RESEARCH ARTICLE

Significance of a Dry Simulation Laboratory for Enhancing Laparoscopy Suturing Abilities

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Abstract

Introduction: Laparoscopic suturing techniques are essential tools for controlling surgical procedures in laparoscopy surgery. Learning laparoscopy suturing techniques seems challenging in terms of adopting skills by observing only in the operating rooms. Early training of suturing skills in surgical curriculum could make suturing skills acquisition easier than learning later in operating rooms.

Materials and methods: We conducted a prospective cross-sectional observational study at Muhimbili University of Health and Allied Sciences after getting an ethical approval. The participants were volunteering residents from surgical, urology, and gynecology departments, and they filled the consent forms prior to enrolment. The research team observed for accuracy and quality of surgeon knot tying using the adapted checklist with step-by-step procedure for surgeon knot tying process and score for the validity of each step followed by the residents during supervised knot construction training. Data were analyzed using Statistical Package for Social Sciences (SPSS) version 26 whereby the mean and frequencies for activities score and time were interpreted.

Results: In this study, eight residents were trained in knot construction for suturing techniques for 4 alternate days. Each day, they were scored for only one knot tying. In making the single knot the step-by-step procedure tasks has a total score of 29 points. The accumulated score expected per day of eight residents was 232 points for making a single cycle of knot construction after several trainings cycles. First day overall for the whole class was 116 scores, which was 48.70% and fourth day 81.33% accuracy, and the lowest and highest scores for one-by-one residents was 8 (27.59%) and 17 (58.62%), respectively. Validity on first day was 50% and fourth day was 91.33%. The fourth day resident score were improved, whereby the lowest score was 20 (68.96%) and highest was 27 (93.10%). The time recorded for the activity was higher on first day but reduced by 50% by the fourth day, whereas on the first day the total time taken for all residents to construct eight knots was 6,560 seconds and on the fourth day, they took 3,312 seconds. This shows that with experience on acquiring skills, speed, accuracy, and validity of performance also improve.

Conclusion: Supervised training in acquisition of laparoscopy suturing skills is required to improve practical experience. The accuracy and validity scores increase with time, which shows that more exposure is required. Time of performing tasks was also improving with time of experience; less time was seen in fourth day compared with the first day of practice. The time intervals for skills acquisitions for laparoscopy suturing skills are to be speculated more by other researchers as the improvement was better with time of exposure. Setting of time of suturing and knotting for one knot may bring the simple approach to assess performance of tasks scores to validate the performance of knot construction.

Clinical significance: Supervised laparoscopy suturing skills training should be of consideration for all residents from surgical departments. Skill labs should be the important prerequisites for surgical requirements in preparation for curricula in these departments. Other studies are required to evaluate the required time for the training for sufficient acquisition of laparoscopy suturing skills.

Keywords: Laparoscopic suturing skills lab, Laparoscopy suturing techniques, Tanzania.

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Introduction

Minimal access surgery (MAS) has expanded rapidly with more advanced surgical operations now being performed by laparoscopic techniques. Laparoscopy surgery has been observed to have superior postoperative outcomes compared with traditional laparotomy.[1] Some of the drawbacks of laparoscopic surgery practice are lengthy operation time and unexpected risk of bowel and vessel injuries that can be reduced by improving laparoscopic surgical skill techniques among surgeons.[2,3] Supervised training of laparoscopy surgical skill techniques in skills laboratory setting is an important part of training curriculum for residents before they are exposed to laparoscopy surgical practice in theatres.[4]

Supervised training of laparoscopy suturing is an essential requirement in surgical practice and has moved from operating rooms to a skills laboratory setting.[5] Laparoscopic suturing techniques are indispensable tools for mastering most procedures in laparoscopy surgery.[6] Learning of laparoscopy suturing

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techniques is challenging in terms of adopting skills by observing only during surgery though easily adopted when one is exposed to supervised training in skills laboratory setting.[7] Early training of suturing skills in surgical curriculum could make suturing skills acquisition easier than learning later in operating rooms.

Majority of the universities, especially in developing countries, have not incorporated supervised training of laparoscopy suturing skills in their curriculum, especially during master's training.[8] Establishment and sustainability of skills laboratory has been very difficult due to lack of sensitization and motivation among facilitators and residents.[9] Some of the donated laparoscopy skill laboratory equipment wearied out due to poor handling and utilization, which might have deactivated facilitators' interest of supervising the training of residents so as to acquire these skills.[10] For most universities, the residency training curriculum remains to be a directional axis for learning and skills acquisition as prerequisite for completion of the program.[5] Therefore, lack of residency-supervised laparoscopy suturing skills curriculum has retarded acquisition of the laparoscopy suturing skills before completion of their training.

Suturing skills techniques acquired through observation during open surgeries cannot be equated to laparoscopy suturing skills because of optical limitations and technical hitches in laparoscopy practice.[11] Some scholars have advised toward early laparoscopy suturing skills training, and this must be a core component during training of residents in skills laboratory while pursuing their master's studies. Including supervised laparoscopy suturing skills curriculum in master's program will empower the supervisors and residents to acquire these skills earlier and shorten the leaning duration in theatres.[5] This study aims to determine the importance of implementation of supervised training of laparoscopic suturing skills for residents during their master's training.

Materials and Methods

Study Design

A prospective cross-sectional observational study was conducted whereby residents were supervised during laparoscopy suturing for skills training. The research team recorded video of the suturing activities to be scored for accuracy and validity of surgeon knot construction. The scoring process was done using adopted checklist with step-by-step procedures for surgeon knot construction from other peer groups publications.

Study Area

The study was conducted at Muhimbili University of Health and Allied Sciences (MUHAS) in Dar es Salaam, Tanzania. The MUHAS is a public university accredited by the Tanzania Commission of Universities. The university registers residents on a yearly basis for different specialties, including general surgery, obstetrics and gynecology, and urology departments for master's training. At MUHAS, laparoscopy curriculum has not yet been fully incorporated into the residency training program. The university has been offering regular sponsorship for laparoscopy programs for laparoscopy enthusiasts for the best students in each academic year as a motivation for best performance for residents.

Study Population

All residents at MUHAS in surgical departments, including urology, general surgery, and obstetrics and gynecology.

journal's standard review procedures, with this peer review handled independently of the Editor-in-Chief and his research group.

Study Sample

Twenty residents from surgical departments, including urology, general surgery, and obstetrics and gynecology, volunteered for the study. Eight residents were recruited to participate in the study by sampling.

Sampling Technique

Cluster sampling technique was used to create clusters from each specific department (urology, obstetrics and gynecology, and general surgery). Eight residents (senior residents from second and third years) were recruited as per the targeted sample size. One of the three clusters lottery method was used to obtain eight residents among those who were willing to participate in this study. The method of recruitment was voluntary basis after consenting to participate.

Data Collection

The structured questionnaires and checklists were pretested among selected senior residents at MUHAS before commencement of actual data collection, and this was done by the principal investigator and the other four research assistants. The assessment tool was adapted from Royal College of England and step-by-step task analysis from World Laparoscopy Hospital, an institution of minimal access surgery as it was used by other researchers for endoscopic suturing skills techniques as it has been similarly utilized for those trained for laparoscopic suturing skills techniques in laparoscopic associations.[8]

The checklist consists of six tasks with 29 instructional items that were scored in terms of "yes" or "no," together with time of task completion. The participants were interviewed about their views about the training at the last assessment as post-training evaluation. This gave an overview of training and gave the resident a chance of discussing about importance of supervised training for laparoscopy suturing skills in their curriculum prior to operating room practice. Data were collected through structured questionnaires and checklists that provided each participant a chance to give and narrate their suggestions and options for the training.

Data Analysis

Analysis of data was done using Statistical Package for Social Sciences (SPSS) version 26. The criteria for scoring the participants were "yes" equal to 1 and "no" equal to 0. The total scored was calculated as a percentage to accumulate the required benchmark. The validity of quality knot tying is when the score is more than 60% calculated from the three score points from the checklist. The learning curves were plotted to show the learning skills improvement with time. The accuracy of knot tying after completion of knot construction with 29 points determines the learning improvement. Time analysis has some significant value to measure skill acquisition with time. The quality of the knot on securing process of a constructed knot explained the validity of that knot. The required score for quality 3 makes up a total of 24 score for eight residents per day. The total time for knot tying was marked and documented for each participant. The accumulated duration used for the participants from the first day to the last day of training was calculated for correlation coefficient determination. The learning curves plus score distribution curve for

Table 1: Participants' demographic characteristics and exposure to laparoscopy ($N = 8$)

Characteristics	*Frequency, n (%)*
Mean age (years)	30 ± 5
Sex	
Female	3 (37.5)
Male	5 (62.5)
Specialty of residents	
Urology	2 (25.0)
Surgery	2 (25.0)
Gynecology	4 (50.0)
Laparoscopy exposure	0 (0.0)

Table 2: Total daily tasks scores for each resident during knot construction ($N = 8$)

	Daily task score			
Resident	*Day 1*	*Day 2*	*Day 3*	*Day 4*
1	16	16	18	24
2	8	19	17	20
3	17	19	24	21
4	14	16	16	24
5	16	18	21	24
6	12	16	23	27
7	16	19	23	23
8	14	19	21	25

accuracy and validity were plotted to see the improvement rate of skills in supervised training in relation to time.

Ethical Considerations

The ethical approval to conduct the study was obtained from MUHAS Directorate of Research and Publication. Study participants volunteered and signed the consent as a basis for their recruitment. There was no harm expected to participants on participation in the study, and they had the right to withdraw from the study even after signing the consent form for his or her participation.

Results

In this study, a total of eight residents were recruited, and the mean age was 30 ± 5 years. None of the residents had prior exposure to laparoscopy (Table 1). Pertaining knot scores upon training, there was an improved score when residents were trained as seen in good scores in day 3 vs day 4 (Table 2). Minimal time was spent in knot construction when residents were trained (day 1 vs day 2 vs days 3 and 4) (Table 3).

Daily Tasks Scores against Time for Each Resident during Knot Construction

The time was plotted against the duration of 4 days for each resident, and for all the eight residents, with increased time of exposure, positive slope graphs were observed, where minimal time was consumed (Fig. 1). In this study, time taken during the construction of knot was not a factor that determines the accuracy and validity of the knot. Accuracy was determined by performance in tasks score, and validity was determined by accuracy and configuration of constructed knot, which was the last three scores

Table 3: Total daily time (seconds) spent by each resident to construct a knot ($N = 8$)

	Daily time spent score			
Resident	*Day 1*	*Day 2*	*Day 3*	*Day 4*
1	1,136	725	678	510
2	777	256	714	302
3	958	935	520	388
4	941	1,083	698	526
5	627	689	581	526
6	559	744	500	479
7	782	500	566	295
8	782	468	594	286

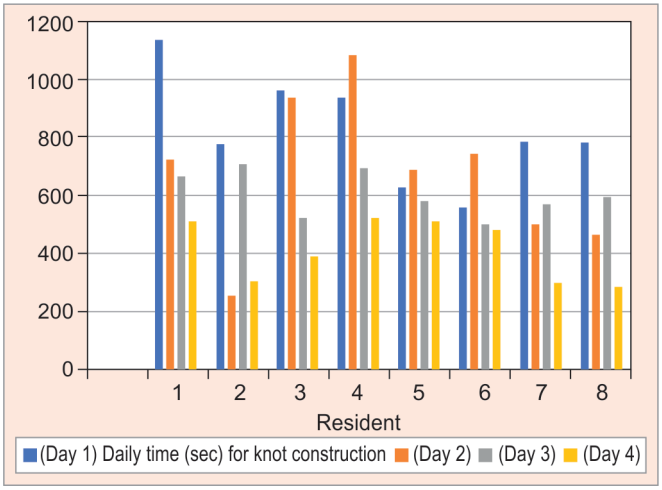

Fig. 1: Total daily tasks scores against time (seconds) for each resident during knot construction, $N = 8$

Table 4: Trends for tasks accuracy against total time (seconds) for 4 days ($N = 29 \times 8 = 232$)

Days	*1*	*2*	*3*	*4*
Tasks accuracy	113 (48.70%)	141 (60.77%)	163 (70.26%)	188 (81.03%)
Total time	6,560	5,400	4,851	3,312

on tasks on knot construction. The well-constructed was noted as accurately made, and when the configuration was assessed, most of these knots scored two or three of quality tasks scores that describe the validity of the specific knot.

Trends for Accuracy in Knot Construction

The accuracy of knot construction is when the score is above 15 tasks scores out of 29 tasks scores, and the validity of knot construction 2 and above out of 3 for each knot constructed (Table 4). The accuracy and validity of constructed knots were gradually increasing with increasing days of training exposure. The time used to construct the knot was inversely proportional to the accuracy scores of tasks scored. The quality/validity of knot frequency ratio 28:27 was equal to accuracy after computation of different variables (Table 5). On the contrary, there was a gradual increase in score against decrease of time for the constructed knot among residents, which explains the trend of skill acquisition with time when one is exposed to a certain task (Fig. 2).

Table 5: The quality/validity of the knots constructed by residents per day ($N = 3 \times 8 = 24$)

Days	*1*	*2*	*3*	*4*
Quality/validity	12 (50%)	21 (21.5%)	20 (83.33%)	22 (91.67%)
Time (sec)	284	175	175	92

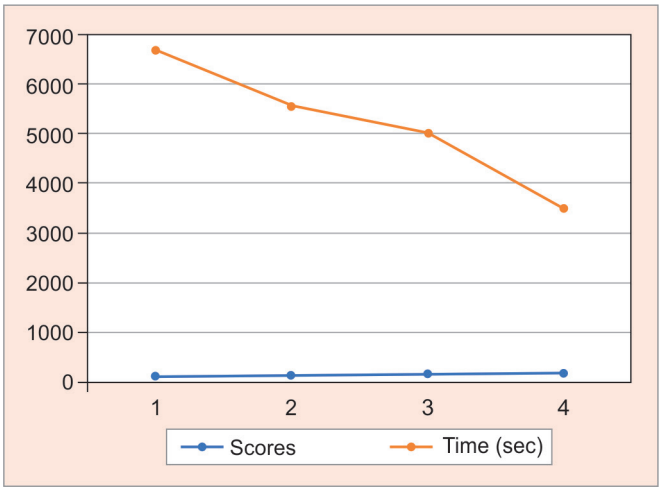

Fig. 2: The trend of daily total scores for eight residents for knot construction for 4 days in 2 weeks

Discussion

In this study, a dry skill lab using endotrainer boxes with a silicone laparoscopic suturing simulation pad containing precut wounds for suturing and knotting were used during supervised training for laparoscopy suturing skills techniques. The residents were naïve about the laparoscopy skills, and the study showed improvement of their suturing and knot tying with time of exposure to the supervised training. According to another study that was assessing the evidence to support the early introduction of laparoscopic suturing skills into the surgical training curriculum, it was proven that the short well-guided course of laparoscopy suturing skills to junior operative residents is feasible and efficacious. In this study, the improvement from first performance to the last at the end of training was by 56%, with the highest score of 94%.[12] Using endolaparoscopic suturing and knotting creates confidence for residents and junior laparoscopy surgeons. Practice and repetition are required to master any skill in surgery and especially in laparoscopic suturing and knotting.[13] Skills lab supervised courses are important for teaching learning programs and should be made essential for all institutions as part of their curricula.

During the training, the video for suturing was automated with the laptops connected with this endo trainer boxes, but scoring was manually done by the supervisor, which could reduce the efficiency of scoring process. The accuracy and validity of suturing and knot construction can be affected by the method or tool used for assessment and training of laparoscopy skills techniques.[14] The mean time taken to construct a knot was 9.78 minutes for 32 knots constructed. The learning curves were dropping with time of experience, with time of practice. Other studies proved the drops in time with experience during the training courses on junior surgeons on cholecystectomy procedures; the meantime improved from 34.3 to 7% at the end of training.[15] In the cross-sectional control study that was comparing between the skills for untrained resident and other who were trained, it was also proved that the mean time and tasks score performance were improving with time of practice, and the difference was statistically significant.[1] It has also been observed in this study that time and performance of tasks have some statistical correlation. The speed of the surgeon in surgical procedures is determined by the confidence and experience of the skills technique together with ergonomic on utilizing the instruments and handle them in a manner that simplifies works and avoids exhaustion and accidents during the process.

Laparoscopic suturing and knotting are known to have challenges and is the most required skill for any laparoscopy surgeon. Some of the studies have drawn attention to the assessment of competency of laparoscopy surgeon and revealed that there are excellence techniques for assessment of instruments and tissue handling.[16] In this study, instruments handling was assessed on performance of tasks scores, which were improving with time of practice and the suturing and knot validity, and accuracy was achieved by 90%, with improvement time of 9.7 minutes. The time for construction of one knot was seen higher, but it is statistically significant when compared for day 1 and day 4 findings. In another study, the residents were given instruction on self-timing on suturing and knot and cutting tasks and time was recorded, and the time improved with days of instructions exposure. This mode of training has shown that the time improvement may not have improved performance of tasks, if the residents were not guided, which is very important in skills adoption.[17]

Conclusion

Supervised training in acquisition of laparoscopy suturing skills is required to improve practical experience. The accuracy and validity scores increase with time, which shows that more exposure is required. Time of performing tasks was also improving with time of experience; less time was seen in fourth day compared with the first day of practice. The time intervals for skills acquisitions for laparoscopy suturing skills are to be speculated more by other researchers as the improvement was better with time of exposure. Setting of time of suturing and knotting for one knot may bring the simple approach to assess performance of tasks scores to validate the performance of knot construction.

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