

Training With Curved Laparoscopic Instruments in Single-Port Setting Improves Performance Using Straight Instruments: A Prospective Randomized Simulation Study

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OBJECTIVE: Lately single-port surgery is becoming a widespread procedure, but it is more difficult than conventional laparoscopy owing to the lack of triangulation. Although, these operations are also possible with standard laparoscopic instruments, curved instruments are being developed. The aims of the study were to identify the effect of training on a box trainer in single-port setting on the quality of acquired skills, and transferred with the straight and curved instruments for the basic laparoscopic tasks, and highlight the importance of a special laparoscopic training curriculum.

DESIGN: A prospective study on a box trainer in single-port setting was conducted using 2 groups. Each group performed 2 tasks on the box trainer in single-port setting. Group-S used conventional straight laparoscopic instruments, and Group-C used curved laparoscopic instruments. Learning curves were obtained by daily measurements recorded in 7-day sessions. On the last day, the 2 groups changed instruments between each other.

SETTING: 1st Department of Surgery, Semmelweis University of Medicine from Budapest, Hungary, a university teaching hospital.

PARTICIPANTS: In all, 20 fifth-year medical students were randomized into 2 groups. None of them had any laparoscopic or endoscopic experience. Participation was voluntary.

RESULTS: Although Group-S performed all tasks significantly faster than Group-C on the first day, the difference proved to be nonsignificant on the last day. All participants achieved significantly shorter task completion time on the last day than on the first day, regardless of the instrument they used. Group-S showed improvement of 63.5%, and

Group-C 69.0% improvement by the end of the session. After swapping the instruments, Group-S reached significantly higher task completion time with curved instruments, whereas Group-C showed further progression of 8.9% with straight instruments.

CONCLUSIONS: Training with curved instruments in a single-port setting allows for a better acquisition of skills in a shorter period. For this reason, there is a need for proficiency-based conventional, but also for a single-port, laparoscopic training curriculum in general surgery residency education. (J Surg Ed 73:348-354. © 2015 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: straight instrument, curved instrument, learning curve, single-port training curriculum

COMPETENCIES: Practice-Based Learning and Improvement, Interpersonal and Communication Skills, Systems-Based Practice

INTRODUCTION

The “learning curve” concept was first introduced by Hermann Ebbinghaus in 1909, a German psychologist who pioneered the experimental study of memory, the “forgetting curve” and the “spacing effect.” In 1936, Theodore Paul Wright proposed a mathematical model for the learning curve in the aircraft industry. In medicine, the concept of learning curve was first assessed in coronary artery bypass grafting, mitral valvuloplasty, and the use of end-to-end anastomosis stapler for low rectal resection. The term was later introduced to laparoscopic surgery.

The learning curve is characterized by a sudden drop in its first phase, followed by a second phase, in which the pace of the drop slows down. In the last stage, a straight line

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indicates no further significant changes, but the aspect depends on the interrelation of the trainee and the training method. The major examined parameter in the study of a surgical intervention's learning curve is the operative time. However, the rate of complications, incidence of conversions, and the duration of hospital stay are also measured. As the initial phase of the learning curve is associated with a high incidence of complications, the common aim of the surgeons, patients, and health insurers is to shorten this initial phase. Published data show that multiple factors influence the learning process of laparoscopic surgery. It is obvious that virtual-reality simulators and training boxes have a positive effect on the learning process of laparoscopy, shortening the first phase of the curve.¹ The findings of such investigations could enhance the efficiency of surgeons (in training) and improve patient safety.

To acquire the basic knowledge, judgment, and technical skills required for laparoscopic operations, the Society of American Gastrointestinal and Endoscopic Surgeons developed an educational program titled "The Fundamentals of Laparoscopic Surgery" in 1997. The Fundamentals of Laparoscopic Surgery is composed of a cognitive component and a skill-based portion pertinent to laparoscopic surgery. The objectives of the manual skills module are (1) to require a surgeon to work using a monocular optical system, (2) to manipulate instruments placed through a trocar, and (3) to use both hands in a complementary fashion to manipulate objects within a box. A metric system was designed for each task to provide objective measurement of efficiency and precision and also penalize specific errors. In the United States, the Fundamentals of Laparoscopic Surgery examination is compulsory for the surgical board examination and has been adopted in several other countries.

Natural Orifice Transluminal Endoscopic Surgery evolved in 2004 to reduce the invasive value of laparoscopic surgery, but numerous problems arose regarding this method. To find solutions of a certain extent, single-port surgery through the umbilicus has been developed. Although this could not eliminate difficulties completely, this does provide some solutions in many cases. The first interventions—such as in case of conventional laparoscopy—were simpler operation types (cholecystectomy² and appendectomy). Lately, all surgical areas use this method. In 2014, the number of articles on single-site laparoscopic interventions published on Pubmed exceeded 100.

An important limitation of single-port surgery is that the triangulation needed for a safe laparoscopic intervention cannot be achieved through a single incision. To eliminate this problem, several methods were introduced. The most appropriate method seems to be the one using special curved instruments. Nonetheless, a notable portion of surgeons still operate with conventional straight instruments through a single port.

The number of surgical procedures performed using single-port access (SPA) is growing; however, the number

of publications on the training and efficiency of this technique and on its learning curve is still insignificant. Therefore, the aim of this study is to compare the acquired skills in using straight vs. curved instruments in a laparoscopic training box and underline their importance in the laparoscopic curriculum.

MATERIAL AND METHODS

A total of 20 ($n = 20$) fifth-year medical students without prior laparoscopic or surgical experience were recruited for this study at the 1st Department of Surgery of Semmelweis University, Budapest, Hungary. The study was approved by the Ethics Committee of the Department.

Equipment

The Single Incision Laparoscopic Surgery port by Covidien (Dublin, Ireland) was inserted into a standard training box. Both conventional straight (Olympus, Hamburg, Germany) and curved instruments (Covidien) were used in an SPA setting.

Tasks

Task 1

(Peg transfer): In this task, a series of 3 rings had to be transferred from the right site to the left of the box and vice versa. In all, 2 graspers had to be used while exchanging the rings between the 2 in air.

Task 2

(Curved peg transfer): This task was similar to the first task, but the pegs were curved to create a further depth of perception. The participants had to perform the task in the same manner as the first one.

Task 3

(Loops and string): This task required passing a string through 3 rings from the right to left. The string had to be passed successively through all rings, starting from the first. Timing for this task began when the participant grasped the string, and ended on its release (Fig. 1).

Protocol

The study participants were prospectively randomized into 2 groups of Group-S (straight and conventional instruments) and Group-C (curved instruments and in a crossed position).

Group-S began the tasks in the SPA-straight setting that lasted for 7 consecutive days, and in the last session they switched to the SPA-curved setting. Group-C started the same tasks in the SPA-curved setting in the same manner, followed by the SPA-straight setting for the last session.

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