Hypothesis: Laparoscopic management of perforated duodenal ulcers is safe and effective.

Design: Prospective nonrandomized controlled trial.

Setting: Tertiary care academic center.

Patients and Methods: Between October 1993 and October 1997, 30 patients underwent laparoscopic Graham patch repair of perforated duodenal ulcers and 16 had an open repair.

Main Outcome Measures: Morbidity, operating time, analgesic requirements, length of hospital stay, and time to return to work.

Results: There was no difference in morbidity between the 2 groups. Operating time was longer in the laparoscopy group (106 vs 63 minutes; \( P = .001 \)). Patients with shock on admission or symptoms for more than 24 hours had a higher conversion rate (\( P < .05 \)). The laparoscopy group required fewer analgesics, had a shorter stay, and a quicker recovery.

Conclusions: Laparoscopic repair for perforated ulcers is safe and maintains benefits of the minimally invasive approach. Laparoscopy is not beneficial in patients with shock.

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Since the initial reports of successful laparoscopic management of perforated duodenal ulcers using various operative methods,1-4 several larger comparative series have been published confirming the technical feasibility and demonstrating some of the established advantages of the laparoscopic approach.5-11 From these reports, it appears that the main benefits of the laparoscopic repair are decreased postoperative analgesic requirements and diminished trauma to the abdominal wall with its inherent potential complications of wound infection and incisional hernia formation. Other proven advantages of the minimally invasive approach were less evident in these studies because of the presence of sepsis, the systemic effects of which often offset the advantages of the laparoscopic approach.

Despite the appeal of the minimally invasive approach to perforated peptic ulcer, no definitive criteria have been established to select patients who may benefit the most from this approach and those in whom its use may be detrimental. This is particularly true today with the current effective antiulcer medications including Helicobacter pylori eradication regimens, which may obviate the need to perform an additional definitive antiulcer procedure. Furthermore, in analyzing published results, no strict parameters to evaluate outcome measures have been established, thus potentially underestimating the true benefits of laparoscopy in this setting.

The aims of this study were to compare outcome and efficacy of laparoscopic and open surgery for perforated duodenal ulcers, and to define the group of patients who might benefit from the laparoscopic approach.

RESULTS

Patient demographics are summarized in Table 1. There was no difference in age, weight, duration of symptoms, and time to surgery between the groups. Of the 30 patients treated laparoscopically, 6 (20%) were in shock on admission, compared with 4 (25%) in the open surgery group. Sixteen (53%) of the 30 patients in the laparoscopy group had a history suggestive of chronic peptic ulcer disease. Alcohol and cocaine use were similar between the 2 groups.

This article is also available on our Web site: www.ama-assn.org/surgery.
PATIENTS AND METHODS

Between October 1993 and October 1997, 30 patients who underwent laparoscopic omental patch repair for perforated duodenal ulcers at the Los Angeles County-UCLA Medical Center were evaluated prospectively. During the same period, 16 patients had an open procedure. All patients were operated on by residents and assisted by senior attending physicians. The decision to perform laparoscopy or an open repair was left to the discretion of the supervising surgeon, and was dependent on his level of laparoscopic expertise. Patients with shock on admission, defined as a systolic blood pressure less than 80 mm Hg, were not excluded from the laparoscopic approach. All patients received appropriate management of their septic condition, including resuscitative measures for the patients with shock. Postoperative pain assessment included careful monitoring of doses of intramuscular or intravenous analgesics (meperidine hydrochloride, 75 mg). Postoperatively, all patients received triple therapy for eradication of H pylori. Liquid diet was started when bowel sounds were present, and patients were discharged home when they tolerated an oral diet, were afebrile, and had a normal white blood cell count.

A comparison was done between the 2 groups by assessing morbidity and mortality, operative time, amount of analgesics required after surgery, time to return to normal diet, length of hospital stay, and time to return to work. Follow-up endoscopy was done at 6 months and ulcer recurrence was assessed.

OPERATIVE TECHNIQUE

A pneumoperitoneum was created using a Veress needle or a Hassan open technique in the presence of abdominal distention. Insufflation pressure was maintained below 11 mm Hg to minimize the risk of transperitoneal localization of bacteria and endotoxemia. Four ports were inserted: the upper trocar was placed in the subxiphoid area and used for irrigation and suction and/or retraction of the liver. An umbilical port was used for the camera and the 2 remaining working ports were placed on each side of the camera port in a triangulated fashion. The surgeon stands between the legs of the patient, with an assistant on each side. The gallbladder, which usually covers the perforation, was retracted upward and held by the assistant. Inflammatory adhesions were divided using harmonic shears (LCS; Ethicon Endosurgery Inc, Cincinnati, Ohio). This device allows a faster dissection while limiting lateral thermal damage. The exposed area was examined and the perforation identified. For the purpose of the study, the tip of the suction-irrigation tube (3 mm) was used to measure the size of the perforation. The next step was careful and thorough irrigation and suction of all intra-abdominal fluid, requiring about 10 L of isotonic sodium chloride solution mixed with local antibiotics. Each quadrant was cleaned methodically, starting at the right upper quadrant and moving in a clockwise fashion. Special attention was given to the vesicorectal pouch retracting the sigmoid colon and accessing all loculated pelvic spillage. Fibrinous membranes on the small bowel were removed as much as possible without damaging the serosal surfaces.

The perforation was closed using the classic Graham patch technique with the omental patch inserted between 2 or 3 stitches with nonabsorbable sutures (Prolene; Ethicon Inc, Sommerville NJ) before tying the knots intracorporeally. This method was preferred to the technique of suturing the perforation closed and buttressing the repair with an omental patch.

Decision to convert to an open approach was dictated by the patient’s intolerance to carbon dioxide insufflation and consequent hemodynamic instability, and the inability to obtain appropriate laparoscopic closure due to the size of the perforation or the friability of the ulcer edges. No drains were placed at the end of the procedure, and the fascia was closed in all ports. The open repair was conducted through a midline incision and followed the same technical guidelines.

STATISTICAL METHODS

All data are expressed as median and interquartile range unless otherwise stated. Comparison between the 2 groups was made using nonparametric methods (Mann-Whitney test). Comparisons between categorical data were made using a chi² test.

The 2 groups were categorized based on an intention-to-treat basis. Thus, patients in the laparoscopy group who were converted to an open procedure remained in the laparoscopy group for the statistical comparisons. $P<.05$ was considered statistically significant.

The median operating time of the laparoscopic patch repair was significantly longer than the open procedure (106 minutes [range, 76-122] vs 63 minutes [range, 51-86]; $P = .001$). Five (17%) patients in the laparoscopy group underwent conversion to an open procedure. The reasons for conversion were large perforations (diameter $>6$ mm) precluding safe laparoscopic closure in 3 patients and cardiovascular instability in the remaining 2 patients.

Of the 6 patients in the laparoscopy group who presented with shock on admission, 3 underwent conversion, as opposed to only 2 conversions of the 24 patients without evidence of shock on admission ($P = .04$). No patients with symptoms for less than 24 hours underwent conversion ($n = 15$), as opposed to 15 patients who had symptoms for more than 24 hours, 5 of whom underwent conversion (33%; $P = .01$).

The postoperative complications are summarized in Table 2. There was no difference in morbidity between the laparoscopy and open surgery groups (6 of 30 patients vs 5 of 16 patients; $P = .09$). One death occurred in each group.

The operative analgesic requirements were significantly less in the laparoscopy group compared with the open surgery group (3 doses [range, 2-7] vs 9 doses [range, 7-11]; $P = .002$). Time to return to a normal diet was also significantly shorter in the laparoscopy group (3 days [range, 1-4] vs 5 days [range, 4-7]; $P < .001$). This was also reflected in the median length of hospital stay that was significantly shorter in the laparoscopy group (3 days [range, 3-7]) compared with the open surgery group (8 days [range, 6-10]) ($P = .003$). The time to return to work in the patients in the laparoscopy group (21 days [range, 846

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The widespread use of histamine₂ (H₂)–receptor blockers, proton pump inhibitors, and, more recently, effective treatment protocols for eradication of H pylori, have reduced the surgeon’s role in the elective treatment of peptic ulcer disease. The frequency of complicated ulcer disease requiring surgery has not changed, and the incidence of perforated ulcers is still about 5% of all duodenal ulcers and may be rising with the increased use of nonsteroidal anti-inflammatory drugs in elderly women.12 With the advancement of laparoscopic techniques, the feasibility and safety of laparoscopic closure of perforated ulcers has been shown in several large series.6,10,11

### Table 1. Patient Demographics*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Laparoscopy Group (n = 30)</th>
<th>Open Surgery Group (n = 16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>42 (31-45)</td>
<td>39 (29-47)</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>71.5 (67.5-80.5)</td>
<td>70.5 (60.0-80.2)</td>
</tr>
<tr>
<td>Duration of symptoms, h</td>
<td>22 (12-33)</td>
<td>27 (12-31)</td>
</tr>
<tr>
<td>WBO on admission, ×10⁹/L</td>
<td>12 (10-17)</td>
<td>13 (10-15)</td>
</tr>
<tr>
<td>Alcohol use</td>
<td>10 (33)</td>
<td>4 (25)</td>
</tr>
<tr>
<td>Cocaine use</td>
<td>10 (33)</td>
<td>6 (38)</td>
</tr>
<tr>
<td>Time to surgery, h</td>
<td>3 (2-4)</td>
<td>4 (2-8)</td>
</tr>
<tr>
<td>Shock on admission</td>
<td>6 (20)</td>
<td>4 (25)</td>
</tr>
</tbody>
</table>

* Data are given as median (interquartile range) or number (percentage). There were no significant differences between groups. WBC indicates white blood cell count.

### Table 2. Postoperative Complications*

<table>
<thead>
<tr>
<th>Complication</th>
<th>Laparoscopy Group (n = 30)</th>
<th>Open Surgery Group (n = 16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound infection</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Intra-abdominal abscess</td>
<td>2*</td>
<td>1*</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Prolonged ileus</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Death</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>7 (23%)</td>
<td>6 (38%)</td>
</tr>
</tbody>
</table>

* Indicating 1 reoperation.

18-27]) was also significantly shorter than that in the open surgery group (30 days [range, 27-38]) (P = .001).

Outcome of patients with shock on admission treated laparoscopically was considerably worse than those without shock (Table 3). Not only was the conversion rate higher, but the rate of complications, length of hospital stay, and time to return to work were all significantly higher. The rate of complications in patients with shock on admission in the open surgery group was also significantly higher than in patients without shock (Table 4). Both deaths occurred in patients who presented with shock.

A follow-up endoscopy at 6 months was performed in 13 patients from the laparoscopy group and in 7 patients from the open surgery group. A recurrent ulcer was documented in only 1 patient in the open surgery group.

### Table 3. Results as Related to Shock on Admission for Laparoscopy Group*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No Shock (n = 24)</th>
<th>Shock (n = 6)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>35 (29-44)</td>
<td>44 (23-59)</td>
<td>.68</td>
</tr>
<tr>
<td>WBO on admission, ×10⁹/L</td>
<td>12.5 (10.0-14.0)</td>
<td>17.5 (10.0-25.0)</td>
<td>.26</td>
</tr>
<tr>
<td>Duration of symptoms, h</td>
<td>27 (12-30)</td>
<td>32 (11-86)</td>
<td>.68</td>
</tr>
<tr>
<td>Time to surgery, h</td>
<td>5 (3-10)</td>
<td>2</td>
<td>.004</td>
</tr>
<tr>
<td>OR time, min</td>
<td>64 (53-97)</td>
<td>59 (38-81)</td>
<td>.26</td>
</tr>
<tr>
<td>Length of stay, d</td>
<td>7 (6-10)</td>
<td>11 (9-13)</td>
<td>.68</td>
</tr>
<tr>
<td>Return to work, d</td>
<td>28 (27-35)</td>
<td>43 (38-48)</td>
<td>.09</td>
</tr>
<tr>
<td>Complications</td>
<td>2 (17)</td>
<td>4 (100)</td>
<td>.02</td>
</tr>
</tbody>
</table>

* Data are given as median (interquartile range) or number (percentage). WBC indicates white blood cell count; OR, operating room.

There are several potential advantages to the minimally invasive approach. Simple patch closure of the perforation can be accomplished relatively easily laparoscopically and is probably a sufficient treatment. Following simple closure and postoperative treatment with H₂-receptor blockers, less than 20% of the patients will require subsequent definitive ulcer surgery. Furthermore, Sebastian et al13 and Tokunaga et al14 demonstrated that in more than 83% to 90% of patients with perforated ulcers, H pylori infection is present. The addition of anti–H pylori treatment postoperatively may even further reduce the number of patients who might require an acid-reducing procedure. The routine addition of an antifulcer procedure such as parietal cell vagotomy as recommended by Jordan and Thornby15 is therefore probably not necessary and might lead to a prolonged operation in gravely ill patients.

Simple laparoscopic patch closure is also an adequate treatment in perforations not associated with acid hypersecretion, as is the case in patients with crack cocaine–induced perforated ulcers and ulcers secondary to use of nonsteroidal anti-inflammatory drugs.16

The laparoscopic approach offers advantages demonstrated in other well-established procedures. In contrast to published data where the main benefit of the laparoscopic repair was decreased postoperative analgesic requirements,5,11 we have demonstrated additional significant advantages: quicker resumption of oral intake, shorter hospital stay, and quicker return to work. This difference may reside in the younger age of our patient...
population compared with the older age group in other series. In addition, we have used strict criteria in defining the stages of postoperative recuperation, whereas in other series the postoperative course was less defined, and in many cases prolonged because of social and nursing problems leading to a mean hospital stay of up to 17 days in one series.\(^9\)

Moreover, the minimally invasive approach has the considerable advantages of diminished trauma to the abdominal wall and improved cosmesis. Large abdominal incisions in the face of peritonitis carry a significant risk of wound infection and postoperative incisional hernias in up to 15% of cases.\(^17\)

An added benefit of laparoscopy is its diagnostic value. Proponents of selective nonoperative management of perforated ulcers by demonstrating the absence of gastrointestinal leakage on a gastrografin swallow test and showing improvement on serial physical examinations do still not address the problem of possible erroneous diagnosis.\(^12,18,19\) Performing a routine laparoscopy as the initial step in managing patients with a suspected perforated ulcer has the advantage of identifying an occasional abnormality. In addition, laparoscopy enables one to perform a thorough cleansing of the abdominal cavity thus decreasing the risk of developing intra-abdominal abscesses, which, as reported by Crofts et al,\(^16\) occurred in 15% of patients treated conservatively.

A disadvantage of the laparoscopic approach is a longer operating time, but this had no effect on the overall results. Some authors were able to shorten the operating time by using sutureless techniques to close the perforation with the use of a gelatin plug and application of fibrin sealant (Tisseel; Baxter Immuno, Deerfield, Ill).\(^4,5\)

We think that this method is elegant and can be added to the surgical armamentarium.

A major concern is the effect of high-pressure insufflation in the face of peritonitis and possible endotoxemia and bacterial translocation through peritoneal surfaces into the bloodstream. Experimental work done in pigs with gastric perforation and peritonitis has shown no difference in mortality between laparoscopic and open repair if surgery was performed less than 12 hours from perforation. After 12 hours, the incidence of bacteremia and endotoxemia was significantly higher in the laparoscopy group.\(^20\) Lau et al,\(^21\) examining acute-phase response markers and endotoxemia in patients with perforated ulcers receiving laparoscopic repair, found no difference in these parameters compared with patients who had open repair. It appears that if the laparoscopic repair is performed relatively early following perforation and insufflation pressures are kept at low levels, the risk from bacterial translocation and endotoxemia is not significant.

In analyzing our results, we found 2 clinical parameters that may preclude safe laparoscopic repair of perforated ulcers—shock and symptom duration more than 24 hours. Patients who presented with evidence of shock and were treated laparoscopically had a high conversion rate and a significantly worse postoperative course than patients without shock on admission. In this clinical situation, a laparoscopic approach that has a high likelihood of failure should not be attempted, and the patient should have an expedient open repair. Patients with symptoms for more than 24 hours represent another group where laparoscopy may be attempted with a high risk of conversion to an open procedure. These risk factors are consistent with the operative risk factors in perforated duodenal ulcers defined by Boey et al.\(^22\)

In conclusion, despite the limitation of a nonrandomized trial, our study shows that laparoscopic repair of perforated duodenal ulcers is safe and carries many of the established advantages of minimally invasive techniques. Nevertheless, it should be used selectively, reserving the traditional open approach for patients presenting with shock on admission. Patients with symptoms for more than 24 hours have a higher chance of conversion to an open technique.

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REFERENCES

DISCUSSION

Edward H. Phillips, MD, Los Angeles, Calif: Virtually every major treatment for perforated ulcer has been studied at LA County–USC Medical Center, from definitive therapy to nonoperation for patients in whom the ulcer has sealed. Now, with recognition of the role of *H pylori* in its pathophysiology and the application of laparoscopy, a new therapy is under investigation at the very center that has already taught us so much. The authors have compared laparoscopic with open omental patch closure of perforated duodenal ulcers and found that patients who were treated laparoscopically resumed oral diets and left the hospital sooner than patients with open procedures. A subset of patients who were in shock on admission had longer hospitalizations, more complications, and more conversions to open operations following attempted laparoscopic repair. Their data show that laparoscopic omental patch repair of perforated ulcers is feasible in skilled hands and has a superior outcome.

I have several questions for the authors. First, treatment protocols for perforated ulcer have always been stratified based upon the presence or absence of shock. Your patients in shock were operated on significantly earlier than those not in shock, with worse outcome. Might they have done better after a longer period of resuscitation, particularly in the laparoscopic group, where abdominal insufflation exacerbates hemodynamic abnormalities? What are your resuscitation protocols? Were the outcomes of laparoscopic, converted, and open techniques in just shock patients compared?

I was impressed that laparoscopic patients were fed on average 3 days after operation. I’ve never been accused of being timid when it comes to laparoscopy, and these experiences have taught me that we can feed patients sooner than we thought. What’s your protocol for oral alimentation? Were nasogastric tubes used? Also, what diagnostic studies were performed preoperatively to see if the ulcer was sealed already, such as a Hypeaque upper GI [gastrointestinal study]? Finally, there is considerable opinion today that simple patch closure is not optimal therapy for chronic ulcer disease, as was the case in 53% of your laparoscopic group. While the emergency general surgeon inside of us may wish to just close the perforation and get back to bed, the foregut surgeon in us says that stable patients should be treated with ulcer closure and parietal cell vagotomy (PGV). Does this mean that the current residents will agree when I say that their faculty is clear evidence that laparoscopic technique, in particular, cirrhosis, advanced cardiac disease, and so forth, were those patients in the laparoscopic group, and those patients were not included in this study.

Second, was there a relationship between the outcome of the operation and the results of cultures of abdominal fluid taken during the laparoscopy?

John Payne, MD, Honolulu, Hawaii: This is a good approach. In your comments on the learning curve and the duration that it takes to do this operation did you notice a difference as you stratified your patients between your first 10, your second 10, and your most recent patients, if there was a difference in the time of the operation?

Carlos A. Pellegrini, MD, Seattle, Wash: You looked at length of stay and you looked at consumption of analgesics. Are these populations matched enough to compare them? For example, the patients who were excluded from the laparoscopic technique, in particular, cirrhosis, advanced cardiac disease, and so forth, were those patients in the laparoscopic group, and those patients were not included in this study.

James J. Peck, MD, Portland, Ore: Do these patients have nasogastric tubes, or do they not? If at the time of surgery you find a callus or evidence of chronic peptic ulcer disease, is that an indication to open or to do the laparoscopic parietal cell procedure?

Karen E. Devenev, MD, Portland: Was the length of stay equivalency possibly due to duration of use of intravenous antibiotics, or what was responsible for that fairly long length of stay in the group repaired laparoscopically?

Bruce E. Stabile, MD, Torrance, Calif: Dr Katkhouda, I am not clear whether there was a bias in the selection of patients. Could you tell us whether it was surgeons’ preference whether the patient had an open operation, or were some surgeons doing only laparoscopic and others doing only open operation?

Dr Berne: To get right to the questions, Dr Phillips pointed out the fact that the patients in shock got to the operating room earlier than the stable patients. He wondered if a longer period of resuscitation wouldn’t have been better for them. The patients in this series were all basically resuscitated to the same end points, that is, slowing of the pulse, good blood pressure, and good urine output. They went to the operating room when we thought that they were resuscitated, and this was done rather quickly. The difference in the time to the operating room is that the sicker patients in our operating room triage system tend to get to the operating room earlier than stable patients.

The next question was about the protocol regarding feeding and the use of nasogastric tubes. I have to say that does seem worrisome, but in the laparoscopic era we have gotten used to giving people food earlier on than we used to. It just doesn’t seem to cause much trouble. Somebody else asked about the leak rate: we did not experience leaks in either group.

Dr Phillips also asked about the use of water-soluble upper GI studies. When he was a resident we felt strongly about the use of water-soluble upper GIs to select patients with perforated ulcer disease for nonoperative management. Today there is clear evidence that *Helicobacter* infection is the major cause. As many as 93% of patients with perforated ulcers can be demonstrated as harboring *Helicobacter*. Now we only use water-soluble GIs in situations where there is a patient who we don’t want to operate on; one of those that Dr Katkhouda mentioned with a bad heart, bad cirrhosis, or some other reason why we want to stay out of their abdomen, we believe you can do a water-soluble upper GI. About half of the patients will be sealed and you don’t need to do anything more. But that is the rare patient, and those patients were not included in this study.

In regard to the technique, it is a reversion back to the simple Graham patch where the omental tab is pulled up and then sutures are placed over it and tied down, trying not to necrose the patch. We do not use hernia staplers as there is no direct attempt to close the hole itself.

Dr Way asked about the outcome vs cultures. We did not look at that. Dr John Payne asked about whether the technique was difficult to learn. Our guess would be that this pro-
...procedure is one of the next things to teach residents after they have mastered cholecystectomy. It is a relatively simple procedure to do. It is a little tedious, particularly the washing out of the peritoneal cavity, but it is not technically challenging.

Dr Pellegrini, you are right. This study was not randomized, controlled, or prospective. Dr Stabile asked a question about the bias for selection for each group in this study. It depended on whether the attending on that day felt that he or she was comfortable with laparoscopic surgery. Our policy with emergency abdominal, nontrauma surgery is that if the attending is comfortable starting with laparoscopic surgery we do that, but with the caveat that if it seems to be not going well or possibly dangerous, that the case is converted to open. If the attending surgeon is starting the case with laparoscopy, then they don’t do that. Therefore, it was by attending staff choice.

Also, the patients were not told when to go back to work. The patients generally decided on their own. We don’t think they were led into returning to work earlier in one group than the other by the instructions from the doctors.

Dr Deveney, we do not think that the length of stay was due to differences in the antibiotics. That didn’t seem to be the limiting factor in the patient’s recovery.

Announcement

New Associate Editor

The ARCHIVES OF SURGERY is pleased to announce the appointment of Gerald W. Peskin, MD, as associate editor. A native Pennsylvanian, he received AB and MD degrees from the University of Pennsylvania. He completed a surgical residency at the same institution (1951-1957) under the tutelage of the legendary I. S. Ravdin. During his residency he was a fellow in the Harrison Department of Surgical Research and on completion of his residency was appointed to the University of Pennsylvania Department of Surgery faculty. Dr Peskin remained at the University of Pennsylvania until his appointment as professor of surgery at the University of Chicago in Illinois (1969) prior to assuming a similar professorship at the University of California, San Diego. In 1984 he became chairman of the Department of Surgery at the St Raphael Hospital (New Haven, Conn), a position he held until joining the faculty of the University of California, Davis.

Dr Peskin was elected to membership in Phi Beta Kappa and Alpha Omega Alpha Honor Medical Society. He is a member of all of the prestigious surgical societies, including the Society of University Surgeons, the American Surgical Association, the Society for Surgery of the Alimentary Tract, the American Association of Endocrine Surgeons, and the New England Surgical Society. He has published more than 175 articles in peer refereed journals. Dr Peskin will bring an experienced clinical and basic science background to these duties as well as clinical maturation.