

# Senior Residents as Teaching Assistants During Laparoscopic Cholecystectomy in the 80-Hour Workweek Era: Effect on Biliary Injury and Overall Complication Rates

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**PURPOSE:** The resident as teaching assistant (TA) in the operating room is an important role in the maturation of surgical trainees. One concern in the current 80-hour workweek era is that current senior residents (SRs) are unprepared to serve as TAs, potentially leading to higher complication rates and a significant increase in the length of operations. The aim of this study was to analyze whether SRs serving as TAs during laparoscopic cholecystectomy (LC) resulted in an adverse effect on complication rates in the 80-hour workweek era.

**METHODS:** A retrospective review was conducted of 1668 LC performed at 2 affiliated general surgery teaching hospitals from 2003 through 2007. Teaching hospital A was a public teaching hospital where junior residents (JR) performed the LC with a scrubbed SR as TA under faculty supervision. Teaching hospital B was a community-based affiliate hospital where the JR performed LC with only scrubbed faculty supervision. Operative case duration, JR level, patient gender/age, operative indication, final pathology, and complication data were gathered and univariate and multivariate analyses were performed.

**RESULTS:** Despite a higher rate of acute cholecystitis in the TA hospital, LC-associated complications occurred at similar rates with and without SR as TA. The rate of biliary injury was also the same in both hospitals. On multivariable analysis, only male gender was associated with complications (odds ratio = 1.7;  $p = 0.004$ ).

**CONCLUSIONS:** In the 80-hour resident workweek era, SRs acting as TAs during LC is not associated with increased total complications or an increased rate of biliary injury.

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**KEY WORDS:** laparoscopic cholecystectomy teaching

**COMPETENCIES:** Patient Care, Practice-Based Learning and Improvement, Systems-Based Practice

## INTRODUCTION

General surgery residency is a prototypical experiential education model. Although the “see one, do one, teach one” approach is now a rarity, the role of the resident as a teacher continues to be a critical component of a general surgery residents’ education. The duty to teach the more junior housestaff escalates in frequency as residents matriculate through their years in a formal 5-year residency training program.<sup>1</sup> Postgraduate year (PGY-4) and PGY-5 level residents spend considerable time teaching lower-level residents basic operative techniques. Teaching assistant (TA)-level cases must be recorded on the Accreditation Council for Graduate Medical Education (ACGME) operative log website, which further emphasizes their importance in a general surgery curriculum.

As duty-hour restrictions have increased over the last decade, one major concern across all general surgery residencies is the level of preparedness of residents as TAs. Junior residents (JR) who operate less because of these new duty-hour mandates (e.g., 80-hour week and 16-hour intern shift) may have more difficulty teaching in their senior resident (SR) years.<sup>2</sup> Patients may endure longer operative times and may have higher complication rates at the hands of less prepared teaching SRs. The aim of this study was to analyze whether SRs serving as TAs during laparoscopic cholecystectomy (LC) resulted in an adverse effect on complication rates in the 80-hour workweek era.

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## METHODS

A retrospective review was conducted of 1668 LC performed at 2 affiliated teaching hospitals from 2003 through 2007. Teaching hospital A is a public hospital where JR performed the LC with a scrubbed SR as TA under faculty supervision. Faculty were always present to confirm the critical view before clipping the cystic duct and cystic artery. Faculty at teaching hospital A were routinely not scrubbed in the case. Faculty would only scrub at teaching hospital A if the patient required conversion to an open cholecystectomy. Teaching hospital B is a community-based affiliate hospital where the JR performed LC only with scrubbed faculty supervision.

Operative case duration, JR level, patient gender and age, operative indication, final pathology, and complication data were gathered for each case. Cholecystectomy-associated complications included biliary injury, bowel injury, wound infection, wound dehiscence, hernia, *Clostridium difficile* infection, postoperative respiratory compromise (hypoxemia, pneumonia, and severe atelectasis), and retained biliary stones. Biliary complications were categorized into 2 types: common bile duct (or hepatic duct) transection/injury requiring operative repair (e.g., hepaticojejunostomy or T-tube placement) and cystic duct leak requiring biliary stent placement.

The patient and resident data were collected in an Excel database (Microsoft Excel, Microsoft Corporation, Redmond, WA) for each year and translated into native SAS format using DBMS/Copy<sup>®</sup> (Dataflux Corporation, Cary, NC). Statistical analyses were performed using SAS 9.3 (SAS institute Inc, Cary, NC).

Descriptive statistics were evaluated for all variables. As the main outcome measures were not normally distributed, they were reported as medians with interquartile ranges and were compared using the nonparametric Wilcoxon rank sum test;  $p < 0.05$  was considered statistically significant.

## RESULTS

Overall, 1070 LCs were performed at teaching hospital A and 601 LCs were performed at teaching hospital B. During the study time period, residents performed an average of 136.3 LCs during their junior years and an average of 95.4 LCs in their senior years.

The JRs performing the LCs at teaching hospital A were primarily at the PGY 2 level of training (mean PGY level = 2.1). Teaching hospital B residents were on average about 1.5 years further advanced in their training (mean PGY level = 3.7,  $p < 0.0001$ ). Public teaching hospital A cared for patients who were younger and had more acute cholecystitis (Table 1). Both hospitals had an equivalent percentage of male LC patients.

Despite teaching hospital A having a higher rate of acute cholecystitis and conversion to open cholecystectomy, cholecystectomy-associated complications occurred at similar rates in both hospitals (Table 2). A similar rate of common bile/hepatic duct injury and cystic duct stump leak was also seen at both hospitals. The duration of surgery was longer in teaching hospital A. More intraoperative cholangiograms were performed at teaching hospital A. Multivariate analysis demonstrated that only male gender was associated with complications (odds ratio = 1.7;  $p = 0.004$ ).

## DISCUSSION

Senior surgical residents teaching JR surgical techniques is a nationwide educational principle in general surgery residency. With the ACGME-mandated duty-hour reductions, there is considerable concern that SRs would be less experienced and thus less well prepared to take on teaching roles in the operating room. The main finding of the present study was that common bile/hepatic duct injury rates (0.19% vs. 0.17%) were similar for LCs performed by JR with SRs serving as TAs as compared with LCs performed by JR with an attending assisting. Power analysis revealed that 1800 patients were needed to show 0.2% difference in biliary injury rate with a statistically significant  $p$  value of 0.05. Although our study only included 1671 patients, the common bile duct injury rates were so similar across both institutions that we would have needed 18,000 patients to show a statistically significant difference. The common bile/hepatic duct injury and cystic duct stump leak rates reported herein are in line with the current literature rates of 0.1 to 0.4% and 1.0 to 1.5%, respectively.<sup>3,4</sup> The overall complication rates in our large sample size were identical (8.5%). These similar complication rates were observed in spite of the fact that patients in teaching hospital A (with TA) had more advanced biliary disease (57.4% with acute cholecystitis vs. 22% at teaching

TABLE 1. Patient Demographics

	Hospital A (Senior Resident as Teaching Assistant) (N = 1070)	Hospital B (No Senior Resident as Teaching Assistant) (N = 601)	p Value
Mean age (y)	38.7	45.4	$p < 0.0001$
Male gender	20.5%	23.7%	$p = 0.1$
Acute cholecystitis	57.4%	22.0%	$p < 0.0001$
Mean junior resident level	3.7 (95% CI 3.6-3.7)	2.1 (95% CI 2.1-2.2)	$p < 0.0001$

**TABLE 2.** Perioperative Findings

	<b>Hospital A (Resident as Teaching Assistant) (N = 1070)</b>	<b>Hospital B (No Resident as Teaching Assistant) (N = 601)</b>	<b>p Value</b>
Conversion to open cholecystectomy rate	12.9%	0.7%	p < 0.0001
Mean duration of surgery (min)	99.7	51.9	p < 0.0001
Intraoperative cholangiogram	53.7%	17.3%	p < 0.0001
Bile duct injury rate	0.19%	0.17%	p = 0.92
Cystic duct stump leak rate	0.47%	1.0%	p = 0.2
Total complication rate	8.5%	8.5%	p = 1.0
Length of stay (days)	5.0 (95% CI 4.7-5.3)	1.3 (95% CI 1.0-1.6)	p < 0.0001

hospital B). The findings offer assurance that SRs serving as TAs during LCs is safe.

The effect of resident participation in surgical operations is a topic of considerable debate. A recent study by Kiran et al. evaluated whether resident involvement in operations influenced patient morbidity and mortality. Patient mortality was similar in cases with and without resident participation (0.18% vs. 0.20%,  $p = 0.55$ ). The 30-day complications classified as “mild” (4.4% vs. 3.5%,  $p < 0.001$ ) and “surgical” (7% vs. 6.2%,  $p < 0.001$ ) were slightly more prevalent in the resident participation group. There was also a higher rate of superficial surgical site infection (3.0% vs. 2.2%,  $p < 0.001$ ).<sup>5</sup> The authors noted that these complications (“mild” and “surgical” as well as superficial surgical site infections) were all considered non-major and that resident involvement was considered to be safe. However, Tseng et al. showed surgical resident involvement to be deleterious. Surgical resident involvement was associated with increased 30-day morbidity and mortality.<sup>6</sup>

Teaching residents how to perform surgery predictably lengthens the operation. Kiran et al.<sup>5</sup> also noted longer operative times in the resident participation group (80 vs. 97 minutes,  $p < 0.001$ ). Linn et al. studied Northwestern University surgery residents before and after removing its minimally invasive surgery fellowship. The case duration increased when the operative experience was shifted to more junior-level residents; however, patient complications remained unchanged.<sup>7</sup> In the present study, longer operative times were observed in public teaching hospital A, which utilized a SR as a TA. The longer operative times at public teaching hospital A are probably multifactorial. Having a SR serve as a TA likely slows down the operation. The higher rate of acute cholecystitis makes the procedure more challenging and increases the likelihood of conversion to open cholecystectomy. There was significantly increased use of intraoperative cholangiograms. Finally, the JR who performed LCs at hospital A were at a lower mean postgraduate training level. It is worth noting that faculty at hospital A would routinely be present in the room for only the critical view, thus there was little, if any, coaching

from the attending during the dissection. The attending would only scrub if the case required conversion to an open cholecystectomy.

There is ongoing controversy as to whether the surgical resident 80-hour work limit has affected surgical patient outcomes. Kaafarani et al.<sup>8</sup> also showed no change in mortality and morbidity observed-to-expected ratios, before and after the 80-hour workweek implementation. Interestingly, Yaghoubian et al.<sup>9</sup> from our institution demonstrated that the 80-hour workweek was protective with regard to biliary injuries (odds ratio, 0.31;  $p = 0.04$ ). In the present study, hospital stay was significantly longer in teaching hospital A. However, this was likely because of the fact that this hospital is also a very busy acute care surgery and level 1 trauma center, and as such, patients with biliary disease typically wait additional days for operating room availability as more emergent cases take precedence. Our study shows that despite progressive work-hour reductions since 2003, SRs are still well suited for teaching JRs basic laparoscopy in the operating room. Our results further support prior 80-hour workweek literature based on patient outcomes post-work-hour reduction.<sup>10</sup>

Numerous studies have shown that high volume is associated with improved surgical outcomes across numerous procedures. It is conceivable that the favorable outcomes in the present study are a reflection of the high volume of LCs performed by our residents. Graduating general surgery residents across all ACGME-accredited residencies (during the years 2003-2007) performed an average of 77.9 LCs during their PGY 1 to PGY 3 years and 23.9 LCs during their PGY 4 to PGY 5 years.<sup>11</sup> At our institution, our residents during these years had mean totals considerably higher—136.3 LCs during years PGY 1 to PGY 3 and 95.4 LCs during years PGY 4 to 5. These operative numbers certainly may have contributed to our residents’ preparedness and ability to be TAs.

Skill laboratory training may be a useful adjunct for preparing residents to become TAs. As of July 2012, the ACGME Residency Review Committee mandated that skills laboratory training be utilized as an academic tool in all ACGME-accredited general surgery residencies.<sup>12</sup> The utility

of skills laboratory training for minimally invasive surgery has recently been validated. Palter et al. randomized 20 surgical trainees to a structured training and assessment curriculum (STAC) or conventional residency training. STAC included case-based learning, proficiency-based virtual reality training, laparoscopic box training, and operating room participation. The STAC group outperformed the conventional group during the first ( $p = 0.004$ ), second ( $p = 0.036$ ), third ( $p = 0.021$ ), and fourth ( $p = 0.023$ ) LCs in terms of technical performance.<sup>13</sup> It is noteworthy that most of the TA cases in the present study were performed before the initiation of a formal laparoscopic skills training at our institution.

General surgery core curriculum is continuing to evolve. By July 2014, general surgery would have its own ACGME “Milestones Development” program, highlighting the key skills required to create a competent general surgeon.<sup>14</sup> We feel that the resident as a TA continues to play a vital role in the development of a competent general surgeon. It would be intriguing to see whether the milestones include a TA milestone, and what specific skills, if any, will be created to foster the development of a reliable TA.

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