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Construct validity of a novel, objective evaluation tool for the basics of open laparotomy training using a simulated model

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ABSTRACT

Background: We describe initial success in designing and implementing an objective evaluation for opening and closing a simulated abdomen.
Methods: (1) An assessment for laparotomy was created using peer-reviewed literature, texts, and the input of academic surgeons nationally; (2) the assessment was evaluated for construct validity, comparing the videotaped performance of laparotomy by surgical experts and novices on a viscoelastic model; and (3) the basics of open laparotomy training (BOLT) curriculum was piloted with junior residents to evaluate efficacy at improving performance.
Results: Experts performed better than novices opening (.94 vs .51; $P < .001$), closing (.85 vs .16; $P < .001$), and overall performance (.88 vs .27; $P < .001$). Novices caused bowel injury more frequently (5 vs 1; $P < .05$) and took longer to open the abdomen (6:06 vs 3:43; $P = .01$). After completing the BOLT curriculum, novices improved for opening (1.00 vs .50; $P = .014$), closing (.80 vs .10; $P = .014$), and overall score (.87 vs .23; $P = .014$).
Conclusions: We demonstrate construct validity of an evaluation tool for simulated laparotomy, and pilot efforts with the BOLT curriculum have shown promise.

1. Introduction

Although most operations performed in the United States are still performed using an open technique,[1] increasing adoption of the minimally invasive approach has resulted in an overall decline in the number of open cases performed.[2–5] Valid, simulation-based curricula exist to teach and assess laparoscopic[6] (Fundamentals of Laparoscopic Surgery), endoscopic[7] (Fundamentals of Endoscopic Surgery), and robotic[8] (Fundamentals of Robotic Skills) surgical skills. However, there is a clear need for validated simulation and assessment of open surgery.

Current methods of open surgical simulation are lacking in comparison with their minimally invasive counterparts (laparoscopic, robotic, and endoscopic surgical simulation). Open surgical simulators are heterogeneous in their design; they are often disparate in the assessment metrics evaluated, and there are few published studies documenting benefit.[9] Laparotomy provides an excellent model whereby the skills of proper instrument choice and use, safe dissection in layers, and tissue reapproximation in a safe and efficient manner can be simulated. Pitfalls in operative technique while opening and closing the abdomen can result in morbid

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complications, such as bowel injury[10] or incisional hernia.[11]

In this study, we describe initial efforts to design and validate an objective assessment tool of the skills required for laparotomy. We have developed and piloted an exportable educational curriculum to teach and assess the cognitive and technical skills required for abdominal entry and closure (basics of open laparotomy training [BOLT]).

2. Methods

2.1. Content validity of the BOLT technical skills assessment tool

To create the BOLT skills assessment tool, we initially reviewed the surgical literature,[12–16] textbooks,[17–20] and atlases[21] to create a comprehensive list of the steps required to safely open and close the abdomen. Then, using an iterative, modified Delphi approach, we surveyed through e-mail attending surgeons from the Philadelphia-area residency programs, the Association for Surgical Education, and the Association for Program Directors in Surgery (APDS). Survey participants were asked to rank the individual elements (n = 70) using a 5-point Likert scale (1 = least important and 5 = most important). Checklist items with a mean score of greater than 4.0 were advanced to the subsequent survey round, whereas all other items were eliminated. At the conclusion of the survey, items were evaluated and classified as cognitive or technical concepts. Cognitive items guided the content of the curricula and creation of the BOLT written multiple-choice question (MCQ) examination, whereas practical steps underwent task analysis to create the BOLT technical skills assessment tool.

2.2. Construct validity of the BOLT assessment tool using a simulated model

To evaluate the construct validity of the BOLT assessment tool, blinded experts (n = 3) rated video recordings of faculty, chief residents, and interns from the Department of Surgery at the Drexel University College of Medicine (DUCOM; Philadelphia, PA) performing a laparotomy on a simulated model (Simulab Corporation, Seattle, WA). To enhance the laparotomy model, an inflated balloon was placed underneath the abdominal wall to simulate a distended loop of bowel located immediately below the peritoneum. To augment the fidelity of the simulation, participants, and surgical assistants were gowned and gloved; the model was covered using a surgical laparotomy drape (Fig. 1). Video recording of the simulated laparotomy was performed using a Cannon Vixia HDR500 camcorder on a 6′ tripod, using a caudal-to-cephalad view of the procedure at a top-down angle of 45°. The camera could be quickly released from the tripod to facilitate additional views or change angles if the view was insufficient. To avoid rater identification of the participants, video footage captured only the laparotomy model and the hands and/or forearms of the operator; audio was also removed postrecording. For each operative step, the consensus of 2

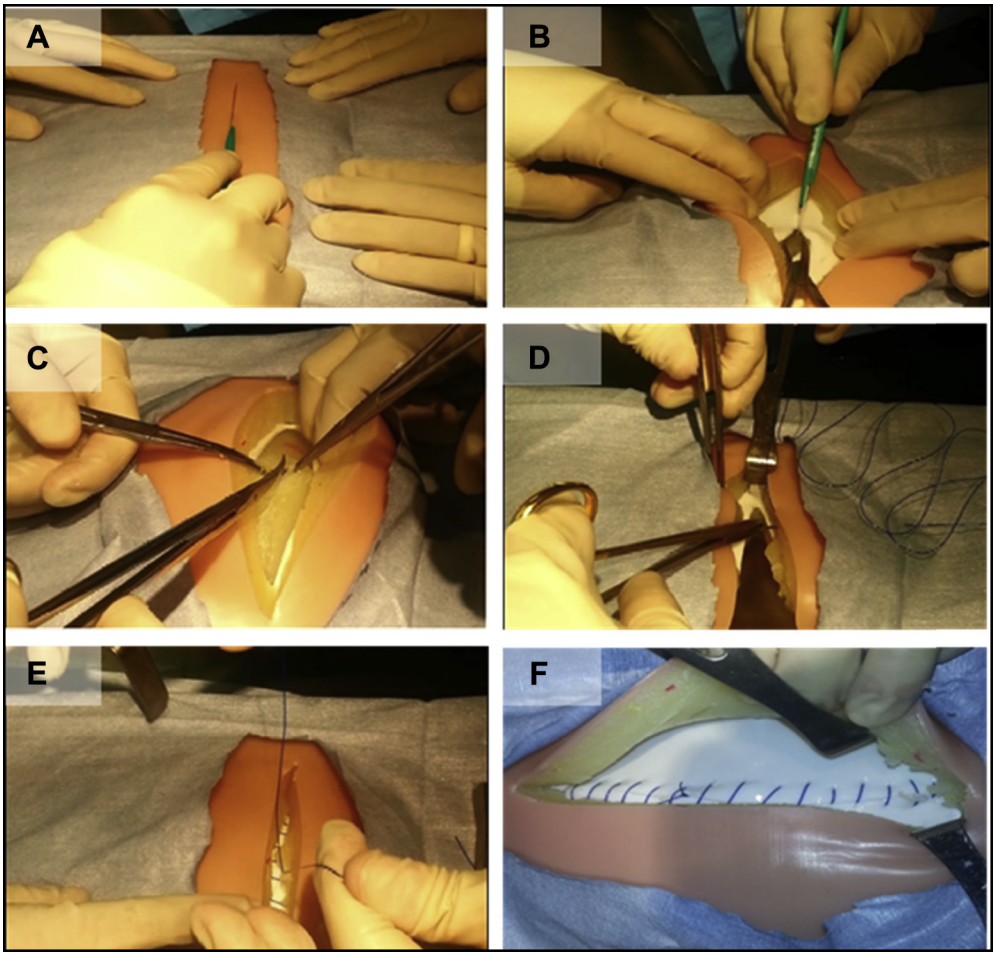

Figure 1. (A–F): Performance of laparotomy on the SIMULAB laparotomy trainer. (A) skin incision, (B) incision on fascia, (C) opening peritoneum, (D) starting fascial closure, (E) completing fascial closure, and (F) completed fascial closure.