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Original Article

Mandatory completion of a box trainer curriculum prior to laparoscopic apprenticeship in the OR for surgical residents: A Before and After study

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ABSTRACT

Introduction. – Training on laparoscopic box trainer (BT) improves surgical skills in the operating room (OR). Despite a large consensus on the educational value of the BT, its use is currently left up to local initiatives among French residency programs. This study evaluated the impact of a requirement to complete the Fundamentals of Laparoscopic Surgery (FLS) curriculum before starting companionship in the OR.

Methods. – This was a "Before and After" study conducted in two French academic hospitals in 2015-2017. Gynaecology and urology residents were given open access to a FLS BT during a six-month surgical rotation. Residents in the first group (Before group) trained on the BT while receiving classic companionship. Residents in the second group (After group) had to complete the FLS curriculum before they were allowed to participate in laparoscopic procedures as a primary operator. Outcomes measures were the time to curriculum completion and the intracorporeal suturing performances based on two validated assessment tools (FLS and GOALS scores).

Results. – Twenty-one surgical residents were included. All but two residents in the Before group completed the curriculum. The time to curriculum completion was longer in the Before group than the After group (69.5 days versus 28 days, $P = 0.001$). Post-curriculum performances were lower in the Before group than in the After group for the FLS scores (452.5 versus 496, $P = 0.01$) and the GOALS scores (14.5 versus 18, $P = 0.01$).

Discussion. – The mandatory completion of a BT curriculum prior to receiving active companionship in the OR is beneficial to residents in reducing time to curriculum completion and in enhancing laparoscopic skills on the BT.

Introduction

Mentorship in the operating room (OR) is no longer the only method of instruction that prepares surgical trainees to enter the modern surgical field. Laboratory practice sessions with a box trainer (BT) have proven to be highly effective for laparoscopic training as compared to performance levels achieved by conventional companionship training [1]. The important question is: "How should simulation training be incorporated into surgical residency programs?"

In many countries, surgical registrars exercise and play with different simulation models in an unstructured manner. BT is common among French residency programs, but its use remains optional and it is used with great disparity – usually without training goals [2]. Structured proficiency-based training curricula like the Fundamentals of Laparoscopic Surgery (FLS) are recognized methods that can be used for laparoscopic skills training in different surgical specialties, including gynaecology [3]. Successful completion of the FLS program is mandated by the American Board of Surgery to ensure an adequate laparoscopic skill level in surgical trainees.

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During surgical residency, it is unclear whether simulation training should be proposed as an adjunct to clinical instruction or should be done before clinical training starts. The simulation laboratory is often used during work hours, and the lack of free time during work hours is most commonly cited reason for underutilization [4]. Other situations may contribute to BT underutilization, including the fact that it is never prioritized as a part of a resident's busy schedule. If training opportunities in the OR are only permitted after successfully passing a skills test on the BT, residents probably would prioritize BT use in order to pass to the following training block.

The primary objective of this study was to evaluate, during a six-month surgical rotation, if the time to FLS curriculum completion is reduced when curriculum completion is a mandatory requirement to start companionship as a primary operator in the OR. The secondary objectives were to assess the residents' opinions and their laparoscopic suturing performances after they completed the curriculum.

Materials and methods

This observational "Before and After" trial was conducted at two French academic hospitals (La Conception – Marseille and Arnaud de Villeneuve – Montpellier) between November 2015 and October 2017 (Fig. 1).

Participants

The study recruited surgical residents (second to fourth year) undergoing a six-month rotation in gynaecology or urology. The exclusion criteria were as follows: prior validation of the FLS curriculum and experience of more than five intracorporeal knots performed in a genuine laparoscopic setting. Before the initial assessment, all residents attended a laparoscopic skills training seminar.

Settings

Participants were trained on a FLS BT in a dedicated room. They had unrestricted access to this room and open access to the didactics of the FLS programs and video demonstrations. They were asked to train on three FLS tasks: pegboard transfer, pattern cutting and intracorporeal knot. The curriculum was considered complete once previously published levels of time (expert) and errors were consecutively reached on three tasks [5,6]. Proficiency was required on two consecutives attempts plus 10 additional attempts for the pegboard transfer and the intracorporeal knot task, and on two consecutive attempts for the pattern cutting task. Each resident received one session of constructive feedback from a content expert following the first session on the intracorporeal knot-tying task. A weekly email was sent to each participant to remind them of training goals.

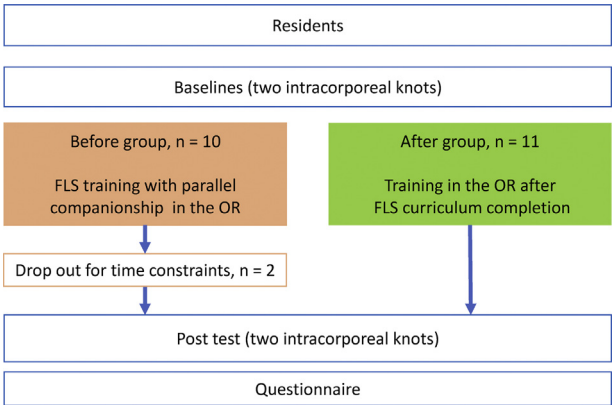

Fig. 1. Study design.

Intervention

During the first period (November 2015–October 2016), residents from the Before group were invited to complete the FLS curriculum while receiving conventional companionship training in the OR. During the second period (November 2016–October 2017), residents from the After group had to complete the FLS curriculum before they were permitted to participate in laparoscopic procedures as a primary operator in the OR. Until curriculum completion, they were only permitted to assist in laparoscopic procedures.

Assessment measures

The participants self-recorded their performances for each task on a dedicated spreadsheet. The required periods (days) and the number of attempts and sessions to complete the curriculum were collected for each participant, based on self-reporting.

During the curriculum completion, practice and assessment was conducted as described in the FLS curriculum [6]. At baseline and following the curriculum completion, intracorporeal knot-tying performance was assessed using FLS scores and GOALS scores. GOALS is a rating scale developed to evaluate intraoperative laparoscopic skills. The five domains of GOALS include depth perception, bimanual dexterity, efficiency, tissue handling, and autonomy. Each domain is scored using a range of one to five points. The autonomy category was removed, since no guidance was provided to residents. Consequently, GOALS scores ranged from 4 to 20 [7] (Appendix). All operators performed two knots during each assessment. Performances of the second knot were video-recorded and analysed. Two experienced laparoscopic surgeons (AA and PC), who were blinded to identity and session, independently assessed the videos.

Assessment schedule

The baseline performances of residents on the intracorporeal suturing task were assessed throughout the first month of their rotation. Post-training assessment took place during a separate session two days after curriculum completion. Before each assessment, participants in both groups were given 15 minutes of warm-up on the FLS BT.

Questionnaire

At the end of the rotation, participants were asked to report their thoughts regarding FLS box training on a Google Forms questionnaire. It was composed of five questions focusing on the perceived educational value of box training and residents' opinions about the ideal timing for box training during residency program (Table 1).

Statistics

First, a descriptive analysis of the demographic and previous laparoscopic experience data was performed. Inter-rater reliability for the GOALS scale was calculated using the intraclass correlation coefficient (ICC). For each group, the residents' performances were compared before and after completion of the FLS curriculum. Performances were compared between the two groups. As the

nature of data was non-parametric, the Wilcoxon signed-rank test was employed to analyse pair-wise data, and the Mann–Whitney U test was employed to analyse independent data. The data were analysed using SPSS version 20.0 (SPSS, Chicago, Illinois, USA). The results were reported as median and interquartile range. $p < 0.05$ was considered statistically significant.

Results

Participants

All participants in the Before group were at the Marseille gynaecology and urology department. Four out of the 11 participants in the After group were at the Montpellier gynaecology department. Demographic data and previous simulation training experience are presented in Table 2.

FLS curriculum

Two participants from the Before group withdrew from the study due to time constraints and did not complete the curriculum. All participants from the After group completed the curriculum during the rotation period. Regarding the participants who completed the curriculum, the number of attempts for each task and training sessions were similar in both groups. The length of time necessary to complete the curriculum was significantly longer in the Before group than in the After group. The results are presented in Table 3.

Intracorporeal suturing skills: baseline versus post FLS curriculum

The two independent raters completed a video-based GOALS assessment of a random sample ($n = 8$) of all eligible knots. The ICC was 0.918. Given the high inter-rater reliability obtained, the rest of the procedures were blindly assessed by only one of the two raters (PC). They are presented as results.

Performances in the Before group were lower at the baseline than they were after curriculum completion for FLS scores [354 (262–375) versus 452.5 (440.5–472.7), $P < 0.012$] and GOALS scores [9 (6.5–10.2) versus 14.5 (13.25–16.5), $P < 0.017$]. Performances in the After group were lower at the baseline than they were after curriculum completion for FLS scores [366 (270–417) versus 496 (486.7–501), $P < 0.005$] and GOALS scores [8 (5–1 2) versus 18 (17–19), $P < 0.005$].

There was no significant difference between the Before group and the After group at baseline for FLS scores [354 (262–375) versus 366 (270–417), $P = 0.360$] and GOALS scores [9 (6.5–10.2) versus 8 (5–12), $P = 0.721$]. Following curriculum completion, the Before group was outperformed by the After group in terms of FLS scores [452.5 (440.5–472.7) versus 496 (486.7–501), $P = 0.01$] and GOALS scores [14.5 (13.25–16.5) versus 18 (17–19), $P = 0.01$]. This results are illustrated in Fig. 2.

Questionnaires

Twenty participants answered the questionnaire. Both groups agreed that BT was useful to enhance laparoscopic skills. A majority of participants from both groups thought that box training should be completed before surgical rotation, and within the first two years of residency programs. Answers to the five questions are detailed in Table 1.

Discussion

This study compared two protocols for incorporation of a laparoscopic BT curriculum into the traditional companionship model during a surgical rotation. Completion of the FLS curriculum as a prerequisite to receive companionship in the OR encouraged participants from the After group to increase the frequency of training sessions. Compared to the Before group, increasing the frequency of training sessions in the After group led to a more than 50 percent reduction in the amount of time necessary to complete the curriculum.

Laparoscopic box training curriculum implemented during a six-month rotation has many potential advantages. Training is parallel to clinical activities, and residents with diverse backgrounds can train following their own learning curve until they reach proficiency-based levels [8]. Furthermore, residents retain

Table 1
Answers to the questionnaire. Results are presented as median (interquartile range) for question 1 and number of answers for question 2 to 5.

	Before group $n = 9$	After group $n = 11$
On a scale from 1 (useless) to 5 (very useful), how do you estimate the value of the BT in enhancing your laparoscopic skills?	4 (4–5)	4 (4–4)
What limited your BT access?		
No reason	0	2
Clinical commitments	10	9
Feeling that box training was not useful in improving skills	0	0
What kind of BT use would be the most efficient?		
Open access	1	4
Access only during organized dedicated sessions	0	0
Open access combined with an organized dedicated schedule	10	5
Do you think that box training should be done before or during the surgical rotation?		
Before the surgical rotation	5	10
During the surgical rotation	4	1
At what time during residency program do you think that BT curriculum should be completed?		
First year	3	4
Second year	6	6
Before the end of residency program	0	1

Table 2
Demographics and simulation training experience of study participants.

	Before group $n = 10$	After group $n = 11$	*P*
Age, y	27.5 (26–28.25)	27 (26–28)	1
Number of six months rotations done	4 (2.75–7.75)	5 (3–7)	0.353
Speciality, Gynaecology: Urology	5:5	11:0	–
Handedness, right: left	9:1	9:2	–
Simulation training experience			
None	7	3	
Initiation session	2	7	–
Workshop session	1	1	

Table 3
Comparison of the Before group versus the After group during the FLS curriculum completion (Mann-Whitney U test). Results are presented as the median (interquartile range).

	Before group $n = 8$	After group $n = 11$	*P*
Peg transfer trial number, *n*	61 (40–101)	64 (40.5–94.5)	0.791
Pattern cutting trial number, *n*	13 (7–15)	8 (6–11.5)	0.263
Intracorporeal knot trial number, *n*	20 (17–24)	20 (18–29)	0.523
Total trial number, *n*	91 (79–141)	87 (77–131)	0.832
Session numbers, *n*	6 (5–9)	8 (6–9.5)	0.148
Length of time to curriculum completion, days	69.5 (56–80.5)	28 (26–39)	0.001

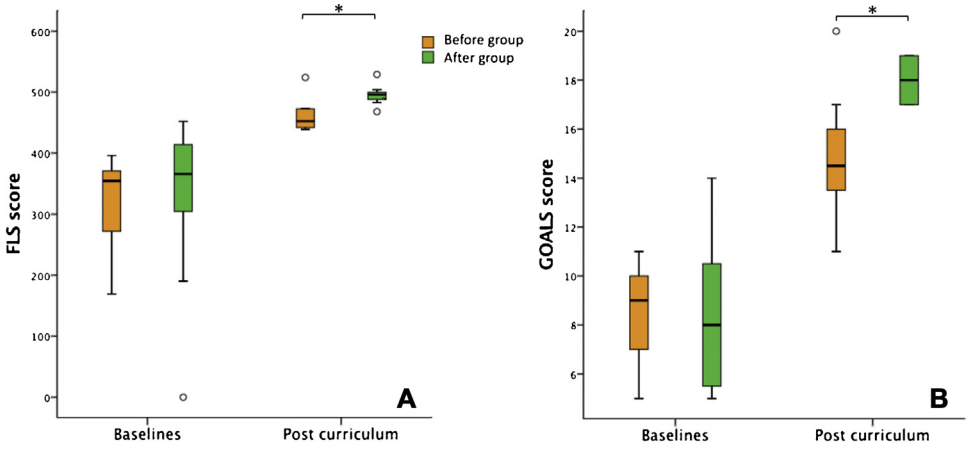

Fig. 2. Intracorporeal suturing performances on the FLS box trainer at baseline and after FLS curriculum completion in After group and Before group. A. FLS score. B. GOALS score. $^{*}P < 0.05$ (Mann–Whitney U test). Horizontal lines within boxes, boxes and whiskers represent median, inter-quartile range and range, respectively. Circles represent outlier case.

and transfer skills better if they are taught in a distributed manner [9]. Additionally, integrating the curriculum into a surgical rotation is a reminder to trainees and seniors of defined objectives and the educational duty of the department.

Simulation has become a component of surgical education over the last decade. Despite the growing evidence in literature to support the use of simulation for surgical training, it remains a challenge to demonstrate the efficiency of a simulation program when transferred to the OR – Kirkpatrick level 3 – and ultimately its impact on patient care – Kirkpatrick level 4 – [10–12]. Additionally, time dedicated to lab training is difficult to integrate within already busy schedules, and number of complex procedures are still not thoroughly reproduced by simulation tools. For all these reasons, faculty and residents still praise the values of companionship in the OR, that remains the cornerstone of surgical education. Consequently, the prospect of being allowed to perform procedures in the OR was a strong incentive for the After group participants, that obviously explain the reduced amount of time to complete the curriculum. Chang et al. found that when given the opportunity to train in a simulation laboratory, many residents chose not to for reasons relating to time, location and lack of interest. To increase participation rates, the authors suggested that simulation-based training would need to be made mandatory [13].

In the present study, the number of sessions and trial attempts were similar in both groups and consistent with outcomes reported in the literature for FLS curriculum completion [14,15]. Interestingly, the Before group did not perform as well as the After group on post-training evaluations on the BT. This difference in the quality of suturing skills between the groups may be explained by the fact that training was more structured due to the prospect of access to training opportunities in the OR. These outcomes suggest that technical skills box training is more efficient when training sessions occur over a reduced period of time. This principle of intensive structured courses opened to surgical residents has been applied by Clermont-Ferrand training center for many years [16].

Training regimens other than companionship combined with simulation have been tested. Preclinical training allows for the development of pretrained novices [17]. Some Boot Camp frameworks propose developing intensive simulated weeks that recreate experiences and situations that junior surgical interns will likely face in their first weeks after graduation [18]. In a randomized trial, De Win et al. found that in terms of performances at six months after the beginning of the rotation, a preclinical proficiency-based laparoscopy course was more efficient than clinical training combined with laboratory training or clinical training alone [19]. Simulation training should be used to replace the early part of the learning curve, which would otherwise be achieved by live practice in clinical situations. The concept of pretrained novices for more complex procedures was found to be efficient in reducing the learning curve of laparoscopic cholecystectomies in the OR [12]. However, a gap remains between current simulators and procedures on real patients, and the integration of simulation within clinical teaching remains sensible for a large part of surgical instruction [20].

According to the questionnaire, residents from both groups are convinced of the effectiveness of this BT curriculum. They point out that clinical duties limit access to BT and thereby favor pre-clinical training to be started before the beginning of surgical rotation. Implentation of this structured training before clinical immersion would imply a paradigm shift in French gynaecology residency programs.

The limitations of this study lie in its "Before and After" design. The Before group consisted of residents from two surgical specialties in one centre, while the After group included only gynaecology residents from two different centres. However, this lack of homogeneity between the two groups had no impact on the BT setting and free access to the training room. Furthermore, selected tasks were basic laparoscopic skills that are fundamental in both specialties. Another limitation was the absence of transfer to the OR for each group.

BT has been used in French academic centres for many years. It is currently the most widely used type of simulator in gynaecology [2,21]. However, there is no consensus on the use of a validated BT curriculum among residency programs. Despite recommendations from the French *Haute Autorité de santé* in 2012 stipulating that simulation is a prerequisite to training in the OR, simulator use remains left to local initiatives and it is still non-mandatory [22]. BT sessions will be integrated into the forthcoming new organization of obstetrics and gynaecology national residency programs. Residents will be encouraged to pass the certification proposed by the European Society of Gynaecologic Endoscopy by the end of the second year of residency [23].

The integration of a box training curriculum during a 6-month surgical rotation before gaining access to companionship in the OR is beneficial to residents, and it maintains the ethical principles that the patients deserve. This is a simple application of the pretrained novice concept within the current educational system. Future developments should focus on relevant simulation programs to be offered to trainees before beginning clinical immersion.

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Disclosure of interest

The authors declare that they have no competing interest.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jogoh.2018.01.002.

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