Thai Journal of Obstetrics and Gynaecology
March 2021, Vol. 29, No. 2, pp. 73-81

GYNAECOLOGY

Effectiveness of Thai-German Multidisciplinary Endoscopic Training (TG-MET) Simulator for Laparoscopic Training

Thanatchaporn Baingam, M.D.*,
Pisutt Srichaikul, M.D.*,
Atthapon Jaishuen, M.D.*,
Dittakarn Boriboonhirunsarn, M.D., M.P.H., Ph.D.*

** Department of Obstetrics and Gynecology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand*

ABSTRACT

Objectives: To evaluate effectiveness of Thai-German Multidisciplinary Endoscopic Training (TG-MET) protocol and identify the appropriate practice time and factors affecting the training protocol.

Materials and Methods: A total of 29 obstetrics and gynecology residents who had no laparoscopic surgery experience were enrolled in a 2-week training program. During the training, participants did the 15 minute-test, including moving beans, cutting the paper into star shape, and simple suturing. Evaluation was done at 5 and 10 hours of training by video recording the tests and interpreted by Global Operative Assessment of Laparoscopic Skills (GOALS) score by two experienced laparoscopists. Scores were compared between tests at the beginning, 5 and 10 hours of training. Various characteristics were compared between those who passed and did not pass the tests.

Results: Mean GOALS scores increased significantly at 5 and 10 hours of training (12.3 vs. 18 vs. 19.3, $p < 0.001$). All domains including depth perception, bimanual dexterity, efficiency, tissue handling, and autonomy were significantly improved at 5 hours ($p < 0.05$). However, only depth perception, bimanual dexterity and efficiency were significantly improved at 10 hours. Participants who can play musical instrument had significantly higher rate of passing the tests at 5 hours of training (50% vs 9.1% $p = 0.044$). No associated factors related to passing the exam at 10 hours.

Conclusion: Training with TG-MET protocol can significantly improve laparoscopic skills at 5 hours significantly and tend to reach the plateau at 10 hours. However, the tasks such as depth perception, bimanual dexterity and efficiency still improved at 10 hours.

Keywords: TG-MET, laparoscopic training, GOALS scores.

Correspondence to: *Dittakarn Boriboonhirunsarn, M.D., Department of Obstetrics and Gynaecology, Faculty of Medicine Siriraj Hospital, Mahidol University, 2 Wanglang Road, Bangkoknoi, Bangkok 10700, Thailand, E-mail: dittakarn.bor@mahidol.ac.th*

Received: 29 September 2019, **Revised:** 13 December 2019, **Accepted:** 19 December 2019

ประสิทธิภาพของหลักสูตร Thai-German Multidisciplinary Endoscopic Training (TG-MET) ในการฝึกทักษะการผ่าตัดผ่านกล้อง

ธนัชพร ใบงาม, พิสุทธิ์ ศรีชัยกุล, อรรถพล ใจชื่น, ดิฐกานต์ บริบูรณ์หิรัญสาร

บทคัดย่อ

วัตถุประสงค์: *เพื่อศึกษาประสิทธิภาพของหลักสูตร Thai-German Multidisciplinary Endoscopic Training (TG-MET) ในการฝึกทักษะการผ่าตัดผ่านกล้อง และศึกษาจำนวนชั่วโมงที่เหมาะสมในการฝึก รวมทั้งปัจจัยที่ส่งผลต่อการฝึกการผ่าตัดผ่านกล้อง*

วัสดุและวิธีการ: *แพทย์ประจำบ้านภาควิชาสูติศาสตร์-นรีเวชวิทยา ที่ไม่เคยผ่าตัดผ่านกล้อง จำนวน 29 คน จะได้รับการฝึกการผ่าตัดผ่านกล้อง โดยใช้เวลาทั้งหมด 2 สัปดาห์ และทำแบบทดสอบก่อนฝึก หลังฝึกชั่วโมงที่ 5 และ ชั่วโมงที่ 10 โดยแบบทดสอบใช้เวลา 15 นาที ประกอบด้วยคีบถั่ว ตัดดาว และเย็บ simple suture พร้อมบันทึกวีดีโอ โดยวีดีโอที่บันทึกไว้ทั้งหมดจะนำมาแปลผลโดยใช้ Global Operative Assessment of Laparoscopic Skills (GOALS) score โดยผู้เชี่ยวชาญด้านการผ่าตัดผ่านกล้อง 2 ท่าน คะแนนก่อนฝึก หลังฝึกชั่วโมงที่ 5 และชั่วโมงที่ 10 จะนำมาเปรียบเทียบและวิเคราะห์เพื่อศึกษาประสิทธิภาพและจำนวนชั่วโมงที่เหมาะสมในการฝึก รวมทั้งเปรียบเทียบปัจจัยที่แตกต่างกันระหว่างกลุ่มที่ผ่านและไม่ผ่านการทดสอบ*

ผลการศึกษา: *คะแนน GOALS เฉลี่ยเพิ่มขึ้นอย่างมีนัยสำคัญหลังฝึกชั่วโมงที่ 5 และ 10 (12.3 กับ 18 กับ 19.3, $p < 0.001$) ทักษะทั้งหมด ซึ่งประกอบด้วย depth perception, bimanual dexterity, efficiency, tissue handling และ autonomy พัฒนามากขึ้นอย่างมีนัยสำคัญหลังฝึกชั่วโมงที่ 5 ($p < 0.05$) อย่างไรก็ตามทักษะด้าน depth perception, bimanual dexterity และ efficiency พัฒนามากขึ้นหลังฝึกชั่วโมงที่ 10 นอกจากนี้ ผู้เข้าร่วมวิจัยที่สามารถเล่นดนตรีได้ผ่านการทดสอบมากกว่าอย่างมีนัยสำคัญหลังฝึกชั่วโมงที่ 5 (50% และ 9.1% $p = 0.044$) และไม่มีปัจจัยที่มีผลต่อการผ่านการทดสอบหลังการฝึกชั่วโมงที่ 10*

สรุป: *การฝึกทักษะการผ่าตัดผ่านกล้องโดยใช้หลักสูตร TG-MET 5 ชั่วโมง สามารถพัฒนาทักษะการผ่าตัดผ่านกล้องได้อย่างมีนัยสำคัญ และมีแนวโน้มคงที่เมื่อฝึก 10 ชั่วโมง อย่างไรก็ตามทักษะด้าน depth perception, bimanual dexterity และefficiency ยังสามารถพัฒนาเมื่อฝึก 10 ชั่วโมง*

คำสำคัญ: *TG-MET, การฝึกทักษะการผ่าตัดผ่านกล้อง, คะแนน GOALS*

Introduction

During the last two decades, laparoscopic surgery has an important role in gynecologic surgery. The benefits of laparoscopy include decreasing postoperative pain, a more rapid return to normal activities, fewer wound complications, short hospital stay, and a lower incidence of postoperative adhesion[1]. However, laparoscopic surgery requires specific skills that include depth perception, fulcrum effect, hand-eye coordination, bimanual manipulation, handling of laparoscopic instruments, ambidexterity[2].

Several studies proved that the use of simulator can improve laparoscopic skill and patient safety. It also causes less stress than training in the operating room[3-5]. There are 2 types of simulator, low and high fidelity simulator. Low fidelity simulator includes box-trainer, tissue model, and knot tying board while high fidelity simulator consists of virtual reality laparoscopic simulator, cadaveric, and live animal model[3]. Vitish-Sharma, et al found both virtual reality and box trainer are effective in acquisition of basic laparoscopic skills[2].

Box trainer is the simulator that contains of surgical instruments and camera/video equipment that the cost is low, less required maintenance and is portable. Box trainers are suitable for the beginners because they make the trainees familiar with the instrument. It improves hand-eye coordinate, cutting, suturing, and bimanual dexterity[3]. Nagendran, et al reported that laparoscopic box model training appears to improve technical skills compare with no training in trainees with no previous laparoscopic experience. There appears to be no significant differences in the improvement of skills between different methods of box model training[6]. Avinash, et al also reported that the training with box trainer can improve the laparoscopic skill and confidence with significant retention of skill at the end of 5 months[5].

Thai-German Multidisciplinary Endoscopic Training (TG-MET) Center is a laparoscopic training center for residents and fellows in Siriraj Hospital since 2000. The TG-MET simulator is used for the training (Fig. 1). Previously, there was no specific training protocol and time required to practice for trainees. In addition, post-training laparoscopic skills were not systematically evaluated. However, the TG-MET protocol for TG-MET simulator to improve laparoscopic skill has been developed and currently use. The TG-MET protocol has the sequential training exercises that start from easy to difficult task and the time for training is well-defined.

Fig. 1. TG-MET simulator.

Therefore, the aims of the present study were to evaluate the effectiveness of laparoscopic training protocol, identify the appropriate practice time, and to find the factors associated with successful training results.

Materials and Methods

After approval of Siriraj Institutional Review Board, an experimental study was conducted at TG-MET center, Department of Obstetrics and Gynecology, Faculty of Medicine Siriraj Hospital, Mahidol university. From June 2018 to July 2019, a total of 29 Obstetrics and Gynecology residents who had no experience on laparoscopic surgery were included. Sample size was estimated from the assumption that the proportion of residents who passed the training protocol would increase from 20% and 70% after training. At 95% significance level and 80% power, at least 26 residents should be included.

After informed consent, baseline characteristics of the participants were collected. Each participant was then introduced to TG-MET protocol by the lecture about basic laparoscopic surgery and watching the laparoscopic training video. The laparoscopic training video consisted of the explanation about using laparoscopic instruments and demonstrating technique of moving the bean, cut the paper into star, and simple suture. The "moving the beans" is aimed to improve hand-eye coordinate and depth perception, the "cut the paper into star" is to improve bimanual dexterity, and the "simple suture" is to improve handling of laparoscopic instruments, ambidexterity and adjust to fulcrum effect.

The laparoscopic training program took 2 weeks. In the first week, the training consisted of moving the beans for 1 hour, cutting the paper into a star shape for 2 hours and simple suturing for 2 hours sequentially. Another 5 hours of training were in the second week. The training schedule was same as the first week. The participants managed the training time per day by themselves. All participants were tested for their performance at the beginning of program, at 5 and 10 hours of training. The test included moving the beans, cutting the paper into star shape, and simple suturing in 15 minutes. The participants can practice over time, but there will be no further examination after 10 hours of practice.

All tests were recorded and the video were assessed using the Global Operative Assessment of Laparoscopic Skills (GOALS) score[6] as shown in Table 1, by 2 expert laparoscopists who were familiar with the scoring systems. Between the 2 experts, the intraclass correlation coefficient was 0.84. The scores were given by each expert in a blind fashion, without knowing the name of participants and order of the test. The average score of the 2 examiners was used for further interpretation. A "pass" for each domain was when the score was ≥ 4. A "pass" of the test was defined as a pass of ≥ 3 domains.

Descriptive statistics were used to describe various demographic data of the participants, using number, percentage, mean, and standard deviation, as appropriate. Dependent student t-test, McNemar chi square, and Fisher's exact test were used to compare the results of the test between time points (baseline, after 5 and 10 hours of training). Various characteristics were compared between those who passed and did not pass the test to determine possible associated factors. A p value of < 0.05 was considered statistically significant.

Table 1. Scoring of Global Operative Assessment of Laparoscopic Skills (GOALS).

Domain	1	2	3	4	5
Depth perception	Constantly overshoots target, wide swings, slow to correct	Constantly overshoots target, wide swings, quick to correct	Some overshooting or missing of target, but quick to correct	Accurately directs instruments to target, but slow to direct	Accurately directs instruments in the correct plane to target
Bimanual dexterity	Uses only one hand, ignores non-dominant hand, poor coordination between hands	Uses both hands, but no interaction between hands	Uses both hands, but does not optimize interaction between hands	Uses both hands with optimize interaction, but not provide optimal exposure	Expertly uses both hands in a complimentary manner to provide optimal exposure
Efficiency	Uncertain, inefficient efforts; many tentative movements; constantly changing focus or persisting without progress	Some tentative movements, occasionally changing focus, slow progression	Slow, but planned movements are reasonably organized	planned movements are reasonably organized, but not confident	Confident, efficient and safe conduct, maintains focus on task until it is better performed by way of an alternative approach
Tissue handling	Rough movements, tears tissue, injures adjacent structures, poor grasper control, grasper frequently slips	Handles tissues reasonably well, but occasionally tears tissue or injures adjacent structures	Handles tissues reasonably well, minor trauma to adjacent tissue (i.e., occasional unnecessary bleeding or slipping of the grasper)	Handles tissues well, but applies inappropriate traction	Handles tissues well, applies appropriate traction, negligible injury to adjacent structures
Autonomy	Unable to complete entire task, even with verbal guidance	Able to complete task with guidance	Able to complete task safely with moderate guidance	Able to complete task safely with little guidance	Able to complete task independently without prompting

Results

A total of 29 residents were enrolled during the study period. Baseline characteristics of the participants are shown in Table 2. Most of participants were female who graduated of ≥ 4 years. Approximately half of them were in the 3rd year residency training program.

Table 2. Baseline characteristics of participants (N=29).

Characteristics	Mean ± SD
Mean age ± SD (years)	28.2 ± 1.2
Mean height ± SD (cm)	162.5 ± 7
Mean BMI ± SD (kg/m^2)	20.8 ± 1.9
	N (%)
Level of training	
1st year resident	3 (10.3)
2nd year resident	11 (37.9)
3rd year resident	15 (51.7)
Female	24 (82.8)
Time after graduation (years)	
≤ 2	3 (10.3)
3	10 (34.5)
≥ 4	16 (55.2)
Open surgery experience (cases)	
< 5	8 (27.6)
≥ 5	21 (72.4)
Right-handed person	27 (93.1)
Video game player ≥ 3 hours/week	7 (24.1)
Can drive	26 (89.7)
Can play musical instrument	10 (34.5)

SD: Standard deviation, BMI: Body Mass Index

Mean scores and percentage of participants who passed the test are demonstrated in Table 3. Mean GOALS scores increased significantly at 5 and 10 hours of training (12.3 vs. 18 vs. 19.3, $p < 0.001$). Percentage of participants who passed the tests also increased significantly at 5 and 10 hours of training (6.9% vs. 64.3% vs. 75.9%, $p < 0.05$). There was no participant who passed the test at 5 hours but did not pass at 10 hours of training. Scores of all domains including depth perception, bimanual dexterity, efficiency, tissue handling, and autonomy were significantly improved at 5 hours ($p < 0.05$). However, only the scores for depth perception, bimanual dexterity and efficiency increased significantly after 10 hours of training. Similar results were observed in terms of percentage of participants who passed the tests.

Table 3. Comparison of mean GOALS scores and percentage of participants who passed the test between baseline, after 5 and 10 hours of training (N=29).

	Baseline	At 5 hours	At 10 hours
Total scores			
Mean score ± SD	12.3 ± 3.5	18 ± 2.9 [a]	19.3 ± 2.4 [b]
Passed	2 (6.9%)	18 (64.3%) [a]	22 (75.9%) [b]
Domains			
Depth perception			
Mean score ± SD	2.3 ± 1.1	3.6 ± 0.6 [a]	4.0 ± 0.3 [b]
Passed	4 (13.8%)	23 (79.3%) [a]	27 (93.1%)
Bimanual dexterity			
Mean score ± SD	2.6 ± 0.9	3.9 ± 0.6 [a]	4.1 ± 0.5 [b]
Passed	4 (13.8%)	22 (75.9%) [a]	27 (93.1%)
Efficiency			
Mean score ± SD	2.1 ± 0.9	3.2 ± 1.0 [a]	3.8 ± 0.8 [b]
Passed	3 (10.3%)	11 (37.9%) [a]	16 (55.2%) [b]
Tissue handling			
Mean score ± SD	2.6 ± 0.8	3.4 ± 0.8 [a]	3.6 ± 0.8
Passed	4 (13.8%)	12 (41.4%) [a]	17 (58.6%)
Autonomy			
Mean score ± SD	2.8 ± 0.6	3.7 ± 0.6 [a]	3.8 ± 0.6
Passed	2 (6.9%)	17 (58.6%) [a]	19 (65.5%)

[a] = significant different from baseline, [b] = significant different from 5 hours. SD: Standard deviation

Comparison of various characteristics was made between those who passed and did not pass the tests at 5 and 10 hours after training and the results are shown on Table 4. It was significantly more likely that, at 5-hour training, those who passed the test can play musical instrument (50% vs. 9.1%, p = 0.044). However, there was no significant difference in age, level of training, dominant hand, video game experience, or driving ability between participants who passed or did not pass the test at both 5 and 10 hours of training.

Table 4. Factors affecting the passing test of the participants after 5 and 10 hours of training.

Characteristics	At 5 hours			At 10 hours		
	Passed N=18	Did not pass N=11	p value	Passed N=22	Did not pass N=7	p value
Mean age (years)	28.1±1.2	28.4±1.2	0.500*	28.1±1.1	28.6±1.3	0.308*
Level of training			0.808*			0.817*
1st year resident	2 (11.1%)	1 (9.1%)		2 (9.1%)	1 (14.3%)	
2nd year resident	6 (33.3%)	5 (45.5%)		9 (40.9%)	2 (28.6%)	
3rd year resident	10 (55.6%)	5 (45.5%)		11 (50%)	4 (57.1%)	
Right-handed person	16 (88.9%)	11 (100%)	0.512**	20 (90.9%)	7 (100%)	1.00**
Video game player ≥ 3 hours/week	6 (33.3%)	1 (9.1%)	0.202**	7 (31.8%)	0 (0%)	0.147**
Can drive	15 (83.3%)	11 (100%)	0.268**	19 (86.4%)	7 (100%)	0.557**
Can play musical instrument	9 (50%)	1 (9.1%)	0.044**	10 (45.5%)	0 (0%)	0.063**

* Student t test, ** Fisher's exact test.

Discussion

The results of this study showed that total GOALS scores increased significantly after 5 hours of training. These results were comparable with other previous studies and showed the effectiveness of the training protocol. Several studies had shown the benefits of simulator and reported increased in GOALS scores varying from 6.1 to 7.1 depending on types of simulator, training protocol, practice time, and surgeon experience[5, 7, 8]. However, after 10 hours of training, GOALS scores increased slightly comparing to those after 5 hours. In addition, proportion of participants who passed the tests also increased significantly and rapidly after 5 hours of training and increased slightly after that. However, all participants will have the further training in operating room in laparoscopic rotation.

These results could imply that the training protocol with TG-MET simulator reached plateau of learning curve at 5 hours. At least 5 hours are needed for training protocol to improve and achieve adequate laparoscopic skill. However, further study is needed to verify the benefits of training up to 10 hours.

For each domain, proportion of those who passed depth perception and bimanual dexterity skills increased to about 75% at 5 hours and reached more than 90% at 10 hours. For other domains, the proportion of those who passed also significantly increased at 5 hours and seemed to reach plateau at 10 hours, but the proportions were relatively low at both 5 and 10 hours (37.9% and 55.2% for efficiency, 41.2% and 58.6% for tissue handling, and 58.6% and 65.5% for autonomy).

For efficiency domain, most of participants performed the tasks slowly and had neither confidence nor efficiency. This might be from lack of feedback and support by expert laparoscopists during the training and from limited experiences of the participants. Tissue handling could be improved not only from training, but also from experiences. The 2-week training period in this study might not be long enough to increase their experience to satisfactory level. Autonomy is the important domain that indicates the competency of the protocol. The lower improvement at 10 hours might be resulted from lack of feedback, guidance by expert laparoscopists or training video during the training, and insufficient explanation in the introduction video.

From previous studies, the factors that affected laparoscopic training were level of resident training, video game experience, confident about driving, and ability of playing musical instruments[9-14]. The result of this study showed that participants passed the tests at 5 hours training were significantly more likely to be those who can play musical instruments. While the level of training, video game experience, and driving ability were not affect the percentage of participants who passed the test. However, the samples were too small to make strong conclusion in this regard.

The strengths of this study included the use of GOALS score which is a validated, standard assessment tool for grading technical proficiency for laparoscopic surgery. The 2 expert laparoscopists who were familiar with this scoring system rated all the participants. Between them, the intraclass correlation coefficient was 0.84. In addition, the 2 experts were blinded from knowing whose video they evaluated.

However, there are also some limitations of the study. The sample size was too small to compare the characteristics between those who passed and did not pass the tests, so the power to detect the differences between the 2 groups was limited. In addition, the long-term retentions of the skills were not evaluated but only short-term outcomes were assessed. Further studies are required to evaluate the retention of the skills after training.

Training with TG-MET simulator and TG-MET protocol is simple, low cost, and effective. So, it is suitable for the beginners. At least of 5 hours of training seems to be adequate for some domains, including, depth perception and bimanual dexterity. On the other hand, efficiency, tissue handling, and autonomy domain improved significantly after 5 hours of training, but less than 70% of participants passed these tests. Therefore, our protocol should be revised and modified to improve the skills for such domains. Use of instrument and

technics should be described and explained with more details in the training video. In addition, feedbacks and supports from expert surgeons during training might also be needed. Duration of training might also need to increase to more than 10 hours, specifically focusing on efficiency, tissue handling, and autonomy domains.

Conclusion

Training with TG-MET protocol can significantly improve laparoscopic skills at 5 hours and tend to reach the plateau at 10 hours of training. Some tasks on depth perception, bimanual dexterity and efficiency still improved at 10 hours.

Potential conflicts of interest

The authors declare no conflicts of interest.

References

1. Shore EM, Lefebvre GG, Grantcharov TP. Gynecology resident laparoscopy training: present and future. Am J Obstet Gynecol 2015;212:298-301.
2. Vitish-Sharma P, Knowles J, Patel B. Acquisition of fundamental laparoscopic skills: is a box really as good as a virtual reality trainer? Int J Surg 2011;9:659-61.
3. Samia H, Khan S, Lawrence J, Delaney CP. Simulation and its role in training. Clin Colon Rectal Surg 2013;26:47-55.
4. Nagendran M, Toon CD, Davidson BR, Gurusamy KS. Laparoscopic surgical box model training for surgical trainees with no prior laparoscopic experience. Cochrane Database Syst Rev 2014;17:CD010479.
5. Supe A, Prabhu R, Harris I, Downing S, Tekian A. Structured training on box trainers for first year surgical residents: does it improve retention of laparoscopic skills? A randomized controlled study. J Surg Educ 2012;69:624-32.
6. Vassiliou MC, Feldman LS, Andrew CG, Bergman S, Leffondre K, Stanbridge D, et al. A global assessment tool for evaluation of intraoperative laparoscopic skills. Am J Surg 2005;190:107-13.
7. Malik AA, Ayyaz M, Afzal MF, Ali AA, Shamim R, Khan R, et al. Use of box simulators for improving intraoperative laparoscopic skills - an essential tool for the surgeon in training. J Coll Physicians Surg Pak 2015;25:172-5.
8. 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.
9. Salkini MW, Hamilton AJ. The effect of age on acquiring laparoscopic skills. J Endourol 2010;24:377-9.
10. Van Hove C, Perry KA, Spight DH, Wheeler-Mcinvaille K, Diggs BS, Sheppard BC, et al. Predictors of technical skill acquisition among resident trainees in a laparoscopic skills education program. World J Surg 2008;32:1917-21.
11. Rosser JC, Jr., Lynch PJ, Cuddihy L, Gentile DA, Klonsky J, Merrell R. The impact of video games on training surgeons in the 21st century. Arch Surg 2007;142:181-6.
12. Nomura T, Miyashita M, Shrestha S, Makino H, Nakamura Y, Aso R, et al. Can interview prior to laparoscopic simulator training predict a trainee's skills? J Surg Educ 2008;65:335-9.
13. Boyd T, Jung I, Van Sickle K, Schwesinger W, Michalek J, Bingener J. Music experience influences laparoscopic skills performance. JSLS 2008;12:292-4.
14. Powers TW, Bentrem DJ, Nagle AP, Toyama MT, Murphy SA, Murayama KM. Hand dominance and performance in a laparoscopic skills curriculum. Surg Endosc 2005;19:673-7.