

Integration of Hands-On Team Training into Existing Curriculum Improves Both Technical and Nontechnical Skills in Laparoscopic Cholecystectomy

Robert C. Caskey, MD, MSc,^{*,‡} Lily Owei, BA,[‡] Raghavendra Rao, MD,^{*} Elijah W. Riddle, MD,[‡] Ari D. Brooks, MD, FACS,^{*,‡} Daniel T. Dempsey, MD, FACS,[‡] Jon B. Morris, MD, FACS,^{*,‡} Christopher J. Neylan, BA,[‡] Noel N. Williams, MD, FRCSI,^{*,†,‡} and Kristoffel R. Dumon, MD, FACS^{*,†,‡}

^{*}Division of Surgical Education, Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania; [†]Penn Medicine Simulation Center, Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania; and [‡]Department of Surgery, Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania

OBJECTIVE: Nontechnical skills are an essential component of surgical education and a major competency assessed by the ACGME milestones project. However, the optimal way to integrate nontechnical skills training into existing curricula and then objectively evaluate the outcome is still unknown. The aim of this study was to determine the effect laparoscopic team-based task training would have on the nontechnical skills needed for laparoscopic surgery.

DESIGN: 9 PGY-1 residents underwent an established training curriculum for teaching the knowledge and technical skills involved in laparoscopic cholecystectomy. Initial training involved a didactic session, expert-led practice on a porcine model in a simulated operating room and laparoscopic skills practice on a virtual reality trainer. Residents then performed a laparoscopic cholecystectomy on the same porcine model as a preintervention test. Three to four months following this, residents were subjected to specific nontechnical skills training involving 2 simple team-based laparoscopic tasks. They then practiced a further 4 to 6 hours on the virtual reality trainer. A repeat postintervention laparoscopic cholecystectomy was then performed 3 to 4 months after nontechnical skills training. Both the preintervention and postintervention laparoscopic cholecystectomies were audiovisually recorded and then evaluated by 2 independent surgeons in a blinded fashion. Technical

skills were assessed using objective structured assessment of technical skills (OSATS) and a technique specific rating scale (TRS) that we developed for laparoscopic cholecystectomy. Nontechnical skills were assessed using nontechnical skills for surgeons (NOTSS). Residents also completed a survey at the beginning and end of the training.

SETTING: Tertiary care, university based teaching institution.

PARTICIPANTS: A total of 9 general surgery residents at the intern level.

RESULTS: The mean OSATS score improved from 13.7 ± 1.24 to 26.7 ± 0.31 ($p < 0.001$), the mean TRS score improved from 6 ± 0.46 to 13.1 ± 0.36 ($p < 0.001$) and the mean NOTSS score improved from 21.7 ± 1.83 to 36.3 ± 0.87 ($p < 0.001$) following the training. There was a strong correlation between OSATS and NOTSS scores (Pearson's $R = 0.98$) and TRS and NOTSS ($R = 0.94$). The inter-rater agreement was 0.79 for NOTSS, 0.9 for OSATS, and 0.82 for TRS. Following completion of the training, residents self-reported improvements in exchanging information ($p < 0.01$), coordinating activities ($p < 0.01$) and coping with pressure in the operating room ($p < 0.001$).

CONCLUSION: Simple, team-based nontechnical skills training for laparoscopic cholecystectomy that was separate from technical skills training led to a sustained increase in residents' nontechnical skills 3 to 4 months after training. This was associated with a self-reported improvement in many nontechnical skills based on

Correspondence: Inquiries to Kristoffel Dumon, MD, FACS, Penn Clinical Simulation Center, Perelman School of Medicine, University of Pennsylvania, 1800 Lombard Street, 2nd Floor, Philadelphia, PA 19146; e-mail: Kristoffel.dumon@uphs.upenn.edu

resident survey. Based on these results, we recommend that such designated nontechnical skills training is a valid alternative to other methods such as coaching and debriefing. We, therefore, plan to continue our efforts to develop team-based simulation tasks aimed at improving nontechnical skills for multiple surgical modalities. (J Surg Ed ■■■■-■■■. © 2017 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Laparoscopy, Nontechnical skills, NOTSS, OSATS, Cholecystectomy

COMPETENCIES: Communication and Interpersonal Skills

INTRODUCTION

Nontechnical skills such as situational awareness, decision making, communication and teamwork, and leadership have a significant impact on surgical outcomes.¹ At least 90% of major surgical cases have one or more instances of safety compromise.² Management of such complications is the largest source of variation in surgical outcomes among hospitals.³ One study attributed 43% of all surgical errors to breakdowns in communication and teamwork among personnel.⁴ Recognizing the importance of competence in this area, the ACGME have included communication and interpersonal skills as one of its 6 core competencies in surgery residency education. Therefore, a nontechnical skill training has become an important element of surgical training. However, the best way to implement this training and measure its effectiveness remains unclear.

Laparoscopic cholecystectomy is one of the most widely studied surgical procedures in the field of surgical education.⁵⁻⁸ To date, most simulation-based studies of laparoscopic cholecystectomy have focused on individual technical skills acquisition. However, as the successful performance of this operation requires 2 surgeons working closely together, simulated laparoscopic cholecystectomy offers an excellent opportunity to both teach and evaluate the acquisition of nontechnical skills. In the few studies that have focused on the acquisition of nontechnical skills for laparoscopic cholecystectomy, the main interventions found to improve team dynamics were debriefing and coaching.⁹⁻¹² Yule et al.¹⁰ found that there was an improvement in nontechnical skills for surgeons (NOTSS) scores for simulated laparoscopic cholecystectomy using debriefing techniques. Nguyen et al. also demonstrated improvements in nontechnical skills during simulated laparoscopic cholecystectomy through using debriefing techniques based on perioperative and intraoperative checklists.⁹ Another study from the orthopedic surgery literature surprisingly found that while team dynamics improved following team-based training, it was associated with an increase in operative errors, thus further highlighting that the best way to train and evaluate these skills is not fully understood.¹³

We have hypothesized that nontechnical skills training can be incorporated into existing technical skills curricula using simple team-based tasks. Furthermore, since this nontechnical skills training is performed in the same setting in which the skills are ultimately required, such training should lead to improved integration of the nontechnical skills. Indeed, we have previously demonstrated that simple team-based tasks in a simulated operating room (OR) improved both the technical and nontechnical skills required to perform open gastrojejunostomy.¹⁴ However, it is currently unknown if laparoscopic team-based task training will have the same effect on the nontechnical skills needed for laparoscopic surgery. To evaluate this, we integrated 2 simple laparoscopic team-based tasks into our existing simulation curriculum for laparoscopic cholecystectomy. We hypothesized that this would lead to an improvement in the nontechnical skills necessary for performing laparoscopic cholecystectomy.

METHODS

Training Curriculum

Nine postgraduate year 1 surgery residents were enrolled in a modular training curriculum for laparoscopic cholecystectomy. The curriculum included an initial training module, which focused on technical skills training, followed by nontechnical skills training 3 to 4 months later and final evaluation 3 to 4 months after this. All training took place at our established off-site surgical skills laboratory within the University of Pennsylvania Simulation Center.

Initial training consisted of a surgeon led didactic session on biliary disease, which focused on how to safely perform a laparoscopic cholecystectomy. This was followed by a surgeon guided, hands-on performance of laparoscopic cholecystectomy in a simulated OR using a well-established, *ex vivo*, porcine model. Next, residents completed 4 to 6 hours of basic laparoscopic skills training on virtual reality (VR) trainers following the guidelines of a previously developed VR training curriculum for laparoscopic cholecystectomy.¹⁵ As a baseline pretest, an *ex vivo* laparoscopic cholecystectomy was then performed by each resident with an assistant. Three to four months following the initial training, the residents returned to the simulation center to receive separate team-based training intended to improve nontechnical skills. To do this, residents had to complete 2 team-based exercises designed to improve communication and coordination of skills between 2 individuals. The first task involved passing a suture through 2 laparoscopic targets each clamped inside the rings of a ring forceps being held by the assistant (target suturing, Fig. 1A). The second task required residents to laparoscopically cut out a predetermined pattern on a gauze being held by the assistant (pattern cutting, Fig. 1B). This training was conducted in a simulated OR environment using box trainers and standard tools such as a 30° laparoscope and clinical grade

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