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EDUCATION AND TRAINING

Validation of a structured intensive laparoscopic course for basic and advanced gynecologic skills training

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ABSTRACT

Objective: To describe and validate a gynecologic laparoscopic-surgery training model. *Methods:* The present prospective observational study was conducted at the Minimally Invasive Surgery Centre Jesús Usón, Cáceres, Spain, between January 2011 and June 2013. Novice gynecologists attended a 3-day course including simulation and animal training. Participants' were assessed, before and after training, using a virtual reality simulator; gynecologists were timed and assessed using an Objective and Structured Assessment of Technical Skills score. The virtual reality simulator-assessed skills were eye–hand coordination, hand–hand coordination, and transference of objects. Participants were asked to rate various elements of the training program using a five-point scale. *Results:* The study enrolled 21 gynecologists. Participants performed all tasks faster ($P < 0.001$), using fewer movements ($P < 0.05$ for left and right instruments) after receiving training. During participants' final animal and simulator training sessions, completion times were reduced ($P < 0.001$) and assessment scores ($P < 0.001$) increased for all techniques and tasks. Participants considered suturing to be the most useful aspect of the basic-skills training (4.95 ± 0.22); animal training received a higher rating than simulator training for practicing new techniques (4.81 ± 0.40 vs 4.05 ± 0.86) and maintaining skills (4.76 ± 0.54 vs 3.95 ± 0.97). *Conclusion:* Combining proficiency-based physical simulation and animal training models under expert guidance is an efficient model for improving basic and advanced laparoscopic skills. Suturing and animal models were the preferred training components.

1. Introduction

The role of laparoscopic surgery in gynecologic practice has increased owing to the benefits it provides for patients when compared with conventional surgery [1,2]; these include faster recovery times and reduced postoperative pain. However, laparoscopic surgery also presents technical challenges for the surgeon, including reduced tactile feedback, two-dimensional vision, the "fulcrum effect", and the requirement of good eye–hand and hand–hand coordination. Consequently, it is challenging to master laparoscopic techniques using the traditional training model of, "see one, do one, teach one".

In order to develop laparoscopic-specific training methods and programs, clinical and nonclinical training has been combined [3]. Clinical training involves both fellowship and residency curricula in a hospital environment; nonclinical training refers to eminently practical modules that usually include the use of simulators and experimental animal models. However, the optimum combination of these components for developing psychomotor skills is unknown [3]. The development of standardized training programs for advanced laparoscopic surgery should be considered a major goal for the future [4]. However, many hospitals currently face restricted duty hours for residents, decreasing hospital and faculty reimbursement, reduced availability of nonclinical time for teaching, and an increasing number of educational requisites and quality and safety objectives [5].

In the present study, an intensive training program was developed with the aim of providing training in laparoscopic surgical skills while minimizing impact on surgeons' already limited time. However, it is necessary to validate the utility and effectiveness of all training programs. Several objective assessment tools have been used previously to validate laparoscopic-training programs, including virtual reality simulations and observational tools [6,7]. However, there are minimal studies that have combined objective and subjective tools to validate gynecologic laparoscopic surgical training. Consequently, the aim of the present study was to use an objective assessment of surgery performance and a subjective validation by participants to evaluate a structured training model for laparoscopic gynecologic surgery skills.

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2. Materials and methods

The present prospective observational study was conducted at the Minimally Invasive Surgery Centre Jesús Usón, Cáceres, Spain, between January 1, 2011 and June 30, 2013. Participants were recruited from the gynecologic laparoscopy training course of the study institution. All gynecologists who were registered on the course were contacted and informed of the study. Participants provided written informed consent to participate in the study 1 month before it began, at which time they were assigned an identification number. Any potential study recruits who had acted as the primary surgeon for more than 10 surgical procedures were excluded. The present study was approved by the Minimally Invasive Surgery Centre Jesús Usón Ethical Committee and the present study was conducted in accordance with EU Directive 2010/63/EU regarding the protection of animals used for scientific purposes.

After recruitment, participants completed a demographic survey and information regarding individuals' previous laparoscopic and simulation experience was recorded.

Following this, all the recruited trainees participated in a progressive laparoscopic training model with a total duration of 21 hours. This course included a short theoretical component (1 hour), a hands-on simulator session (7 hours), and experimental animal surgery (13 hours).

The theoretical component was aimed at teaching general concepts regarding laparoscopic equipment and ergonomics, including correct and incorrect operator body positioning for preventing muscle fatigue and paresthesia. Additionally, trained instructors corrected participants during the practical session if they adopted poor positioning.

During simulator training, participants performed five tasks using a physical simulator (Simulap; Surgery Centre Jesús Usón, Cáceres, Spain) [8]. Initially, participants practiced basic skills on inorganic tissue, including an eye–hand coordination task, a hand–hand coordination task, and a cutting task. Following this, participants performed advanced maneuvers while practicing using on ex vivo porcine stomachs, including dissection and intracorporeal suturing tasks. These tasks were repeated until participants achieved a predetermined proficiency level (assessed through the time taken to complete the tasks). The necessary proficiency level was determined based on the average completion time of five expert surgeons (each expert had completed more than 100 surgeries as the primary surgeon). If participants achieved proficiency before the end of the 7-hour training session, they could continue suturing for the remaining time. Following the simulated training, surgeons practiced a variety of in-vivo surgical techniques during the second and third days of the course.

During the animal experimentation session of the course, gynecologic training techniques were performed on sheep, which were utilized owing to their anatomic similarities to other animal species. All animals were anesthetized and attended by veterinarians to assess their welfare. The techniques practiced by the participants were salpingectomy, ovariectomy, dissection and ligature of the uterine artery, and hysterotomy. Participants practiced each of these techniques at least twice. Vessel and fallopian tube occlusions were simulated using thread ligatures.

During both the physical-simulator and animal training sessions, participants were supervised and tutored by expert surgeons; one expert surgeon was present for every two surgeons participating in the course. Additionally, participants' first and last repetition of each task and surgical technique were assessed for their completion time and Objective and Structured Assessment of Technical Skills (OSATS) score [9]. Assessments were made by two expert surgeons who were masked to each participant's identity. Assessments were made by viewing recordings of the procedures. The OSATS scoring system assesses seven surgical disciplines (e.g. "respect for tissue" and "instrument handling") that are rated on a five-point Likert scale, resulting in a maximum score of 35 [9].

Participants' pre- and post-training skills were assessed across three tasks (eye–hand coordination, hand–hand coordination, and transference of objects) using a virtual reality simulator (LAPMentor; Simbionix Corporation, Cleveland, OH, USA). The assessment of eye–hand coordination entailed using the right and left tips of the instrument to touch a random sequence of flashing blue and red balls, respectively. The hand–hand coordination assessment required participants to grasp nine balls from a jelly, using both the left and right instruments, before placing them into a basket. The transference of objects assessment consisted of placing colored objects, by passing them from one instrument to the other, in response to on-screen prompts. Owing to the long length of the transference of objects task, participants were only assessed for the first two objects out of a total of six included in the task. The simulator software was used to assess the participants' dexterity in terms of the total time (seconds), number of movements, path length (cm), and speed of movements (cm/s) throughout each task for the left and right instruments.

At the end of the course, all participants were asked to complete a questionnaire employing a five-point rating scale to assess the length and components of the training course.

The statistical analyses were performed using SPSS version 15.0 (SPSS Inc, Chicago, IL, USA). All procedure times and OSATS scores were expressed as the mean ± SD. A Shapiro–Wilk test was applied to verify if the data were parametric or non-parametric. Nonparametric and parametric data were analyzed using a Wilcoxon signed-rank test and a paired Student *t* test, respectively. The Cronbach alpha coefficient was calculated to estimate inter-rater reliability of OSATS scoring. $P < 0.05$ was considered statistically significant.

3. Results

The present study recruited 21 gynecologists. The mean ± SD age of participants was 33.81 ± 8.67 years and all the trainees were right handed. Previous experience of gynecologic surgery among the study group included acting as the primary surgeon during ovarian cystectomy and salpingectomy procedures. Most participants had no previous experience using physical simulators (85.7%), augmented-reality simulators (95.2%), or virtual reality simulators (90.5%)

Participants were able to complete the physical-simulator tasks faster ($P < 0.001$) and achieved higher OSATS scores ($P < 0.001$) in their final repetition of tasks compared with their first attempt (Table 1). The Cronbach alpha coefficient between OSATS scores was 0.87.

Additionally, procedural time was reduced ($P < 0.001$) and participant OSATS scores were increased ($P < 0.001$) in participants' final attempts to complete the animal-model procedures compared with their initial attempts (Table 2). For the animal-model tasks, the Cronbach alpha coefficient between OSATS scores was 0.85.

When assessed using the virtual reality simulator, all participants performed the eye–hand coordination task faster (85.48 ± 13.17 s vs 67.38 ± 7.91 s; $P < 0.001$) after completing the training program.

Table 1
Comparison of surgical time and OSATS scores during the first and last repetition of training tasks performed using a physical simulator.[a]

Task	Repetition	Surgical time, s	*P* value[b]	OSATS score	*P* value[b]
Eye–hand coordination	Initial	244.68 ± 82.00	0.001	18.07 ± 1.80	0.001
	Final	191.18 ± 60.87		19.55 ± 1.47	
Hand–hand coordination	Initial	1067.36 ± 385.79	0.001	17.84 ± 1.38	0.001
	Final	862.48 ± 280.16		19.36 ± 1.45	
Cutting tissue	Initial	551.48 ± 241.07	0.001	17.82 ± 1.23	0.001
	Final	432.77 ± 173.92		19.59 ± 1.21	
Dissection	Initial	389.70 ± 236.37	0.001	18.83 ± 1.59	0.001
	Final	193.16 ± 76.47		20.98 ± 1.36	
Intracorporeal suturing	Initial	604.05 ± 255.29	0.001	18,06 ± 1.23	0.001
	Final	248.94 ± 114.19		21.44 ± 1.24	

Abbreviation: OSATS, Objective and Structured Assessment of Technical Skills.
[a] Values are given as mean ± SD unless indicated otherwise.
[b] Paired samples Student *t* test.

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