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Laparoscopic Training Opportunities in an Emergency Biliary Service

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ABSTRACT

Background and Objectives: Optimizing single-session management of biliary emergencies whilst maximizing laparoscopic training opportunities is challenging. We analyzed training opportunities available in an emergency biliary department and its impact on service provision and patient outcomes.

Methods: A single surgeon's practice of 2049 emergency laparoscopic cholecystectomies and common bile duct explorations was prospectively analyzed. Training involved a modular stepwise approach incorporating access, gallbladder bed dissection, pedicle dissection, intracorporeal tying, and cholangiogram ± common bile duct exploration. Training cases were identified, trainee involvement ascertained, and parameters predictive of a training case were established.

Results: Thirty percent of laparoscopic cholecystectomies were performed in part or completely by trainees, with a training component in 30% of bile duct explorations. Trainee involvement increased mean operating time by approximately 10 minutes. There was no difference in minor (5% vs 5%, $P = .8$) or major complications (1% vs 0.9%, $P = .7$) on trainee versus consultant cases. Postoperative hospital stay was greater in consultant cases (2.87 vs 4.44 days, $P = .0025$).

Multivariate analysis identified predictors of trainee cases including lower age (OR, 1.3; 95% CI, 1.1–1.7), female sex (OR, 1.6; 95% CI, 1.3–2), normal-weight subjects (OR, 1.54; 95% CI, 1.3–1.9), lower difficulty grade (1–2) (OR, 1.8; 95% CI, 1.4–2.2), and American Society of Anesthesiologists score ≤ 2 (OR, 1.8; 95% CI, 1.4–2.4).

Conclusions: Surgical training is possible in a single-session biliary emergency service without significantly impacting theatre utilization times or early patient outcomes. Further dedicated studies will allow individual learning curves to be determined.

Key Words: Difficulty grading; Gallstones; Biliary emergencies; Laparoscopic cholecystectomy; Common bile duct exploration; Laparoscopic training.

INTRODUCTION

There is a growing body of evidence that index admission laparoscopic cholecystectomy (LC), combined with laparoscopic common bile duct exploration (CBDE) when necessary, is the optimal treatment for acute presentations of gallstone disease including cholecystitis, pancreatitis, obstructive jaundice, and biliary pain.[1–3]

Acute biliary admissions have a significant impact on the United Kingdom National Health Service.[4] Therefore, improving training in laparoscopic skills will form an integral component in the management of acute biliary presentations.

Trainee exposure to laparoscopic management of acute biliary presentations should include acquiring skills in intraoperative cholangiography (IOC), transcystic CBDE, and choledochotomy CBDE. It would seem that relatively few units provide such a service and it is unclear what exposure a trainee can expect to receive in each of the aforementioned skill sets. Furthermore, the impact of delivering training in these subspecialist skills on patient outcome and resource utilization needs to be determined.

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The learning curve associated with LC has been well described in previous studies.[5,6] Although the operative case volume in surgery is a key factor for progression of skills, there is also the need for a defined and stepwise learning approach, which has not previously been fully established. In addition, the delivery of optimal outcomes for safe emergency LC mandates an advanced skill set and when compared to elective cholecystectomy. The ideal skillset should include the ability to perform and interpret IOC in all subjects and proceed to successful laparoscopic bile duct exploration, if necessary, while minimizing the open conversion rate, bile duct injuries, and other major complications.

Our institute provides an emergency biliary service with the aim to manage the great majority of patients presenting with acute gallstone disease, who are fit for surgery, definitively in a single session during the index admission. Routine IOC is performed and, if necessary, laparoscopic bile duct exploration is carried out via the transcystic or choledochotomy approach. This provides a regular and wide-ranging exposure to training opportunities in advanced laparoscopic skills.

This study sought to evaluate and quantify the training opportunities available to trainees within an emergency biliary service through the retrospective analysis of a single surgeon's practice between 1992 and 2016. In addition, the impact of training on patient outcome and institutional resource utilization was also evaluated.

METHODS

Data were collected prospectively in paper format and then transferred to an electronic database. Demographics identified were age, sex, emergency or elective cases, and body mass index. Operative data included intraoperative difficulty grading according to the Nassar scale and extent of trainee involvement. Operating time was used as the main surrogate of operating room resource utilization and intraoperative complications (stratified by the Clavien Dindo classification) and hospital stay were used to inform patient outcomes.

The unit operates according to a set protocol. Patients admitted acutely with biliary emergencies including biliary colic, cholecystitis, choledocholithiasis, and gallstone pancreatitis are referred to the biliary service and, if deemed fit for surgery, are considered for index admission LC, IOC, and/or CBDE. The LCs were carried out on the next available theatre slot.

Cases with trainee involvement were identified. The extent of trainee participation in cases and predictors of what constituted a training case were ascertained using univariate tests of association and logistic regression modelling.

The impact of training cases on patient outcomes was also quantified. The primary outcome was the operating time and the secondary outcomes were open conversion, minor and major complications as defined by the Clavien-Dindo classification grades 1–4, and the postoperative hospital stay.

Statistical Analysis

All statistical analysis was carried out using Stata 14 (StataCorp 2015, Stata Statistical Software, Release 14, StataCorp, LLP, College Station, Texas, USA). Univariate tests of association were with χ^2 test for categorical variables and student *t*-test for continuous variables. Multivariate analysis was with binary logistic regression. A significance level was set at 0.05 for all tests.

Operative Technique

LC was performed with routine open cut down access using a modified Hasson technique. For central abdominal scars epigastric entry was used. The mainstay of dissection was performed using a so-called "duckbill" grasper without the use of hook diathermy. Cystic pedicle structures were identified and routine intracorporeal tying of the cystic artery and duct was carried out with 2/0 polysorb sutures. Routine IOC was performed through an incision of the cystic duct. The duct was then cannulated using a 5Fr ureteric catheter within an introducer cannula inserted through the 5-mm subcostal port.[7]

Progression to CBDE using either a trancystic or a choledochotomy approach was based on IOC findings. Trancystic exploration followed a reproducible stepwise process incorporating the deployment of a 5/12 wire Dormia basket inserted through the cholangiography catheter. This Basket in Catheter method has previously been described by the senior author.[8] If stone extraction and bile duct clearance was not achieved using this method, transcystic 3-mm choledochoscopy was carried out. A choledochotomy was performed if indicated by the cholangiogram or if the transcystic approach failed.

Modular Training Algorithm

Trainees were attached to the biliary firm for 6 months duration and comprised trainees of all levels (junior first-year registrars to penultimate-year trainees). All trainees underwent modular training with on-table consultant supervision for all cases. Trainees progressed through stepwise competence in 5 individual components: 1) access and pneumoperitoneum, 2) gallbladder dissection, 3) pedicle dissection and visualization of the critical view of safety when feasible and safe, 4) intracorporeal knot tying of the cystic duct and cystic artery, and 5) cholangiography ± proceeding to bile duct exploration.

Local simulation facilities were available to junior trainees, with box laparoscopic trainers to complement their learning and to practice laparoscopic instrument handling and tying. Trainees who acquired the appropriate skills for the individual steps were able to perform complete cases under supervision. Establishing access and pneumoperitoneum was often the last component to be routinely performed by trainees according to their seniority and experience, especially in patients with central abdominal scars. After demonstrating a level of competence in the 5 components, senior trainees progressed to transcystic or choledochotomy CBDE with or without the assistance of either a 3-mm or 5-mm choledochoscope (**Figure 1**). The consultant was present as a scrubbed supervisor for all procedures in the case series providing continuity in assessment, feedback, and direct observership of all aspects of the overall training experience.

RESULTS

A total of 2049 cholecystectomies for acute biliary presentations were performed during the study period, of which 2030 procedures had full data including difficulty grading status available. The primary clinical presentation modalities were obstructive jaundice/cholangitis (40.3%), acute biliary pain (33.5%), acute cholecystitis (16.9%), and acute pancreatitis (9.3%).

Seventy-two percent (n = 1475) of patients were female and the mean age was 51.9 years (95% CI, 51–53 years); and 18.8% (n = 385) of patients had a body mass index > 30 kg/m^2. Twenty-eight percent (n = 573) of patients had documented previous abdominal surgery. Thirty-five percent (n = 717) of the emergency cases in this series underwent bile duct exploration.

Table 1 shows the breakdown of the preoperative diagnoses leading to acute admissions, as concluded after clinical, laboratory, and radiological data were considered.

Trainee participation was stratified by each modular component of training as a proportion of the total case volume (**Table 2**). Thirty percent of cases had active trainee involvement in performing part of or whole procedures. This included 127/463 transcystic explorations and 50/304 choledochotomy bile duct explorations. **Table 3** highlights how many component modules trainees performed in each case.

Trainees were always greater than postgraduate year 3. Trainees performed components of or whole LC with a range of operative difficulty; 37% of difficulty grade I/II cases and 23% of grade III/IV/V cases according to the Nassar scale.[9]

Operative outcomes parameters were comparable as far as rates of intraoperative events and conversion rates were concerned. This is an advantage of the policy of close supervision and timely intervention in difficult situations. This also reflected on the rates of postoperative complications. As expected there was a slight difference in the operating times between cases operated by the consultant and those operated by trainees. Unadjusted analysis of the operating time demonstrated a mean operating time of 84 minutes (SD, 57 minutes) for cases wholly operated upon by the principal surgeon and 87 minutes (SD, 36 minutes) (P = .22) for a trainee (**Table 4**).

To account for more technically challenging cases, operating times were stratified by the Nassar difficulty grading

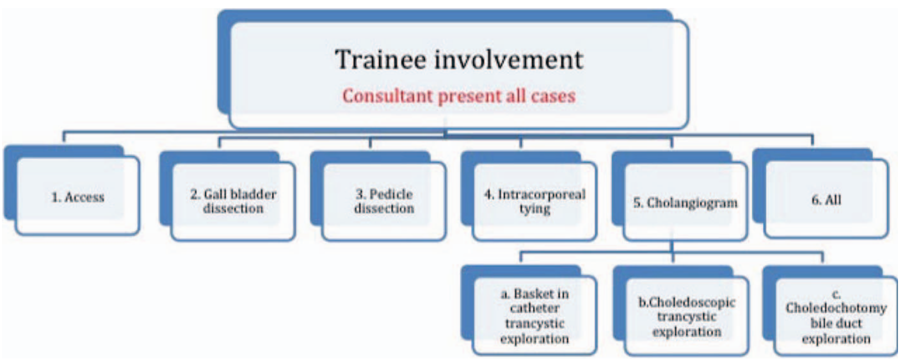

Figure 1. Component training algorithm: **I**, access; **II**, gall bladder dissection; **III**, pedicle dissection; **IV**, intracorporeal tying; **V**, cholangiogram ± CBDE; **VI**, complete case.

Table 1.
Subdivision of Emergency Biliary Presentations and the Propensity for Training

Preoperative Diagnosis	Total Cases (%)	Trainee Case Percentage
Acute biliary pain	1272/2049 (62)	430/1272 (33.8%)
Acute cholecystitis	392/2049 (19)	106/392 (27%)
Acute pancreatitis	339/2049 (16.5)	99/339 (29.2%)
Acute cholangitis	94/2049 (4.6)	15/94 (16%)
Jaundice	797/2049 (38.9)	175/797 (22%)

Table 2.
Components Performed by Trainees

Training Component	Components Performed by Trainee (%)
Gallbladder dissection	18.5
Cholangiogram	15
Pedicle dissection/ties	26
Access/pneumoperitoneum	15
Bile duct exploration	27
Complete case	10

(grading I–II vs III–V). In the Grade I–II cohort (technically easier cases), the mean operating time of the principal surgeon vs trainee was 62 vs 72 minutes ($P < .001$). In the Grade III–V cohort, the mean operating time of the principal surgeon vs trainee was 108 vs 105 minutes ($P < .38$). Hence, overall trainee participation led to a modest increase in the mean operating time of approximately 10 minutes.

Minor complication rates (Clavien Dindo classification 1 or 2) were comparable for principal surgeon versus trainee cases (5% vs 5%, $P = .8$). Rates of major complications were also equivalent (1% vs 0.9%, $P = .7$) for both groups. Postoperative hospital stay was greater in the cohort operated on by the principal surgeon due to the higher percentage of complex cases and those undergoing duct explorations. The open conversion rate for the principal surgeon cases was 0.78% versus no open conversions for trainee cases ($P = .005$).

A logistic regression model of the perioperative parameters predictive of trainee involvement in emergency laparoscopic biliary surgery showed age < 50 years, female gender, nonobese subjects (body mass index < 30 kg/m^2), American Society of Anesthesiologists score of 2 or less and lower difficulty grades to be independent predictive factors (**Table 5**).

DISCUSSION

The learning curve and numbers required to achieve competence in LC have been evaluated extensively.[10–13] From a trainee's perspective, opportunities to perform challenging cases in an emergency scenario consistently can be limited due to the level of expertise required.

In the setting of emergency biliary surgery, it may seem a greater challenge to acquire such experience, especially with many surgical departments favoring conservative treatment for acute biliary admissions. However, studies have demonstrated that emergency biliary surgery can be performed with low morbidity and open conversion rates.[14–17]

Furthermore, when operative parameters of consultants and senior trainees performing acute cholecystectomy were analyzed, open conversion and complication rates were comparable in most studies.[18,19] Our study demonstrates that training in laparoscopic emergency biliary surgery need not compromise safety, conversion rates, and hospital resources if delivered in a modular fashion with direct supervision.

Our study also supports the conclusions of current literature, with trainees being offered significant (30%) involvement in emergency cases and producing comparable outcome parameters to cases performed by consultants. Trainees were performing important components of cases with difficulty grades I and II (37%) as well as more difficult tasks of grades III, IV, and V (23%), thus gaining experience from basic to challenging cases.

The operating time of the principal surgeon and the trainees, performing difficult (grade III–V) cholecystectomies, remained the same, as case selection was based on the individual ability of the trainee. All trainees were exposed to the advanced dissection techniques of emergent cholecystectomy, to routine cholangiography and regular intracorporeal knot tying to secure the cystic duct and cystic artery. Trainees therefore not only performed emergency biliary cases but also developed and consolidated such advanced laparoscopic tasks without compromising outcomes.

The fundamental principle behind gaining competence in LC is performing a high volume of procedures under the supervision of an expert trainer.[20] A well-designed learning curve is equally essential for the acquisition of lapa-

Table 3.
Number of Components Performed by Trainee in Each Case

	1 Training Component	2 Training Components	3 Training Components	4 or More Training Components
Percentage performed by trainee	31% (633/2049)	26% (532/2049)	18% (369/2049)	16.2% (332/2049)

Table 4.
Outcomes of Consultant Versus Trainee Cases

Outcome	Consultant Case	Trainee Case	Statistic
Nassar difficulty, Grade I or II	n = 638/1031 (62%)	n = 393/1031 (38%)	χ^2 $P < .001$
Nassar difficulty, Grade III, VI, or V	n = 769/999 (77%)	n = 230/999 (23%)	χ^2 $P < .001$
Overall operating time	84	87	*t*-test $P = .23$
Minor complications (Clavien 1/2)	5%	5%	χ^2 $P = .8$
Major complications	1%	1%	χ^2 $P = .7$
Postoperative hospital stay (days)	4.44	2.87	*t*-test $P = .0025$
Days spent in hospital (including complications and wait for surgery)	9.1	7	*t*-test $P < .001$

Table 5.
Parameters Predictive of Training Case

Perioperative Predictor Variable of an Emergency Training Case (Logistic Regression Equation n = 2023, LR $\chi = 101.87$, prob $> \chi$ $P < .001$ Pseudo $R^2 = 0.04$)	Odds Ratio of Being an Emergency Training Case (OR with 95% CI)
Younger subjects (age < 50 years)	1.3 (1.1–1.7)
Female sex	1.6 (1.3–2)
Non-obese subjects (BMI < 30 kg/m^2)	1.54 (1.3–1.9)
ASA score 2 or less	1.8 (1.4–2.4)
Nassar difficulty grade 2 or less	1.8 (1.4–2.2)

ASA, American Society of Anesthesiologists.

roscopic skills. We established a modular training algorithm divided into the key components of access, gall bladder dissection, pedicle dissection, intracorporeal ligation of the cystic structures, cholangiography, and complete cases. Senior trainees were able to perform access in cases with central and upper abdominal scars from previous abdominal surgery. Once trainees demonstrated competence in components I–V they were supervised completing whole cases. More advanced trainees progressed to CBDE. They were able to develop and refine the advanced maneuvers of intracorporeal ligation, suturing, and bile duct explorations.

The complication rates of trainee cases and principal surgeon cases were comparable for minor and major complications. This data replicates other studies in vascular, breast, and colorectal cohorts, which have demonstrated no differences in terms of outcome of cases performed by trainees.[21–24]

Some studies have shown significant differences in minor complication rates between consultants and trainees explained by the difference in skills and dissection technique.[5] However, our study showed equal rates (5%) in minor complications.

Serious complications seem to be avoidable in teaching LC when performed under direct supervision. Previous studies demonstrate that major complications, the most significant being bile duct injuries, were due to anatomical variations, scarring, inflammation or poor view rather than reflecting the experience of surgeons.[25] Bile duct injuries can still be encountered by experienced surgeons.[26] While the experience of the surgeon undoubtedly represents a favorable prognostic indicator, many groups have illustrated that senior residents can perform at a level comparable to that of experts, when under supervision for the duration of the procedure.[26–28]

We demonstrated a 10-minute difference in the operating time when trainee procedures were compared to principal surgeon procedures for simpler grade I–II LC and no difference in the operative time for the more complex grade III–V cases. The operative time differential between trainee and principal surgeon is less than that reported in previous series and probably reflects the close on-table supervision by the principal surgeon.[29] As expected, the operative duration of trainees decreased with the number of cases performed.

Open conversion rates range from 2% to 15%.[29,30] The conversion rate in this emergency cholecystectomy series including bile duct explorations was 0.78% in the consultant group, as the consultant performed cases with higher difficulty grading. Any cases requiring open conversion were taken over by the supervising surgeon and a decision to convert would always be taken by him. This also explains the increased hospital stay of consultant vs trainee cases. The consultant performed a much higher percentage of bile duct explorations, which would normally require a longer hospital stay. Our hospital stay included the interval between admission under the care of other consultants, departments or, occasionally, hospitals and referral to the biliary unit. It also included hospital stay during any readmissions resulting from complications or reinterventions. Other studies confirmed the longer hospital stay for cases operated on by trained surgeons compared to those performed by trainees.[18]

A multivariate analysis of the factors linked to a trainee operation has highlighted a number of favorable preoperative demographics. Early trainees should be given the opportunity to operate on younger women with normal body mass index, lower American Society of Anesthesiologists score, and operative difficulty grades I and II. In the era of reduced training hours in Europe, this serves to optimize the training experience.

Our study does have limitations. Individual learning curves of trainees and individual trainee caseloads are not available for interrogation. Furthermore, a large degree of heterogeneity of baseline trainee surgical experience and specifically their laparoscopic skills prior to their commencement of training is likely to be present. This is especially the case when modern trainees are compared to a historical cohort as there has been, in the last decade, more use of simulator training which cannot be directly accounted for in this analysis. Hence, the results incorporate a wide variety of trainee skills that were acquired at previous placements. Inferences on an individual's learning curve in terms of cases required to achieve competence cannot be made. This would be an interesting area for future research.

CONCLUSIONS

Training can be effectively incorporated into an emergency biliary service with a high caseload and can be delivered while maintaining optimal surgical quality outcomes. The delivery of such a service and training model is dependent on the presence of the principal surgeon as a scrubbed supervisor and on consolidating skills in a modular progressive fashion. The exact nature of an individual trainee's learning curve requires further investigation to fully optimize this model of training.

References:

1. Koc B, Karahan S, Adas G, Tutal F, Guven H, Ozsoy A. Comparison of laparoscopic common bile duct exploration and endoscopic retrograde cholangiopancreatography plus laparoscopic cholecystectomy for choledocholithiasis: a prospective randomized study. *Am J Surg.* 2013;206:457–463.

2. Rogers SJ, Cello JP, Horn JK, et al. Prospective randomized trial of LC+LCBDE vs ERCP/S+LC for common bile duct stone disease. *Arch Surg.* 2010;145:28–33.

3. Bansal VK, Misra MC, Rajan K, et al. Single-stage laparoscopic common bile duct exploration and cholecystectomy versus two-stage endoscopic stone extraction followed by laparoscopic cholecystectomy for patients with concomitant gallbladder stones and common bile duct stones: a randomized controlled trial. *Surg Endosc.* 2014;28:875–885.

4. Rossi BW, Bassett E, Martin M, Andrews S, Wajed S. Prompt laparoscopic cholecystectomy would reduce morbidity and save hospital resources. *Ann R Coll Surg Engl.* 2014;96:294–296.

5. Imhof M, Zacherl J, Rais A, Lipovac M, Jakesz R, Fuegger R. Teaching laparoscopic cholecystectomy: Do beginners adversely affect the outcome of the operation? *Eur J Surg.* 2002;168:470–474.

6. Cagir B, Rangraj M, Maffuci L, Herz BL. The learning curve for laparoscopic cholecystectomy. *J Laparoendosc Surg.* 1994;4:419–427.

7. Nassar AH, El Shallaly G, Hamouda AH. Optimising laparoscopic cholangiography time using a simple cannulation technique. *Surg Endosc.* 2009;23:513–517.

8. Qandeel H, Zino S, Hanif Z, Nassar MK, Nassar AH. Basket-in-catheter access for transcystic laparoscopic bile duct exploration: technique and results. *Surg Endosc.* 2016;30:1958–1964.

9. Nassar AHM, Askhar A, Mohamed AY, Hafiz A. Is laparoscopic cholecystectomy possible without video technology. *Minim Invasiv Ther.* 2009;4:63–65.

10. Gigot J, Etienne J, Aerts R, et al. The dramatic reality of biliary tract injury during laparoscopic cholecystectomy. An

anonymous multicentre Belgian survey of 65 patients. *Surg Endosc.* 1997;11:1171–1178.

11. Steele RJ, Marshall K, Lang M, Doran J. Introduction of laparoscopic cholecystectomy in a large teaching hospital: independent audit of the first 3 years. *Br J Surg.* 1995;82:968–971.

12. Koulas SG, Tsimoyiannis J, Koutsourelakis I, et al. Laparoscopic cholecystectomy performed by surgical trainees. *JSLS.* 2006;10:484–487.

13. Jakimowicz J. The European Association for Endoscopic Surgery recommendations for training in laparoscopic surgery. *Ann Chir Gynaecol.* 1994;83:137–141.

14. Lai PB, Kwong KH, Leung KL, et al. Randomized trial of early versus delayed laparoscopic cholecystectomy for acute cholecystitis. *Br J Surg.* 1998;85:764–767.

15. Kolla SB, Aggarwal S, Kumar A, et al. Early versus delayed laparoscopic cholecystectomy for acute cholecystitis: a prospective randomized trial. *Surg Endosc.* 2004;18:1323–1327.

16. Gurusamy KS, Samraj K. Early versus delayed laparoscopic cholecystectomy for acute cholecystitis. *Cochrane Database Sys Rev.* 2006;4:CD005440–CD005440.

17. Lau H, Lo CY, Patil NG, Yuen WK. Early versus delayed-interval laparoscopic cholecystectomy for acute cholecystitis: a metaanalysis. *Surg Endosc.* 2006;20:82–87.

18. Sanjay P, Moore J, Saffouri E, et al. Index laparoscopic cholecystectomy for acute admissions with cholelithiasis provides excellent training opportunities in emergency general surgery. *Surgeon.* 2010;8:127–131.

19. Teoh AYB, Chong CN, Wong J, et al. Routine early laparoscopic cholecystectomy for acute cholecystitis after conclusion of a randomized controlled trial. *Br J Surg.* 2007;94:1128–1132.

20. Pugliese R, Bailey M. Laparoscopic surgery: the need of training centres to spread knowledge. *J Med Person.* 2008;6:160–163.

21. Singh KK, Aitken RJ. Outcome in patients with colorectal cancer managed by surgical trainees. *Br J Surg.* 1999;86:1332–1336.

22. Tytherleigh M, Wheeler J, Birks M, Farouk R. Surgical specialist registrars can safely perform resections for carcinoma of the rectum. *Ann R Coll Surg Eng.* 2002;84:389–392.

23. Naylor AR, Thompson MM, Varty K, et al. Provision of training in carotid surgery does not compromise patient safety. *Br J Surg.* 1998;85:939–942.

24. Moorthy K, Asopa V, Wiggins E, Callam M. Is the reexcision rate higher if breast conservation surgery is performed by surgical trainees? *Am J Surg.* 2004;188:45–48.

25. Archer SB, Brown DW, Smith CD, Branum GD, Hunter JG. Bile duct injury during laparoscopic cholecystectomy: results of a national survey. *Ann Surg.* 2001;234:549–558; discussion 558–559.

26. Calvete J, Sabater L, Camps B, et al. Bile duct injury during laparoscopic cholecystectomy. Myth or reality of the learning curve? *Surg Endosc.* 2000;608–611.

27. Elder S, Kunin J, Chouri H, et al. Safety of laparoscopic cholecystectomy on a teaching service: a prospective trial. *Surg Laparosc Endosc.* 1996;6:218–220.

28. Wilson P, Leese T, Morgan WP, Kelly JF, Brigg JK. Elective laparoscopic cholecystectomy for "all-comers". *Lancet.* 1991; 338:795–797.

29. Pariani D, Fontana S, Zetti G, Cortese F. Laparoscopic cholecystectomy performed by residents: a retrospective study on 569 patients. *Surg Res Pract.* 2014;2014:912143.

30. Simopoulos C, Botaitis S, Polychronidis A, Tripsianis G, Karayiannakis AJ. Risk factors for conversion of laparoscopic cholecystectomy to open cholecystectomy. *Surg Endosc.* 2005; 19:905–909.