

# Laparoscopic Simulation Training for Residents in Obstetrics and Gynecology Over 12 Months

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## Abstract

**Objectives:** As gynecology surgical cases are declining across the country, residency programs can benefit by training residents with simulation. We evaluate five Fundamentals of Laparoscopic Surgery (FLS) tasks over 12 months.

**Materials and Methods:** This was a retrospective study of 16 obstetrics and gynecology residents. Residents practiced on a FLS simulation box trainer. They were evaluated on completion time and pass/fail performance for the five tasks of peg transfer, precision cutting, loop ligation, suture with extracorporeal knot, and suture with intracorporeal knot. Resident satisfaction with FLS simulation box training was evaluated.

**Results:** We found improvement of reduced time from baseline to 12 months for the tasks of peg transfer, precision cutting, suture with extracorporeal knot, and suture with intracorporeal knot. No time improvement was noted for loop ligation. We only found increased passing rates for the precision cutting task from baseline to 12 months. Residents agreed that simulation training improves surgical skills, improves patient safety, and improves confidence level in the operating room.

**Conclusion:** We found improvement of decreased time with FLS simulator box training for FLS tasks of peg transfer, precision cutting, suture with extracorporeal knot, and suture with intracorporeal knot. We recommend that routine practice with the FLS simulator box trainer will increase resident confidence level and potentially improve surgical outcomes when in the operating room. We recommend including a dedicated portion of the academic curriculum for simulation training. FLS box training can be an essential tool for residency programs in obstetrics and gynecology.

**Keywords:** Curriculum, gynecology, internship and residency, laparoscopy, simulation training

## INTRODUCTION

Minimally invasive surgery with laparoscopic-assisted surgery is clinically useful and a popular approach used by surgeons.<sup>[1,2]</sup> Formal training occurs with the Fundamentals of Laparoscopic Surgery (FLS) which is a series of didactics which is accompanied by a standardized skill and knowledge examination.<sup>[3]</sup> The American Board of Obstetrics and Gynecologists requires passing the FLS examination for board certification in obstetrics and gynecology.<sup>[4]</sup> There is a simulation training box available for residents to practice.<sup>[5]</sup>

Simulation training is an integral part of resident education due to less duty hours and overall less surgical volume for many resident training programs.<sup>[6]</sup> Simulation provides exposure to new procedures and techniques needed to bridge the gap for acquiring the necessary basic surgical skills and confidence before surgery in the operating room.<sup>[7]</sup> Simulation training for gynecological surgery can potentially help minimize complications occurring with gynecological surgeries performed by resident physicians.<sup>[8]</sup> The leading professional accrediting organizations of the American College of Obstetrics and Gynecology and the American

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Association of Gynecologic Laparoscopists both encourage simulation training.<sup>[9]</sup>

Simulation training is reported as useful for obstetrics and gynecology residents where simulation training improved knowledge,<sup>[10]</sup> surgical skills assessed by virtual reality,<sup>[11]</sup> and surgical skills assessed in the operating room.<sup>[10]</sup> Simulation training reduced time for peg transfer<sup>[12]</sup> and intracorporeal suturing,<sup>[12]</sup> while some reported reduced time for circle cut,<sup>[12,13]</sup> and others only reported reduced time for circle cut for certain types of residents.<sup>[14]</sup> Simulation training improved performance for peg transfer<sup>[13]</sup> and single stitch/knot,<sup>[13]</sup> while some reported improved performance for circle cut<sup>[13]</sup> and others did not report any improved performance for circle cut.<sup>[14]</sup>

We are aware of two studies using FLS simulator box training in obstetrics and gynecology. One study compared 12 obstetrics and gynecology residents that received FLS simulator box training for pegboard transfer, pattern cutting, and intracorporeal knot over 4 months to six surgeons. Residents improved from before to after training with reduced operating time and better performance for both the box trainer and the operating room. There were no differences between residents and surgeons for intracorporeal knot FLS box training score, while residents had slower performance than surgeons in the operating room.<sup>[15]</sup> Another study of 2<sup>nd</sup> to 4<sup>th</sup> year surgical residents undergoing a 6-month rotation in gynecology or urology over 6 months compared FLS simulator training with conventional instructor training in the operating room ( $n = 10$ ) versus completing FLS simulator training before entering the operating room ( $n = 11$ ). Both the groups increased their FLS scores from before to after training. However, there were no differences between the groups for pegboard transfer, pattern cutting, and intracorporeal knot completion time.<sup>[6]</sup>

We are aware of only one simulation study that has a follow-up over 1 year.<sup>[12]</sup> However, this was studied with general surgery residents and not obstetrics and gynecology residents. The FLS simulation studies<sup>[6,15]</sup> report better overall performance but do not specify performance for each of the tasks. Furthermore, we are not aware of any FLS simulator box training or any simulation training that assesses the skills of loop ligation and extracorporeal knot. This study assesses FLS simulator box training for the five FLS tasks of peg transfer, precision cutting, loop ligation, suture with extracorporeal knot, and suture with intracorporeal knot at 6- and 12-month follow-up.

## MATERIALS AND METHODS

### Setting and procedure

This was a retrospective study of 16 obstetrics and gynecology residents. This study was conducted from January 1, 2019,

to April 15, 2021. The study was performed using the FLS simulator box trainer (Limbs and Things, Savannah, Georgia, 2015) at a suburban community hospital of New York City. Inclusion criteria included all residents from all postgraduate years within the obstetrics and gynecology program. Before the initial testing, each resident received detailed instructions on completion and pass/fail criteria for the five required tasks of peg transfer, precision cutting, loop ligation, suture with extracorporeal knot, and suture with intracorporeal knot.

Peg transfer required lifting six objects with a grasper in the nondominant hand, transferring the objects to the opposite hand, and then placing the objects on a pegboard. This process was then repeated in reverse. Precision cutting required cutting a circle within 2 mm deviation from a square piece of gauze suspended between clips. Loop ligation required placing a pretied ligating loop or endloop around a tubular foam appendage on the provided mark followed by securing the knot near the marker on the appendage. Extracorporeal knot tying required suturing a small longitudinal slit in the drain and making at least three throws extracorporeally that must include one double throw and two single throws on the suture. Intracorporeal knot tying required suturing a small longitudinal slit in the drain and making at least three throws intracorporeally that must include one double throw and two single throws on the suture.

FLS testing was conducted over a period of 1 year at baseline, 6 months, and 12 months. Time to completion and pass/fail as per the FLS criteria were evaluated at each time period. Residents were given unlimited access to the FLS box training between testing periods. We also invited each resident to participate in a satisfaction questionnaire to assess how they felt including a surgical curriculum would benefit resident's success in the operating room. Ethical approval was received from the Nassau Health Care Corporation Institutional Review Board to conduct this study. The approval number was 21–375. A waiver for informed consent was received due to the study being a quality improvement study.

### Variables

Demographic variables for participants were postgraduate year 1 to 4, sex (male/female), and race/ethnicity (white, Hispanic, Asian, and others). The outcome variables were total time to completion of each task at baseline, 6 months, and 12 months and also pass/fail for each task at baseline, 6 months, and 12 months.

Satisfaction questions consisted of (1) the tasks on the simulator improved my surgical skills, (2) a block in the curriculum for simulation training is useful, (3) use of the simulator led to improved patient safety, (4) I would practice with the simulator during my off time, and (5) practicing the tasks in the simulator improved my comfort level in the

operating room. These were measured on a Likert-type scale ranging from 1 = strongly disagree to 5 = strongly agree. Furthermore, participants were asked, “How many hours a week on the simulator will lead to improvement in your surgical skills?”

**Statistical analysis**

Descriptive statistics consisted of mean and standard deviation for the continuous variables and frequency and percentage for the categorical variables. Repeated measures analysis of variance (ANOVA) with the Bonferroni correction compared the time to complete the tasks. Time to complete the tasks of peg transfer and cutting was logarithmic transformed due to the presence of skewness. The McNemar’s test compared pass/fail percentage for the tasks. All *P* values were two-sided. Alpha level for significance was *P* < 0.05. IBM SPSS Statistics version 26 was used for all analyses (IBM, Armonk, NY, 2019.).

**RESULTS**

The 16 residents consisted of the entire residency program with four residents in each of the 4 years of postgraduate year 1, postgraduate year 2, postgraduate year 3, and postgraduate year 4. More than two-thirds were women (*n* = 11, 68.8%). Race/ethnicity consisted of white (*n* = 7, 43.8%), Hispanic (*n* = 5, 31.3%), Asian (*n* = 2, 12.5%), and others (*n* = 2, 12.5%).

Table 1 shows the mean comparisons for time to complete the training task. For peg transfer, due to not meeting Mauchly’s assumption of sphericity, the conservative Greenhouse–Geisser correction was used. There was an overall significant ANOVA (*P* = 0.01). *Post hoc* analyses with the Bonferroni correction showed that peg transfer significantly differed with lower means from baseline to 6 months (*P* = 0.004) and baseline to 12 months (*P* = 0.03). For loop ligation, due to not meeting Mauchly’s assumption of sphericity, the conservative Greenhouse–Geisser correction was used. The overall ANOVA was not significantly different (*P* = 0.15). Cutting met Mauchly’s assumption of sphericity. There was an overall significant ANOVA (*P* < 0.001). *Post hoc*

analyses with the Bonferroni correction showed that cutting significantly differed with lower means from baseline to 6 months (*P* = 0.01) and baseline to 12 months (*P* < 0.001). For extracorporeal knot, due to not meeting Mauchly’s assumption of sphericity, the conservative Greenhouse–Geisser correction was used. There was an overall significant ANOVA (*P* = 0.01). *Post hoc* analyses with the Bonferroni correction showed that extracorporeal knot (*P* = 0.01) significantly differed with lower means from baseline to 6 months (*P* = *P* = 0.049) and baseline to 12 months (*P* = 0.02). For intracorporeal knot, due to not meeting Mauchly’s assumption of sphericity, the conservative Greenhouse–Geisser correction was used. There was an overall significant ANOVA (*P* = 0.02). *Post hoc* analyses with the Bonferroni correction showed that intracorporeal knot significantly differed with lower means from baseline to 12 months (*P* = 0.04).

Table 2 shows the percentage comparisons for passing the training task. Only cutting from baseline to 12 months had significantly increased percentages for passing (*P* = 0.01). The other tasks of peg transfer, loop ligation, extracorporeal knot, and intracorporeal knot did not significantly differ between the training sessions.

Table 3 shows the descriptive statistics for the satisfaction items. All five items were rated as agree or higher. The item of “the tasks on the simulator improved my surgical skills” had the highest mean of 4.75. Participants reported a mean of 9.38 hours (standard deviation = 5.74) as the weekly hours of practice on the simulator that will lead to improvement in surgical skills.

**DISCUSSION**

We found improvement of reduced time from baseline to 12 months for the four tasks of peg transfer, precision cutting, suture with extracorporeal knot, and suture with intracorporeal knot. We did not find any improvement for loop ligation. We only found increased passing rates for the precision cutting task from baseline to 12 months. Residents agreed that simulation training improves surgical skills,

**Table 1: Mean comparisons for time in seconds to complete the training task**

Variable	Mean±SD (n=16)			P (95% CI)		
	0 month	6 months	12 months	0 versus 6	6 versus 12	0 versus 12
Peg transfer	190.63±99.93	163.88±108.47	140.31±91.31	0.004 (0.03-0.15)	0.52 (-0.05-0.17)	0.03 (0.01-0.28)
Loop ligation	112.50±51.99	108.88±43.15	104.50±38.27	1.00 (-8.77-16.02)	0.28 (-3.98-19.98)	0.08 (-0.42-9.17)
Cutting	443.13±156.67	365.50±166.55	270.88±86.68	0.01 (0.02-0.17)	0.10 (-0.02-0.23)	<0.001 (0.09-0.31)
Extracorporeal knot	340.19±185.55	287.25±161.97	268.31±160.45	0.049 (0.27-105.60)	0.06 (-0.86-38.73)	0.02 (12.05-131.70)
Intracorporeal knot	444.44±286.59	362.19±241.64	326.25±207.27	0.15 (-20.90-185.40)	0.21 (-85.68-13.80)	0.04 (3.63-232.74)

All comparisons performed with an overall repeated measures analysis of variance followed by *post hoc* comparisons with the Bonferroni correction. Peg transfer and cutting were analyzed with logarithmic transformed variables due to presence of skewness. Nontransformed values are reported for ease of understanding. The 95% CI for the mean difference. SD: Standard deviation, CI: Confidence interval

**Table 2: Percentage comparisons for passing the training task**

Variable	0 month (n=16), n (%)	6 months (n=16), n (%)	12 months (n=16), n (%)	0 versus 6 (P)	6 versus 12 (P)	0 versus 12 (P)
Peg transfer (pass)	13 (81.3)	14 (87.5)	15 (93.8)	1.00	1.00	0.50
Loop ligation (pass)	13 (81.3)	14 (87.5)	15 (93.8)	1.00	1.00	0.50
Cutting (pass)	7 (43.8)	11 (68.8)	15 (93.8)	0.13	0.13	0.01
Extracorporeal knot (pass)	12 (75.0)	11 (68.8)	12 (75.0)	1.00	1.00	1.00
Intracorporeal knot (pass)	10 (62.5)	11 (68.8)	12 (75.0)	1.00	1.00	0.50

All comparisons performed with the McNemar’s test

**Table 3: Satisfaction items description**

Item	Mean ± SD
1. The tasks on the simulator improved my surgical skills	4.75±0.44
2. A block in the curriculum for simulation training is useful	4.00±0.89
3. Use of the simulator led to improved patient safety	4.37±0.62
4. I would practice with the simulator during my off time	4.37±1.09
5. Practicing the tasks in the simulator improved my comfort level in the operating room	4.44±0.89

SD: Standard deviation

improves patient safety, and improves confidence level in the operating room. Residents agreed that time dedicated to simulation training in the curriculum is useful and that they would practice with the simulator during off time.

We found that after FLS simulator box training, the peg transfer time decreased over both 6 and 12 months. However, performance of passing did not change over time. Previous research for non-FLS simulator box training reports reduced time for peg transfer<sup>[12]</sup> and improved performance for peg transfer.<sup>[13]</sup> Our findings for FLS simulator box training are similar to the time findings but are not similar to the performance findings. We suggest that increased practice reduces time needed to complete a task. However, our performance of passing did not change as our sample had a very high pass rate.

After FLS simulator box training, we did not find any significant change for loop ligation time over 12 months. Similarly, performance of passing did not change over time. A study with surgical residents using a simple portable collapsible mobile box trainer showed decreased time for loop ligation from baseline to 6 months.<sup>[16]</sup> Our findings differ from this study as we did not see any time decrease for loop ligation. Our simulator uses the standard FLS simulator box. We suggest that for whatever time residents believe is reasonable to practice with the FLS simulator box that loop ligation may need more practice than just for 12 months to decrease time.

We found that after FLS simulator box training, the precision cutting time decreased over both 6 and 12 months. Performance of passing also increased from baseline to

12 months. Previous research with non-FLS simulator box training reports mixed findings for simulation training time for precision cutting where some report a decrease<sup>[12,13]</sup> while others only report decreased time for certain types of residents.<sup>[14]</sup> Previous research with non-FLS simulator box training reports mixed findings for simulation training performance for precision cutting where some report improved performance<sup>[13]</sup> while others do not report improved performance.<sup>[14]</sup> Our findings for FLS simulator box training are similar to those reporting decreased time<sup>[12,13]</sup> and improved performance.<sup>[13]</sup> We suggest that FLS simulator box training is helpful to residents with time decreases occurring over 6 months, while the higher level of improved performance passing rates needs more practice over 12 months.

We found that after FLS simulator box training, the extracorporeal knot tying time decreased over both 6 months and 12 months. However, performance of passing did not change over time. Previous research with surgical residents using a simple portable collapsible mobile box trainer did not show any change in time or performance for extracorporeal knot tying over 6 months.<sup>[16]</sup> Our study with the standard FLS simulator box differs from this pattern. It is possible that our simulator offers additional training benefits than a portable collapsible mobile box trainer. Although a portable collapsible mobile box trainer is cheaper in cost and can be easily transported and set up, it does not provide the same training experience for extracorporeal knot tying as the standard FLS simulator box.

We found that after FLS simulator box training, the intracorporeal knot tying time decreased over 12 months. However, performance of passing did not change over time. Previous research with non-FLS simulator box training reported reduced time for intracorporeal knot tying<sup>[12]</sup> over 12 months with surgical residents. Our findings with FLS simulator box training for obstetrics and gynecology residents are similar to this pattern. Although surgical residents may have slightly different laparoscopic training than obstetrics and gynecology residents, our study suggests that obstetrics and gynecology residents can also benefit with simulation training for improving intracorporeal knot tying time.



Although we only found increased percentage rates of passing only for precision cutting, the lack of increased percentage rates of passing for the other tasks is likely due to the high levels of passing rates for most of the participants at baseline for the other tasks. Furthermore, we found that residents were satisfied with FLS simulator box training. They agreed that simulation training was useful for their skill improvement and for patient safety. They also agreed that time dedicated to simulation training in the curriculum is useful and that they would practice with the simulator during off time. Previous research reported that simulation box training is valued for enhancing laparoscopic skills.<sup>[6]</sup> Our findings add to the literature on other satisfaction topics about why residents value simulation training.

A strength of this study is the long follow-up duration of over 12 months to ensure that skills were retained. This study has several limitations. First, we had a small sample size of 16 participants. However, much of the previous simulation research for FLS and related tasks also included small sample sizes ranging from 12 to 24 participants,<sup>[6,10,12,14]</sup> while only one study had 33 participants.<sup>[13]</sup> Our sample size is consistent with the sample sizes studied in previous simulation studies. Second, we included residents from different training years and did not focus on those from a particular year. However, much of the previous simulation research for FLS and related tasks also included participants from different training years<sup>[6,12-14]</sup> with only one study including those of the same training year.<sup>[10]</sup> Third, we did not measure any operating room outcome. Future research should include FLS simulation box training and its impact on operating room outcomes.

## CONCLUSIONS

We found improvement of decreased time with FLS simulator box training for FLS tasks of peg transfer, precision cutting, suture with extracorporeal knot, and suture with intracorporeal knot. We recommend that routine practice with the FLS simulator box trainer will increase resident confidence level and potentially improve surgical outcomes when in the operating room. We recommend incorporating a dedicated portion of the academic curriculum for simulation training. FLS box training can be an essential tool for residency programs in obstetrics and gynecology.

## Center box message

Over 12 months time we found that after simulation training on the FLS box trainer that residents improved on FLS

tasks with reduced time. We recommended that residency programs include simulation training in their didactic programming.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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