Use of Box Simulators for Improving Intraoperative Laparoscopic Skills - An Essential Tool for the Surgeon in Training

Awais Amjad Malik[1], Mahmood Ayyaz[1], Muhammad Farooq Afzal[1], Abrar Ashraf Ali[1], Romaisa Shamim,[2] Ruqayya Khan[1], Huma Sabir Khan[1], Awais Naeem[1] and Samiullah Bhatti[1]

ABSTRACT

Objective: To compare the improvement of intraoperative laparoscopic skills by measuring GOALS score between residents who have undergone simulator training with those who have not received any simulator training.
Study Design: A randomized controlled trial.
Place and Duration of Study: Department of Surgery, Services Hospital, Lahore, from August 2013 to February 2014.
Methodology: Thirty residents belonging to year 1, 2 and 3 were included in the study. They were randomly divided into 2 groups. Both groups had a baseline evaluation with GOALS score while performing dissection of gallbladder from liver bed during laparoscopic cholecystectomy. Group-A underwent formal training on simulators whereas group-B did not receive any formal training on simulators. After 6 months, a repeat evaluation was done again by measuring GOALS score while performing gallbladder dissection.
Results: Baseline GOALS scores of both the groups were similar. Group-A baseline score was 7.66 ± 0.93 and group-B score was 7.46 ± 1.04 ($p = 0.585$). However repeat scores for group-A showed a significant improvement (an increase of 7.16 ± 1.48 to 14.76 ± 1.67, $p < 0.001$) from baseline scores. Residents in group-B improved their scores by 2.30 ± 0.99 to 9.76 ± 0.79 ($p < 0.001$). When inter group comparison was done the second score of group-A was significantly higher than that of group-B (14.76 ± 1.67 vs. 9.76 ± 0.79, $p < 0.001$). Inter-rater reliability was moderately significant (Kappa 0.540).
Conclusion: Training on laparoscopic simulators results in significant improvement of intraoperative laparoscopic skills.

Key Words: *Simulators. Laparoscopic cholecystectomy, Training. Box trainers. GOALS. Surgical residents.*

INTRODUCTION

William Halstead's model of apprenticeship for surgical education has effectively trained generations of surgeons, successfully sustaining the art and science of surgery.[1] This traditional residency model of see one; do one and teach one has been shown to be failing recently. Pressures on this system including increased public scrutiny, financial concerns, restricted work hours, and expanded skill requirements threatens to produce residents who may, for the first time, be less skilled than the previous generation. Laparoscopic surgery requires additional training compared with open surgery. It challenges surgeons' skills on multiple factors like; inability to touch the tissue, lack of a 3-dimensional view, counter-intuitive fulcrum lead, and the loss of finger dexterity. Adding to it the rising costs of operation theaters; makes the teaching of this modality very cumbersome. Because of patient safety constraints and financial considerations, achieving proficiency in an operating room through clinical experience has become more challenging.[2]

Department of General Surgery[1]/Plastic Surgery[2], Services Institute of Medical Sciences, Services Hospital, Lahore.

Correspondence: Dr. Awais Amjad Malik, 350 SD House, Askari 5, Gulberg III, Lahore.
E-mail: awaisamjad@gmail.com

Received: May 18, 2014; Accepted: December 9, 2014

There is a need to train surgical residents in these skills in a more controlled and safe environment. Simulators are being used more frequently for teaching and testing laparoscopic skills in a cost-effective and controlled environment.[3,4] This form of training allows residents to attain a basic level of laparoscopic skills that can be transferred from the laboratory to the operating room environment. Sturm *et al.* and Dawe, *et al.* showed that there is an evidence for transferability of skills acquired in the simulator to operating room performance in laparoscopic cholecystectomy.[5,6] Others have also proven that simulators can actually help in improving surgical skills in the intraoperative environment.

Department of Surgery at Services Hospital, Lahore, has acquired its own simulators to train its residents in the art of laparoscopic surgery. The simulators train the residents in the 5 basic skills of laparoscopic surgery based on the MISTELS program developed at the McGill University.[7] However, there was no evidence to prove that this training was actually helping the residents in improving their skills. To prove this transferability, the authors wanted to see whether training on simulators actually helped their residents improve on their laparoscopic skills? For intraoperative evaluation of residents, the validated GOALS (Global Assessment of

Laparoscopic Skills) score was used with permission. This score was developed at McGill University,[8] and has been proven to be a reliable indicator of intraoperative assessment of laparoscopic skills.[9]

The objective of this study was to compare the mean increase in GOALS score measuring intraoperative laparoscopic skills between residents who have undergone simulator training for 16 hours with those who have not received any simulator training.

METHODOLOGY

It was a randomized clinical trial conducted at the Department of Surgery, Services Hospital, Lahore, from August 2013 to February 2014, after getting permission from the ethical review committee. A total of 30 surgical residents belonging to year 1, 2 and 3 of residency were voluntarily enrolled for the study. Residents were randomly allocated into two groups using a random number table, however, randomization was done separately for each training level so that there was no discrepancy in terms of training in between the two groups. So each group had similar number of residents from each year. No residents had a prior exposure to box trainers and had minimal experience in laparoscopic surgery. Year four residents, Senior Registrars and Consultants were exempted. Residents having previous experience on box trainers were also excluded in the study.

All the residents were required to perform dissection of gallbladder from liver bed. The procedure was video recorded. The video was then assessed by two assessors who were blinded to the randomization status. Assessment was done using the validated GOALS score which was used after taking permission from the ethical review committe of the hospital. Each assessor provided his/her own score for each participant independently. The average of the two scores was taken as the final score for each resident.

Group-A residents underwent regular training on laparoscopic skills using laparoscopic simulators. Residents were given a video tutorial of the tasks they were required to perform. All residents were required to practice on all the 5 MISTELS tasks for multiple sessions lasting for 1 hour each. Residents took 2 sessions per week and they were trained for a total of 8 weeks. Hence a total of 16 hours of training was given. Group-B residents did not undergo any formal training on simulators. However, they continued to work in theaters.

All residents had a second assessment. Again the dissection of gallbladder from the liver bed was done and a video recording was made. Video was assessed by the same assessors who were again blinded to the randomization status. A second GOALS score was recorded. Average score based on scores assessed by both the consultants was taken as final score.

The data was entered into IBM SPSS version 20 and analyzed through its statistical program. All demographic data including age, gender, level of training was recorded. The GOALS score for group-A and group-B prior to study and after the completion of study was recorded. Mean difference in GOALS score was calculated by subtracting the baseline GOALS score from second GOALS score. The mean increase in GOALS score from baseline and also in between two groups was compared using the independent sample t-test and using ANOVA of repeated measures. For comparison of time taken to complete tasks paired sample t-test was used. A p-value of 0.05 or less was taken as significant.

RESULTS

A total of 30 residents belonging to year 1, 2 and 3 of surgical training were included in the study. Ten residents belonged to year 1, 12 belonged to year 2 and 8 residents belonged to year 3. Mean age of the residents was 27.40 ± 1.99 for group-A and 26.93 ± 1.33 for group-B. Male to female ratio was 6:1 with group-A having 4 and group B having 2 female residents (Table I).

Baseline GOALS scores of both the groups were similar. Group-A baseline score was 7.66 ± 0.93 and group-B score was 7.46 ± 1.04. The difference was insignificant ($p = 0.585$). However, repeat scores for group-A showed a significant improvement (an increase of 7.16 ± 1.48 to

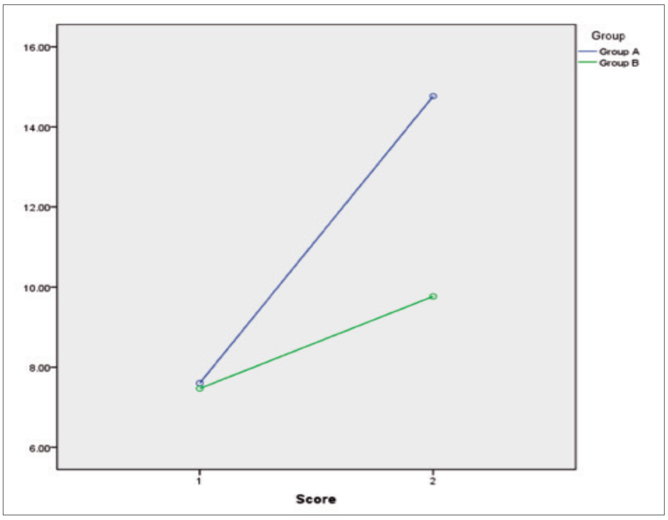

Figure 1: GOALS score comparison between two groups using ANOVA of repeated measures.

Table I: Demographics of the two groups.

Demographics	Group A	Group B
Age	27.40 (±1.993)	26.89 (±1.335)
Male	11	13
Female	4	2
Year-1	5	5
Year-2	6	6
Year-3	4	4

Table II: Comparison of GOALS score of first vs. second assessment.

	Group A	Group B	Significance
GOALS-1	7.66 (± 0.93)	7.46 (±1.04)	0.585*
GOALS-2	14.76 (±1.67)	9.76 (±0.79)	< 0.001*
Mean difference in score	7.16 (±1.48)	2.30 (±0.99)	< 0.001*
Significance	< 0.001†	< 0.001†	

** p-value is calculated by Independent Sample t-test.*
† p-value is calculated by repeated measure ANOVA.

Table III: Comparison of time taken to complete the task between two groups.

	Group A	Group B	Significance
Average timings for 1st assessment	24.8±7.36	23.6±5.44	0.400*
Average timings for 2nd assessment	22.0±4.59	24.7±6.74	0.225*
Significance	0.055†	0.604†	-

** p-value is calculated by Independent Sample t-test.*
† p-value is calculated by Paired sample t-test.

14.76 ± 1.67, p < 0.001) from baseline scores. Residents in group-B improved their scores by 2.30 ± 0.99 to 9.76 ± 0.79, p < 0.001). When inter group comparison was done the second score of group-A was significantly higher than that of group-B (14.76 ± 1.67 vs. 9.76 ± 0.79, p < 0.001, Table II).

Another assessment which was made was inter-rater reliability for assessment of GOALS score. It was found that both the consultants gave similar scores while assessing scores for residents. When the results were compared they showed moderate reliability (Kappa 0.545).

Time to complete the task was also compared in between group-A and B at the initial assessment and after second assessment. Initial comparison between times of both the groups were not significant (p = 0.400). After second assessment, the comparison of time taken to complete the task between both the groups were compared and results were again insignificant (p = 0.225). Intra group comparison was done and group-A residents showed improvement in their timings which was not significant (p = 0.055) whereas group-B resident showed no improvement on their timings (p = 0.604, Table III).

DISCUSSION

The residents showed a significant improvement in their scores. Not only did we manage to train the residents effectively but also we did this by reducing the costs required. No trainers were required and no expensive simulators were required to measure performance metrics. Repeated training on simple box trainers was sufficient to have an overall improvement.

These results are *at par* with other international studies which also show that training on box simulators improves intraoperative skills. Sroka *et al.* had a baseline score of (11.3 ± 2.0 vs. 12.0 ± 1.8; p = 0.47) as compared to (7.66 ± 0.93 vs. 7.46 ± 1.04) for these residents.[9] After training, the control group improved by 1.8 to 13.8 ± 2.2 whereas our control group improved by 2.30 ± 0.99 to 9.76 ± 0.79). The trained group in their study improved by 6.1 to 17.4 ± 1.9 whereas these residents improved their score by 7.16 ± 1.48 to 14.76 ± 1.67.

Different studies have used different protocols for training their residents. Some used fixed hours of training in the laboratory and others train their resident to achieve the required proficiency before they are allowed to go for a second assessment.

The authors trained these residents for 16 hours based on the fact that residents can take anywhere from 5 to 14 hours to achieve proficiency.[9-11] So it would not be wrong to say they had achieved proficiency in the tasks before they were taken to the theater for their second assessment. However, since these never actually focused on their evaluation in MISTELS tasks we cannot prove whether they had actually achieved proficiency.

Box simulators are simple, cheap and easy to use. Some have even made these simulators at home using simple card board boxes and web cameras.[12,13] There was no difficulty in training the residents on these simulators which were of low fidelity and lacked any measure of performance metrics. But they served their purpose well and helped the residents significantly improve on their laparoscopic skills.

When a comparison was done regarding time taken to complete the task, baseline times were similar for both the groups. After the second assessment it was found that group-A had a better average time than group-B but the difference was not significant. When compared to baseline time group-A showed an improvement in time but again the results were insignificant. Similarly, group-B residents also failed to show any significant improvement in their time. These results, however, cannot be relied upon as time to do the required task varies from one case to another and cannot be standardized. A person can have a very good GOALS assessment but still spend a lot of time on the case just because the case was actually difficult and *vice versa*. A person can have a bad GOALS assessment and still spend very little time to complete the task.

The inter-rater reliability of the GOALS score was also tested. The authors made sure every recording of dissection of gallbladder by a resident was scored by two consultants who were blinded to the randomization status of the resident. Dath *et al.* have proven that video tape assessment of laparoscopic skills is reliable, feasible and valid.[14] The scores of both the assessors were compared and found that the scores of both the assessors were similar and the results were moderately significant (Kappa 0.545). GOALS was found to be a very reliable, valid and an easy to use tool to assess intraoperative laparoscopic skills. This is *at par* with other studies.[15-18]

Another important point to be considered in this study is the level of training required to allow a resident to be able to perform laparoscopic procedures such as laparoscopic cholecystectomy. Our current practice is to allow junior residents to hold cameras from first year. However, procedures are started from year 4 of residency. But as is evident from my study that although the residents performed poorly on the initial assessment but by training on simulators they improved their performance and were able to perform dissection of gallbladder more meticulously. So it would not be wrong to say that by allowing residents to attain a minimum required set of skills on the simulators we can allow them to perform procedures such as laparoscopic cholecystectomy during the early years of residency

CONCLUSION

Training on simulators significantly improves the performance of laparoscopic skills in the intraoperative environment.

REFERENCES

1. Grillo HC. To impart this art: the development of graduate surgical education in the United States. *Surgery* 1999; **125**:1-14.
2. Lucas S, Tuncel A, Bensalah K, Zeltser I, Jenkins A, Pearle M, *et al.* Virtual reality training improves simulated laparoscopic surgery performance in laparoscopy naive medical students. *J Endourol Soc* 2008; **22**:1047-51.
3. Reznick R, Regehr G, MacRae H, Martin J, McCulloch W. Testing technical skill via an innovative "bench station" examination. *Am J Surg* 1997; **173**:226-30.
4. Scott DJ, Bergen PC, Rege RV, Laycock R, Tesfay ST, Valentine RJ, *et al.* Laparoscopic training on bench models: better and more cost effective than operating room experience? *J Am Coll Surg* 2000; **191**:272-83.
5. Dawe SR, Windsor JA, Broeders JA, Cregan PC, Hewett PJ, Maddern GJ. A systematic review of surgical skills transfer after simulation-based training: laparoscopic cholecystectomy and endoscopy. *Ann Surg* 2014; **259**:236-48.
6. Sturm LP, Windsor JA, Cosman PH, Cregan P, Hewett PJ, Maddern GJ. A systematic review of skills transfer after surgical simulation training. *Ann Surg* 2008; **248**:166-79.
7. Vassiliou MC, Ghitulescu GA, Feldman LS, Stanbridge D, Leffondre K, Sigman HH, *et al.* The MISTELS program to measure technical skill in laparoscopic surgery : evidence for reliability. *Surg Endoscop* 2006; **20**:744-7.
9. Sroka G, Feldman LS, Vassiliou MC, Kaneva PA, Fayez R, Fried GM. Fundamentals of laparoscopic surgery simulator training to proficiency improves laparoscopic performance in the operating room - a randomized controlled trial. *Am J Surg* 2010; **199**:115-20.
10. Stefanidis D, Acker C, Heniford BT. Proficiency-based laparoscopic simulator training leads to improved operating room skill that is resistant to decay. *Surg Innov* 2008; **15**:69-73.
11. Stefanidis D, Korndorffer JR Jr., Black FW, Dunne JB, Sierra R, Touchard CL, *et al.* Psychomotor testing predicts rate of skill acquisition for proficiency-based laparoscopic skills training. *Surgery* 2006; **140**:252-62.
12. Beatty JD. How to build an inexpensive laparoscopic webcam-based trainer. *BJU Int* 2005; **96**:679-82.
13. Chung SY, Landsittel D, Chon CH, Ng CS, Fuchs GJ. Laparoscopic skills training using a webcam trainer. *J Urol* 2005; **173**:180-3.
14. Dath D, Regehr G, Birch D, Schlachta C, Poulin E, Mamazza J, *et al.* Toward reliable operative assessment: the reliability and feasibility of videotaped assessment of laparoscopic technical skills. *Surg Endoscop* 2004; **18**:1800-4.
15. Choy I, Fecso A, Kwong J, Jackson T, Okrainec A. Remote evaluation of laparoscopic performance using the global operative assessment of laparoscopic skills. *Surg Endosc* 2013; **27**:378-83.
16. Gumbs AA, Hogle NJ, Fowler DL. Evaluation of resident laparoscopic performance using global operative assessment of laparoscopic skills. *J Am Coll Surg* 2007; **204**:308-13.
17. Hogle NJ, Liu Y, Ogden RT, Fowler DL. Evaluation of surgical fellows' laparoscopic performance using Global Operative Assessment of Laparoscopic Skills (GOALS). *Surg Endosc* 2014; **28**:1284-90.
18. Kurashima Y, Feldman LS, Al-Sabah S, Kaneva PA, Fried GM, Vassiliou MC. A tool for training and evaluation of laparoscopic inguinal hernia repair: the Global Operative Assessment Of Laparoscopic Skills-Groin Hernia (GOALS-GH). *Am J Surg* 2011; **201**:54-61.