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Multicenter proficiency benchmarks for advanced laparoscopic suturing tasks☆

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ABSTRACT

Background: Advanced laparoscopic suturing (LS) tasks were developed based on a needs assessment. Initial validity evidence has been shown. The purpose of this multicenter study was to determine expert proficiency benchmarks for these tasks.

Methods: 6 tasks were included: needle handling (NH), offset-camera forehand suturing (OF), offset-camera backhand suturing (OB), confined space suturing (CF), suturing under tension (UT), and continuous suturing (CS). Minimally invasive surgeons experienced in LS completed the tasks twice. Mean time and median accuracy scores were used to establish the benchmarks.

Results: Seventeen MIS surgeons enrolled, from 7 academic centers. Mean (95% CI) time in seconds to complete each task was: NH 169 (149–189), OF 158 (134–181), OB 189 (154–224), CF 181 (156–205), UT 379 (334–423), and CS 416 (354–477). Very few errors in accuracy were made by experts in each of the tasks.

Conclusions: Time- and accuracy-based proficiency benchmarks for 6 advanced LS tasks were established. These benchmarks will be included in an advanced laparoscopic surgery curriculum currently under development.

1. Introduction

Over the past two decades, laparoscopic surgery has advanced in both the range of procedures commonly performed and the skills required to perform these procedures safely. Despite these skills demands, many advanced laparoscopic procedures have become routine practice in general surgery. At the conclusion of training, however, the majority of general surgery residents may not be either comfortable or adequately prepared to perform advanced

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laparoscopic procedures. Most residents pursue fellowships, in many cases specifically to hone technical skills relevant to advanced laparoscopic surgery.[1–3]

Although simulation has become an important part of residency training for a number of different procedures and skills, there are many aspects of surgical training for which few, if any, simulation opportunities exist. A comprehensive needs assessment identified a considerable gap between the advanced skills required to perform safe laparoscopic suturing in the operating room and the basic skills targeted by current simulators.[4] A recent survey of Fellowship Council program directors for non-ACGME accredited Minimally Invasive Surgery (MIS) fellowships in Canada and the US reported that 60% of program directors thought that graduates were not proficient in laparoscopic suturing at the beginning of their MIS fellowships.[5]

Laparoscopic suturing is an essential technique required for a wide range of advanced laparoscopic procedures including closure of hiatal defects, peritoneal and mesenteric closure, and bowel anastomosis.[6] It is also needed in order to manage a variety of intraoperative complications. This skill, however, is one of the most challenging for surgical trainees to master. Reasons for this may include variability of suturing techniques, lack of advanced models and training curricula that reflect clinical complexities, and limited trainee exposure to advanced MIS procedures during residency.[7,8]

Several advanced laparoscopic suturing tasks have been developed in the past including synthetic bowel models, virtual reality simulations with motion-based metrics, explanted porcine small intestine models, and live animal models.[6,9,10] These models have several limitations in terms of cost, practical usability, and lack of robust validity evidence to support them as measures of advanced laparoscopic suturing skills. Based on these gaps, and a previous needs assessment, advanced laparoscopic suturing (ALS) skills were identified that are not effectively taught and assessed using current bench-top modules.[11] Subsequently, 6 ALS tasks were developed using inexpensive, readily available materials: needle handling (NH), offset-camera forehand suture (OF), offset-camera backhand suture (OB), confined space suture (CF), suturing under tension (UT), and continuous suturing (CS). Performance metrics of these tasks were shown to have preliminary validity evidence as measures of advanced suturing skills.[4,12]

Proficiency-based training provides an optimal approach for technical skills acquisition by enabling goal-directed practice to pre-determined levels of expertise, leading to uniform skill acquisition by trainees regardless of individual learning curves.[13–15]The purpose of this multicenter study was to determine expert-derived performance benchmarks for the ALS tasks in order to design a proficiency-based advanced laparoscopic surgery curriculum.

2. Methods

This was a multi-institutional prospective study conducted at health care institutions in the United States and Canada and approval from the Institutional Review Boards at all sites was obtained. Experienced laparoscopic surgeons on MIS or Bariatric services at all sites were recruited to perform the ALS tasks. Participants were considered eligible to participate if they performed 25 or more laparoscopic suturing cases per year as responsible faculty surgeon, without the use of a robot or other assist device (such as the endostichTM).

After consent for participation was obtained, all surgeons performed 2 consecutive repetitions of the 6 advanced laparoscopic suturing tasks placed in the FLS trainer box (Limbs & Things, Savannah, GA). All participants performed the Fundamentals of Laparoscopic Surgery (FLS) intra or extra-corporeal suturing task (surgeons' choice) for 1–3 min before testing as a warm up prior to proceeding with ALS tasks. They viewed instructional videos explaining each of the ALS tasks before performing them. After completion of the tasks, participants were asked to complete a questionnaire that solicited demographics, and clinical experience information. The tasks were timed by two raters at each institution, and accuracy was assessed by two raters (Y.W and E.B) at host institution. The inter-rater reliabilities were calculated using a two-way random effects model of intraclass correlation coefficients (ICCs).

2.1. Advanced laparoscopic suturing tasks

The 6 tasks were developed based on a needs assessment study that demonstrated the necessity for simulated advanced suturing tasks. The tasks included needle handling (NH), offset-camera forehand suture (OF), offset-camera backhand suture (OB), confined space suture (CF), suturing under tension (UT), and continuous suturing (CS; Fig. 1).[4,12] In NH, participants pass a needle through six holes of a circle starting from the top right, in a sequential, counter-clockwise fashion. In OF and OB, participants perform forehand and backhand suturing respectively, first a double throw and then two single throws with the camera offset from the standard view. In CF, participants perform forehand suturing in a confined space. In UT, participants perform 3 interrupted sutures to close a wide defect, while they decide on suture length and knot type; they have to have 3 ties for each suture. In CS, participants perform suturing to close a defect in a continuous fashion. These tasks are inexpensive and made using readily available materials. More details on the development of these tasks have been published previously.[4,12]

The tasks are assessed using time and accuracy. Time represents the time taken to complete the tasks and accuracy is measured using predefined penalties for each task. The accuracy scores for each task include: the number of times the needle is dropped outside the field of view (NH); gaps in the closure, the distance of the suture from the pre-marked dots and where the suture is placed, and the security of the knots (OF, OB, CF, UT, CS); and number of skipped dots (CS).

2.2. Development of proficiency benchmarks

The proficiency benchmarks for each task were determined based on the performance of surgeons using time and accuracy (penalty) metrics. Mean performance times and median accuracy scores for all subjects were used. For time, any outliers beyond 2 standard deviations from the mean were excluded. The trimmed mean time was then used as the basis for determining the recommended benchmarks, along with the median accuracy scores.

3. Results

A total of 17 surgeons participated in this study from 7 academic centers in North America. Seventy-six percent were male and 76% had completed an MIS or Bariatric surgery fellowship. The median number of years in practice was 6 (2–15), and 58% reported that they perform over 101 cases per year using intracorporeal suturing without an assist device (Table 1). All of the participants used intracorporeal suturing.

The inter-rater reliability was 0.99. The mean (95% CI) time in seconds to complete each task was: NH 169 (149–189), OF 158 (134–181), OB 189 (154–224), CF 181 (156–205), UT 379 (334–423), and CS 416 (354–477). For the CS task, all of the participants used an intracorporeal suturing technique. For the median accuracy scores; there were no needles dropped outside the field of view for NH, no gaps between sutures for all tasks, knot was secure