Effectiveness of Learning Advanced Laparoscopic Skills in a Brief Intensive Laparoscopy Training Program


*Experimental Surgery and Simulation Center, Department of Digestive Surgery, Clinic Hospital, School of Medicine, Pontificia Universidad Católica de Chile, Santiago, Chile; †Department of Surgery, Faculty of Medicine, McGill University, Montreal, Quebec, Canada; and ‡Arnold and Blema Steinberg Medical Simulation Centre, Faculty of Medicine, McGill University, Montreal, Quebec, Canada

BACKGROUND: Intensive training programs arose from limitations in access to simulation centers. The aim of this study is to evaluate the effect and associated factors involved in an intensive course for learning advanced laparoscopic skills, which include validated teaching techniques.

METHODS: General surgeons and final-year residents were analyzed after completing an intensive 5-session advanced laparoscopy course. Initial (IA) and final assessment (FA) consisted in performing a jejunojejunal anastomosis in a live porcine model, measured using objective structured assessment of technical skill (OSATS) (GRS and SRS, that is, global rating scale and specific rating scale, respectively) and operative time (OT). The 3-session training was structured in a bench model with an ex vivo bowel. For the demographic analysis, 3 groups were defined according to the presentation of relevant changes in OSATS and in OT between IA and FA: group A, no changes; group B, change in 1 variable; and group C, change in both variables.

RESULTS: After the course, all 114 participants presented a significant improvement in OT (37 vs 24.6 min, p < 0.001) and in OSATS; global rating scale (10.5 vs 16 points; p < 0.001) and Specific Rating Scale (8.5 vs 12.7 points; p < 0.001). In the IA, 70 (61%) participants completed the jejunojejunal anastomosis and 105(92%) in the FA (p < 0.01).

CONCLUSIONS: This intensive course is set out as a viable alternative to teach basic skills in advanced laparoscopy in a short period of time, which is ideal for surgeons with difficult access to training centers. It remains necessary to establish the participant profile for which this type of course is most beneficial. (J Surg 72:648-653. © 2015 Published by Elsevier Inc. on behalf of the Association of Program Directors in Surgery)

KEY WORDS: training courses, simulation, advanced laparoscopy, laparoscopic training

COMPETENCIES: Medical Knowledge, Practice-Based Learning and Improvement, Systems-Based Practice

INTRODUCTION
At present, surgery residents must graduate with competence in basic laparoscopic skills. However, residents have limits regarding working hours, and hospital safety regulations have limited their access to operating rooms.1,2 Simulation has risen as a viable alternative for learning such skills in a safe, controlled, and standardized environment.1,4

Most of the simulated programs of laparoscopic training are focused on teaching basic laparoscopic skills. One of these programs is “Fundamentals of Laparoscopic Surgery,” an examination held in the Unites States as a graduation prerequisite for surgery residents.5,6

Most of the current residency programs do not guarantee that future surgeons will be able to complete complex laparoscopic procedures, such as a small bowel
anastomosis. New training programs in advanced laparoscopy have been created to rectify this and have shown transfer of simulator-acquired skill to the operating room.7-12

Many types of advanced training programs have been suggested (structured, short, self-regulated courses, etc.), most of them with indicators showing skills acquisition. However, there are various factors related to the training subjects themselves that do not allow all programs to adapt to their requirements, such as innate abilities, availability, and access to simulation centers. These qualities make it difficult to compare different types of programs.13-15

Intensive training programs (within the length of a few days) arose as a response to the needs of surgeons and residents with time constraints or with geographic limitations on their access to simulation centers. This type of program could be effective in the initial stages of simulated laparoscopic training in untrained surgeons16 or for surgeons with little laparoscopic experience.17,18 The implementation and design of these courses requires a structured confrontation, a valid analysis of effectiveness, and a clear understanding of individual factors associated with the results. This achieves effective instruction of an advanced surgical technique in a short period of time.6,19

The aim of our study is to evaluate the effect and factors associated with a 5-session intensive course on advanced laparoscopic skills with validated teaching techniques.

METHODS

The Simulation and Experimental Surgery Centre of Pontificia Universidad Católica de Chile performed a quasi-experimental study of the participants of the course “Basic Techniques of Advanced Laparoscopic Surgery” from the year 2010 to 2014. This course was addressed to surgeons and residents in the final year of general surgery with experience in basic laparoscopic surgery.

Study Design

The 2-week course consisted of daily practical and theoretical sessions with approximately 30 hours of lectures, 2 sessions of laparoscopic videos, and a practical training course of advanced laparoscopy. The practical module included 3 training sessions in a simulation bench model and 2 evaluation sessions in a live porcine model (1 at the beginning of the course and a final assessment [FA] after the 3 training sessions). The Ethics and Animal Welfare Committee of the University approved the work protocol.

All participants completed a survey with demographic data related to their surgical experience.

Study Organization

Initial Assessment

Before the initial assessment (IA), the trainees attended a master class about how to perform a proper jejunojejunal anastomosis (JJO) with a stapler device using a video as an example and a live explanation by an expert instructor (Fig.). Afterward, they were filmed and pre-evaluated when performing the procedure on a live porcine model. A 40-minute time limit was established for each trainee owing to time and space limitations.

Training Sessions

Training was structured based on the following concepts: part-task training, constructivism, and effective feedback. The task to be taught was deconstructed in its key components to facilitate learning. The progression continued for a series of tasks of increasing complexity.20 Expert tutors gave effective feedback, which consisted in recognizing the strengths and weaknesses of the trainees and instruction on how to increase performance in the succeeding stages.

Participants performed 3 sessions of specific training to learn the necessary skills to perform a JJO with the stapler device in a validated bench model using an ex vivo bovine intestine.8,21 The sessions were performed in a 2-week

FIGURE. Diagram of diploma course “Basic Techniques of Advanced Laparoscopic Surgery.”
period. Each lasted 160 minutes, including 10 minutes of break. All sessions were supervised by 3 or 4 expert tutors who gave instructions on how to perform each task and gave effective feedback regarding each trainee’s progress.22,23

The sessions were organized in the following way:

**Session 1**: Basic laparoscopic skills training in interrupted intracorporeal sutures. Participants practiced each stage until they were considered competent and could move on to the following one. Afterward, they were instructed about how to perform a proper enterotomy using an ultrasonic device and how to use the stapler device to perform a laparoscopic mechanical anastomosis.

**Session 2**: Practice of skills learned in session 1 and instruction on how to perform a closure of an anterior surface with a continuous suture technique.

**Session 3**: Training of complete JJO.

Participants with lower performance were identified for more effective feedback.

**Final Assessment**

After finishing the 3 training sessions, all the trainees were evaluated under the same standard of IA with a live porcine model.

**Assessment Tools and Variables**

Both the IA and FA were videotaped and subsequently analyzed by 2 expert surgeons using validated objective structured assessment of technical skills (OSATS)24 scales, 1 global, 1 specific, (global rating scale [GRS] and specific rating scale [SRS], respectively)8 measuring the performance of different aspects of the laparoscopic technique.21 The scores ranged from 5 to 25 points in GRS and from 4 to 20 in SRS. Both variables were analyzed individually and as a sum of both scores (total GRS-SRS from 9-45 points). The operative time (OT) used in JJO and the completion rate of the anastomosis were also included in the analysis.

Evaluated primary outcomes were the comparison of GRS and SRS scores and the OT between IA with FA. For the subgroup analysis, which was performed secondarily, a positive variation of the score total GRS-SRS from 8 or more points between IA and FA was defined as a relevant quality change of the procedure. A relevant change of time was defined as a reduction of 10% or more OT between IA and FA. According to these categories, 3 subgroups of participants were defined: those that did not have any relevant change (group A), those who had a relevant change in one of the 2 variables (group B), and those who had relevant change in both variables (group C).

Among the defined subgroups variables such as age, years of practice as a surgeon, number of basic laparoscopic surgeries performed, and training stage (surgeon or resident) were considered and analyzed.

**Statistical Analysis**

SPSS IBM 20.0 software was used for statistical analysis. The “Wilcoxon match pair signed rank test” was used to compare predistributions and postdistributions of nonparametric continuous variables with the Student t tests for paired samples for parametric continuous variables. The Kruskal-Wallis and Mann-Whitney U tests were used for continuous variables in the subgroup analysis, correcting by multiple comparisons. The McNemar test was used to compare categorical dependent variables and the Fisher test to compare categorical independent variables. A p < 0.05 value was established as statistically significant for all tests. On the post hoc analysis using the Mann-Whitney U test, p < 0.016 (n = 3, post hoc comparisons) was defined as significant.

**RESULTS**

A total of 114 participants attended the course between 2010 and 2014. Of them, 95 (83%) were men, 90 (79%) were surgeons, and 24 (21%) were final-year residents of general surgery. All participants were evaluated at the beginning and at the end of the course, and all completed the 3 training sessions. Table 1 summarizes the characteristics of the sample.

**Primary Outcomes**

All participants, by comparing their IA and FA, had a statistically significant improvement in the OSATS score and OT. There was an increase in the score averages: global OSATS (10.5 [standard deviation, (SD), 3.2] vs 16 [SD, 3.9] points; p < 0.001) and specific OSATS (8.5 [SD, 2.5] vs 12.7 [SD, 3.4] points; p < 0.001). There was a decrease in OT medians between IA and FA (37 [11.5-40] vs 24.6 [10-40] min; p < 0.001) (Table 2).

In IA, 70 participants (61%) completed the JJO with a statistically significant difference from the completion rate in the FA (105 participants, 92%) (p < 0.01). The participants that did not complete the JJO in the FA (8%) also failed in completing the exercise in their IA.

**TABLE 1. Participants Baseline Characteristics**

<table>
<thead>
<tr>
<th></th>
<th>n = 114</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>37 (27-66)</td>
</tr>
<tr>
<td>Sex (men)</td>
<td>95 (83%)</td>
</tr>
<tr>
<td>Training stage</td>
<td></td>
</tr>
<tr>
<td>Residents</td>
<td>24 (21%)</td>
</tr>
<tr>
<td>Surgeons</td>
<td>90 (79%)</td>
</tr>
<tr>
<td>Years of practice as surgeon</td>
<td>3 (0-26)</td>
</tr>
</tbody>
</table>
Secondary Outcomes

For the subgroups analysis that considers relevant change in OSATS and OT, 16 participants (14%) did not have a relevant change in both dimensions (group A), 34 participants (30%) showed a change in 1 dimension (group B), and 64 participants (56%) showed a significant change in both dimensions (group C).

By analyzing age among subgroups, significant differences among them were made clear (p < 0.001). Post hoc analysis showed that the age median of group C was significantly lower than the one of group A (34 vs 45 y, p < 0.001) and than the one of group B (34 vs 40 y, p = 0.002).

It was observed that the number of years of professional experience as a surgeon was distributed differently among the subgroups (p < 0.001), where group C had fewer years of professional experience than group A (2 vs 9 y, p = 0.001) and than group B (2 vs 5 y, p = 0.009) in the post hoc analysis.

Furthermore, residents and surgeons were distributed differently among the subgroups. Most residents were gathered in group C (p = 0.01). The number of laparoscopic surgeries previous to the course was distributed with no differences among the subgroups (p = 0.448). Outcomes are summarized in Table 3.

DISCUSSION

This intensive training program in advanced laparoscopic skills using a validated simulator demonstrated an improvement in performance for most of the subjects after finishing the course. Even though improvement was different among the participants, the skill acquisition could be a contribution in their laparoscopic surgical experience.

An optimal simulated training program for surgical skills must include the following components: the appropriate selection of participants regarding the program’s objectives, suitable and assertive teachers who can give effective feedback,8,22 use of teaching methodologies such as deliberate practice, part-task training, and overtraining,25 pretraining and posttraining evaluation of each participant to measure progress in skills, use of validated simulation models26 with instructive videos for its proper use,27 and finally an optimal temporal distribution for training.28 These elements must be considered for a simulated training program as long as they can adjust to its context and objectives.

An improvement in motor skills in a reduced period of time was achieved through training optimization with the inclusion of innovative teaching techniques, such as part-task training, constructivism, and effective feedback.25 The inclusion of part-task training and constructivism allowed trainees to learn essential basic skills that made it easier to execute more complex tasks in an efficient way.20 Effective feedback made the participants’ progress easier and improved the identification of those who needed further instruction, which were key for obtaining results. All these teaching elements have already been recognized in training curricula based on performance. They are the basis for effectiveness in competence acquisition, especially in simulation.22,23 The content validity was objectified through predistribution to postdistribution assessments to trainees through a widely validated scale (OSATS).19,24

The anastomosis bench model used in this course has already been validated,8,21 and it obtains better results when it is part of a structured training program (16 sessions). The analyzed course comes from a validated curriculum and maintains its virtues and condenses the 16 training sessions of 60 minutes each into 3 sessions of 160 minutes. Even though it does not get the same results, significant changes are apparent in all participants in quality terms and execution time.

Diverse performance scores were identified among the course participants, associated with variables such as age, experience, and stage of surgical training. It was revealed that younger participants with less surgical experience achieved better results. This could be explained by the existing generation gap in basal fine motor skills and more exposure to laparoscopy, because their surgery residencies are more

### TABLE 2. Results Obtained in Initial (IA) and Final (FA) Assessment

<table>
<thead>
<tr>
<th></th>
<th>IA (n = 114)</th>
<th>FA (n = 114)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRS (media)</td>
<td>10.5</td>
<td>16</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>SRS (media)</td>
<td>8.5</td>
<td>12.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total GRS-SRS (media)</td>
<td>18.9</td>
<td>28.9</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Operative time (median)</td>
<td>37</td>
<td>24.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Completion percentage</td>
<td>61%</td>
<td>92%</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

### TABLE 3. Subgroups Analysis Defined by Relevant Change in OSATS and Operative Time

<table>
<thead>
<tr>
<th></th>
<th>Group A* n = 16</th>
<th>Group B* n = 34</th>
<th>Group C* n = 64</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (median)</td>
<td>45</td>
<td>40</td>
<td>34</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Years of practice as surgeon (median)</td>
<td>9</td>
<td>5</td>
<td>2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Number of performed basic laparoscopic surgeries (median)</td>
<td>82</td>
<td>63</td>
<td>43</td>
<td>0.448</td>
</tr>
<tr>
<td>Resident percentage</td>
<td>1 (6%)</td>
<td>3 (9%)</td>
<td>20 (31%)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

* Subgroups were defined as a relevant change in total GRS-SRS (≥ 8 points between IA and FA) and operative time (≥ 10% of operative time in IA). Group A: without change; Group B: change in 1 dimension; Group C: change in both dimensions.
In our national reality, the profile of participants to perform this type of course corresponds to surgeons with difficult access to simulated training as an approach to advanced laparoscopic surgery. It allows them to shorten their natural learning curve in a safe environment, as compared with conventional training with tutors. This training does not attempt to replace current surgical practice, but rather it tries to deliver surgeons an opportunity to improve their technical skills baseline, ultimately allowing them to continue improving their professional competences.  

The present study is not exempt from methodological limitations. First, the number of training sessions was set based on availability in the context course; outcomes were not evaluated with more sessions. Even though skills acquisition was demonstrated, there are no elements that predict their skill loss. Future studies should analyze the effect of increasing the number of sessions and how the curve of skill loss manifests. Regarding the classification for the subgroup analysis, the criterion used was a change of more than 10% of the value obtained in the IA. Unfortunately, there are no publications about a significant threshold shift in skills. In this study, a significant change was considered when its magnitude was not attributable to chance.

CONCLUSION

In conclusion, this 5-session intensive course is set out as a viable alternative to teach basic skills in advanced laparoscopy in a short period of time and is ideal for surgeons with difficult access to training centers. As the final skill level of the trainees was not uniform, it is necessary to establish a participant profile for whom this type of course is most beneficial.

REFERENCES

17. Van Rijssen LB, van Empel PJ, Huirne JA, Bonjer HJ, Cuesta MA, Meijerink WJHJ. Simulation-based


