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The impact of aptitude on the learning curve for laparoscopic suturing

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Abstract

BACKGROUND: Within surgery, several specialties demand advanced technical skills, specifically in the minimally invasive environment.

METHODS: Two groups of 10 medical students were recruited on the basis of their aptitude (visual-spatial ability, depth perception, and psychomotor ability). All subjects were tested consecutively using the ProMIS III simulator until they reached proficiency performing laparoscopic suturing. Simulator metrics, critical error scores, observed structured assessment of technical skills scores, and Fundamentals of Laparoscopic Surgery scores were recorded.

RESULTS: Group A (high aptitude) achieved proficiency after a mean of 7 attempts (range, 4–10). In group B (low aptitude), 30% achieved proficiency after a mean of 14 attempts (range, 10–16). In group B, 40% demonstrated improvement but did not attain proficiency, and 30% failed to progress.

CONCLUSIONS: Distinct learning curves for laparoscopic suturing can be mapped on the basis of fundamental ability. High aptitude is directly related to earlier completion of the learning curve. A proportion of subjects with low aptitude are unable to reach proficiency despite repeated attempts.

The technique of laparoscopic suturing was well described by Szabo et al.[1] Laparoscopic suturing is an advanced skill that enables surgeons to broaden the application of laparoscopy.[2] However, the skill is difficult to acquire and requires specialized training.[3] Complex laparoscopic tasks such as laparoscopic suturing and intracorporeal knot tying require a very high level of technical ability. This can be developed using a simulated model.[4]

Previous studies have shown that increasing the complexity of a procedure is associated with a progressively steeper learning curve.[5] In particular, a protracted learning curve has been demonstrated in laparoscopic suturing.[6] When the learning curve for laparoscopic suturing was examined by Botden et al,[7] the number of repetitions required to reach the top of the performance curve was 8. We planned to establish if this learning curve differs depending on a subject's aptitude.

Several studies have examined the relationships between specific areas of aptitude, such as visual-spatial and perceptual abilities, and laparoscopic technical skill performance.[8,9] These studies have concluded that superior laparoscopic performance is demonstrated among novice surgical trainees who possess such attributes.

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Table 1 Fundamentals of Laparoscopic Surgery suturing principles

1. Positioning the needle in the needle holder
2. Running the needle through the suturing pad
3. Taking proper bites of the suturing pad while performing the suture
4. Throwing the thread around the needle holder
5. Pulling the thread tightly in the proper direction
6. Tying the correct surgical knot

We have previously shown that aptitude can predict the rate at which a surgical novice achieves proficiency in a basic laparoscopic task, such as laparoscopic appendicectomy.[10] It is intuitive that the more complex the laparoscopic procedure, the greater effect that fundamental ability will have on achieving proficiency.

We aimed to compare the rate at which 2 groups of surgical novices became proficient in laparoscopic suturing and intracorporeal knot tying. These 2 groups were at opposite ends of the aptitude spectrum.

Methods

Setting and study participants

Participants were recruited to take part in this study on a voluntary basis. Sixty-two medical students with no prior surgical experience were tested in 3 different dimensions of aptitude, described below. All participants were asked to sign a consent form allowing the data collected to be used for research purposes. It was made clear to all the subjects that the data were stored and presented in an anonymous format. Ethical approval was granted by the Research Ethics Committee of the Royal College of Surgeons in Ireland.

On the basis of the results of aptitude testing, 2 groups of 10 participants were selected from opposite ends of the aptitude spectrum. Participants in the first group (group A) were considered to have high aptitude, with scores 1 standard deviation higher than the mean score of the study population. Participants in the second group (group B) were considered to have low aptitude, as their scores were 1 standard deviation lower than the mean score of the study population. Five experienced laparoscopic surgeons were also recruited to set benchmark proficiency levels on the ProMIS III simulator (CAE Healthcare, Sarasota, FL). Each of these surgeons had performed >100 complex laparoscopic procedures.

Simulator and materials

The ProMIS III simulator was used for assessment. It facilitates the use of physical models, which ensures tactile feedback, and by tracking the instruments, it provides measurements of performance. Upon completion of a procedure, the simulator generates an immediate profile summary of objective measurements. These include time,

Table 2 Demographic details of the subjects

Variable	High-aptitude group (n = 10)	Low-aptitude group (n = 10)	P (ANOVA)
Age (y)			NS
Range	19–27	19–36	
Mean	21.1	23.5	
Standard deviation	2.6	5.5	
Sex (%)			NS
Male	50	20	
Female	50	80	
Dominant hand (%)			NS
Right	100	100	
Left	0	0	
Corrected vision (%)			NS
Yes	70	50	
No	30	50	
Video games (%)			.001
Yes ($\geq$1 h/wk)	90	10	
No	10	90	
Music (%)			NS
Yes (achieved distinction)	70	50	
No	30	50	
Sports (%)			NS
Yes (intercollegiate level)	80	40	
No	20	60	

ANOVA = analysis of variance.