Introduction to Open Surgical Skills Curriculum: Randomized Trial of Self-Paced vs Group Video Tutorial Viewing

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OBJECTIVE: At our residency program, incoming interns are traditionally taught fundamental open surgical skills like suturing and knot tying in a group setting by viewing 12 instructional videos consecutively followed by individual baseline skill testing. We sought to evaluate if introduction to open surgical skills via self-paced viewing of video tutorials, as opposed to traditional group viewing, results in improved surgical skill acquisition in Obstetrics and Gynecology (OBGYN) interns as measured by higher proficiency score with decreased workload stress and anxiety.

DESIGN, SETTING, PARTICIPANTS: A randomized control trial was conducted in which OBGYN PGY-1 residents in 2015 and 2016 ($N = 35$) were introduced to basic open surgical skills, such as knot tying and suturing, by viewing 12 video tutorials produced at UTSW (https://youtu.be/4w3hyL9muVU) for a surgical skills curriculum. Residents were randomized to 2 groups: group viewing vs self-paced viewing. Performance scores were calculated based on time and accuracy while workload and anxiety were measured by preand post-testing surveys using the National Aeronautics and Space Administration-Task Load Index and Spielberger State-Trait Anxiety Inventory 6 item questionnaires.

RESULTS: There was no significant difference in proficiency score between the group vs self-paced viewing in 8 out of 12 tasks using the Wilcoxon signed rank test ($p > 0.10$). There was no statistically significant differences in workload stress based on the National Aeronautics and Space Administration-Task Load Index questionnaire ($p = 0.399$) or self-reported anxiety based on the Spielberger State-Trait Anxiety Inventory 6 item questionnaire ($p = 0.607$).

CONCLUSIONS: Contrary to recent educational data suggesting self-paced learning may improve outcomes, viewing instructional videos in a group setting continues to be a time efficient method to introduce basic open surgical skills to incoming OBGYN interns. (J Surg Ed 76:453–458. © 2018 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Resident training, Skills acquisition, Skills lab, Surgical education, Suturing curriculum, Suturing models

COMPETENCIES: Medical Knowledge, Practice-Based Learning and Improvement, Patient Care

INTRODUCTION

The transition from the final year of medical school to resident physician entails a considerable amount of anxiety and stress—particularly for those entering a surgical specialty. Interns must not only acquire the knowledge and judgment required for patient care but also master the surgical skills necessary for the operating room. Due to new regulations set forth by the Accreditation Council of Graduate Medical Education, surgical residents are now required to acquire basic and advanced surgical skills in less time than their predecessors.[1,2] The development of novel teaching methods to include in surgical training curricula is an important agenda for residency programs.

Residents must master basic open surgical skills, such as open knot-tying and suturing, in order to be competent in the operating room and to advance to complex surgical skills.[3-5] Scott et al.[6] developed a proficiency-based open skills curriculum utilizing video tutorials that is cost-effective, feasible within the context of residency training, educationally beneficial, and demonstrates construct validity.

Stress hinders both surgical learning and performance[7-9] and can create barriers to an already steep learning curve for novice learners. Recent trends in educational methods suggest that self-paced curriculums may be more efficient for higher level teaching and acquisition of skills.[10,11]

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Therefore, the goal of this study was to evaluate if introduction of basic surgical skills using video-based tutorials can be further improved by allowing residents to view videos at their own pace as opposed to the current method of group viewing. Additionally, we aimed to examine if individualized pacing of video viewing would decrease anxiety and stress level.

METHODS

Obstetrics and Gynecology (OBGYN) residents ($N = 36$, PGY-1) were enrolled in an Institutional Review Board-approved prospective study, which was conducted between July 2015 and July 2016 in the Simulation and Training Laboratory at the Southwestern Center for Minimally Invasive Surgery. Training was a requirement as part of the Department of OBGYN Skills Curriculum, however participants volunteered to have their data collected and informed consents were obtained from all participants. The surgical skills curriculum for PGY-1 trainees involves 12 proficiency—based open knot-tying and suturing tasks (Table 1). The tasks required the use of readily available, low fidelity bench models such as laminated fabric models by Dasie International (Elora, Canada) and suture boards with latex rubber bands by Ethicon, Inc. (New Jersey).

Performance scores were calculated based on time and errors using a previously published formula[6]: cutoff time—completion time—(10× sum of errors). This scoring system was modified from the Fundamentals of Laparoscopic Surgery program, which has been extensively validated.[6,12]

Seventeen interns were randomized to the traditional group and 18 to the self-paced group. The traditional group was shown a 52-minute video tutorial (12 clips total) produced by UT Southwestern Center for Minimally Invasive Surgery (SCMIS) faculty[6] that demonstrates appropriate surgical techniques and error—avoidance strategies for each of the 12 tasks in a classroom setting with no play-backs or pauses allowed. At the completion of the video tutorial, interns proceed with the proctored baseline skills test which required participants to perform 1 repetition of all 12 tasks under the observation of a proctor with timer. Testing took place in the same setting—our multidisciplinary skills surgical skills lab. Testing proctors were the same for both groups and remained unchanged over the course of 2 years of testing. In the self-paced group, each of the 18 residents were given a personal iPAD (Apple, Cupertino, California) to view each of the 12 video tutorials at their own pace with re-plays and pauses allowed. The self-paced group underwent a timed baseline skills test after the viewing of each corresponding video. Participants in neither group were allowed to practice with instruments or sutures prior to undergoing baseline testing.

At the beginning of the study, participants completed a questionnaire regarding demographics, baseline open skills, and prior operative experiences in medical school. Additionally, participants also completed the National Aeronautics and Space Administration-Task Load Index (NASA-TLX), a subjective mental workload assessment tool commonly used in surgical research[13] to assess their baseline workload. This validated questionnaire measures a participant's self-reported mental demand, physical demand, temporal demand, performance, effort, and frustration along a 21-increment scale of very high, medium, and very low. Subjective anxiety level was assessed by having trainees completed the validated State-Trait Anxiety Inventory (STAI) questionnaire before the start of video tutorial and after baseline testing of the 12 tasks.[14,15] Descriptive statistics were used and Wilcoxan rank sum and student's t tests employed where appropriate; a p-value < 0.05 was established to

TABLE 1. Task Descriptions and Expert Proficiency Levels

Task Name	Cutoff Time (seconds)	Proficiency Score*
Palm needle driver	60	53 (7 seconds)
2-Handed knot tying without tension	60	50 (10 seconds)
1-Handed knot tying without tension	60	50 (10 seconds)
2-Handed knot tying with tension, surgeon's knot	60	47 (13 seconds)
2-Handed knot tying with tension, slip knot	60	45 (15 seconds)
1-Handed knot tying with tension, slip knot	60	45 (15 seconds)
Simple interrupted suturing	120	102 (18 seconds)
Interrupted horizontal mattress sutring	120	89 (31 seconds)
Interuptted vertical mattress suturing	120	89 (31 seconds)
Simple running suturing	600	435 (165 seconds)
Subcuticular running suturing	600	396 (204 seconds)
Subcuticular interrupted suturing	120	87 (33 seconds)

*score = cutoff time − completion time − (10 × sum of errors). Modified from Scott et al.

determine statistical significance. SAS 9.4 (SAS Institute, Cary, North Carolina) was used for analysis.

After the baseline testing, residents were given 12 weeks to master the 12 surgical skills and achieve proficiency. This time frame was determined based on the amount of clinical responsibility, duty hours, and workload that residency demanded. Residents had 24/7 access to the surgical skills laboratory as well as unlimited access to the video tutorials online.

RESULTS

In total 36 incoming residents in 2016 and 2017 participated in the study during their intern orientation, prior to any clinical exposure as a resident. One resident was excluded as she had completed the program curriculum previously, leaving 35 subjects in this analysis. There were 5 men and 31 women with the average self-reported prior surgical experience of 3 hours. There was no difference in number of left-handed residents between the 2 groups. There was no gender difference between the traditional and the self-paced group (3 vs 2 male residents). All residents passed the final open skills testing within the 12 weeks mandatory time frame.

There was no significant difference in proficiency score between the traditional group vs self-paced viewing in 8 out of 12 tasks. The traditional group had higher proficiency scores in the 4 tasks that showed score differences: the palm needle driver (47 vs 37), 2-handed slip knot-tying under tension (42 vs 28), 1-handed knot-tying under tension (42 vs 33), and interrupted suturing in horizontal mattress (49 vs 35) (Table 2). There was no difference in proficiency scores between the traditional group and the self-paced group when tested 12 weeks later (72.11 ± 142.25, 72 ± 141.63, $p = 0.99$).

There was no difference between traditional and self-paced groups in workload stress based on the median NASA-TLX scores (6 ± 1.17 vs 7 ± 1.03, $p = 0.399$; Table 3). A post hoc power analysis for a 1/3 reduction in NASA-TLX scores from 6 to 8, with a power of 80% would require $N = 12$ for each group. Additionally, there was also no difference in anxiety level as measured by STAI between the traditional group and the self-paced group (3 ± 6 vs 0 ± 3, $p = 0.607$; Table 4).

TABLE 2. Comparison of Standardized Scores for Each Open Surgical Task

Outcome	Traditional Group Viewing	Self-Paced Viewing	p Value
n	17	18	
Palm needle driver	47 [40, 49]	37 [26, 45]	0.016
2-handed knot tying without tension	43 [28, 46]	37 [30, 39]	0.477
1-handed knot tying without tension	45 [33, 48]	40 [16, 48]	0.372
2-handed knot tying with tension, surgeno's knot	34 [30, 42]	32 [24, 42]	0.488
2-handed knot tying with tension, slip knot	42 [34, 43]	28 [12, 41]	0.036
1-handed knot tying with tension, slip knot	42 [35, 43]	33 [14, 40]	0.032
Simple interrupted suturing	74 [68, 81]	80 [57, 83]	0.766
Interrupted horizontal mattress suturing	49 [41, 54]	35 [21, 42]	0.015
Interrupted vertical mattress suturing	55 [40, 69]	49 [27, 63]	0.198
Simple running suturing	246 [227, 299]	218 [115, 285]	0.125
Subcuticular running suturing	145 [52, 232]	76 [0, 135]	0.102
Subcuticular interrupted suturing	25 [8, 54]	44 [32, 48]	0.499

Data presented as median [1st quartile, 3rd quartile], Significance level (p value) is for the Wilcoxon rank-sum test.

TABLE 3. Comparison of Subjective Workload Stress Based on NASA-TLX

Outcome	Traditional Group Viewing	Self-Paced Viewing	p Value
n	17	18	
Mental Demand	6 [4, 7]	7 [5, 8]	0.124
Physical Demand	5 [3, 6]	5 [3, 7]	0.595
Temporal Demand	6 [2, 8]	7 [5, 9]	0.689
Performance	5 [4, 8]	7 [4, 8]	0.343
Effort	8 [7, 8]	8 [7, 8]	0.720
Frustration Level	7 [6, 8]	6 [3, 8]	0.375
Raw Score	34 [29, 43]	36 [31, 45]	0.399

Data presented as median [1st quartile, 3rd quartile], Significance level (p value) is for the Wilcoxon rank-sum test.

TABLE 4. Comparison of Subjective Anxiety Based on STAI

Outcome	Traditional Group Viewing	Self-Paced Viewing	p Value
n	17	18	
Initial observation	47 [40, 57]	50 [43, 53]	0.752
Final observation	50 [47, 57]	53 [43, 57]	0.934
Difference (Final-initial)	−3 [−6, 6]	0 [−3, 3]	0.607

0.607Data presented as median [1st quartile, 3rd quartile], Significance level (p-value) is for the Wilcoxon rank-sum test.

DISCUSSION

It is critical for incoming residents in a surgical specialty to master fundamental open knot-tying and suturing skills in order to provide safe patient care and to advance to more complex surgical skills. Numerous curricula, ranging from low- to high-fidelity bench models have been reported in the literature, though none have been widely adapted.[16,17] Using low fidelity bench models with easily accessible training tools such as rubber tubes and laminated fabric models made by Dasie International (Elora, Canada), have shown to be highly effective for the acquisition of technical skills [5,6,18] (Image 1).

Studies have shown that faculty directed skills learning have no objective improvement in tasks skills by residents when compared to those who underwent self-directed multimedia learning.[19,20] Xeroulis et al. demonstrated that video instruction was as effective as expert feedback for suturing and knot-tying skill in fourth year medical students.[21] In fact, the optimal instructor to student ratio has been reported to be 1:4[22] which can be difficult to accomplish in larger residency programs. A viable alternative to the traditional method of instructor led introduction to basic surgical skills is to utilize multimedia resources. Video tutorials act as a virtual instructor that enhances learning while eliminating the need for personnel resources.[22] In a national survey of 266 OBGYN residency programs in the United States, fewer than 10 programs used small group tutoring or video tutorials as a method to teach surgical skills.[23]

IMAGE 1. The suture board, Dasie model, needle driver, and sutures are easily accessible, low-cost tools that can be used to teach basic open surgical skills.

A proficiency-based knot-tying and suturing curriculum by Scott et al.[6] has been implemented since 2007 to incoming residents in surgical fields, including OBGYN at University of Texas Southwestern Medical Center. The curriculum involves 12 tasks that range from needle driver palming to suturing. As first described in Scott et al,[6] a 52-minute video tutorial is shown followed by individualized proctored baseline testing. Residents are not allowed to practice prior to their pretesting and no verbal assistance or cues are given by the proctor during pretesting. Afterward, residents have 12 weeks to become proficient at the 12 tasks. Both groups were given full 24/7 access to the simulation lab to practice as well as online access to the tutorials. Our study aimed to look at task performance and anxiety and stress level involved in the pretesting phase of the knot-tying and suturing curriculum. Specifically we aimed to see if self-paced viewing of the 12 video tutorials would help to decrease anxiety and stress level leading to improved proficiency scores.

We found that there was no difference in the pretest proficiency score between the group vs self-paced viewing in 8 out of 12 tasks. The 4 tasks that were statistically significant for superior proficiency scores were palm needle driver, 2-handed slip knot-tying under tension, 1-handed knot-tying under tension, and interrupted suturing in horizontal mattress. It is interesting to see that those assigned to group viewing achieved higher proficiency scores in each of these 4 tasks (higher scores indicate better performance). It is also notable that there was no significant difference in proficiency scores between the traditional and self-paced groups when tested 12 weeks later. We found no differences in workload stress based on self-reported anxiety. This suggests that self-paced viewing does not positively contribute to skill acquisition and may in fact hinder initial performance of certain tasks. We hypothesize that the

self-paced group may have been negatively impacted by watching the videos over extended periods of time while pausing throughout the demonstration, rather than simply attempting the entire process fluidly.

We agree with Scott et al. that video tutorials can take the role of a virtual proctor and group viewing of instructional videos does not appear to have a negative effect on pretesting proficiency scores, workload stress, or anxiety level. All 35 residents met proficiency in the 12-open knot-tying and suturing tasks at the completion of 12 weeks. This suggests that video tutorials are an underutilized tool that has the potential to play a key role in a residency surgical curriculum.

There are some limitations in our study. Mainly, we were not able to track the in vivo differences in skill performance after the post-test proficiency scores between the 2 groups. The proctors were also not blinded though they were the same proctors throughout the 2-year course of the study. We did not asses the differences between the 2 groups in total time spent practicing in the surgical skills lab before proficiency was reached. Finally, the self-paced group completed all viewing and testing within 2 hours however, the exact time difference between self-paced and traditional was not measured.

In conclusion, video based tutorials, as part of a proficiency-based curricula, are an effective method to introduce open surgical skills to novice learners. Group viewing of video tutorials, such as in a classroom setting, is a reasonable method to teach open surgical skills without negatively impacting performance or increasing resident workload stress and anxiety levels.

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SUPPLEMENTARY INFORMATION

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jsurg.2018.08.019.