Predicting Mortality and Morbidity of Patients Operated on for Perforated Peptic Ulcers

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Hypothesis: Since the early 1990s, the laparoscopic technique has been increasingly used for the treatment of perforated peptic ulcer. It is important to validate a risk scoring system that can stratify patients into various risk groups before comparing the treatment outcome of laparoscopic repair against that of conventional open surgery. The scoring system should be able to predict the likelihood of mortality and morbidity. Boey score and APACHE II (Acute Physiology and Chronic Health Evaluation II) score may be of use in patient stratification.

Design: Retrospective review of relevant case notes by one reviewer.

Setting: A teaching hospital treating 0.5 million to 1 million patients during the study period.

Patients: Patients operated on for perforated peptic ulcer between January 1989 and December 1998. Patients treated conservatively were excluded.

Main Outcome Measures: Mortality and postoperative complications (morbidity).

Results: A total of 436 patients (365 male and 71 female) with a mean±SD age of 51.5±18.3 years (range, 14-92 years) were studied. Duodenal perforation accounted for 344 (78.9%) of 436 cases. The mortality rate was 7.8% (34/436), and 89 patients had postoperative complications. Multivariate analysis demonstrated that only the APACHE II score predicted both mortality and morbidity. Although the Boey score predicted mortality, it failed to predict morbidity. However, the Boey score predicted the chance of conversion in patients undergoing laparoscopic repair.

Conclusions: The APACHE II score may be a useful tool for stratifying patients into various risk groups, and the Boey score might select appropriate patients for laparoscopic repair.

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IN THE ERA OF open surgery, 3 prognostic factors (preoperative shock, perforation for more than 24 hours, and associated medical diseases) have been identified in patients with perforated peptic ulcer.1 With the introduction of laparoscopic repair techniques in the treatment of perforated peptic ulcer in 1990, many retrospective2-5 and prospective nonrandomized trials have been published.6-9 It is important to stratify patients into various risk groups in comparing the laparoscopic and conventional open techniques. There is no doubt that the Boey scoring system accurately predicts mortality after open surgery10; however, it is not known if the Boey scoring system is equally good for predicting morbidity. This is important because decrease in morbidity is a major outcome measure in minimally invasive surgery.

The aim of this study was to evaluate the usefulness of 2 scoring systems, the Boey scoring system and the APACHE II (Acute Physiology and Chronic Health Evaluation II) score as a potential tool to stratify patients with perforated peptic ulcer.

RESULTS

DEMOGRAPHIC DATA

The mean ± SD age for the 436 patients was 51.5 ± 18.3 years (range, 14-92 years), with male predominance (365 male vs 71 female). Seventy-seven patients (17.7%) had an underlying medical illness, and 14 patients (3.2%) had malignant neoplasms.

TYPES OF OPERATION PERFORMED

The duodenum was the most common site of perforation, accounting for 344 (78.9%) of 436 cases. One hundred ninety-six patients underwent open suture repair, and 46 received laparoscopic suture repair. Su-
PATIENTS AND METHODS

This retrospective review involved patients operated on for perforated peptic ulcers from January 1989 to December 1998. A total of 436 patients were recruited. Case notes were reviewed with particular attention to the preoperative risk factors. The Boey score and the APACHE II score were calculated based on data recorded at hospital admission. These patients were operated on by open and laparoscopic means, and reasons for conversion were sought from the operative record. Two types of laparoscopic repair were performed, the suture repair and the sutureless repair (fibrin glue technique). The latter procedure has previously been reported by our group.11 Ninety-three patients were randomized into 4 different operative approaches from August 1992 to December 1994: open suture, open sutureless, laparoscopic suture, and laparoscopic sutureless repair. Results of that randomized trial have been previously published.12 Because of the promising outcome of laparoscopic repair, patients with suspected perforated peptic ulcers were subjected to laparoscopic repair from 1995 onward unless the surgeon or the anesthetist considered the patient not suitable for laparoscopic repair. However, the choice between laparoscopic suturing and laparoscopic sutureless repair depended on the individual surgeon’s expertise and preference. Outcome measures evaluated in this study included mortality and postoperative complications (morbidity). The following complications were of particular interest: wound infection, prolonged ileus, intra-abdominal abscess, and leakage. Exact causes of death were individually examined.

The Pearson χ² test, the Mann-Whitney U test, and logistic regression were used for statistical analysis; P<.05 was considered statistically significant.

FUTURELESS REPAIR

Sutureless repair was performed in 132 patients: laparoscopic fibrin glue repair was performed in 109 patients, and open glue repair was performed in 23 patients. Definitive procedure was performed in 59 patients (Table). The initial planned procedure for 209 patients was laparoscopic repair (153 patients) and laparoscopic suture repair (56 patients). Conversion to open suture repair or definitive procedure was required in 46 patients and 10 patients, respectively. The conversion rate of laparoscopic glue repair and laparoscopic suture repair showed no statistically significant difference (28.8% vs 21.4%; P=.3, χ² test). The 2 most common reasons for conversion were difficulty in identifying the perforation site (34.8%) and huge ulcer considered not safe for laparoscopic repair (47.2%).

OUTCOME

The mortality rate was 34 (7.8%) per 436 cases, with sepsis associated with multorgan failure being the most common cause of death (15 of 34 cases). Leakage after simple closure accounted for only 3 of 15 deaths. The other causes of death are as follows:

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>No. of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute myocardial infarction</td>
<td>2</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>4</td>
</tr>
<tr>
<td>Respiratory failure</td>
<td>8</td>
</tr>
<tr>
<td>Chest infection</td>
<td>4</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>1</td>
</tr>
<tr>
<td>Sepsis with multiorgan failure</td>
<td>15</td>
</tr>
</tbody>
</table>

The median hospital stay among the survivors was 6 days (range, 2-77 days), and the median hospital stay for the nonsurvivors was 6.5 days (range, 0-64 days). One survivor stayed exceedingly long (77 days) because of necrotizing fasciitis, which required multiple operations for debridement and skin grafting.

Among the survivors, 89 patients (22.1%) had postoperative morbidities, including wound infection, prolonged ileus, leakage, intra-abdominal abscess, and other complications. Wound infection was the most common morbidity (Table). The leakage rate (including radiologically and clinically detected leak) after simple closure (including suture and sutureless repair) was 23 (6.1%) per 374 cases.

BOEY SCORE, APACHE II SCORE, AND ULCER SIZE IN PREDICTING MORTALITY AND MORBIDITY

Thirty patients (6.9%) had a Boey score of 2 or more. The mortality rate increased progressively, with increasing numbers of Boey risk factors: 1.5%, 14.4%, 32.1%, and 100% for 0, 1, 2, and 3 factors, respectively (P<.001, Pearson χ² test). The morbidity rates for 0, 1, and 2 Boey risk factors were 17.4%, 30.1%, and 42.1%, respectively (P=.002, Pearson χ² test). The median APACHE II score was 5 (range, 0-24). The APACHE II score was higher among the nonsurvivors than among the survivors (P<.001, Mann-Whitney U test) and among patients with postoperative complications (P<.001, Mann-Whitney U test). The median size of the ulcer was 5 mm. When compared with that of the survivors, the median ulcer size of the nonsurvivors was significantly larger (P<.001, Mann-Whitney U test). Similarly, the ulcer was significantly larger in patients with morbidity (P<.001, Mann-Whitney U test). It appeared that the Boey score, the APACHE II score, and the ulcer size independently predicted mortality and morbidity of patients with perforated peptic ulcer. Using multivariate analysis (logistic regression, forward stepwise), patients’ likelihood of death could be predicted by the Boey score (P=.02) and the APACHE II score (P<.001) but not the ulcer size (P=.88). In terms of morbidity, only the APACHE II score (P<.001) could predict the risk of complications (logistic regression, forward stepwise); the Boey score and the ulcer size were nonsignificant (P=.88 and P=.47, respectively).

PREOPERATIVE RISK FACTORS IN PREDICTING CONVERSION RATE

The overall conversion rate for laparoscopic attempted repair was 26.8%. The conversion rates for 0, 1, and 2 Boey risk factors were 21.4%, 30.2%, and 81.8%, respectively. No patients with 3 risk factors were subjected to laparo-

Table

|_preoperative risk factors: 21.4%, 30.2%, and 81.8%, respectively. No patients with 3 risk factors were subjected to laparo-
A significantly higher conversion rate was noted in the high-risk group (P<.001, Pearson $\chi^2$ test). On the other hand, using univariate analysis, the conversion rate for patients with worse APACHE II score was also significantly higher (P=.005, Mann-Whitney U test). However, multivariate analysis confirmed that only the Boey score predicted the risk of conversion (logistic regression, forward stepwise, P<.001). With regard to outcome measures, conversion to open surgery was not associated with higher mortality (P=.33, $\chi^2$ test) or morbidity (P=.37, $\chi^2$ test).

PROCEDURE-RELATED MORTALITY AND MORBIDITY AFTER RISK STRATIFICATION

Using the median APACHE II score as the dividing line, patients could be divided into 2 groups, a low-risk group with APACHE II score less than or equal to 5 (256 patients) and a high-risk group with a score greater than 5 (180 patients). After stratification, the mortality rate of different procedures showed no statistically significant difference (P=.22, Pearson $\chi^2$ test) in the high-risk group. Zero mortality was recorded in the low-risk group. Likewise, the morbidity rate of different procedures showed no difference in both the low- and high-risk group. Before stratification, the mortality rate of open suture repair (13.3%) was apparently higher than the other techniques. This could be explained by the fact that a greater proportion of high-risk patients (104/180) were treated by open suture repair. The technique per se sustained no impact on survival outcome after risk stratification.

A previous study by Boey et al.\textsuperscript{10} in the era of open surgery validated a set of risk factors to stratify patients with perforated duodenal ulcers. Patients with 0, 1, 2, and all 3 risk factors were noted to have mortality rates of 0%, 10%, 45.5%, and 100%, respectively.\textsuperscript{10} Similar findings were observed in this study. Although the Boey scoring system accurately predicted the chances of survival in patients with perforated peptic ulcer, it failed to estimate the likelihood of postoperative complications. When evaluating clinical outcome of perforated peptic ulcer, the procedure-related morbidity rate is equally important. The APACHE II scoring system is commonly used in the modern-day management of surgical intensive care patients.\textsuperscript{13-18} This scoring system gives a detailed documentation of the acute physiological disturbance. In contrast, the Boey scoring system takes into consideration only one of the physiological parameters, ie, preoperative hypotension in classifying patients into different risk categories. In the present study, worse APACHE II score was predictive of high mortality and morbidity rate. Therefore, the APACHE II score should be considered an appropriate prognostic marker in managing patients with perforated peptic ulcers. More important, when comparing treatment outcome (mortality and morbidity) of different procedures, patients can be accurately stratified into various risk groups according to their APACHE II score before comparison.

Recent studies have demonstrated that laparoscopic repair of perforated peptic ulcer is feasible and as safe as conventional open surgery.\textsuperscript{3-7,9,12} The overall conversion rate in this study was 26.8%. Although conversion to open surgery apparently did not affect the clinical outcome of perforated peptic ulcer, the total operative time was prolonged and the workload of theater staff was increased. Only the Boey scoring system could predict the risk of conversion as confirmed by multivariate analysis. The conversion rate for patients with 2 points was more than 80%. Laparoscopic attempt in these patients did not appear to be beneficial at all.

In conclusion, the APACHE II score, which could predict the mortality and the morbidity rate, should be used for patient stratification in clinical research setting. On the other hand, one may contemplate the use of the Boey scoring system preoperatively to select patients for laparoscopic repair. Thus, both scoring systems serve as valuable predictors in the modern-day management of perforated peptic ulcers.

**Mortality and Common Morbidities of Various Procedures**

<table>
<thead>
<tr>
<th>Operation</th>
<th>Total</th>
<th>Mortality*</th>
<th>Wound Infection</th>
<th>Intra-abdominal Abscess</th>
<th>Leakage</th>
<th>Prolonged Ileus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open suture</td>
<td>196</td>
<td>26 (13.3)</td>
<td>16</td>
<td>15</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Laparoscopic glue</td>
<td>109</td>
<td>4 (3.7)</td>
<td>4</td>
<td>2</td>
<td>17</td>
<td>3</td>
</tr>
<tr>
<td>Laparoscopic suture</td>
<td>46</td>
<td>2 (4.3)</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Open glue</td>
<td>23</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Vagotomy and pyloroplasty</td>
<td>29</td>
<td>1 (3.4)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gastrectomy</td>
<td>30</td>
<td>1 (3.3)</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ulcerectomy</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

* Data are given as number (percentage).

**REFERENCES**


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We find some serious problems with the retrospective study of Lee et al from Hong Kong regarding its methodology and interpretation. The Boey score and its measurement are poorly defined. We are told that since 1995 patients were subjected to laparoscopic repair “unless the surgeon or the anesthetist considered the patient not suitable,” but the criteria used to make such a decision are not given. We learn that leakage after simple closure accounted for only 3 of the 19 deaths. In the absence of routine postoperative contrast or computed tomographic studies, reexplorations, or autopsies, this figure has to be a pure guess. Fifteen patients died of “sepsis with multiorgan failure,” but the causes are not provided. Was it nonidentified leak?

With regard to the Boey and APACHE II scores, the authors tell us about the results but do not provide the actual results. Reporting P values without the actual numbers used to calculate them is meaningless. We are told about complex multivariate statistical analysis and its “final conclusions” but are not permitted to see the actual numbers that led to the “results.”

Although not cited in this article, the use of the APACHE II score has been previously validated (retrospectively and prospectively) in patients with perforated peptic ulcers. As opposed to the APACHE II score, the weakness of the Boey scoring system lies in its crudeness. The degree of the severe medical illness is not well defined; the duration of the perforation is often difficult to assess, especially in retrospective studies; and the definition of shock (systolic blood pressure <100 mm Hg) does not take into account normotensive patients with low systolic blood pressure. The APACHE II, on the other hand, offers certain advantages. It defines and scores associated chronic illnesses, and instead of measuring the cause for the acute physiologic insult (eg, long duration of perforation), it measures its physiologic consequences. For example, it would measure and reflect the differences between the minimal severity of physiologic compromise caused by a sealed perforation of long duration as opposed to that of a recent, but free, perforation.

Lee et al suggest that, using the median APACHE II score, patients could be divided into a “low-risk” group (scores ≤5) and a “high-risk” group (scores >5). They claim that different procedures carry similar morbidity and mortality rates in the so-defined high-risk group. We do not agree with their conclusions, because the dividing score of 5 used by the authors is much too low. Other studies have shown that the morbidity and mortality in patients with scores of 11 or less are negligible. We believe that in truly high-risk patients, the type of procedure is likely to have an impact on outcome. It is obvious that the higher the APACHE II score, the higher the morbidity and mortality; thus, reporting mean or median scores in survivors and nonsurvivors adds nothing to our knowledge. Instead of using the dividing score of 5, the authors should have divided their patients into subgroups of increasing scores (eg, 0-10, 11-15, 16-20, 21-15, and 26-30). Then, by assessing their results with the various procedures in patients in these score subgroups, more meaningful information could be derived. Most probably, results would have shown that patients with scores above 20 poorly tolerate the physiologic insult of a prolonged laparoscopic pneumoperitoneum, especially when it is superimposed on intra-abdominal infection. In addition, had the authors not excluded patients who were managed conservatively, they may have shown, for example, that in patients with extremely high APACHE II scores (ie, >25), who usually die after the operation, nonoperative treatment may have been better.

Most surgeons know that young, healthy patients who present early with perforation do well, whereas older, sick patients with neglected perforation tend to do poorly. Therefore, most surgeons do not routinely score their patients with perforated ulcer. This is unfortunate because accurate stratification of these patients could determine whether tailoring the management (eg, open vs laparoscopic vs conservative) to the severity of the patient’s illness may improve results.

Because of the above-mentioned limitations, we cannot accept the authors’ conclusion that the Boey score is useful to select preoperatively patients for laparoscopic repair. We agree, however, that the proper use of a scoring system is valuable. In essence, the Boey score and APACHE II score serve the same purpose. The former, however, being much more crude, “paints” the patients in black or white only. The APACHE II offers a few more shades in between. The fineness of the picture may matter!

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Once again we have to emphasize that this nonrandomized retrospective study only aims at validating a risk scoring system that can be used to stratify patients operated on for perforated peptic ulcers—we do not aim to compare treatment outcomes of different operative techniques. Because of its nonrandomized nature, there was a general tendency to subject “ill” patients to open repair.

Leakage after simple repair accounted for 3 of 15 deaths; all 3 patients underwent reoperation and the leakage was confirmed. For the remaining 12 patients who died of multiorgan dysfunction as a result of sepsis, postmortem examination did not reveal any evidence of leakage.

The mortality and morbidity rates of patients with different Boey scores have been stated in the text. Concerning the APACHE II score, the median scores of survivors and nonsurvivors were 4 (range, 0-21) and 15 (range, 6-24), respectively. The median scores of those with and without complications were 7 (range, 0-21) and 4 (range, 0-24), respectively. The median ulcer perforation sizes of nonsurvivors were larger than those of survivors: 10 (range, 2-23) mm vs 5 (range, 1-80) mm. Similarly, median ulcer perforation size was larger in patients with morbidity: 8 (range, 2-80) mm vs 5 (range, 1-60) mm.

The use of median APACHE II score as the dividing score is to illustrate the importance of stratifying patients before comparing treatment outcome of various techniques. We have not advocated the use of “APACHE II score 5” in general. Even if we divided our patients into different subgroups according to their APACHE II score, individual procedures did not significantly influence the mortality and morbidity (see the Table).

Although Drs Schein and Wise suggest that nonoperative treatment might be beneficial for high-risk patients, a previous randomized trial conducted at our institute demonstrated that high-risk patients were less likely to respond to a conservative approach.1

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