JOURNAL OF Surgical Simulation

Journal of Surgical Simulation (2022) **9,** 120–126
DOI: https://doi.org/10.1102/2051-7726.2022.0016

ORIGINAL ARTICLE

The impact of feedback on laparoscopic skills for surgical residents during COVID-19

Chelsea Harris,[a] Casey Thorburn,[b] Claire Skanes,[c] Robert Kennedy[a] and Chris G. Smith[b,*]

[a]*Discipline of Obstetrics and Gynecology, Memorial University of Newfoundland, Canada;* [b]*Discipline of General Surgery, Memorial University of Newfoundland, Canada;* [c]*Medical Student, Memorial University of Newfoundland, Canada*

**Corresponding author at: Minimally Invasive General Surgeon, 300 Prince Philip Drive, St. John's, NL, A1B 3V6, Canada. Email: chris_g_smith78@yahoo.ca*

Date accepted for publication: 1 July 2022

Abstract

Background: Feedback is a crucial component in skill development, especially for minimally invasive surgery. Our objective was to determine how real-time video verbal feedback compares with delayed written feedback on junior resident performance in laparoscopic skills using at-home laparoscopic training boxes. **Methods:** Junior surgical residents, training at Memorial University, were randomized into three groups: control group (group A), delayed written feedback group (group B), and live verbal feedback group (group C). Data were collected for a period of 5 months. Participants practiced biweekly on a set of prescribed laparoscopic skills, including peg transfer and intracorporeal knot tying. Intervention groups (groups B and C) received either delayed or live feedback with weekly practice from an expert from the surgical field. Pre- and post-testing were completed. **Results:** Twelve residents were recruited; one was lost to follow-up. After the data collection period, the average number of pegs transferred correctly increased by 2.8 ± 1.7 for control group A, 3.0 ± 2.6 for group B, and 2.0 ± 1.4 for group C. There was significant group variance as shown by $F(2,8) = 5.928$, $P = 0.026$. Post-hoc testing resulted in group B outperforming groups A and C. Groups B and C both improved for the intracorporeal knot-tying task and the number of throws completed; no significant difference was noted between the groups. Qualitative data reported an increase in confidence in completing the tasks at the end of the study for all groups as well as a preference for live verbal feedback versus delayed written feedback. **Conclusions:** Access to box trainers allowed residents to practice at home, leading to improved skills and confidence. Participants receiving delayed written feedback showed a significant improvement in peg transfer. Further studies with larger sample sizes should be conducted on how feedback, verbal live versus delayed written feedback, can affect resident outcomes in laparoscopic surgery skills.

Keywords: *surgical education; laparoscopic surgery; simulation; feedback*

Introduction

The educational value of simulation training is well defined in the literature.[1,2] Access to high fidelity training equipment for medical residents is difficult secondary to cost, time, and geographic constraints.[3] Portable simulators provide low-cost, easily accessible alternatives for junior trainees to practice outside the traditional hospital setting.[4] Despite the understanding that simulation-based training improves surgical skills in junior learners, the use of laparoscopic box trainers is limited in residency training. Access to laparoscopic training became increasingly difficult during the COVID-19 global pandemic. Health authorities limited operating room times to reduce public health risks, resulting in less exposure and educational opportunities for residents. During such a difficult time, it is key for learners to have access to training tools that allow them to maintain their skill proficiency and advance through their residency training.

Self-directed learning and at-home practice have been shown to have a positive impact on hand-eye coordination, speed, and confidence with basic tasks. However, many low-cost, at-home training systems lack validity and, without supervision, trainees can adopt bad practices or skills that are not transferable to the operating room.[5–7] Thus, feedback is a crucial component in skill development, especially in minimally invasive surgery. It is well documented and a common requirement of medical school programs that feedback be frequent to enable physicians to develop early in their training.[8] Feedback can reinforce well-performed tasks and

correct deficiencies.[8] Coupled with the knowledge that feedback is beneficial and necessary for learner improvement in the field of surgery, we were interested in determining the type of feedback that provides the best opportunity for junior surgical residents to improve their skills.

The objective of this study was to determine the role of feedback during at-home training by comparing written and live verbal feedback, using video capture, on junior resident performance of basic laparoscopic skills using low-cost laparoscopic training boxes.

Methods

Study design

This study received ethical approval from the Health Research Ethics Board (# 2020.105). Twelve individuals were recruited for the study. The inclusion criteria consisted of post-graduate surgical residents enrolled in either the general surgery or obstetrics and gynecology program at Memorial University in their first (PGY1), second (PGY2), or third (PGY3) year of training. The exclusion criteria consisted of individuals in their fourth and fifth year of training or individuals who were completing their training at sites outside St. John's, NL. Participant demographics are shown in Table 1.

Participants were randomized to either the control group or to one of the two intervention groups. Each of the three groups (group A, group B, group C) included four junior surgical residents. An expert from each surgical field acted as feedback evaluator for a minimum of four feedback or training sessions. Both experts were licensed surgeons practicing in Newfoundland and Labrador, Canada.

Table 1. Participant demographics

	Group A, n (%)	Group B, n (%)	Group C, n (%)
Number of participants	4	4	4
Surgical program			
Obstetrics and gynecology	2 (50)	2 (50)	2 (50)
General surgery	2 (50)	2 (50)	2 (50)
Year of training			
PGY1	4 (100)	1 (25)	1 (25)
PGY2	0 (0)	2 (50)	2 (50)
PGY3	0 (0)	1 (25)	1 (25)
Sex			
Female	3 (75)	4 (100)	3 (75)
Male	1 (25)	0 (0)	1 (25)

Expert 1 is a general surgeon with a fellowship in minimally invasive surgery. He has worked as a faculty member at Memorial University since 2012. In addition to his work at Memorial University, expert 1 has acted as an instructor for the Skills Enhancement for Endoscopy Program, Canadian Association of Gastroenterology, and acts as a preceptor for medical students and surgical residents.

Expert 2 was trained in obstetrics and gynecology. He acts as a faculty member at Memorial University and associate professor at the Memorial University Medical school. Through these roles, expert 2 is a preceptor for medical students and surgical residents.

All participants were provided with their own low-cost laparoscopic training box (Fig. 1). The laparoscopic box trainers are known as the Train Anywhere Skill Kit (TASKit). The TASKit is manufactured by Ethicon, a subsidiary of Johnson-Johnson. Each TASKit contained laparoscopic instruments, pegs, and peg boards.

Before randomization, each participant completed pre-testing of timed laparoscopic tasks as per the Fundamentals of Laparoscopy Surgery (FLS) course.[9] Participants were then encouraged to practice tasks twice weekly for approximately 5 months, referred to as the data collection period. After the data collection time period, participants were to complete post-testing consisting of a written survey and the same timed laparoscopic tasks.

Participants were randomized to one of three groups. Group A was the control group. Participants in this group were encouraged to practice the tasks twice weekly and did not receive any form of feedback. Group B was the delayed feedback group. This group recorded videos of themselves completing the tasks, which were submitted to the experts for written feedback. To mitigate costs, individuals used their personal smartphones as cameras to record the laparoscopic field as they completed the prescribed tasks. Written feedback was provided on each session submitted to their assigned expert. Group C was the live verbal feedback group. This group had scheduled sessions via online video conference with the experts. Verbal feedback was provided in real time, via video conference, as they completed their tasks. A minimum of four sessions was asked of both intervention groups B and C.

The FLS-specific tasks used for assessment in this study included peg transfer and intracorporeal knot tying. For the peg transfer, participants were instructed to grasp a peg with their non-dominant hand, pass it to their dominant hand, and place it on the other side of a peg board. A penalty was noted if an object was dropped outside the field. The knot-tying task required participants to place a long suture through the two marks in a Penrose drain where a

Figure 1. Train Anywhere Skill Kit (TASKit).

slit was cut. They were instructed to tie three single throws of a knot and secure each throw onto the Penrose drain, thus, closing the slit. Penalties were noted if the participant deviated from the two marks, if the knots were not secured tightly, or if they avulsed the Penrose drain.

Primary outcome measures were (1) speed, (2) improvement in skills, and (3) self-reported confidence in basic laparoscopic skills. All measures were collected at the initial visit and after the intervention. The study design is shown in Fig. 2.

Data analysis

The data collected were analyzed and then presented as means ± standard deviation. The differences between groups were evaluated with one-way ANOVA using SPSS version 27 (IBM, Armonk, NY).

Results

Data collection took place from October 2020 until March 2021. Of the 12 residents who were recruited, one was lost to follow-up secondary to isolation requirements due to COVID-19. Further, although a minimum of four feedback sessions was requested for each individual in the intervention groups, there was some variation in this as seen in Table 2. The results are presented under the subcategory of each laparoscopic task.

Peg transfer

Peg transfer time improved in all groups. Group A improved by 60.0 ± 71.2 s, group B improved by 63.3 ± 60.3 s, and group C improved by 80.8 ± 73.6 s. The one-way ANOVA was $F(2,8) = 0.100$, $P = 0.906$, demonstrating that the differences between groups were not statistically different and the variance was predominantly attributed to within-group differences.

The total number of pegs transferred improved in all groups from pre- to post-testing. Group A improved by 2.8 ± 1.7 pegs, group B improved by 3.0 ± 2.6 pegs, and group C improved by 2.0 ± 1.4 pegs. There was a statistically significant difference in the number of pegs transferred, which was attributed to between-group variance as opposed to within-group variance ($F(2,8) = 5.928$, $P = 0.026$). Post-hoc testing using Tukey analysis demonstrated that group B (delayed feedback) was better than the control group (group A) and statistically different.

All groups demonstrated an overall average worsening in the number of pegs dropped when comparing post- to pre-test results. Group A had an increase in pegs dropped (1.5 ± 5.4 pegs). Group B increased their dropped pegs by

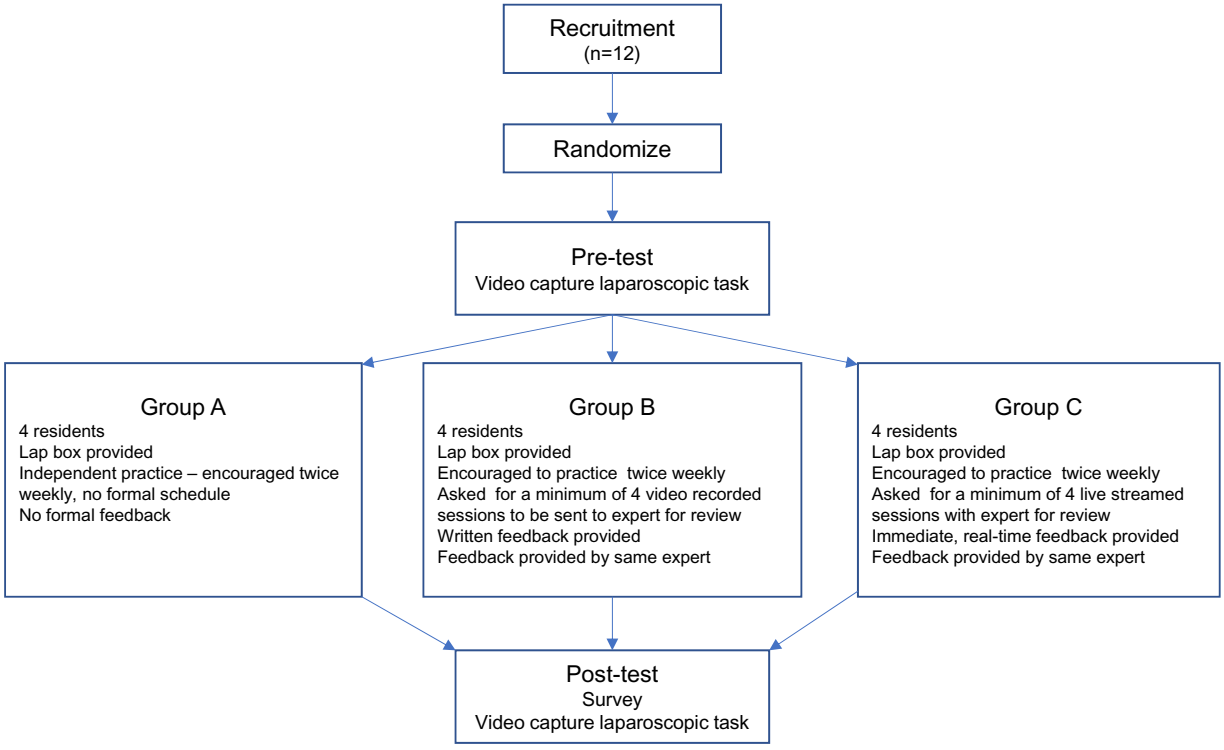

Figure 2. Study design.

Table 2. Summary of number of feedback sessions with expert

Group	Participant	Number of feedback sessions
A	1	–[a]
	2	–[a]
	3	–[a]
	4	–[a]
B	1	3
	2	3
	3	4
C	1	4
	2	2
	3	4
	4	3

[a]Not applicable because group A was the control group and did not receive any expert feedback.

1.7 ± 2.1 pegs. Group C increased their pegs dropped by 1.6 ± 4.7. The differences in pegs dropped were more attributable to within-group variance and the difference in between-group variances was not significant ($F(2,8) = 0.001$, $P = 0.999$).

Knot tying

Feedback groups (groups B and C) both improved on average in terms of intracorporeal knot time, whereas there was no change in group A. Group B improved by 4.7 ± 8.1 s and group C improved by 5.0 ± 10.0 s. Intracorporeal knot-tying time was not significantly different between groups as shown by the ANOVA test ($F(2,8) = 0.560$, $P = 0.592$).

All groups showed a small overall improvement in the number of throws completed. Group A improved by 0.5 ± 0.6 throws, group B improved by 1.7 ± 2.1 throws, and group C improved by 1.8 ± 2.1 throws. There was no significant difference between the groups ($F(2,8) = 0.672$, $P = 0.537$).

Additional results recorded from the intracorporeal knot task that were not analyzed with quantitative statistical analysis are shown in Table 3. The parameters recorded include whether the knot was secured, whether the slit was closed, the distance in millimeters the suture was placed from the dots (representing suture placement accuracy), and whether the suture tore through the material which would result in an automatic failure.

Qualitative data

Participants completed a post-testing survey to gauge how they perceived the study affected their proficiency and confidence in performing the prescribed laparoscopic skills. The residents provided any comments on their specific

Table 3. Additional parameters tested in the intracorporeal knot-tying test

Group	Participant	Knot secure (Y/N)		Slit closed (Y/N)		Distance suture from dots (mm)		Suture tear through material (Y/N)	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
A	1	N	N	N	N	0	1	N	N
	2	N	N	N	N	–[a]	1	N	N
	3	N	N	N	N	–[a]	–[a]	N	N
	4	N	N	N	N	–[a]	5	N	N
B	1	N	Y	N	Y	0	0	N	N
	2	N	N	N	N	0	0	N	N
	3	–[b]	Y	–[b]	N	–[b]	0	Y	N
C	1	N	Y	N	N	1	1	N	N
	2	N	Y	N	Y	2	1	N	N
	3	N	Y	N	Y	0	0	N	N
	4	N	–[b]	N	–[b]	0	–[b]	N	Y

[a]Not applicable because the suture was not passed through the material.
[b]Not applicable because the suture tore through the material resulting in automatic fail.

experiences and content from the survey was analyzed to identify themes.

Participants felt that live feedback was beneficial. Without directed feedback, motivation to improve and accountability to practice was felt to be lacking.

Participants in the groups without live feedback (groups A and B) felt more frustrated trying to learn specific skills, such as knot tying. Participants reported that they felt their skills would have improved more if they had someone directly guiding them through the various tasks with immediate feedback. Participants reported that direct feedback may have resulted in more immediate and efficient improvements in laparoscopic skills. There was concern about adopting bad habits among participants in groups that did not have real-time feedback.

Participants from all groups felt having access to a laparoscopic box trainer was useful for convenience and confidence. Overall, all participants felt that they benefited from the study and noticed improvements in their laparoscopic skills and confidence. Results from the post-testing survey, including feedback, from the study participants are presented in Table 4.

Discussion

Laparoscopic skills

Minimally invasive surgery is becoming more prevalent and developing a strong foundation in laparoscopic skills is important for junior surgical residents. Research shows that simulation-based training, such as a low-cost, portable laparoscopic box trainer, can be an effective method to teach learners to complete laparoscopic tasks for future use in the operating room.[2] Furthermore, feedback plays an important role in learner progress in laparoscopic skill acquisition. Although text feedback has been shown to be helpful to learners, feedback in general is an area that requires more study.[6] The purpose of this study was to determine whether various types of feedback were useful in the advancement of skill and confidence among junior surgical residents in both obstetrics and gynecology as well as general surgery during a global pandemic, when the ability to practice their skills in the operating room and in person with experienced staff members was limited.

In the quantitative portion of this study, FLS-specific tasks, including peg transfer and intracorporeal knot tying, were used to examine participant improvement over the study period. Results suggest that having access to a laparoscopic box trainer and being encouraged to practice predefined tasks had a positive effect on proficiency. This is supported by overall improvement in multiple task parameters across all groups. Although feedback and feedback type (delayed written versus live verbal) both did not lead to a statistically significant difference in between-group improvement, the results of this study are likely still clinically relevant because most learners progressed from a basic laparoscopic skill level during a time when they were not active in the operating room.

On further examination, only group B's results in the number of pegs transferred task were statistically significant. Delayed feedback significantly improved the results compared with the control group. This may be accounted for by the fact that feedback was provided in writing in a low-stress environment, which gave study participants the opportunity to think about their specific feedback, process the information, and then apply it. The quick nature of verbal live feedback from an expert or mentor has the

Table 4. Results of the post-test survey

	Number of participants
What year of training are you currently in?	
PGY1	6
PGY2	4
PGY3	1
How many times per week are you practicing laparoscopic skills outside of the OR?	
0	1
1	8
2	2
>2	0
Currently, how confident are you in your laparoscopic suturing?	
Not confident at all	2
Slightly confident	7
Somewhat confident	2
Fairly confident	0
Completely confident	0
Currently, how confident are you in your laparoscopic peg transfer?	
Not confident at all	0
Slightly confident	2
Somewhat confident	4
Fairly confident	5
Completely confident	0

potential to be stressful. Further, this environment might also cause learners to fail to retain all that is said. By having written feedback, participants in group B could refer back to their specific feedback as many times as they needed to. This aspect likely acted as a benefit to participants in that group and could be a reason why there was significant improvement in their skills.

When analyzing the quantitatively assessed results for the intracorporal knot-tying task, there was an overall improvement in the tasks. However, group A did not show any improvement. The complexity of the intracorporal knot task requires more time and ongoing feedback to master this advanced skill with greater participant success.

Based on the additional parameters that were collected for the intracorporeal knot-tying task, (summarized in Table 3), not all members in the control or intervention groups improved in each task. However, when assessed more closely, the live feedback group (group C) had a greater number of its participants complete a secured knot and close the slit than the delayed feedback group or the control group. This could indicate that live feedback was in fact superior to no feedback or delayed feedback in improving resident skills as opposed to improvement solely due to increased practice time.

Resident feedback

Overall, the opportunity for the junior residents to take home a laparoscopic box trainer was well received by the study participants. Participants reported that having time outside the operating room to practice their laparoscopic skills enabled them to increase their confidence in performing the assigned tasks. Many residents felt live feedback was more beneficial than delayed feedback. Residents also felt live feedback was more helpful in avoiding the development of poor habits, such as poor posture, maneuvering of the equipment, etc., which might not have necessarily been reflected in resident performance but is still important to correct early in a resident's training. Furthermore, the residents believed that having to schedule feedback sessions with their expert led to an increased feeling of accountability to maintain regular practice sessions, which they also believed to be helpful.

Limitations

One limitation of our study was the small sample size (n = 12) due to the limited number of eligible participants training at Memorial University of Newfoundland. Ideally, with a power of 0.80 and significance set at 0.05, testing between-subject effects would require a sample size of 16. However, due to the limitations of training at a small facility, this was not possible and the closest possible sample size to this was obtained. Furthermore, one member in group B was lost to follow-up. If a similar study were to be completed in the future, a larger sample size would be needed to mitigate some of the negative effects that our sample size had on our data.

Another limitation of this study were the potential discrepancies in the specifics of feedback given by each of the two experts. Ideally, both experts would give the same standard and type of teaching and quality of feedback throughout the study follow-up period, however, this can never be ensured entirely.

Finally, it was noted that COVID-19 was a limiting factor in optimizing participation because some equipment was shared between residents and sanitizing and transfer became challenging with isolation regulations. Due to COVID-19 regulations, sessions were mostly competed remotely and thus the experts were unable to provide specific feedback on participant posture, hand positioning, and body movements. A more comprehensive assessment of the overall performance would be achieved in the future if sessions took place in person or were filmed to include both the resident's body and the laparoscopic box trainer task field.

Conclusions

Although this study did not definitively answer the research question as to whether live verbal feedback (group C) was superior to no feedback (group A) or delayed written feedback (group B) when examining the quantitatively assessed task data, group B appeared to have some superiority. Based on the qualitative feedback gathered from the post-test survey, live verbal feedback was desired from the residents. Thus, based on the quantitative and qualitative data, both forms of feedback appear to have a certain level of value. We hypothesize that the delayed written feedback group (group B) had the best subjective improvements overall because they were able to take their feedback, analyze it, apply it, and review it at their own convenience in attempting to improve their skills. This style of feedback removed the potential stress associated with direct contact with a supervisor and allowed time to process the information. Further research is required to determine if this type of feedback results in objective improvements in skills.

Overall, at-home laparoscopic box trainers were beneficial. Participants enjoyed having a box trainer at their disposal for practice in addition to the desire of having live feedback from staff even if it was only to remind them to improve posture and minimize discomfort while using the laparoscopic tools.

It is important to instill confidence in junior trainees because this will promote continued engagement and encouragement for skill acquisition. Providing positive and constructive feedback during a resident's training was desired by the participants in this study because they believed it would improve both their confidence and skill. A certain level of proficiency in basic tasks will promote staff confidence in the junior learners and potentially give learners the opportunity to obtain greater exposure and independence earlier in their training in the operating room.

Additional studies examining how feedback affects surgical learners, particularly in developing their laparoscopic abilities, should be completed with larger sample sizes.

Conflict of interest

None declared.

References

1. Li MM, George J. A systematic review of low-cost laparoscopic simulators. Surg Endosc 2017; 31(1): 38–48. https://doi.org/10.1007/s00464-016-4953-3.
2. Vanderbilt AA, Grover AC, Pastis NJ, Feldman M, Diaz Granados D, Murithi LK, et al. Randomized controlled trials: a systematic review of laparoscopic surgery and simulation-based training. Glob J Health Sci 2014; 7(2): 310–327. https://doi.org/10.5539/gjhs.v7n2p310.
3. Enani G, Watanabe Y, McKendy KM, Bilgic E, Feldman LS, Fried GM, et al. What are the training gaps for acquiring laparoscopic suturing skills? J Surg Educ 2017; 74(4): 656–662. https://doi.org/10.1016/j.jsurg.2016.12.004.
4. Thinggaard E, Kleif J, Bjerrum F, Strandbygaard J, Gogenur I, Ritter M, et al. Off-site training of laparoscopic skills, a scoping review using a thematic analysis. Surg Endosc 2016; 30(11): 4733–4741. https://doi.org/10.1007/s00464-016-4834-9.
5. Timberlake MD, Stefanidis D, Gardner AK. Examining the impact of surgical coaching on trainee physiologic response and basic skill acquisition. Surg Endosc 2018; 32(10): 4183–4190. https://doi.org/10.1007/s00464-018-6163-7.
6. Tanoue N, Korovin LN, Carton M, Galvani CA, Ghaderi I. Faculty feedback versus residents' self-assessment of operative performance: Different but complementary. Am J Surg 2018; 215(2): 288–292. https://doi.org/10.1016/j.amjsurg.2017.11.016.
7. Axt S, Storz P, Ehrenberg C, Falch C, Immenroth M, Kirschniak A, et al. Evaluation of self-educational training methods to learn laparoscopic skills - a randomized controlled trial. BMC Med Educ 2018; 18(1): 85. https://doi.org/10.1186/s12909-018-1193-3.
8. Accreditation Council for Graduate Medical Education. Common program requirements. Chicago: Accreditation Council for Graduate Medical Education; 2021. Available from: https://www.acgme.org/globalassets/PFAssets/ProgramRequirements/CPRResidency2021.pdf (accessed 24 February 2022).
9. Society of American Gastrointestinal Endoscopic Surgery (SAGES). Fundamentals of laparoscopic surgery. Available from: https://www.flsprogram.org/ (accessed 21 March 2022).