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Using three-dimensional laparoscopy as a novel training tool for novice trainees compared with two-dimensional laparoscopy

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Abstract

BACKGROUND: Laparoscopic skills training is an essential component of general surgery training. This study proposes the use of three-dimensional (3D) laparoscopy as the initial training tool for beginners to shorten the learning curve.

METHODS: This study evaluates the surgical performance and subjective experience of junior and senior trainees with 3D versus two-dimensional laparoscopy. Peg transfer task was used as the objective time measurement. A subjective evaluation of the 2 systems using a questionnaire was also used.

RESULTS: The mean difference in the juniors was 16.33 seconds, while in the seniors it was only 3.46 seconds ($P = .036$). The time difference between groups was much smaller in the 3D than the two-dimensional ($P = .14$ vs $.02$) laparoscopy. In the subjective evaluation, the novice group also scored significantly higher for the 3D system in the bimanual dexterity category ($P = .004$, $.007$).

CONCLUSION: Our study demonstrates the feasibility of using 3D laparoscopy for laparoscopic skills training in novices.

Laparoscopic surgery is one of the major advances in modern surgery aimed at improving outcomes for patients. With conventional, 2-dimensional (2D) systems, the surgeon faces a loss of binocular vision and dexterity.[1] The use of three-dimensional (3D) cameras for laparoscopic procedures is proposed to increase accuracy and efficiency of the operator, thus cutting down on operating time, decreasing the learning curve, and improving safety.[2] However, clinical application of the 3D systems has yielded mixed results in studies.[3–5]

Studies on utilizing 3D systems as a training tool have been limited. Laparoscopic skills training is an essential component of general surgery training. With reduced work hours and development of competency-based training, innovative delivery of laparoscopic skills training is required.[6,7] The initial learning curve of 2D laparoscopy is high because of loss of depth perception. This study proposes the use of 3D laparoscopy as the initial training tool for beginners to shorten the learning curve.

The authors declare no conflicts of interest.

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Table 1 Demographic information of the novice and senior group

Variable	Novice (n = 12, 48%)	Senior (n = 13, 52%)
Female sex	8 (66.7%)	8 (61.5%)
Average laparoscopic experience (years)	0	3.36
Average 2D laparoscopic experience (number of cases)	.25	73.85
Average 3D laparoscopic experience (number of cases)	0	1.57
Average numbers of formal laparoscopic training sessions	0	7.46
Training level breakdown (number of participants)	PGY 1—(5) Medical student—(7)	PGY 3—(6) PGY 4—(2) PGY 5—(5)

2D = 2-dimensional; 3D = 3-dimensional; PGY = postgraduate year.

Patients and Methods

This is a prospective study to evaluate the surgical performance and subjective experience of novice and senior surgical trainees with 3D versus 2D laparoscopy. The novice group includes medical students and first-year surgical residents who have no formal laparoscopic skills training. The senior group is composed of surgical residents from year 3 to 5 who have undergone previous laparoscopic skills training or performed laparoscopic procedures during training.

The peg transfer task from the Fundamentals of Laparoscopic Surgery was used as the objective time measurement.[8] The participants were given 20 minutes to familiarize themselves with the equipment and to practice handling the instruments and the pegs before time trials. The novice group did not receive additional time to practice. The years of surgical experience and training level of the participants were recorded. The participants were divided randomly into 2 groups consisting of both beginners and seniors. One group of participants began with the modules using the 3D system, while the second group started with the 2D system. The task was performed twice on each system by participants and the average time was recorded. Subjective evaluation of the operator's experience with the 2D and 3D system was evaluated with a questionnaire after the time trial (please see attached sample evaluation). The questionnaire asked the participants to compare the 2 systems in the following categories including bimanual dexterity, efficiency, and tissue/target handling. The results were translated into numerical scores for statistical analysis (0 = strongly disagree and 5 = strongly agree).

A standard laparoscopic skills trainer box and 5-mm laparoscopic Maryland graspers were used for the PEG transfer task. The PEG transfer board and pegs were obtained from official Fundamentals of Laparoscopic Surgery equipment. The only difference between the 2 systems was the laparoscope mounted on the box. For the 2D system, the Storz high definition (HD) 10-mm 30° laparoscope was used, while the Viking 3D HD 10-mm 30° laparoscope (CONMED Corporation, Utica, NY) was used for the 3D system. The 3D-HD scope is a dual-channel stereo endoscope that allows for visualization in 0° and 90° position. Every participant wore polarized lenses for 3D visualization with a 1080p HD 3D monitor.

Results

A total of 25 participants were recruited, consisting of 12 in the novice group and 13 in the senior group (Table 1). None of the novice group participants had prior laparoscopic skills training or handling of laparoscopic instruments. All senior group participants had either performed laparoscopic surgery or had formal laparoscopic skills training with a trainer box or live models. The time trial results are presented in Table 2. The 3D system yielded a shorter average time for both the novice and senior groups. The average time difference in the PEG transfer task between the 2D and 3D system for the novice group was significantly shorter than for the senior group ($P = .036$). As expected, the seniors perform better using either the 2D or 3D system. However, the statistical difference was much smaller with the 3D system than the 2D ($P = .14$ vs .02).

The statistical analysis from the subjective evaluation (Table 3) also demonstrated that the novice group favored

Table 2 PEG transfer time trial results for the novice and senior trainee groups using 2D and 3D laparoscopy

Variable	2D system	3D system	*P* value	Mean difference
Novice PEG time (seconds)	113.33 ± 28.71	97.00 ± 22.00	.132	16.33
Senior PEG time (seconds)	80.15 ± 18.70	76.69 ± 16.08	.342	3.46
P value comparing time in the same system and mean difference between groups	.02	.14		.036

2D = 2-dimensional; 3D = 3-dimensional.