

The Benefits of a Dedicated Minimally Invasive Surgery Program to Academic General Surgery Practice

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In 2001, a dedicated minimally invasive surgery (MIS) program was established at a large university hospital. Changes included improvement and standardization of equipment and instruments, patient care protocols, standardized orders, and staff education. The aim of this study was to evaluate the impact of this program on an academic surgery practice. From January 1999 through October 2003, hospital and departmental databases were reviewed for all records pertaining to general surgery cases. Data trends were analyzed by regression analysis and are expressed as mean \pm SEM. In 1999, 15.0 \pm 0.1% of all general surgery cases were MIS cases compared with 30.2 \pm 0.1% in 2003 ($P < 0.0001$). During this period, the number of patients requiring conversion from a laparoscopic to an open approach decreased from 14.4% to 4.0% ($P = 0.0007$). In 1999, 30% of appendectomies were laparoscopic, compared with 92% in 2003 ($P < 0.0001$). This increase in the rate of laparoscopic appendectomy resulted in a decrease in average length of hospital stay for all patients with acute appendicitis, from 5.5 \pm 1.0 days in 1999 to 2.7 \pm 0.2 days in 2003 ($P < 0.0001$), and a decrease in total hospital cost per case, from \$6569 \pm 400 in 1999 to \$4819 \pm 175 in 2002 ($P < 0.001$). Total operating room time per case for cholecystectomy decreased from 131 \pm 3.7 to 108 \pm 3.2 minutes ($P < 0.0001$), and actual surgery time decreased from 95 \pm 4.1 to 74 \pm 4.0 minutes ($P = 0.0006$). Implementation of a dedicated MIS program resulted in a significant increase in the number of MIS cases and percentage of general surgery cases performed by MIS. This increase in the utilization of MIS resulted in reduced length of stay and cost and has been accompanied by improvements in operating room efficiency. Changes in practice associated with development of an MIS program have had measurable institutional benefits. (J GASTROINTEST SURG 2004;8:869-873) © 2004 The Society for Surgery of the Alimentary Tract

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The introduction of minimally invasive surgical (MIS) techniques to general surgical practice has revolutionized patient care. Although widely accepted as the standard of care in the management of many gastrointestinal disorders, such as gallstone and reflux disease, laparoscopic surgery is often viewed as inefficient and costly compared with open surgery. This perception is based on the acquisition cost of minimally invasive equipment, longer duration of surgery, and increased operating room expenditures. In addition, the introduction of MIS to a hospital requires training of hospital staff and personnel. In an era of limited resources and cost containment, these issues

dampen hospital enthusiasm for introducing new laparoscopic technology and procedures.

Some evidence suggests that a dedicated MIS program provides improved operating room efficiency and surgical volumes compared with MIS performed outside the context of a dedicated program. For example, when comparing laparoscopic cholecystectomy performed by a dedicated MIS team compared with that performed without a trained team, decreased operative time, an improvement in patient care, and decreased costs to the patient have been observed.^{1,2} In the academic environment, the introduction of a full-time director of MIS resulted in a 100%

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increase in laparoscopic surgery volume and an increase in MIS research and training.³

Recognizing the importance of the current and future role of MIA in academic general surgical practice and resident training and the potential benefit to an academic institution in the form of improvements in patient care, a dedicated MIS program was established at a large university hospital in 2001. The aim of this study was to evaluate the impact of this program on an academic surgery practice, including surgical volumes and approaches, operating room efficiency, and cost.

MATERIAL AND METHODS

Under the direction of a fellowship trained faculty member, changes were implemented to standardize and improve the MIS practice of a busy academic general surgery practice at a university hospital. Changes included improvement and standardization of equipment and instruments, patient care protocols, postoperative orders, and staff education. Instrument standardization included acquisition of new, reusable instruments and elimination of disposable instruments. In addition, imaging equipment was updated and made more available by increasing the number of towers. Changes in the surgical management of patients with acute appendicitis and symptomatic gallstones were studied to ascertain the impact of a dedicated MIS program on the practice of common general surgical operations. In addition, trends in the number of advanced laparoscopic gastrointestinal procedures were studied to ascertain the impact of this program on the referral practice within the institution. These index procedures included laparoscopic small bowel, colon, esophageal, stomach, hepatic, pancreatic, adrenal, and spleen surgery. Hospital and departmental databases were reviewed for all records pertaining to general surgery cases performed from January 1999 through October 2003. Data trends were analyzed by regression analysis.

RESULTS

After the introduction of a dedicated MIS program in 2001, a dramatic increase in the number of minimally invasive operations was observed. The average monthly number of minimally invasive general surgery cases increased from 25 in 1999 and 2000 to 61

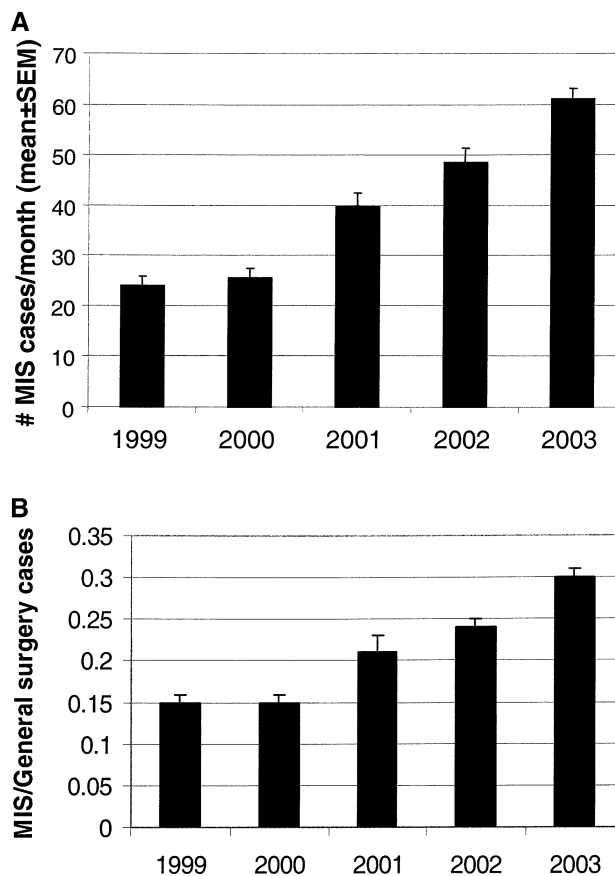


Fig. 1. (A) Average number of minimally invasive surgery (MIS) cases per month by year. (B) Percentage of all general surgery cases done via a minimally invasive approach. Data are given as monthly mean \pm SEM; $P < 0.0001$ by regression analysis.

in 2003 (Fig. 1, A). In addition, the percentage of all general surgery cases performed via a minimally invasive approach increased from 15% in 1999 and 2000 to nearly 30% in 2003 (Fig. 1, B). These trends were statistically significant ($P < 0.001$ by regression analysis).

The impact of the dedicated MIS program on choice of operative approach and conversion rates were analyzed. In the case of appendectomy, a significant increase in the use of the laparoscopic approach was seen after introduction of the program. Thirty-one percent of appendectomies were laparoscopic in 1999. By 2003, 92% were laparoscopic (Fig. 2). This trend was highly significant ($P < 0.0001$). A significant increase in the number of index cases was also observed. In 1999, 37 advanced minimally invasive cases were performed. By 2003, the yearly number of the index cases had significantly increased to 145 per year (Table 1). This increase in the number of advanced laparoscopic cases included increases in the number of commonly performed operations and

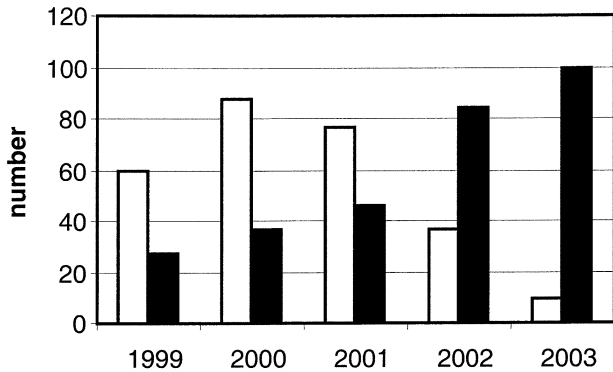


Fig. 2. Number of open (*open*) and laparoscopic (*shaded*) appendectomies by year. $P < 0.0001$ by regression analysis.

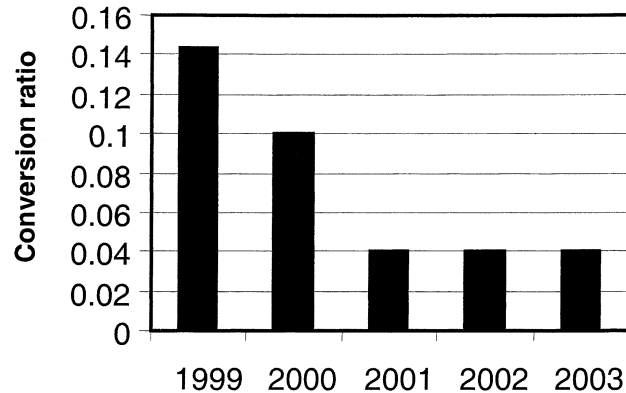


Fig. 3. Ratio of conversion of laparoscopic to open cholecystectomy by year. $P = 0.007$ by regression analysis.

the introduction of operations previously not performed at the institution. For example, the number of laparoscopic antireflux procedures increased more than two-fold from 34 in 1999 to 74 in 2003. Before 2001, all colectomies were open. With the introduction of the MIS program, the number of laparoscopic colectomies increased from 10 in 2002 to 20 in 2003. Similarly, 31 laparoscopic esophageal, hepatic, gastric, and pancreatic operations were performed between fall of 2001 to fall of 2003. During this same period, a significant reduction was observed in the rate of conversion of laparoscopic to open cholecystectomies, from 14.4% in 1999 to 4.0% in 2003 (Fig. 3).

Laparoscopic appendectomy was associated with a shorter length of hospital stay in any given year of the study (Fig. 4). Yearly average length of hospital stay ranged from 1.4 to 2.0 days for laparoscopic appendectomy and 3.2 to 5.5 days for open appendectomy. As the percentage of appendectomies performed by a laparoscopic approach increased between 1999 and 2002, the average length of hospital stay for all patients with acute appendicitis decreased from 5.5 days to 2.7 days ($P < 0.0001$). Similarly, a significant reduction in average total hospital costs for patients with acute appendicitis was observed. The

average total cost was \$6569 in 1999 compared with \$4819 in 2002 (Table 2). Cost data were not available for the calendar year 2003.

Changes implemented with the MIS surgery program included standardization and improvement of instruments and imaging equipment and training of a dedicated nursing and operating room staff. For laparoscopic cholecystectomy, average disposable instrument costs decreased from \$526 to \$119 per case. These changes also resulted in significant improvements in operating room efficiency. A significant reduction in overall operating room time and surgery times was observed. The mean \pm SEM operating room times for patients undergoing laparoscopic cholecystectomy decreased from 131 ± 3.7 minutes in 1999 to 108 ± 3.2 minutes in 2003 (Fig. 4). The mean \pm SEM surgical times decreased from 95 ± 4.1 minutes in 1999 to 74 ± 4.0 minutes in

Table 1. Advanced minimally invasive cases per year

Year	No. of cases
1999	37
2000	37
2001	60
2002	96
2003	145

Advanced minimally invasive surgical cases include esophageal, gastric, colon, small bowel, liver, pancreas, spleen, adrenal.

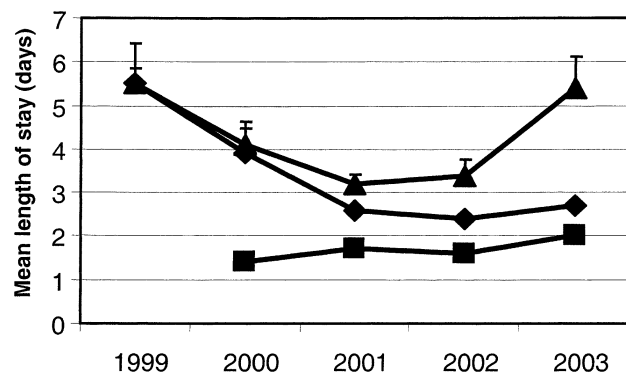


Fig. 4. Average length of hospital stay by year for patients undergoing appendectomy by approach: all patients undergoing appendectomy (diamond line), patients undergoing laparoscopic appendectomy (square line), and patients undergoing open appendectomy (triangle line). Data are given as yearly mean \pm SEM; $P < 0.001$ by regression analysis for all patients.

Table 2. Appendectomy costs by approach

	Mean total hospital costs (\$)		
	All patients*	Laparoscopic	Open
1999	6569	Not Available	6569
2000	5662	3318	5846
2001	4646	4086	4982
2002	4819	4224	6432

Data are yearly mean cost in U.S. dollars.

* $P < 0.001$.

2003. These trends were highly significant ($P < 0.0001$ and $P = 0.006$, respectively) (Fig. 5).

DISCUSSION

In the fall of 2001, a dedicated MIS program was established at a large academic, referral center. Changes instituted under the direction of a fellowship-trained program director included improvement and standardization of equipment and instruments, patient care protocols, standardized postoperative orders, staff education and establishment of a dedicated MIS operating room team, and limited marketing on the part of the hospital and health plan. The implementation of this program has resulted in significant changes to the general surgery practice.

Increases in the number of MIS cases and the percentage of general surgery cases performed via a minimally invasive approach were observed. This was accompanied by an increase in the number of advanced laparoscopic surgery cases not previously performed at the institution. These increases in case volume have previously been reported elsewhere.³ In addition, a significant change in the operative approach to common diseases was observed. At the current time, more than 90% of appendectomies are

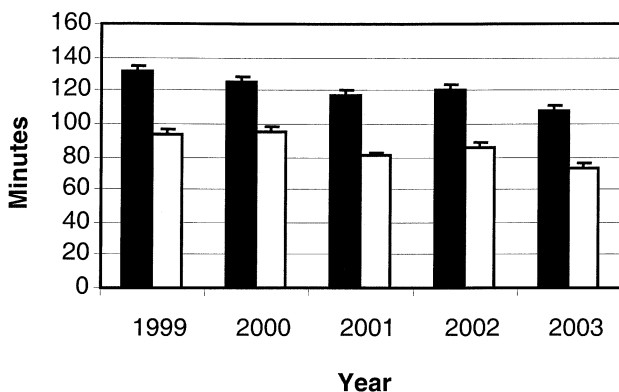


Fig. 5. Mean \pm SEM operating room time (filled bar) and surgery time (open bar) for laparoscopic cholecystectomy by year. Both trends are significantly shorter, $P < 0.001$ by regression analysis.

performed via a laparoscopic approach, whereas less than one third were performed laparoscopically before development of the program. This represents an evolution in surgeon preference, likely in response to improvement in feasibility of laparoscopic appendectomy stemming from improvements in imaging, equipment, and staff training.⁴

The increase in the use of a laparoscopic approach to common diseases such as appendicitis and more complicated advanced minimally invasive operations has also resulted in significant reductions in length of hospital stay and hospital cost. In this study, length of hospital stay was significantly shorter for patients with acute appendicitis treated laparoscopically compared with those treated with an open approach. As the use of laparoscopic appendectomy increased, the overall length of hospital stay for patients with acute appendicitis decreased by 2.8 days, from 5.5 days in 1999, when the majority of appendectomies were open, to 2.7 days in 2003, when most appendectomies were laparoscopic. At our current volume of 140 appendectomies per year, this is a reduction of 392 patient-days per year, creating an opportunity for additional hospital admissions for other conditions. Similarly, a dramatic reduction in the total hospital costs associated with treating patients with acute appendicitis has occurred. Average cost associated with the laparoscopic approach was significantly lower than cost for the open approach. As the percentage of patients treated via a laparoscopic approach increased, overall total hospital costs associated with the treatment of all patients with acute appendicitis decreased an average of \$1750 per patient. This translates into a savings of \$245,000 per year for the institution. Further savings were generated through the use of reusable instruments, the standardization of surgeon preference cards, and the use of patient care protocols.^{5,6}

In addition to savings resulting from decreased length of hospital stay and standardization of instruments, improvements in operating room efficiency and surgery times were observed. Others have reported similar improvements in operating room efficiency.^{1,7} At our institution, a 23-minute reduction in overall operating room time was observed between 1999 and 2003. Most of this time savings resulted from a 21-minute reduction in average surgery times. At a current volume of approximately 350 cholecystectomies per year and an operating room cost of \$17 per minute, this translates into a potential savings of \$136,850 per year. As seen in other studies, we observed an added benefit of a dedicated minimally invasive team in a lower rate of open conversion.^{7,8}

These data may be criticized based on the retrospective and unmatched nature of data collection and comparisons between open and laparoscopic approaches. The purpose of this study was not to compare surgical approaches but rather to provide an analysis of the impact of program development on the overall practice of general surgery at our institution. The increased use of a laparoscopic approach to common diseases like appendicitis and gallstones has resulted in significant reductions in hospital stay and cost to the institution. Similar dramatic savings have been previously reported.^{6,7} In addition, improvements in patient outcomes with lower conversion rates and increased exposure of the surgical trainees to advanced laparoscopic procedures have occurred. At our institution, a dedicated MIS program is an asset and worthwhile investment for the academic surgery department and hospital.

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