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The efficacy of robotic driven handheld instruments for the acquisition of basic laparoscopic suturing skills

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ABSTRACT

Objective: To evaluate the efficacy of robotic-driven handheld laparoscopic instruments for the acquisition and improvement of basic laparoscopic suturing skills.

Study design: A prospective study was carried out on 15 physicians grouped by previous experience. They were evaluated on the completion of basic surgical laparoscopic skills. First, they used traditional non-articulating laparoscopic instruments, and later they used robotic-driven articulating instruments.
Results: Significant time reduction was observed in the group of inexperienced physicians when they used robotic-driven instruments for needle loading and placing stitches. An 8.3% time reduction was observed in the same group when considering total times for the completion of all exercises. No significant differences for the experienced groups were found.
Conclusions: Robotic-driven handheld instruments could help inexperienced physicians acquire basic skills in laparoscopic techniques. No benefit has been observed when previous laparoscopic experience is present.

Introduction

Laparoscopic surgery is the cornerstone of the surgical techniques in gynecology. Using this route, almost all procedures of the specialty could be carried out. The main limitations to performing complex interventions are the slow learning curve compared to open surgery and the surgeon's experience [1,2]. In order to ease the training and development of the necessary skills to perform difficult surgical procedures, new instruments have been developed during recent years.

Robotic-assisted surgery has decreased the length of learning curves in gynecologic procedures areas but at a very high cost [3]. A new robotic-driven articulating handheld laparoscopic instrument, Kymerax™ (Terumo Europe N.V., Leuven, Belgium), tries to simulate the advantages of robotic technology, such as increased dexterity and precision, but at a much lower expense. Although it seems to offer advantages compared to traditional non-articulating laparoscopic instruments, no evidence on its clinical efficacy has been reported at this time. We found one article on gynecological surgery describing its use for the performance of a total laparoscopic hysterectomy with good results [4].

Before using the new device in clinical practice, residents and senior staff need to familiarize themselves with it in the laboratory, by performing basic laparoscopic exercises. It has been proven that the training of surgical skills in the laboratory is cost-effective and less risky than direct in-vivo application [5] regardless the type of simulation [6–8].

Our aim was to evaluate the efficacy of the robotic-driven handheld laparoscopic instruments for the acquisition and improvement of basic laparoscopic suturing skills among gynecologic residents and consultants.

Material and methods

After approval by the institutional ethics committee (reference #PI-1335), a prospective study was carried out on 15 physicians from the Gynecology Department of La Paz University Hospital in Madrid, Spain.

Basic surgical laparoscopic skills were evaluated (by means of three basic exercises for laparoscopic suturing) using first, traditional non-articulating instruments, followed by the Kymerax™ robotic-driven articulating instrument. It consists of a generator where the instruments are plugged in, a non-heavy handle with three buttons to control horizontal, vertical and rotation movements of the instruments, and the instruments (grasper, scissors, dissector, etc.). Detailed specifications can be found on the manufacturer's webpage.

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Prior to the test we obtained data on previous laparoscopic experience and manual abilities of the physicians, such us dominant hand, years of experience, number of gynecological procedures related to their complexity grade (all laparoscopic procedures were divided into four groups according to the European Society for Gynaecological Endoscopy, as shown in Table 1). We also collected data on previous experience in simulated training in animal models, virtual reality, pelvic trainers, previous use of entertaining consoles and experience with musical instruments.

The protocol of evaluation was carried out in the laparoscopic laboratory in a single setting including three steps. First of all, attendees watched an 8-min educational video where the use of the new device was explained and developed by Terumo Europe N.V., Leuven, Belgium, followed by a first contact with it during 4 min. Secondly, the attendees were asked to complete three exercises performed with traditional laparoscopic instruments and the time to complete was measured by the same investigator for all for them. Finally, the same timed exercises were performed using the robotic driven device. Each exercise was repeated three times by each participant and the mean time for each exercise was taken into account.

The three exercises that we considered basic steps in the laparoscopic suturing process evaluated and measured: (1) to load a CT-1 needle to a laparoscopic needle holder; the task was consider completed when the needle was placed perpendicularly to the closed instrument; (2) to place a stitch across two marked points to evaluate the precision of its performance; (3) to perform an intracorporeal knot tie; this task was considered completed when a double square knot and two simple additional knots were carried out.

Each physician was provided with a pelvic trainer with an integrated camera, with two 5-mm trocars inserted lateral to the midline. They also used two needle holders and precut 15 cm 1-0 Vicryl sutures on a CT-1 needle to perform the exercises.

Among all candidates, 11 were trainees in gynecology and obstetrics and 4 were consultants. None of them practiced any exercise in the pelvic trainer before the study, since they were informed of the details of the exercises at the moment of performance. Moreover, they had not previously been exposed to the articulated instruments, either for training or during surgery.

To perform the statistical analysis, participants were divided into three groups according to their previous laparoscopic experience: low, medium and high experience. The quantitative variables were defined by median and range, and qualitative variables by absolute value and percentage. To compare quantitative variables among groups, the T-test and ANOVA were used. To compare qualitative variables among groups, the chi-square test was used. Alpha error was set at 5% for all comparisons.

Table 1
Classification of laparoscopic procedures according to the European Society for Gynaecological Endoscopy.

Level of complexity	Procedures
BASIC	-Diagnostic laparoscopy ± biopsies
	-Tubal ligation
	-Cyst aspiration
INTERMEDIATE	-Salpingectomy
	-Oophirectomy
	-Cystectomy
	-Moderate adhesiolysis
	-Mild endometriosis
ADVANCED	-Hysterectomy
	-Myomectomy
	-Urinary incintinence
	-Extensive adhesiolysis
	-Severe endometriosis
	-Bowel/bladder lesion repair
EXPERT	-Pelvic floor disorders
	-Oncological procedures (lymphadenectomy or radical hysterectomy)
	-Recto-vaginal endometriosis

Results

Among all participants, 11 were residents and 4 consultants in obstetrics and gynecology. Six participants had low experience in laparoscopic skills (50% 1-year residents and 50% 2-year residents), 5 had medium experience (60% 3-year residents and 40% 4-year residents), and 4 of them had high experience (median years of experience 16 years; range 3 to 19). All previous experience among groups is shown in Table 2.

The times for performing all exercises among groups of differing experience are shown in Table 3.

When we compared the times measured by groups comparing the exercises carried out using traditional laparoscopy or robotic handheld instrument we did not find a statistical significance,

Table 2
Previous laparoscopic experience of participants by groups.

Items	Group 1 Low ($n=6$)	Group 2 Medium ($n=5$)	Group 3 High ($n=4$)	p-value
Dominant hand				0.488
right-handed	5 (83.3%)	5 (100%)	4 (100%)	
left-handed	1 (16.7%)	0 (0%)	0 (0%)	
Clinical experience no	6 (100%)	0 (0%)	0 (0%)	0.001
yes	0 (0%)	5 (100%)	4 (100%)	
Basic procedures				<0.001
none	6 (100%)	0 (0%)	0 (0%)	
<30	0 (0%)	5 (100%)	0 (0%)	
30–50	0 (0%)	0 (0%)	0 (0%)	
>51	0 (0%)	0 (0%)	4 (100%)	
Intermediate level				0.001
none	6 (100%)	2 (40%)	0 (0%)	
<30	0 (0%)	3 (60%)	0 (0%)	
30–50	0 (0%)	0 (0%)	0 (0%)	
>51	0 (0%)	0 (0%)	4 (100%)	
Advanced procedures				0.001
none	6 (100%)	3 (60%)	0 (0%)	
<30	0 (0%)	2 (40%)	0 (0%)	
30–50	0 (0%)	0 (0%)	0 (0%)	
>51	0 (0%)	0 (0%)	4 (100%)	
Expert procedures				0.030
none	6 (100%)	5 (100%)	0 (0%)	
<30	0 (0%)	0 (0%)	1 (25%)	
30–50	0 (0%)	0 (0%)	2 (50%)	
>51	0 (0%)	0 (0%)	1 (25%)	
Simulated training				0.078
no	3 (50%)	0 (0%)	0 (0%)	
yes	3 (50%)	5 (100%)	4 (100%)	
Animal models				0.007
no exposure	6 (100%)	5 (100%)	0 (0%)	
1–2 times	0 (0%)	0 (0%)	0 (0%)	
>2 times	0 (0%)	0 (0%)	3 (75%)	
anually	0 (0%)	0 (0%)	1 (25%)	
Pelvic trainer				0.030
no exposure	3 (50%)	0 (0%)	0 (0%)	
1-2 times	3 (50%)	3 (60%)	0 (0%)	
>2 times	0 (0%)	2 (40%)	3 (75%)	
anually	0 (0%)	0 (0%)	1 (25%)	
Virtual reality				0.417
no exposure	6 (100%)	5 (100%)	3 (75%)	
1–2 times	0 (0%)	0 (0%)	1 (25%)	
>2 times	0 (0%)	0 (0%)	0 (0%)	
anually	0 (0%)	0 (0%)	0 (0%)	
Other abilities (h./week)	(mean ± SD)	(mean ± SD)	(mean ± SD)	
Videogames	0.67 ± 1.63	0.25 ± 0.50	0	0.654
Musical instruments	0.83 ± 2.04	0	0	0.551

SD: standard deviation; h.: hours.