Original articles

Surgical Endoscopy
Ultrasound and
Interventional Techniques

Surg Endosc (2000) 14: 16–21
DOI: 10.1007/s004649900003

Laparoscopic vs open surgery

A preliminary comparison of quality-of-life outcomes

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Received: 10 March 1998/Accepted: 2 April 1999

Abstract
Background: The purported advantages of laparoscopic surgery over conventional open techniques are less pain and faster return to normal functional status. Very few studies have included validated measures of quality of life as end points. This study prospectively assessed the health status outcomes of patients undergoing four types of laparoscopic and open operations.
Methods: Preoperatively, patients undergoing elective inguinal hernioplasty, esophageal surgery, cholecystectomy, and splenectomy completed the SF-36, a well-tested, validated health-status instrument. This instrument measures physical functioning (PF), role-physical (RP), role-emotional (RE), bodily pain (BP), vitality (VT), mental health (MH), social functioning (SF), and general health (GH) health status domains. Patients then underwent either laparoscopic or open surgery. Patients were reassessed with the instrument ≥6 weeks after surgery. A total of 100 patients underwent these procedures.
Results: Compared to preoperative values, median SF-36 scores for laparoscopic cholecystectomy patients were improved in the domains of PF (85 vs 95, $p = 0.01$), BP (42 vs 75, $p = 0.002$), and VT (47.5 vs 70, $p = 0.04$); open cholecystectomy patients did not show statistically significant improvements over preoperative values. In addition, laparoscopic cholecystectomy patients had a better score than open cholecystectomy patients in the BP domain (75 vs 41, $p = 0.05$). Laparoscopic esophageal surgery patients had better scores than open surgery patients in the domains of RP (100 vs 0, $p = 0.02$) and VT (65 vs 52.5, $p = 0.05$). Compared to preoperative values, laparoscopic splenectomy patients had an improved score in GH (52 vs 77, $p = 0.02$) and better scores than open splenectomy patients in PF (90 vs 45, $p = 0.05$) and BP (84 vs 55.5, $p = 0.01$). Compared to preoperative values, open mesh hernioplasty patients showed improved scores in PF (70 vs 92.5, $p = 0.03$) and MH (72 vs 84, $p = 0.05$). Laparoscopic hernioplasty did not produce improved scores compared to either preoperative values or open hernioplasty.
Conclusions: Laparoscopic surgery has demonstrably better quality-of-life outcomes than open surgery for cholecystectomy, splenectomy, and esophageal surgery. However, open hernioplasty has at least as good, if not better, health status outcomes than laparoscopic repair.

Key words: Laparoscopic antireflux surgery — Heller myotomy — Splenectomy — Inguinal hernioplasty — Cholecystectomy — Quality of life

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The laparoscopic approach to conventional surgery is a burgeoning area of surgical practice, with new techniques and procedures introduced on a yearly if not monthly basis. This revolution has been fueled by the belief among surgeons, referring physicians, and the general public that laparoscopic procedures are "minimally invasive" and thus entail less pain (compared to traditional open surgery) and lead to a faster recovery. However, although there is a large body of literature concerning the technical success of completing these procedures [2, 10] and some data have been published on pain medication requirements and the relative number of days for hospital stay or return to work, little research has been done on quality of life using standardized, validated measures of health status. Such measures are important if laparoscopic techniques, which are initially more costly in terms of equipment and time, are to be accepted in the long term, particularly by administrators and third-party payers.

The purpose of this study was to evaluate health status outcomes in groups of patients undergoing the same procedures either through a laparoscopic or open approach for the common general surgical procedures of cholecystectomy, splenectomy, inguinal hernioplasty, and esophageal surgery for benign disease.

Materials and methods

Patients and procedures

All patients referred to a single surgeon (V.V.) from July 1, 1996 through June 30, 1997 for surgical evaluation and treatment were included in the study. The patients were evaluated by history and physical examination; further laboratory or radiologic testing was done as deemed necessary for diagnosis or surgical planning. Patients were categorized as follows:

Cholecystectomy group

All patients in this group had symptomatic biliary colic due to cholelithiasis or biliary dyskinesia. Patients with biliary tract malignancies, asymptomatic gallstones, primary choledocholithiasis, postcholecystectomy pain, or primary hepatic disease without biliary colic were not included. Diagnostic criteria were biliary colic, defined as right upper quadrant or epigastric pain, with possible radiation to the right scapula, associated with meals, especially fatty meals, that awakened the patient from sleep; these symptoms were further associated with nausea and vomiting. For a diagnosis of chronic calculus cholecystitis, ultrasound examination of the gallbladder must have demonstrated gallstones. For a diagnosis of biliary dyskinesia, the above symptoms must have been present, ultrasound examination must have shown the gallbladder to be free of stones, and a cholecystokinin (CCK)-hepatobiliary scan must have demonstrated a gallbladder ejection fraction of <35% with associated reproduction of symptoms with the CCK injection.

A total of 30 patients were included in this group. Most cases were planned as a laparoscopic approach. Two cases were planned as open procedures. Of the cases begun as laparoscopic procedures, three were converted to open cases due to adhesions or bleeding causing poor visualization. There were no bile duct injuries or other laparoscopic complications. Laparoscopic cholecystectomy was done thorough a standard four-trocar approach. Open cholecystectomy was done through a right subcostal incision. Cholangiography was done on a selected basis.

Esophageal surgery group

This group consisted of patients with benign esophageal disease referred for nonresectional surgical therapy. The disease processes evaluated were gastroesophageal reflux disease (GERD), paraesophageal hernia (PEH), and achalasia. Patients with esophageal malignancies or those requiring esophageal resection were excluded from this study. After initial history and physical examination, further evaluation included, as deemed necessary, esophageal manometry, 24-h esophageal pH monitoring, esophagogastroduodenoscopy (EGD), and upper gastrointestinal contrast radiography. Indications for surgery for GERD were symptoms consistent with acid reflux, EGD-documented esophagitis, and a hypotensive lower esophageal sphincter. In questionable cases, 24-h pH monitoring was used to document pathologic reflux. The presence of a PEH was considered an indication for surgery, and no other diagnostic testing was done. Indications for surgery for achalasia included lifestyle-limiting dysphagia with a hypertensive lower esophageal sphincter and radiologic evidence of "bird's beaking" of the distal esophagus.

Thirteen patients were surgically treated for GERD, five for PEH, and three for achalasia. Surgical intervention for GERD was always planned as a laparoscopic approach, but one of these patients was converted to open surgery; three of the patients with PEH required open surgery; and one patient with achalasia required conversion to open surgery. Conversions to open surgery were due to poor visualization of the gastroesophageal junction, adhesions that made reducing the PEH difficult, and a mucosal perforation during the laparoscopic Heller myotomy. GERD patients were treated with a standard five-trocar Nissen or Toupet fundoplication, depending on manometry results. Patients with PEH were treated by reduction of the herniated stomach, closure of the hiatal hernia posterior to the esophagus, and Toupet fundoplication to fix the gastric fundus to the hiatus. Achalasia patients were treated via a laparoscopic approach, with a Heller cardiomyotomy, the length of which was controlled by concomitant EGD visualization of the stricture. When the gastroesophageal junction was widely patent, the myotomy was considered adequate, and the operation completed with an anterior Dor fundoplication. There were no complications in any patient that led to long-term sequelae.

Splenectomy

Patients in this group suffered hematologic diseases that failed to respond to medical management. These included eight cases of immune thrombocytopenic purpura, two cases of autoimmune hemolytic anemia, and three cases of hypersplenism due either to chronic lymphocytic leukemia or sickle cell disease. Evaluation included history and physical examination with appropriate documentation; additional imaging with CT scanning was used only in cases of splenomegaly.

Three cases were planned as open procedures through a left subcostal incision due to splenomegaly. The other 10 were begun as laparoscopic cases. Two patients required conversion to open procedures—one due to equipment failure and the other due to poor visualization secondary to thick omentum adherent to the abdominal wall and spleen. These procedures were completed through left subcostal incisions. Laparoscopic splenectomy was accomplished using the "hanged spleen" technique through four or five trocars [5]. Dissection of the splenic attachments and division of the short gastric vessels was done using the harmonic scalpel. The splenic artery and vein were divided with the linear, vascular (2.5-mm staples) endo-stapler. The spleen was placed in a bag and morcelated for removal from the abdomen. There were no operative complications in either the laparoscopic or open groups.

Inguinal hernia

All patients referred for assessment of possible groin hernias were included. Diagnosis was made using history and physical examination. No additional laboratory or imaging testing was required. Only patients with demonstrable groin hernias were included. Patients with incisional, umbilical, epigastric, or other types of ventral hernias were not included in this study.

Patients with first-time unilateral groin hernias underwent planned open mesh hernioplasty using the Lichtenstein technique. Under local anesthesia, a groin incision was made and the inguinal canal entered. If an indirect hernia was found, the sac was excised. A cone of polypropylene mesh was fashioned and then inserted into the internal inguinal ring, deep to the transversalis fascia. The floor was repaired with a large piece of mesh. The mesh was attached using interrupted polypropylene sutures to the inguinal ligament, the lateral border of the rectus abdominis, and the internal oblique aponeurosis. Thirty-one patients were treated with this technique.

Laparoscopic hernioplasty was reserved for patients with either recurrent unilateral or bilateral hernias who were fit for general anesthesia. Laparoscopic hernioplasty was done using the extraperitoneal technique. One 10-mm and two 5-mm trocars were placed in the low midline, and balloon dissection of the preperitoneal space was accomplished. An oval-shaped polypropylene mesh measuring ~8 × 12 cm was placed to cover the entire myopectineal complex and stapled. Care was taken to avoid placing staples inferior to the iliopubic tract laterally or in the vicinity of the femoral vessels. Five patients were treated with this technique. No operative complications were encountered in either group of patients.

A combined total of 100 patients were evaluated and treated for all groups.

Health status assessment

The SF-36 was chosen because it is a well-validated and widely used generic health status instrument. A generic instrument was believed to be better suited to this type of study over a disease-specific instrument because a wide range of disease processes were being evaluated. The SF-36 measures eight domains of health status: physical functioning (PF), role-physical (RP), role-emotional (RE), bodily pain (BP), vitality (VT), mental health (MH), social functioning (SF), and general health (GH). The scores are standardized so that the worst possible score is 0 and the best possible score is 100. Therefore, patients with poorer physical functioning, more bodily pain, more emotional disturbances, and more mental health problems will all have scores that trend toward 0.

Upon initial consultation, patients were asked to complete the SF-36. This will define the *preoperative scores*. They subsequently underwent further evaluation, if needed, and ultimately received surgical therapy. After an initial 1-week postoperative visit, patients were asked to follow up no sooner than 6 weeks from the time of the initial procedure. This time period was chosen because it represents the customary length of time manual laborers are allowed off work after surgery and represents the point in time that wounds are nearly completely healed. All patients completed the follow-up questionnaire between 6 and 9 weeks. This will define the *postoperative scores*. These postoperative scores were then categorized into open and laparoscopic groups. Eight of the 30 cholecystectomy patients, eight of the 21 esophageal patients, none of the splenectomy patients, and 15 of the 36 hernia patients failed to complete the SF-36 postoperatively.

Statistical analysis

Statistical analysis was done using the True Epistat statistical computer program (Epistat Services, Richardson, Texas, USA). Initially, the preoperative and postoperative SF-36 scores were tested for a normal distribution using the Wilk-Shapiro test. It was found that the scores did not conform to a normal distribution; therefore, they were treated as nonparametric data. These data are presented as median with ranges. Tests for significant differences were done using the Mann-Whitney U test. A p value of ≤ 0.05 was considered significant.

Results

Cholecystectomy

Figure 1 presents the median scores for all eight domains of the SF-36 in the cholecystectomy group. Statistically significant improvements were noted between the median preoperative scores and postoperative laparoscopic scores in the domains of PF (85 vs 95, $p < 0.05$), BP (42 vs 75, $p < 0.05$), and VT (47.5 vs 70, $p < 0.05$). This implies that laparoscopic cholecystectomy improved patient-perceived health status in the areas of physical functioning, bodily pain, and vitality. However, no such differences were noted with the postoperative open cholecystectomy group. When comparing the postoperative laparoscopic scores to the open scores, a statistically significant difference was noted in the BP domain (70 vs 41, $p = 0.05$). This implies that patients undergoing laparoscopic cholecystectomy experienced less postoperative pain than patients undergoing open cholecystectomy.

Esophageal surgery

Figure 2 presents the median SF-36 scores for patients undergoing procedures for benign esophageal disease. Compared to preoperative scores, patients in the open group had poorer scores in the domain of RP (100 vs 0, $p < 0.05$). There were no statistically significant differences between scores of the preoperative versus laparoscopic or open postoperative groups. However, the laparoscopic group had statistically significant better scores than to the open surgery group in the domains of PF (90 vs 62.5, $p = 0.05$), RP (100 vs 0, $p = 0.02$), and VT (65 vs. 52.5, $p = 0.05$). This implies that patients undergoing laparoscopic esophageal surgery for GERD, PEH, and achalasia have better health status in the areas of physical functioning, role-physical, and vitality than patients undergoing open esophageal surgery.

Splenectomy

Figure 3 presents the median SF-36 scores for patients requiring splenectomy for treatment of hematologic diseases. Compared to preoperative scores, there was a statistically significant improvement in the domain of MH in the postoperative open group (80 vs 90, $p = 0.02$), and in the domain of GH in the postoperative laparoscopic group (52 vs 77, $p = 0.02$). When comparing laparoscopic splenectomy to open splenectomy, statistically significant better scores were noted in the domains of PF (90 vs 45, $p = 0.05$) and BP (84 vs 55.5, $p = 0.01$). This implies that patients undergoing laparoscopic splenectomy have better postoperative physical functioning and less bodily pain than patients undergoing open splenectomy.

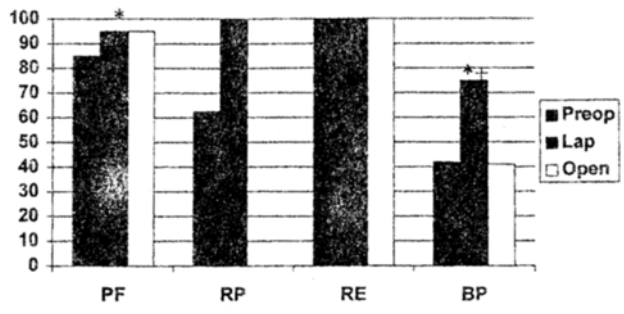
Inguinal hernia repair

Figure 4 presents the median SF-36 scores for patients undergoing repair of groin hernias. Compared to preoperative scores, statistically significant improvements were noted for open mesh hernioplasty in the domains of PF (70 vs 92.5, $p < 0.05$) and MH (72 vs 84, $p = 0.05$). No statistically significant improvements were noted between the preoperative and postoperative laparoscopic group in any domain. In addition, there were no statistically significant differences between the laparoscopic and open hernioplasty group. This finding implies that although open mesh hernioplasty leads to improvements in physical functioning and mental health domains, laparoscopic hernioplasty does not. However, it should be acknowledged that the sample size in this study was small.

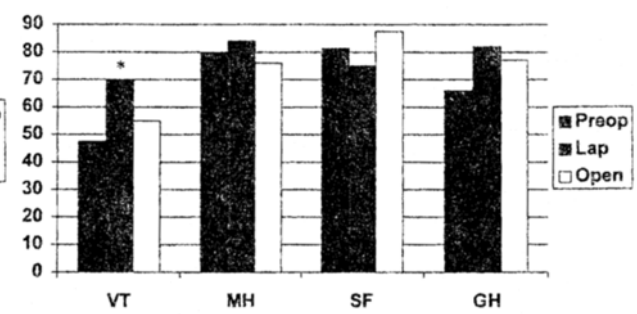
Discussion

This is a preliminary study to determine if the laparoscopic approach to these surgical problems leads to better quality-of-life outcomes than open surgery. Although the sizes of the samples are small, the results indicate that laparoscopic approaches to benign diseases of the upper abdomen does lead to health status outcomes that tend to be superior to open surgical techniques. Moreover, health status in certain domains is improved over preoperative states with laparoscopic surgery. On the other hand, the same cannot be said of laparoscopic hernioplasty. This technique was not demonstrated to have better health status outcomes than open mesh hernioplasty.

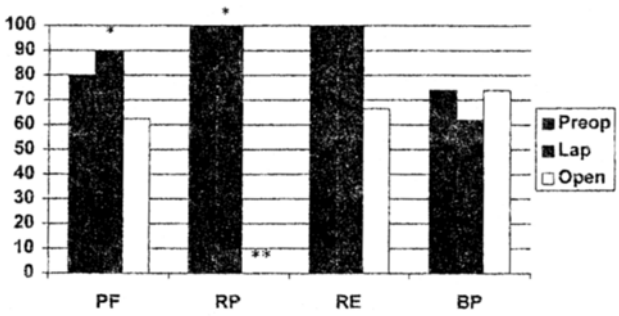
Nevertheless, certain weaknesses of this study need to be addressed. Firstly, this is not a randomized trial. Therefore, potential biases exist. The most important of these is the fact that most of the open cases in the patients requiring upper abdominal surgery were converted from laparoscopic cases. This may imply that these cases were more difficult due to more severe disease processes or that some complication requiring conversion occurred, thereby leading to poorer scores. Most conversions were due to poor visualization, adhesions, or some other technical factor that was



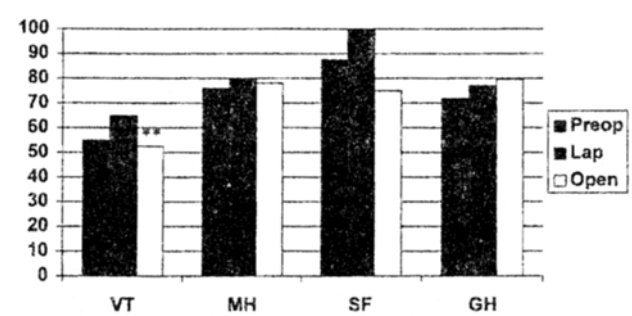
1A * lap v. preop, $p<0.05$; + lap v. open, $p<0.05$



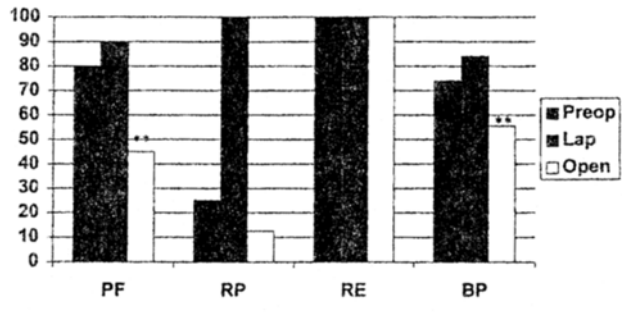
B *lap v. preop, $p<0.05$



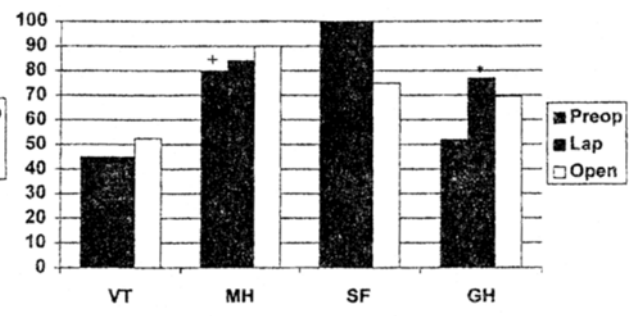
2A lap v. preop, $p<0.05$. **lap v. open, $p<0.05$



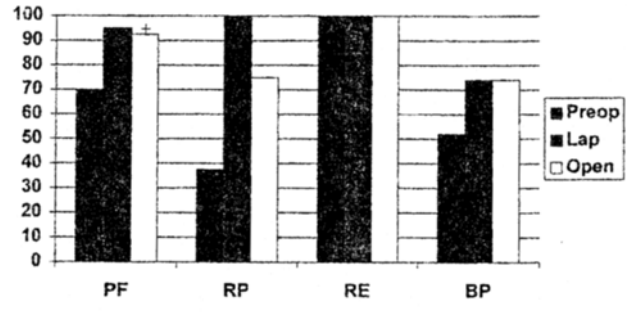
B lap v. open, $p=0.05$



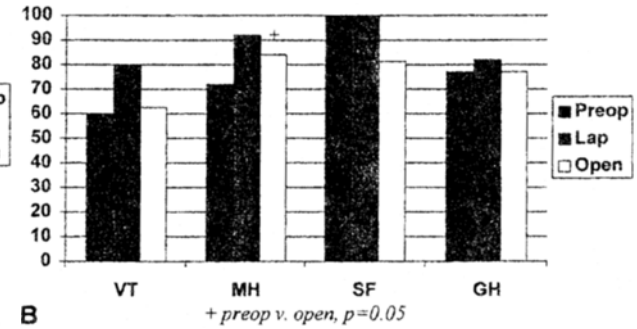
3A **lap v. open, $p\leq0.05$



B + preop v. open, $p<0.05$. *lap v. preop, $p<0.05$



4A + preop v. open, $p<0.05$



B + preop v. open, $p=0.05$

Fig. 1. Median scores of the SF-36 domains for cholecystectomy patients. **A** Physical functioning (PF), role-physical (RP), role-emotional (RE), bodily pain (BP). **B** Vitality (VT), mental health (MH), social functioning (SF), general health (GH). For PF, preop vs lap, $p = 0.01$. For BP, preop vs lap, $p = 0.002$; lap vs open, $p = 0.05$. For VT, preop vs lap, $p = 0.04$. All other comparisons not statistically significant.

Fig. 2. Median scores of the SF-36 domains for esophageal surgery patients. **A** Physical functioning (PF), role-physical (RP), role-emotional (RE), bodily pain (BP). **B** Vitality (VT), mental health (MH), social functioning (SF), general health (GH). For PF, lap vs open, $p = 0.05$. For RP, preop vs open, $p = 0.0004$; lap vs open, $p = 0.02$. For VT, lap vs open, $p = 0.05$. All other comparisons not statistically significant.

Fig. 3. Median scores of the SF-36 domains for splenectomy patients. **A** Physical functioning (PF), role-physical (RP), role-emotional (RE), bodily pain (BP). **B** Vitality (VT), mental health (MH), social functioning (SF), general health (GH) For PF, preop vs open, $p = 0.05$. For BP, lap vs open, $p = 0.01$. For MH, preop vs open, $p = 0.02$. For GH, preop vs lap, $p = 0.02$. All other comparisons not statistically significant.

Fig. 4. Median scores of the SF-36 domains for inguinal hernia patients. **A** Physical functioning (PF), role-physical (RP), role-emotional (RE), bodily pain (BP). **B** Vitality (VT), mental health (MH), social functioning (SF), general health (GH) For PF, preop vs open, $p = 0.03$. For MH, preop vs open, $p = 0.05$. All other comparisons not statistically significant.

believed to make a continued effort at laparoscopy unsafe. No laparoscopic misadventures occurred in the patients reported in this study. Furthermore, preoperative median scores of the SF-36 were similar (i.e., no statistically significant differences) for patients who ultimately required open surgery and those whose surgery was completed laparoscopically. However, in the inguinal hernia repair group, only patients with bilateral or recurrent hernias were offered laparoscopic repair, as compared to the open group who had first-time unilateral hernia. Clearly, a bilateral dissection or a dissection for recurrent hernia is more extensive than a dissection for a first-time hernia. But, once again, the preoperative SF-36 scores between the laparoscopic versus open group were similar, implying that their health statuses were similar.

Second, in patients undergoing upper abdominal surgery, the sample sizes of the open groups were relatively small; similarly, in the inguinal hernia repair group, the sample size of the laparoscopic group was small. This is in keeping with the preliminary nature of this report. Nevertheless, statistical significance was reached in a number of domains, implying that at least for these domains, the sample size was adequate. This result also could imply that if sample sizes were larger, statistical significance could be reached in other domains. Another possibility is that if more data were collected, the differences presently noted would disappear. Only the collection of additional data will answer this criticism.

Regardless of the above flaws, the results of this study do in fact mirror those of other studies comparing open and laparoscopic procedures. These findings will be addressed in turn.

Laparoscopic inguinal hernioplasty

Laparoscopic inguinal hernioplasty has been shown to be safe and effective in the treatment of groin hernias [9]. There is a different spectrum of short-term complications, and the recurrence rates are somewhat higher. Long-term results are not available at present. The question then becomes, Just because it can be done, should it be done?

Assuming that long-term recurrence rates are similar to open hernioplasty (by no means a proven assertion), then the choice of one over the other rests on costs and quality-of-life issues. Although potentially flawed by bias, this study does not support the notion that measurable domains of quality of life are superior with the laparoscopic technique. Other studies have also found this to be true. Goodwin and Traverso [11] found that when compared to an open tension-free mesh repair, laparoscopic hernioplasty had no substantial improvement in outcome but substantially increased costs ($1,340 vs $2,170). In a randomized, prospective study using the standardized health status instrument, the Sickness Impact Profile (SIP), and the visual pain analogue scale, the Pain-O-Meter, Filipi et al. [8] showed "modest" benefit in the SIP for the laparoscopic group and no statistically significant reduction in pain. On the other hand, in a randomized trial of 487 laparoscopic repairs to 507 nonmesh open repairs, Liem et al. [16] concluded that patients who undergo laparoscopic repair recover more rapidly and have fewer recurrences than those who undergo open surgical repair. Given these conflicting data, the meta-analysis of Chung et al. [4] of 13 trials of laparoscopic vs open herniorrhaphy is important. They found that there is an advantage to laparoscopic herniorrhaphy over open, nonmesh, tension repairs; however, this advantage dissappears when the comparison is made with tension-free mesh repairs.

If we accept Traverso's [23] definition of *value = quality/cost*, it appears that for routine unilateral hernias, laparoscopic repair offers no benefit over open mesh repair. However, head-to-head comparisons of bilateral open mesh repairs vs laparoscopic bilateral repairs need to be done to confirm this conclusion.

Laparoscopic esophageal surgery

This area of minimally invasive surgery exploded with the popularization of laparoscopic antireflux procedures. Laparoscopic antireflux procedures (primarily the 360° Nissen fundoplication and 270° Toupet fundoplication) have been shown to be safe and effective in the management of gastroesophageal reflux disease [7, 12]. Symptomatic improvement has been demonstrated by objective symptom severity instruments [25, 26]. Direct comparisons between open and laparoscopic fundoplications have in general demonstrated similar symptomatic and physiologic outcomes [14, 18].

Paraesophageal hernias can also be approached laparoscopically. Some authors have reported great success in repairing these laparoscopically [13, 27], although, in general, the conversion rate to an open technique is higher and the complication rate is greater [24]. The experience reported here supports assertions that these are more difficult repairs, often requiring conversion.

Minimally invasive approaches to esophageal cardiomyotomies for achalasia were initially done thoracoscopically [17], but now are routinely approached laparoscopically [20]. When Ancona et al. [1] compared a group of patients undergoing laparoscopic Heller myotomy with Dor fundoplication to a matched group who underwent open Heller myotomy with Dor fundoplication, they found that laparoscopic management of achalasia led to short-term results comparable to those achieved with open surgery.

This study demonstrates that in the aggregate, patients undergoing laparoscopic repair fared better than those undergoing open repair in the areas of physical functioning, role-physical (i.e., limitations to the patient's normal activities), and vitality. Interestingly, bodily pain scores were similar for all groups. Nevertheless, when taken as a whole, the laparoscopic approach offers the same symptomatic success as open surgery, with better quality-of-life outcomes.

Laparoscopic cholecystectomy

Laparoscopic cholecystectomy was the first laparoscopic procedure to become popularized. However, it has become the standard of care without any trials to demonstrate its superiority over open cholecystectomy—despite a complication rate for bile duct injury that is higher than that for open surgery [6] and a rapid increase in the cholecystectomy rate after its introduction [15]. Laparoscopic cholecys-

tectomy does in fact shorten hospital stay and produce less pain (as measured by narcotic use) than open cholecystectomy [19]. This study confirms that bodily pain scores are better in the laparoscopic group than the open cholecystectomy group. This finding implies that laparoscopic cholecystectomy through the four-trocar technique is indeed less painful than an open cholecystectomy through a right subcostal incision.

Laparoscopic splenectomy

Laparoscopic splenectomy is a safe and effective treatment for hematologic diseases [21, 22]. As compared to open splenectomy, laparoscopic splenectomy was associated with longer operative times but less blood loss, less pain medication, more rapid return to regular diet, and shorter hospital stay [3]. This study also demonstrates better health status for patients undergoing laparoscopic splenectomy rather than open surgery in the domains of physical functioning and bodily pain, implying that the four- or five-trocar technique is less debilitating than the right subcostal incision.

Conclusions

The weaknesses of this study have been acknowledged. Nevertheless, it does have certain strengths. All procedures were done by a single surgeon; therefore, variability in approach and technique is not an issue. All data were prospectively gathered and the questionnaires were completed by the patients, thereby eliminating investigator bias. The health status instrument used is a well-validated, reliable instrument that is designed for and has been used in a wide variety of clinical and research settings; hence, potential data problems with disease-specific or ad hoc instruments are not an issue. Nevertheless, only 69% of patients completed the SF-36; therefore, sample bias is also a potential problem. Although the sample sizes in some groups were small, because statistical significance was reached in many comparisons, the concern about beta error is not great. Lastly, the data presented are supported by other studies in the literature. Therefore, the conclusions reached appear to be justified.

The value of laparoscopic surgery of the upper abdomen appears clear. However, it should be emphasized that these results are for patients who have not had complications from their surgery. If there is any doubt in the mind of the operating surgeon that the laparoscopic procedure can be completed safely, conversion to open surgery is mandatory. On the other hand, minimally invasive approaches to groin hernias do not carry the same quality-of-life benefit. Given the cost of these procedures, their routine use does not appear to be justified.

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