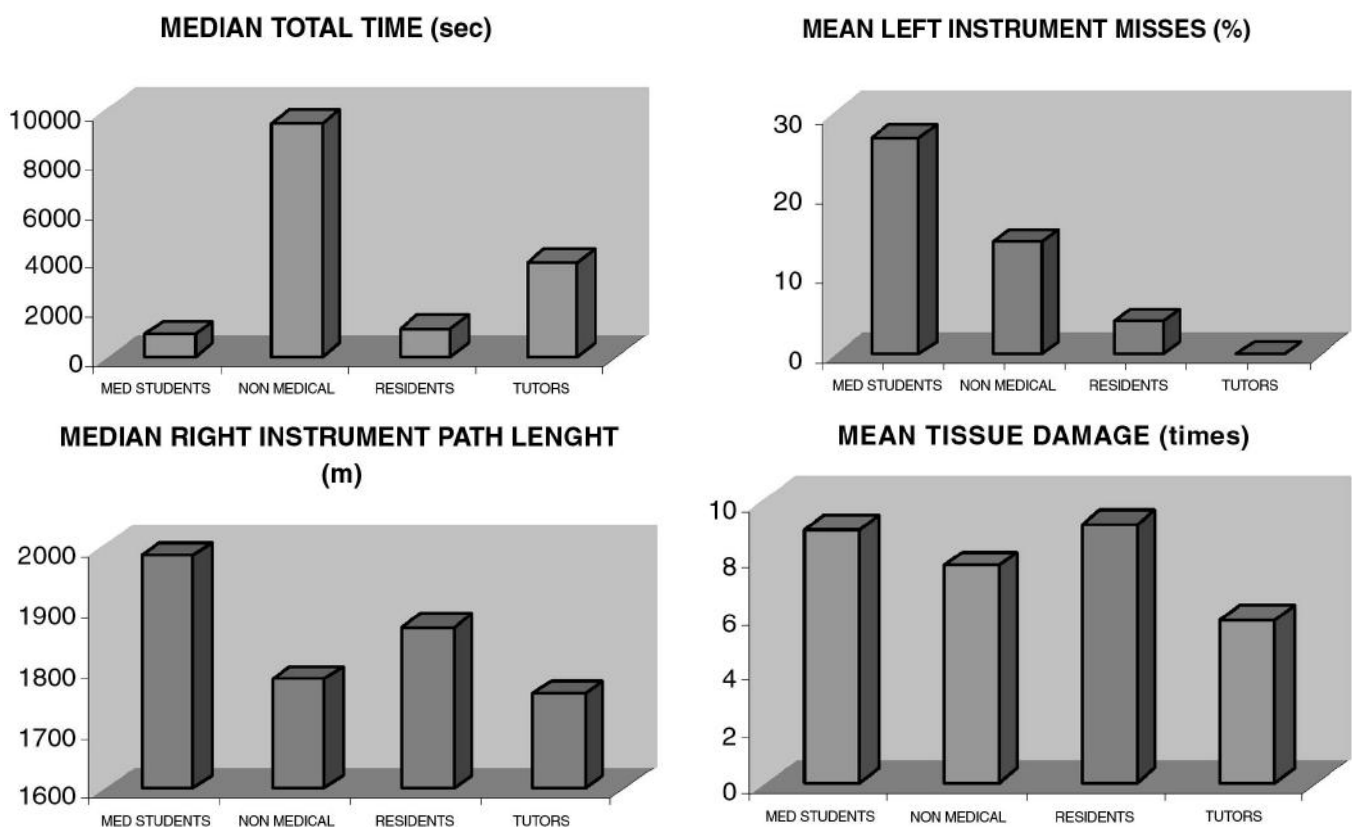


Fig. 1: Example of some data compared among the four training groups after the lift and grasping task.

later (from 3 to 6 attempts) experienced surgeons appeared to be able to perform the basic tasks with less errors in a quicker time (Fig. 1). Even so statistically significant evidences ($P < 0.05$) were reached in the more surgical specific manoeuvres such as clip applying and cutting. Within the set time limit only the senior surgeons could finish the intraperitoneal suturing task and be able to advance in the more difficult sessions. To get over the latter task surgical residents needed extension of time and more training sessions.

At the moment 12 residents have been evaluated after performing cholecystectomy in the pig and ranked according with number of operative errors as previously defined. The first data analysis shows a fair correlation between the residents rank positions after the training tasks on the simulator and those obtained in the surgical operation (Pearson's ranks correlation coefficient = 0.715. Note: perfect correlation coefficient = +1, no correlation = 0, perfect inverse correlation = - 1.)

TABLE I - Example of the computer processed data of a medical students group after the camera navigation task.

Group: Medical Students							
Task: CAMERA NAVIGATION							
Students	TIME (S)	MISSES (%)	DRIFT (MM)	PATH (M)	ANGULAR PATH (DEGREES)	TISSUE DAMAGE (NUMBER)	MAX DAMAGE (MM)
1	33.118.717	0.0	8.335.752	11.209.052	2.963.672	0.0	0.0
2	23.344.364	0.0	8.618.477	11.442.502	27.122.693	0.0	0.0
3	5.463.755	0.0	19.037.207	19.755.093	63.185.693	1.0	17.892.366
4	4.210.364	0.0	758.674	1.835.037	7.242.247	0.0	0.0
5	29.585.995	0.0	54.828.915	0.8709631	3.116.001	0.0	0.0
6	47.016.754	20.0	68.204.474	17.619.128	6.081.636	0.0	0.0
7	26.867.876	0.0	4.686.041	10.007.467	22.183.458	0.0	0.0
8	26.036.575	0.0	12.404.976	11.541.024	37.345.096	0.0	0.0
9	45.550.602	0.0	8.300.941	24.643.543	96.644.556	0.0	0.0

Discussion and comment

Since the ultimate goal of every surgical training program is to produce competent professionals capable of meeting the healthcare needs of society, it must provide the opportunity for resident to acquire this competency with all the technical attributes ⁵. A virtual reality surgical simulator could offer the possibility of having the surgical resident of the future perfect a procedure without harming a patient, learning surgical anatomy and repeatedly practicing technique prior to performing surgery on the actual patient. At the moment literature data suggest that simulators are beneficial in training novice surgeons in the basic psychomotor skills required for laparoscopy and that these skills translate into more effective operating room performance ⁶. Our preliminary data support the correlation between performance in laparoscopic inanima-

te simulator and in vivo animal model. On the other hand relationship between objective performance on a laparoscopic trainer and subjective assessment of technical skill in surgical residents has been already published ⁷.

In our opinion, however, the currently available training virtual programs on the simulator are not sufficient in themselves for a fully assessment of technical ability: even the more experienced surgeon needs time and exercise to acquire confidence with the new training technology before to be able to show his dexterity in the basic virtual tasks ⁸. Time and exercises number required to show statistical distance between novice subjects and experts as well as task difficulty are not yet well established ⁹. In spite of the tutorial video provided by the LapSim System the present suturing task seems far too difficult for a novice. So a valid and reliably gold standard tool for evaluating operating room performance, likely based on global rating scales, needs to be established and a "passing score" based on the scores of "competent" surgeons defined. The present cost, limited specifically surgical programs and lack of validation hamper the rapid incorporation of the simulator into surgical residencies and training centres. The individual learning curves of surgeons beginning with laparoscopic tasks are to be well studied and understood in the view of adopting an effective virtual reality training program in the academic institutions and recommending the simulation technology in the general surgical education curriculum

Conclusions

Even if more data are to be obtained, virtual reality simulator appears a valid training and assessment tool of laparoscopic skills.

The skills acquired or showed in a virtual reality simulator seem to correlate with the ability to perform a real surgical procedure.

Additional studies are needed to establish the performance levels to be achievable by surgical residents and before to recommend the integration of virtual reality simulation into surgical education.

Riassunto

OBIETTIVO DELLO STUDIO: Lo scopo di questo progetto di ricerca, finanziato dal Ministero Italiano dell'Università e della Ricerca scientifica e condotto in collaborazione tra quattro dipartimenti di chirurgia delle università di Padova, Verona, Pisa e Roma-TorVergata, è quello di studiare l'efficacia di un simulatore della realtà virtuale come mezzo per esercitare gli specializzandi in chirurgia e come metodo per misurare le abilità chirurgiche.

MATERIALI E METODI: Le prestazioni al computer degli specializzandi sono state confrontate con quelle di altri gruppi di esercitanti: studenti di medicina senza preparazione chirurgica, chirurghi più anziani con esperienza in campo laparoscopico e studenti non di medicina con riferita abilità nell'uso dei videogiochi. Gli specializzandi sono stati anche inviati in un centro di chirurgia sperimentale su animali dove hanno potuto eseguire un intervento di colecistectomia sul maiale. Il loro intervento è stato valutato da due osservatori indipendenti che hanno utilizzato una nuova scala di punteggio per misurare gli errori operatori.

RISULTATI: Differenze statisticamente significative tra i quattro gruppi sono apparse solo dopo diverse sessioni di esercizi ed negli esercizi più specificamente di carattere chirurgico.

L'analisi dei primi dati ottenuti dimostra una discreta correlazione tra le posizioni in classifica raggiunte dagli specializzandi dopo gli esercizi al simulatore e quelle raggiunte nell'intervento chirurgico.

CONCLUSIONI: Benché i dati ottenuti non siano conclusivi ed i simulatori chirurgici debbano senz'altro sviluppare un più alto grado di fedeltà e permettere una maggiore diversità di prove, il potenziale valore della simulazione della realtà virtuale nel campo dell'educazione medica sembra davvero impressionante.

References

- 1) O' Toole RV, Playter RR, Kummel TM, Blank WC, Cornelius NH, Roberts WR, Bell WJ, Raibert M: *Measuring and developing suturing technique with a Virtual Reality Surgical Simulator*. Am Coll Surg 1999; 189(1):114-28.
- 2) Sachdeva AK: *Educational interventions to address the core competencies in surgery*. Surgery, 2004; 135 (1):43-47.
- 3) Haluck RS, Krummel TM: *Computers and virtual reality for surgical education in the 21st century*. Arch Surg, 2000; 135:786-92.
- 4) Seymour NE, Gallagher AG, Roman SA, O'Brien MK, Andersen DK, Satava RM: *Analysis of errors in laparoscopic surgical procedures*. Surg Endosc 2004; 18(4):592-95.
- 5) Sidhu RS, Grober ED, Musselman ED, Reznick RK: *Assessing competency in surgery: Where to begin?* Surgery 2004; 135(1):6-20.
- 6) Fried GM, Derossis AM, Bothwell J, Sigman HH: *Comparison of laparoscopic performance in vivo with performance measured in a laparoscopic simulator*. Surg Endosc, 1999; 13:1077-81.
- 7) Feldman LS, Hagarty SE, Ghitulescu G, Stanbridge D, Fried GM: *Relationship between objective assessment of technical skills and subjective in-training evaluation in surgical residents*. J Am Coll Surg, 2004; 198:105-10.
- 8) Eriksen JR, Grantcharov T: *Objective assessment of laparoscopic skills using a virtual reality stimulator*. Surg Endosc, 2005; 19(9):1216-219.
- 9) Feldman LS, Sherman V, Fried GM: *Using simulators to assess laparoscopic competence: Ready for widespread use?* Surgery, 2004; 135(1):28-42.