APPLICABILITY AND EFFECTIVENESS OF VIRTUAL REALITY SIMULATOR TRAINING IN UROLOGIC SURGERY: A DOUBLE-BLIND RANDOMISED STUDY

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ABSTRACT

Objective: *Recently introduced laparoscopic virtual reality training simulators (LVRTS) are teaching systems designed to increase laparoscopic skills, and operating room performance virtual reality (VR) surgical training simulator is designed as a virtual setting resembling an operating field where basic, and advanced laparoscopic tasks can be realized. The aim of this study is to investigate the applicability, and also contribution of LVRTS which has a haptic-tactile feedback features to basic laparoscopic skills in the field of urologic surgery.*

Material and Method: *In this study LapSim VR simulator training (Haptic LapSim Surgical Science Ltd), and conventional laparoscopic training were compared in a double-blind randomized study. Eight urologists completed the course under the supervision of the responsible mentor using VR Simulator Training System with haptic-tactile feedback features. (Group A). However, other eight urologists completed conventional physical laparoscopic training box still under the supervision of the responsible mentor (Group B). Then, all candidates attended standard specific laparoscopic training course. All of sixteen surgeons in both groups performed "Transperitoneal Laparoscopic Renal Cyst Decortication" under the guidance of the instructor in-charge. Video films of the operation were recorded. Objective Structured Assessment of Technical Skills scale scores of the candidates were evaluated in a randomized double-blind design by four independent mentors.*

Results: *Mann Whitney U test was used for the two group comparisons of the variables which were given numeric value specified by the measurement. There was no statistically significant difference observed between the two groups, in terms of respect to the tissue (p=0.64), duration of the operation and manipulations (p=0.50), instrumental experience (p=0.50), safety of manipulations (p=1.00), use of an assistant (p=1.00), flow of the operation (p=1.00) and the accuracy of the operative technique (p=0.38).*

Conclusion: *Computerized laparoscopic VR simulator training system with haptic feedback is an effective, and applicable method in the achievement of basic, and advanced level laparoscopic skills.*

Key Words: *Laparoscopy, LapSim, surgical training, virtual reality* ***Nobel Med 2014; 10(2): 66-71***

LAPAROSKOPİK SANAL GERÇEKLİK SİMÜLATÖR EĞİTİMİNİN ÜROLOJİK CERRAHİDE UYGULANABİLİRLİĞİ VE ETKİNLİĞİ: ÇİFT KÖR, RANDOMİZE ÇALIŞMA

ÖZET

Amaç: Son yıllarda kullanıma girmiş olan laparoskopik sanal gerçeklik [virtual reality (VR)] eğitim simülatörü cerrahın temel laparoskopi becerilerini ve ameliyathane performansını artırmaya yönelik olarak planlanmış sistemlerdir. Bu çalışmanın amacı dokunsal geri bildirim özelliğe sahip laparoskopik sanal gerçeklik eğitim simülatörü (LVRES) ürolojik cerrahi alanında uygulanabilirliğinin ve temel laparoskopik becerilere katkısının araştırılmasıdır.

Materyal ve Metod: Bu çalışmada LapSim VR simülatör eğitimi ve konvansiyonel laparoskopik eğitim çift-kör, randomize olarak karşılaştırıldı. Sekiz ürolog dokunsal geribildirim özelliğine sahip VR Simülatör Eğitim sisteminde sorumlu eğitmen gözetiminde kursu tamamladı (A grubu). Diğer sekiz ürolog klasik fiziksel laparoskopik eğitim kutusunda sorumlu eğitmen gözetiminde kursu tamamladı (B grubu). Ardından tüm adaylar standart spesifik laparoskopi eğitim kursu aldı. Her iki gruptaki toplam sekiz cerraha "Transperitoneal Laparoskopik Renal Kist Dekortikasyonu" operasyonu, sorumlu eğitmen tarafından yaptırıldı. Operasyon video görüntüleri kaydedildi. Adayların teknik becerilerin nesnel yapısal değerlendirilme skalası dört bağımsız mentor tarafından randomize çift kör olarak değerlendirildi.

Bulgular: İki grup arası farklılık non-parametrik analiz (Mann-Whitney U Test) kullanılarak değerlendirildi. Dokuya saygı (p=0,64), operasyon ve manipülasyonlar süresi (p=0,50), alet tecrübesi (p=0,50), hareketlerin güvenliği (p=1,00), asistanın kullanması (p=1,00), operasyonun akışı (p=1,00), operatif tekniğin doğruluğu (p=0,38) izlendi, istatistiksel olarak anlamlı fark bulunamadı.

Sonuç: Bilgisayar destekli, dokunsal geri bildirimli, laparoskopik VR simülatör eğitim sistemi temel ve ileri düzey laparoskopik becerilerin kazanılmasında klasik yöntem gibi etkin ve uygulanabilir bir yöntemdir.

Anahtar Kelimeler: Laparoskopi, LapSim, cerrahi eğitim, sanal gerçeklik **Nobel Med 2014; 10(2): 66-71**

INTRODUCTION

Laparoscopy is widely used in urologic surgery. Its technique and learning curve demand extremely longer time spans, when compared with the open surgery. Training of technical skills outside the operating room is considered as a prerequisite for candidate surgeons.[1] A consensus as to the method of training, and performance assessment criteria has not been established yet. In addition, increasing numbers of technical details, and indications, complicated achievement of a unanimous consensus about the laparoscopic training in the urological community.[2,3] Widely used physical simulators contain closed pelvic training box contains, real instruments, and (biologic, and non-biologic) tissue mimicking materials (determined by the training center) inside the kit. Advanced skills can be easily gained by training in intracorporeal anastomosis, and knotting techniques on simulated tissues such as kit chicken skin, leg, pig bladder, urethra and intestines placed inside the conventional pelvic training box.[4,5]

Recently introduced laparoscopic virtual reality training simulators (LVRTS) are teaching systems designed to increase laparoscopic skills, and operating room performance.[6] These simulators have widespread usage in billion-dollar game sector, civil aviation, fashion design, and architecture in addition to surgical training. In the war industry, pilots and weapon system operators are given real-time flight training, weapon system training, radar system, tactics and emergency system trainings using virtual reality (VR) simulators. VR training is also employed predominantly in general surgery, gynecology, and obstetrics also in the fields of urology, radiology, cardiology, orthopedics, neurosurgery, ear nose throat diseases and dentistry. In urology, the field of its application consists of transurethral prostatic resection, cystoscopy, ureteroscopy, percutaneous renal access and laparoscopy. VR surgical training simulator is designed as a virtual setting resembling an operating field where basic and advanced laparoscopic tasks can be realized. The system essentially consists of two endoscopic instruments, a computerized equipment, and a monitor. Additionally, foot pedal and a laparoscope are supplied. Portable models of simulators are also available. Computerized equipment and its monitor are designed as a desktop computer system. The surgeon can easily practise at home, also in the workplace. These simulators are available in models with or without haptic feedback systems. In recent years advancement in software technology, improvement in the quality of images, and haptic feedback system adnexed to instruments have increased the perception of reality. Besides, in recent years VR laparoscopic simulators with sophisticated design and haptic feedback have

Table 1: Playing video games / an instrument			
Group	n	No	Yes
Group A	8/8	5 (62.5%)/ 7 (87.5%)	3 (37.5%)/ 1 (12.5%)
Group B	8/8	6 (75.0%)/ 7 (87.5%)	2 (25.0%)/ 1 (12.5%)
Total	16/16	11/14	5/2

Table 2: Operations time						
Group	n	Mean ± Std Deviation	Median Value	Minimum Value	Maximum Value	p
Group A	8	36.13 ± 5.79	34.50	30	46	0.72
Group B	8	35.13 ± 6.33	34.00	28	47	

Table 3: Objective Structured Assessment of Technical Skills assessment results laparoscopic cyst decortication being watched						
	N	Mean ± Std Deviation	Median Value	Minimum Value	Maximum Value	p
Respect to the tissue						
Group A	8	3.25 ± 0.46	3	3	4	0.64
Group B	8	3.38 ± 0.74	3.5	2	4	
Total	16	3.31 ± 0.60	3	2	4	
Time taken, and manipulations						
Group A	8	3.00 ± 0.76	3	2	4	0.50
Group B	8	2.63 ± 0.74	3	1	3	
Total	16	2.81 ± 0.75	3	1	4	
Instrumental experience						
Group A	8	3.13 ± 0.64	3	2	4	0.50
Group B	8	3.38 ± 0.52	3	3	4	
Total	16	3.25 ± 0.58	3	2	4	
Safety of manipulations						
Group A	8	3.00 ± 0.53	3	2	4	1.00
Group B	8	3.00 ± 0.76	3	2	4	
Total	16	3.00 ± 0.63	3	2	4	
Use of an assistant						
Group A	8	3.50 ± 0.53	3.5	3	4	1.00
Group B	8	3.50 ±0.53	3.5	3	4	
Total	16	3.50 ± 0.52	3.5	3	4	
Flow of the operation						
Group A	8	3.13 ± 0.35	3	3	4	0.23
Group B	8	3.50 ± 0.53	3.5	3	4	
Total	16	3.31 ± 0.48	3	3	4	
Accuracy of the operative technique						
Group A	8	3.25 ± 0.46	3	3	4	0.38
Group B	8	3.50 ± 0.76	4	2	4	
Total	16	3.38 ± 0.62	3.375	2	4	

been developed.→ During this training, skills of the candidates can be evaluated instantly with reliability and objectivity. However, studies investigating its extent of contribution to basic laparoscopic skills in the field of urologic surgery are lacking. The aim of this study is to investigate the applicability and also contribution of LVRTS which has a haptic-tactile feedback features to basic laparoscopic skills in the field of urologic surgery. In this study LapSim VR Simulator Training (Haptic LapSim Surgical Science Ltd), and conventional laparoscopic training were compared in a double-blind randomized study. LapSIM (Surgical Science®, Sweeden) Simulator system used in our study is the most widely employed system after MIST-VR stimulator.[7,8]

MATERIAL and METHOD

Sixteen urologists working in the TR Ministry of Health, Istanbul, Taksim Training, and Research Hospital participated in the study conducted between February 2009 and December 2011. The study was designed in 2 groups of eight subjects each (Group A, and Group B). The participating surgeons did not have any laparoscopic experience and did not receive VR training, but they had surgical talents and expertise in open renal cyst decortication. The Ethical Committee of Taksim Training and Research Hospital provided ethical approval for the study. Written and verbal consent was obtained from all patients. Eight urologists completed the course under the supervision of the responsible mentor using VR Simulator Training System with haptic-tactile feedback features (Group A). However, other eight urologists completed conventional physical laparoscopic training box still under the supervision of the responsible mentor (Group B). Then, all candidates attended standard specific laparoscopic training course. All of sixteen surgeons in both groups performed "Transperitoneal Laparoscopic Renal Cyst Decortication (TLRCD)" under the guidance of the instructor in-charge. Video films of the operation were recorded. Objective Structured Assessment of Technical Skills (OSATS) scale scores of the candidates were evaluated in a randomized double-blind design by four independent mentors.

Training program, and equipment

All candidates received specific laparoscopic training.[9] All participants were compelled to attend both theoretic and practical courses. In the theoretical course, both groups were instructed about laparoscopic instruments, physiologic basics, indications, contraindications, management of complications, techniques of access, laparoscopic suturing and operation. In the hands-on course, in Group A, with LapSim VR Simulator Training Program (Haptic LapSim Surgical Science Ltd) with haptic-tactile feedback characteristics and SSBS course, basic →

skills of the candidates were assessed, while in Group B, physical laparoscopic training course used widely in courses performed domestic, and foreign programs and also Heilbronn Training Program were used.[10,11] All trainees participated equally in laparoscopic cyst decortication, pelvic lymphadenectomy, nephrectomy, radical prostatectomy operations as a first assistant.

Basic skills with LapSim VR Simulator Training Program (Haptic LapSim Surgical Science Ltd), and SSBS06 course

As a training program the surgeons in Group A received specified modules of LapSim VR Simulator training program. The system consists of an 18 inch-TFT monitor, a laparoscopic interface module (Immersion Inc, San Jose, CA), 2 laparoscopic instruments and a foot pedal. The software was uploaded with 256 MB RAM Geforce instrument, double core Pentium IV computer Windows XP SP3 processing system Haptic box was of Xitact Model IHP. Two modules of Software LapSim 2009 (Surgical Science Ltd) were used. These modules were LapSim task training course and, LapSIM basic skills training system real-time surgical field SSBS06 course. System and all modules were compatible with haptic feedback system.

SSBS06 course

LapSIM which is one of the basic skills training system modules includes 35 training items with an increasing levels of difficulty. This training system is a compelling, intensive training course. The course is completed by training approximately 30 minutes a day for one or two months. LapSIM basic skills training system consists of 11 modules (Figure 1, LapSIM basic skills training suturing models). Each module of the simulator training has three phases as easy, intermediate and difficult. The user continues his/her training up to achievement of an expert competency.

Heilbronn Laparoscopic Training Program (HLEP) with a conventional physical laparoscopic training box

A training box widely used in courses was employed as a conventional physical laparoscopic training box, Surgeons in Group B received a HLEP training program comprising six modules.[10,11]

Operation

Sixteen non-obese patients (12 males and 4 female; mean age, 47.5 yrs [43-55 yrs]) with symptomatic Bosniak type I renal cysts ranging between 8 and 11.5 cm in diameter who had no history of abdominal surgery participated in the study. Age, gender, personal and familial medical history, general and urologic physical examination findings were recorded. The patients were evaluated preoperatively with routine biochemical analyses, urinary ultrasound, abdominopelvic computed tomography with or without contrast-enhancement. The patients were randomized into 2 groups. The operations were performed by the same operating team excluding the surgeon in-charge. Transperitoneal technique was used for all patients.

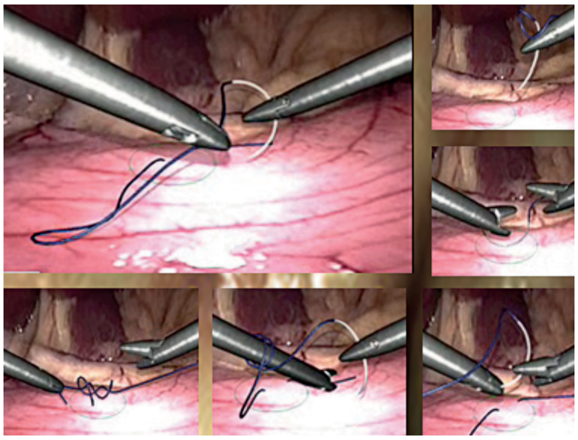

Figure 1: Suture training on Virtual reality (VR) simulator training system

Randomization and blinding

Groups and video records of the operations performed by candidates were randomized using computer-aided "simple randomization" method. Personnel ID numbers were used for the randomization procedure. Blinded evaluation method was not used because of the inherent characteristics of this method. The video films of the operations performed by the trainees were recorded on DVDs without any processing, and mailed to mentors in compliance with a randomized double-blinded design. The data obtained by OSATS survey were gathered on-line from internet using a computer-aided system.

Statistical evaluation

SPSS 13.0 program was used for statistical analyzes of the study. The categorical variables in the data set are shown together with their frequency and percent values and the numerical variables in the data set are shown together with their mean, standard deviation, median, minimum and maximum values. Mann Whitney U test was used for the two group comparisons of the variables which were given numeric value specified by the measurement. The categorical variables were compared with chi-square test. During the statistical analyzes of the study, the comparisons below p-value of 0.05 were considered statistically significant

RESULTS

Mean (range) ages of the participating surgeons in Group A and B were 38.63 (36-46), and 38.50 (33-44) →

years of age, respectively. All study participants were males. In Group A, right hands of all surgeons were dominant, while in Group B, right hands of seven surgeons and left hand of one surgeon were dominant. Four surgeons in Group A, and three surgeon in Group B had developed motor skills like playing video games or an instrument (Table 1). In both groups, in terms of motor skills like playing video games or an instrument, with chi-square test (p=1.00), no significant difference was observed. Operations in both groups were in accordance with surgical procedures, and any complication was not observed. According to preoperative planning, in case of development of an intraoperative complication or prolongation of the operation, instructor would intervene the procedure. However any adverse event requiring such an intervention was not encountered. Duration of the operations was calculated after entry of trocars or the retraction of liver or spleen, and abdominal exploration. Mean (range) duration of operations was 36.13 (30-46) mins and, 35.13 (28-47) mins, in Groups A, and B respectively (Table 2). There was no statistically significant differences between the two groups in terms of operation times (p=0.72). All surgeons in both groups were successful based on OSATS assessment criteria. According to OSATS assessment criteria median (range) values were as follows: In Group A; respect to the tissue 3.25 (3-4), duration of the operation and manipulations 3 (2-4), instrumental experience 3.13 (2-4), safety of manipulations 3 (2-4), use of an assistant 3.5 (3-4), flow of the operation 3.13 (3-4), and accuracy of the operative technique 3.25 (3-4). In Group B; respect to the tissue 3.38 (2-4), duration of the operation and manipulation 2.63 (1-3), instrumental experience 3.38 (3-4), safety of manipulations 3 (2-4), use of an assistant 3.5 (3-4), flow of the operation 3.5 (3-4), and accuracy of the operative technique 3.5 (2-4) (Table 3). There was no statistically significant difference observed between the two groups, in terms of respect to the tissue (p=0.64), duration of the operation and manipulations (p=0.50), instrumental experience (p=0.50), safety of manipulations (p=1.00), use of an assistant (p=1.00), flow of the operation (p=1.00) and the accuracy of the operative technique (p=0.38).

DISCUSSION

In the present study, a statistically significant difference has not been detected between the success rates of computer-aided laparoscopic simulator, and laparoscopic classical box training. In both groups, any statisticallly significant difference was not detected between motor skills gained. Besides, both groups were observed successful in the specific laparoscopic training they had received. Mean operating times of both groups were close to each other. Both groups yielded nearly similar median values in the OSATS surveys. We have observed that VR simulators might be helpful in gaining basic andadvanced laparoscopic skills in urologic surgery. A few studies conducted in the clinics of general surgery have stated that the computer-aided VR surgery using surgical field simulation models offers many advantageous options in which this simulation method had boosted the experience of the surgeon to peak levels, decreased the duration of learning curve for the surgeons with respect to complex procedures.[12-15] It was reported that after receiving VR laparoscopic cholecystectomy training, the students became enormously successful in porcine laparoscopic nephrectomy.[16] It was also stated that in addition to offering an ability to imitate all methods available, models closer to reality had been continually evolving.[17] Only a few simulation systems for urologic operations are available. The first VR software for laparoscopic urologic operations was first introduced in 2004 as a prototype.[18] This procedure was a laparoscopic nephrectomy with a sensorial feedback (haptic feedback). Nowadays, any other operation simulator in the field of urology is not available. Laparoscopic cholecystectomy designed as a VR simulation in the field of general surgery among other disciplines has established its place as a simulation operation in the literature. Related reports are detailed so as to comprise nearly all complications encountered. Comparative evaluation of laparoscopic cholecystectomy performances of the surgeons with VR simulation training revealed that their performances were 29% faster than those with physical simulation training together with six-fold lesser probability of procedure failure.[19\]

In the past, the mostly emphasized imperfections of the VR simulation such as deficient perceptions of tension and pressure, reality of images have been the subject matter of the studies. In the last years, a few trials related to the subject in question had evaluated the validity, and the reliability of the VR training methods developed for the current surgical training.[20-22] We might contemplate that candidates receiving VR simulation courses are more enthusiastic and, hardworking might be a favourable factor influencing learning curve.[23] Although in most of the studies, superior advantages of simulators are mentioned, many confusing issues still exist. With successful simulations in urologic operations mainly in prostatic and renal surgery, this confusing issues can be resolved. Despite lack of studies using methods in laboratories equipped with conventional and new generation models, preoperative training with both approaches might be useful. Further studies are required to determine the duration of training for laparoscopic VR simulator →

or conventional box models. We have observed that in addition to these data, practicability of VR simulator, instantaneous display of the performance, unboring nature of the training, usage of animated tissue instead of tissue- mimicking material have encouraged self- confidence, and desire to exercise in novice laparoscopists. Advanced VR simulators are potentially excellent alternatives preventing ethical concerns about applications on cadavers, and animals. When the validity of 3 R rule (ie. replacement, reduction and refinement which correspond to modification of the material, decreasing the the number of material, and subjecting them to processes appropriate to their physiologies, respectively) which is required ethically for laparoscopic trials in animals is considered, training not necessitating use of animal tissue is extremely important.

CONCLUSION

Computerized laparoscopic VR simulator training system with haptic feedback is an effective and applicable method in the achievement of basic and advanced level laparoscopic skills. We recommend further development of these promising VR simulators before including them in training programs. Additionally, it should not be forgotten that laparoscopic VR simulators are easily applicable, but still expensive equipments.

Acknowledgement: We, hereby take the oppurtinity to thank all participants and the mentor of this study for their valuable inputs and guidance.

* The authors declare that there are no conflicts of interest.

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DELIVERING DATE: 09 / 01 / 2013 • **ACCEPTED DATE:** 03 / 03 / 2014

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