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Changing paradigms in minimally invasive surgery training

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Abstract

BACKGROUND: Realizing the trends toward minimally invasive procedures, the Accreditation Council for Graduate Medical Education (ACGME) increased the requirements for laparoscopic procedures effective 2007 to 2008. Our purpose was to analyze the trend of laparoscopic versus open cases.

METHODS: We analyzed national ACGME general surgery operative log program data for basic and advanced open and laparoscopic procedures performed by graduating surgical residents between academic years 1996 to 1997 and 2009 to 2010.

RESULTS: From 1997 to 2010, the average number of procedures performed by graduating residents increased for appendectomies (36.5 to 59.3), cholecystectomies (90.9 to 112), hernia repairs (58.9 to 67.4), and colectomies (40.1 to 60.2). These increases have been accompanied by decreases in the percentage of open procedures for appendectomies (84% to 30%), cholecystectomies (24% to 9%), hernia repairs (90% to 70%), and colectomies (97% to 71%), which have resulted primarily from a decrease in open procedures (basic) or an increase in laparoscopic procedures (advanced).

CONCLUSIONS: The rising number of laparoscopic procedures performed by surgical residents is associated with a drastic decrease in the number of basic open procedures. Although the number of open procedures is sufficient to meet ACGME requirements for now, this is an area of concern for the adequacy of training in the future.

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The advent of laparoscopy has been one of the most dramatic developments in surgery. Since the first attempt by Dr. Bertram Bernheim (1911) in which a proctoscope was used for resection of pancreatic cancer, 1 the technique of laparoscopy has advanced manifold in its technology and its application in various surgical procedures.

Through improvements such as creating a pneumoperitoneum and improving visualization aids, surgeons were able to apply technology to perform procedures such as appendectomies and cholecystectomies. The first laparoscopic appendectomy was performed in 1980 by a German gynecologist named Kurt Semm. 2 Fascinated by his countryman’s technique, German general surgeon Dr. Erich Mühe 3 performed the first laparoscopic cholecystectomy in 1985. Dr. J. Barry McKernan at the Marietta Surgical Center, Marietta, GA, was the first to perform this procedure in the United States in 1988. 4

Since then, there has been an exponential increase in the number of basic surgical procedures performed
laparoscopically, and today a minimally invasive approach remains the choice for procedures like appendectomy and cholecystectomy (basic procedures). Following this trend, in 2005, the Resident Review Committee in association with the Accreditation Council for Graduate Medical Education (ACGME) increased the required numbers of basic and advanced laparoscopic procedures from 25 and 9 to 60 and 25, respectively, effective with the 2007/2008 academic year. Although this change was intended to ensure adequate training in basic and advanced minimally invasive procedures, there were no specifications for requirements in basic open procedures. Multiple studies have established a steady decrease in the number of open cases logged by surgical residents, more specifically basic procedures. Most recently, Carson et al proved beyond a doubt that even in individual subcategories the number of laparoscopic cases has been steadily increasing over the past 10 years.

The objective of our study was to analyze the trend of required numbers in laparoscopic procedures and compare them with the number of open procedures performed by graduating residents. Our aim was to assess the adequacy of training in laparoscopic and open surgical procedures in an era of minimally invasive surgery, resulting in almost eliminating the surgical resident experience in open procedures.

Methods

A retrospective review of ACGME general surgery operative log program data was performed from academic year 1996/1997 to 2009/2010. The records were analyzed for basic (ie, appendectomy and cholecystectomy) and advanced (ie, hernia repair and colectomy) surgical procedures. We collected data for the average number of open and laparoscopic procedures logged by a graduating surgical resident for a particular procedure nationally. We also examined data on the number of cases performed for the particular procedure nationwide.

Data were compared and plotted for each year. The percent increase or decrease in the number of procedures performed was calculated. The Student’s t test was used to compare the mean of the average yearly totals of the graduating residents for the 3-year periods 1997 to 1999 versus 2008 to 2010. P values <.05 were considered statistically significant.

Results

Basic surgical procedures: appendectomy and cholecystectomy

Laparoscopic versus open appendectomy. The average number of appendectomies logged by graduating surgical residents nationally in 1997 was 36.5 (n = 30.8 open, n = 5.7 laparoscopic), and the number increased to 59.3 in 2010 (n = 17.5 open, n = 41.8 laparoscopic, Fig. 1). When comparing the average yearly totals of the graduating residents for the 3-year periods 1997 to 1999 versus 2008 to 2010, the increase in laparoscopic procedures (P < .001) and the decrease in open procedures (P < .002) were significant. Most (84%) of these cases in 1997 were performed using the open technique (Fig. 2). However, this percentage decreased to around 30% by 2010. This was because of

![Figure 1](Image)
an approximately 7-fold increase in the number of laparoscopic appendectomies and a 43% decrease in the number of open appendectomies.

Laparoscopic versus open cholecystectomy. The average number of cholecystectomies logged by graduating surgical residents nationally in 1997 was 90.9 (n = 21.6 open, n = 69.3 laparoscopic), and the number increased to 112 in 2010 (n = 10.6 open, n = 101.1 laparoscopic). When comparing the average yearly totals of the graduating residents for the 3-year periods 1997 to 1999 versus 2008 to 2010, a significant increase in laparoscopic procedures (P < .001) and a decrease in open procedures (P < .005) were observed. Many (24%) of these cases in 1997 were performed using the open technique, but this percentage decreased to around 9% by 2010. This was because of an approximately 1.5-fold increase in the number of laparoscopic cholecystectomies and a 51% decrease in the number of open cholecystectomies. Overall, the percentage of open cholecystectomies decreased from over 70% in 1993 to 9% in 2010 (data not shown).

**Advanced surgical procedures: hernia repair and colectomy**

Laparoscopic versus open hernia repair. Although the trends for advanced procedures have not been as dramatic, the numbers of laparoscopic hernia repairs and colectomies have steadily increased over the 13-year period. The average number of hernia repairs logged by graduating surgical residents nationally in 1997 was 58.9 (n = 53.3 open, n = 5.6 laparoscopic), and the number increased to 67.4 in 2010 (n = 47.0 open, n = 20.4 laparoscopic, Fig. 1). The increase in laparoscopic procedures was significant when comparing the average yearly totals of the graduating residents for the 3-year periods 1997 to 1999 versus 2008 to 2010 (P < .01); the decrease in open procedures was not significant (P = .72). The majority (90%) of these cases in 1997 were performed using the open technique. However, this percentage decreased to around 70% by 2010. This was because of an approximately 4-fold increase in the number of laparoscopic hernia repairs and a 12% decrease in the number of open hernia repairs.

Laparoscopic versus open colectomies. The average number of colectomies logged by graduating surgical residents nationally in 1997 was 40.1 (n = 39.0 open, n = 1.1 laparoscopic), and the number increased to 60.2 in 2010 (n = 43.0 open, n = 17.2 laparoscopic). The increase in laparoscopic procedures was significant when comparing the average yearly totals of the graduating residents for the 3-year periods 1997 to 1999 versus 2008 to 2010 (P < .001); the increase in open procedures was not significant (P = .08). The majority (97%) of these cases in 1997 were performed using the open technique. However, similar to hernia repairs, this percentage decreased to 71% by 2010. This was because of an approximately 16-fold increase in the number of laparoscopic colectomies and only a 10% increase in the number of open colectomies.

**Comments**

With advancements in laparoscopic technology and increasing experience with minimally invasive procedures, surgeons who had trained before this phenomenon had to learn to use this new technology and familiarize themselves
with laparoscopic techniques and procedures. Therefore, surgical training had to be changed in terms of laparoscopic procedures as required by the ACGME. Many surgeons who had previously used open techniques for basic (eg, cholecystectomies and appendectomies) and advanced procedures (eg, hernia repairs and colectomies) had to learn how to perform these procedures laparoscopically.

Currently, most teaching hospitals have enough qualified and experienced laparoscopic surgeons, and, therefore, residents can obtain laparoscopic training in their residency and perform basic laparoscopic procedures under the supervision of a surgeon. One study showed that laparoscopic cholecystectomies performed by surgeons versus those performed by surgical residents only differed in the amount of time the procedure took (ie, 97 minutes for surgeons vs 119 minutes for residents). The incidence of complications and the postoperative length of stay did not differ significantly whether a surgeon or a surgical resident performed the procedure. Thus, it is not surprising that training in laparoscopic surgery has gained such impetus over the past 25 years.

Recognizing this trend, the ACGME increased the requirements for basic laparoscopic procedures to 60 and advanced laparoscopic procedures to 25 for the 2008 graduating resident. To accommodate this, programs had to introduce various modifications to surgical education. In 1 study, a stable general surgery residency program doubled their graduating chief’s mean number of advanced laparoscopic cases (17.7 vs 35.6) by simply adding a fellowship-trained minimally invasive surgeon to their staff and incorporating an independent minimally invasive service. The American Board of Surgery requires fundamentals of laparoscopic surgery as a prerequisite for applying for board certification.

In 1 survey of 284 general surgery residents, 90% of residents felt that they would be comfortable performing basic laparoscopic procedures, but only 8% felt comfortable performing advanced laparoscopic procedures. In this study, 90% of residents felt that it was the academic surgical department’s responsibility to teach both basic and advanced procedures, but only 35% felt their surgical program was meeting this requirement. Furthermore, only half of the residents felt they could be the primary surgeon, primarily because of limited opportunities with the presence of minimally invasive surgery fellows. Whether surgery fellows hinder surgery residency training is the holy grail of questions; however, the answer is beyond the scope of this article. What it does show is that regardless of the reason, despite feeling comfortable with most basic laparoscopic procedures, most residents feel they receive insufficient laparoscopic procedure training for advanced procedures.

To compound this problem, the classic apprenticeship model of surgical resident training taking place in the operating room is not easily converted to laparoscopic procedures because of ethical, medicolegal, and economic considerations. Simulators are gaining ever-increasing acceptance for laparoscopic surgical training, and there is controversy regarding the amount of training necessary before residents are allowed to perform advanced laparoscopic surgery. Despite the advent of minimally invasive surgery skills training and the increasing trends in laparoscopic cases logged by residents nationally, the survey by Qureshi et al revealed that 47% of respondents felt that there was no standardized minimally invasive surgery curriculum. Despite its globally increasing use, laparoscopic surgery training still warrants further attention in light of the increasing requirements of laparoscopic procedures set forth by the ACGME, especially with regards to decreasing resident work hour limits.

The direct consequence of increasing trends in minimally invasive procedures has been the steady decrease in open procedures performed by surgical residents and therefore decreased training in open cases. Although basic open procedures have reached dramatic lows nationally, the ACGME has not placed attention on maintaining and encouraging adequate training for open procedures. For example, although ACGME has specifications for the required number of basic versus complex laparoscopic procedures (60 vs 25), no such specification exists for open cases. The total number of cases required for graduating from surgical residency is 750, of which 150 cases have to be logged as graduating surgical residents. It is required that 72 of these cases should involve primarily the “alimentary tract”; however, the specific number for open appendectomies or cholecystectomies, which are the most commonly conducted procedures, is not evident.

With so much attention given to simulators in laparoscopic training, could simulators hold the key to open procedure training? Should residents be mandated to rotate in rural or even international settings in which laparoscopic technology is lacking? Currently, residents meet the minimum requirements for basic open procedures, but it is clear from the trend that the numbers will continue to decrease. The downstream effects on patient care and operative outcomes in view of the decreasing numbers of open procedures performed by residents are yet to be determined.

Conclusions

There has been an exponential increase in the number of laparoscopic procedures performed, and the number of basic and advanced procedures logged by residents is steadily increasing. There has also been a commensurate decrease in the number of basic open procedures logged by residents. Thus, there arises an ambiguity in regards to the adequacy of experience in open cases if this trend persists.

Although residents meet the requirements for laparoscopic procedures, it is clear from the trend that the numbers of basic open procedures will decrease further. We suggest that although the ACGME has increased the number of required laparoscopic procedures in light of the
advances in the laparoscopic technique, attention also should be placed on maintaining and encouraging adequate training for basic open procedures by adding a minimal number of open procedures for different surgical procedures.

References


Discussion

Donn M. Schroder, M.D. (Grosse Pointe Shores, MI): You depict a challenge that surgical educators must overcome, but why did you pick 1997 and 2000 as the target dates of your study? I suspect if you went before 1997 you might have even shown a greater trend in this regard. Also, I notice that you note that the overall numbers of operations performed by surgical residents increased over this time period, specifically, a 23% in cholecystectomies per resident and a 63% increase in appendectomies per resident despite a reduction in hours. Finally, what steps have been initiated by your program to cope with decreasing open operative experience?

Vijay K. Mittal, M.D. (Southfield, MI): I thought about it. Question number 1, why we took 7 and 7. When the numbers were increased by the ACGME to get some statistical significance, we wanted to have the same time period, 7 years each. We reviewed the data from 20 years, but for statistical purposes we took only 7 when the number was increased and 7 before the number was increased. Regarding your second question, yes, if you look at what our graduating residents do nationwide because the data are available our graduating residents do only 18% of the total surgical volume nationwide. Hospitals are looking at a consortium model (i.e., consolidation), where programs can exchange residents to get experience for open cases. So I think that may be 1 reason that this number is increasing at a pace that may not be good in the long run for us. Another factor could be all these quality measures, including those from insurance companies which put pressure on the administration because of the financial incentive to get cost-effective and efficient outcome studies. Your third question is kind of sensitive. Yes, the population is increasing. We have only 68 slots added to the whole residency training program nationwide. Can we really do anything to add the data from the Institute of Medicine and other organizations? In 2015, we will be 14,000 general surgeons short. Can we produce in that time? There is no way we will be able to produce nationally another 14,000 to 15,000 general surgeons. I think what is happening now is that this year the ACGME and American College of Surgeons have put in a team of people to look at the development of rural surgery residency. I think that will be upcoming. They have given a period of 2 years to come up with a curriculum, and then I think we might see a new subspecialty popping up such as rural surgery because they will be more concentrated toward the open cases. The last question regarding the approximate timeline of changes in our program is very hard to answer. We want the faculty to be more cognizant of the time needed to convert a laparoscopic procedure to an open procedure. Every week, we review how much time was taken for the laparoscopic portion of an open converted procedure. We suggested to them, if within 15 minutes you do not convert, then there is a problem. We recommend that they should convert the case earlier or perform that procedure by open technique from the beginning. Two more things that we have instituted with the help of my administration are: One, for senior and junior residents, we have implemented a laboratory with a curriculum to perform basic and advanced laparoscopic procedures; and two, the residents also have a curriculum to perform open surgical procedures. Each subspecialty curriculum has a dissection laboratory. Ultimately, the ACGME has to provide some numbers for open procedures that will be minimally required for graduation.