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# Minilaparotomy for Perforated Duodenal Ulcer

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**The usefulness of the minilaparotomy approach for perforated duodenal ulcer repair was retrospectively evaluated in 37 patients (26 men; mean age, 56.5 years). Simple closure with an omental patch by minilaparotomy (skin incision, ≤7 cm) was successful in 86.5% of the cases, with an operative mortality of 2.7%. Compared with the results in historic control patients who underwent conventional open surgery (n = 27), a shorter operative time ($P < 0.01$), lower frequency of analgesic use ($P = 0.03$), earlier passage of flatus ($P < 0.01$), and shorter hospital stay ($P = 0.04$) were obtained in the patients undergoing minilapartomoy. The postoperative morbidity was identical between the two groups (16.2% versus 33.3%, $P = 0.40$). On multivariate analysis, a large amount of intra-abdominal fluid was the only significant risk factor for extension of the minilaparotomy wound ($P = 0.012$). The minilaparotomy approach appears to be a feasible, safe, and less invasive approach compared with the conventional open approach and could be a useful alternative to the laparoscopic approach in selected patients with perforated duodenal ulcer.**

*Key words:* Minilaparotomy – Duodenal ulcer – Perforation – Laparoscopy

Perforated duodenal ulcer still remains the most common indication for emergency surgery, although the incidence of this condition has decreased recently with the introduction of effective antisecretory agents, including $H_2$ receptor antagonists and proton pump inhibitors, and also effective regimens for the eradication of *Helicobacter pylori* infection.[1–3] Depending on the condition of the affected patients and/or the nature of the disease itself, the strategy for treatment could range from conservative therapy to emergency surgery.

The standard surgical procedures for closure of a perforated duodenal ulcer include simple closure and/or omentoplasty (omentopexy). However, there is no consensus regarding the optimal approach for the closure of a perforation. The laparoscopic approach may seem to be the optimal approach, as laparoscopic repair offers advantages

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over open surgery such as smaller wounds, less trauma, and better cosmetic results. The technical feasibility of the laparoscopic approach for the treatment of perforated duodenal ulcer has been well established,[4,5] since the first report of successful use of the laparoscopic approach was published in 1990.[6] However, there are several limitations to the use of the laparoscopic procedure for perforated duodenal ulcer, such as the longer operation time, higher cost, and the need for experienced surgical skills. Furthermore, a systematic review[7] comparing laparoscopic and open repair for perforated duodenal ulcer could not yield a definitive conclusion as to which approach might be better, although lower frequency of analgesic use, shorter hospital stay, lower incidence of wound infection, and lower mortality rate were all in favor of the laparoscopic approach.

The potential disadvantages of the laparoscopic approach prompted us to explore the feasibility and usefulness of the minilaparotomy approach as an alternative for the treatment of perforated duodenal ulcer. This is based on our favorable results using the minilaparotomy approach in the treatment of colon cancer.[8–11] Thus, we performed this study to evaluate the usefulness of the minilaparotomy approach for the treatment of perforated duodenal ulcer, by analyzing its feasibility, safety, and minimal invasiveness.

## Patients and Methods

### *Definition of minilaparotomy*

In this series, we defined minilaparotomy as an upper median abdominal skin incision with a maximum length of 7 cm.

### *Indication of minilaparotomy*

Minilaparotomy was performed on any patient who did not meet the indications for conservative treatment or conventional open surgery. Conservative therapy was chosen when all of the following conditions were satisfied: evidence of localized peritonitis on physical examination, stable circulatory condition, and/or localized intraperitoneal fluid collection in the upper abdominal cavity as visualized on computed tomography (CT). Conventional open laparotomy was performed for patients showing evidence of generalized peritonitis with shock and/or intra-abdominal fluid filling the entire pelvic cavity as visualized on CT. All the selected candidates for the minilaparotomy approach gave their consent for undergoing the procedure and for possible conversion to conventional open surgery. During the study period, the laparoscopic approach was also used for selected patients who presented with localized peritonitis and were in a stable condition, in deference to the patients' preference.

### *Patients*

We conducted a retrospective review of the medical charts and found 87 patients treated for gastroduodenal perforation at our hospital from April 2005 to November 2010. The diagnosis of gastroduodenal perforation was comprehensively made, based on the patients' physical status, prior history of peptic ulcer, use of nonsteroidal anti-inflammatory drugs, findings on X-rays of the abdomen, and findings on abdominal CT.[12] There were 68 patients with perforated duodenal ulcer, 15 patients with perforated gastric ulcer, and 4 patients with perforated gastric cancer. We focused on the data of the 68 patients with perforated duodenal ulcer for this study. Conservative therapy was selected in 16 patients (23.5%), 15 of whom subsequently improved, whereas the remaining 1 patient needed additional surgical treatment with a minilaparotomy due to the progression of peritonitis. Fifty-two patients underwent emergency surgical intervention as the initial treatment. Of these, 3 patients underwent laparoscopic repair based on their preference, 12 patients underwent conventional open surgery, and the minilaparotomy approach was attempted in the remaining 37 patients. These latter 37 patients constituted the subjects of this study. In terms of the preoperative diagnosis of perforated duodenal ulcer, we did not perform upper gastrointestinal endoscopy or a gastrografin meal study. Instead, we confirmed the presence of the duodenal ulcer in all cases after conservative therapy or postoperatively by upper gastrointestinal endoscopy.

### *Surgical procedures*

Each candidate for minilaparotomy was placed on the operating table in a supine position. The abdominal cavity was entered through an upper midline abdominal incision with a maximum length of 7 cm. A wound retractor, Alexis (medium size; Applied Medical, Rancho Santa Margarita, California) was applied to the edge of the wound. The perforation site was closed with 3-0 absorbable sutures, which was reinforced by a pedicled omental

patch.[13] Peritoneal lavage was performed using 3 to 6 L of warm normal saline. In principle, a closed-suction drain was placed in the infrahepatic space.

### *Factors evaluated*

The characteristics of the patients initially selected as the candidates for the minilaparotomy approach were evaluated. These factors were age, gender, body mass index, American Society of Anesthesiologists (ASA) physical status classification, interval from onset to surgery, Boey score[14] (comprising prolonged perforation persisting for more than 24 hours, shock on admission, and confounding medical conditions, defined as ASA grade III-IV), intraperitoneal fluid collected during surgery, and the size of the perforation. Various clinical factors, including the preoperative and postoperative white blood cell (WBC) counts and serum C-reactive protein (CRP) levels, the frequency of analgesic use (pentazocine, 15 mg/kg, administered intramuscularly), the time to the first passage of gas, time to resumption of oral intake, postoperative length of hospital stay, and postoperative complications, which were defined as any adverse events occurring postoperatively, were compared between the patients who were initially selected as candidates for the minilaparotomy (minilaparotomy group, n = 37) and the historic control patients (control group, n = 27) who met the indication criteria for the minilaparotomy approach, but had actually undergone conventional open surgery (skin incision, >15 cm) at our institute between April 2000 and March 2005.

The risk factors for extension of the minilaparotomy wound were also assessed.

### *Statistical analysis*

Because this study was performed on an intention-to-treat basis, patients who needed extension of the minilaparotomy wound were also included in this study. All the statistical analyses were performed using a statistical software package (Statview version 5.0; SAS Institute, Cary, North Carolina). Continuous data were expressed as the mean and standard error of means (mean ± SE) and compared using Student's *t*-test. Categorical data were compared using the Fisher's exact probability test. Univariate and multivariate logistic regression analyses were performed to determine the risk factors for extension of the minilaparotomy wound. Continuous variables were introduced into the logistic regression analysis models without dichotomization. *P* values of less than 0.05 were considered to denote statistical significance.

*Table 1 Patient characteristics*

| | |
|---|---|
| Age (years) | 56.5 ± 2.4 |
| Sex (male:female) | 26:11 |
| Body mass index (kg/m$^2$) | 20.5 ± 0.4 |
| ASA classification (I:II:II) | 26:8:3 |
| Boey score (0:1:2:3) | 30:5:1:1 |
| Interval from onset to admission (hour) | 15.5 ± 3.0 |
| Succcess of the minilaparotomy approach | 32 (86.5%) |

ASA, American Society of Anesthesiologists.

## Results

### *Patient characteristics*

The patient characteristics are shown in Table 1. The mean age of the patients was 56.5 ± 2.4 years. The male:female ratio was 26:11. The mean body mass index was 20.5 ± 0.4 kg/m$^2$. The ASA physical status classification was class I in 26, class II in 8, and class III in 3 patients. The Boey score was 0 in 30 patients, 1 in 5 patients, 2 in 1 patient, and 1 in 1 patient. The interval from the onset to admission was 15.5 ± 3.0 hours. At laparotomy, the perforation was identified in the anterior site of the duodenal bulb in all 37 patients, and simple closure with a pedicled omental patch repair could be performed in all. Surgical repair using the minilaparotomy approach was successful in 32 patients (86.5%). Five patients required extension of the wound up to 10 cm, because of a smaller than adequate operative field obtained with the smaller incision.

Comparisons of the operative time, preoperative and postoperative WBC counts and serum CRP levels, and other clinical parameters are shown in Table 2. The mean operative time was shorter by 18.4 minutes in the minilaparotomy group than in the control group ($P < 0.01$). No significant differences in the preoperative and postoperative WBC counts or serum CRP levels (postoperative days 1, 4, and 7) were observed between the two groups. The analgesic use was less ($P = 0.03$), the time to first passage of flatus was earlier ($P < 0.01$), and the length of hospital stay was shorter ($P = 0.04$) in the minilaparotomy group. The time to oral intake did not differ significantly between the two groups; however, it tended to be shorter in the minilaparotomy group ($P = 0.14$). The postoperative complications in the minilaparotomy group included wound infection (n = 4), intra-abdominal abscess (n = 1), and disseminated intravascular coagulopathy (n = 1). There were no cases of leakage. A 65-year-old

*Table 2 Clinical and laboratory parameters*

| | Minilaparotomy group (n = 37) | Control group (n = 21) | *P* value |
|---|---|---|---|
| Operative time (min) | 70.0 ± 5.9 | 88.2 ± 6.7 | < 0.01 |
| White blood cell count (/mm$^3$) | | | |
| Preoperative | 12,467 ± 889 | 12,253 ± 2232 | 0.92 |
| POD 1 | 12,532 ± 734 | 13,276 ± 1885 | 0.67 |
| POD 4 | 8583 ± 765 | 8229 ± 755 | 0.76 |
| POD 7 | 8943 ± 994 | 8273 ± 599 | 0.63 |
| Serum C-reactive protein (mg/dL) | | | |
| Preoperative | 6.3 ± 1.9 | 7.4 ± 1.7 | 0.70 |
| POD 1 | 13.7 ± 1.4 | 14.5 ± 1.6 | 0.72 |
| POD 4 | 8.4 ± 1.3 | 9.3 ± 1.4 | 0.66 |
| POD 7 | 4.3 ± 0.8 | 4.5 ± 0.7 | 0.89 |
| Analgesic use | 1.1 ± 0.2 | 2.0 ± 0.4 | 0.03 |
| First passage of flatus (days) | 3.5 ± 0.4 | 5.6 ± 0.7 | < 0.01 |
| Start of oral intake (days) | 5.6 ± 0.7 | 7.7 ± 1.4 | 0.14 |
| Length of hospital stay (days) | 13.4 ± 1.9 | 19.1 ± 1.6 | 0.04 |

Mean ± SE.

POD, postoperative day.

woman with a Boey score of 3 at the time of surgery developed disseminated intravascular coagulopathy and died on postoperative day 27. The remaining 5 patients who developed postoperative complications recovered with conservative treatment. The postoperative complications in the control group included wound infection (n = 6), intra-abdominal abscess (n = 1), and pneumonia (n = 2). There was no mortality in the historic control group. The incidence of postoperative complications did not differ between the two groups (16.2% in the minilaparotomy group versus 33.3% in the control group, $P = 0.40$) (Table 3). Comparisons of various parameters between patients with successful minilaparotomy (n = 32) and those who needed extension of the minilapatrotomy wound (n = 5) are shown in Table 4. In terms of age, sex, body mass index, interval from onset to admission, and the preoperative WBC, there were no significant differences between the patients with successful repair by the minilaparotomy and those who needed extension of the minilaparotomy wound. The incidence of absence of Boey risk factors tended to be higher in the patients with successful surgery by the minilaparotomy than in those who needed extension of the minilaparotomy wound (71.9% versus 40%, $P = 0.07$). The amount of intra-abdominal fluid was greater ($P < 0.01$), the size of perforation was larger ($P < 0.01$), and the preoperative CRP level was higher ($P < 0.01$) in the patients who needed extension of the minilaparotomy wound. Univariate logistic regression analysis revealed that a large amount of intra-abdominal fluid ($P = 0.012$), large size of perforation ($P = 0.013$), and elevated preoperative serum CRP level ($P = 0.016$) were significant risk factors for extension of the minilaparotomy wound, whereas multivariate analysis with backward stepwise selection only selected a large amount of intra-abdominal fluid ($P = 0.012$) as a significant risk factor for extension of the incision (Table 5).

## Discussion

During the past few decades, the treatment for perforated duodenal ulcer has changed, with the advances in medical and surgical treatments.[1–3] In fact, the frequency of conservative therapy in place of surgical treatment has increased for perforated duodenal ulcers. However, perforated duodenal ulcer still remains one of the most common indications for emergency surgery. Laparoscopic techniques have been developed and generally established for the treatment of perforated duodenal

*Table 3 Postoperative complications*

| | Minilaparotomy group (n = 37) | Control group (n = 21) | *P* value |
|---|---|---|---|
| Wound infection | 4 | 6 | |
| Intra-abdominal abscess | 1 | 1 | |
| Disseminated intravascular coagulopathy | 1 | | |
| Pneumonia | | 2 | |
| Total | 6 (16.2%) | 8 (33.3%) | 0.40 |

*Table 4 Various parameters in cases with successful or unsuccessful use of the minilaparotomy approach*

| | Successful minilaparotomy (n = 32) | Extension of the minilaparotomy wound (n = 5) | *P* value |
|---|---|---|---|
| Age | 55.2 ± 2.7 | 60.8 ± 2.5 | 0.43 |
| Sex (male:female) | 23:9 | 3:2 | 0.62 |
| Body mass index (kg/m$^2$) | 20.2 ± 0.5 | 21.6 ± 0.7 | 0.29 |
| Boey score (0 vs. 1–3) | 32:7 | 2:3 | 0.07 |
| ASA classification (I vs. II/III) | 23:9 | 3:2 | 0.63 |
| Interval from onset to admission (hours) | 14.2 ± 3.2 | 22.6 ± 5.0 | 0.38 |
| Intra-abdominal fluid (mL) | 377 ± 74 | 1725 ± 287 | < 0.01 |
| Size of perforation (mm) | 6.8 ± 0.9 | 20.0 ± 4.2 | < 0.01 |
| Preoperative WBC (/mm$^3$) | 12,654 ± 977 | 13,160 ± 2579 | 0.85 |
| Preoperative serum C-reactive protein (mg/dL) | 4.6 ± 1.7 | 20.6 ± 6.7 | < 0.01 |

Mean ± SE.

ASA, American Society of Anesthesiologists; WBC, white blood cell.

ulcer. A systematic review,[7] comprising 2 randomized prospective studies, 5 nonrandomized prospective studies, and 8 retrospective studies comparing laparoscopic and open repair, demonstrated that the statistically significant findings in favor of laparoscopic repair compared to open repair, were the lower frequency of analgesic use, shorter hospital stay, lower incidence of wound infection, and lower mortality rate. On the other hand, this review also indicated that the advantage of using the laparoscopic approach versus open repair was inconclusive because of the limited number of well-designed randomized trials, and that patients with no Boey risk factors may particularly benefit from laparoscopic repair.

With regard to the widespread use of laparoscopic repair for perforated duodenal ulcer, there may be several limitations. For example, laparoscopic instruments are expensive and manpower is required, even at midnight. Specialized surgical skills are also necessary. The operative time for laparoscopic repair is usually relatively long,[7,15] although it is becoming shorter with increasing laparoscopic expertise and the introduction of more advanced equipment. Furthermore, the incidence of postoperative leakage has been reported to be higher after laparoscopic repair than after conventional open repair.[7,15] We thus began to explore the usefulness of minilaparotomy to overcome these problems. Several reports, including our own studies, have demonstrated the safety and feasibility of the minilaparotomy approach in the treatment of colon cancer[8–11,16–18] as well as gastric cancer.[19] This approach was found to be significantly more advantageous in terms of the surgical invasiveness compared with conventional open laparotomy.[8,20–23] To the best of our knowledge, this is the first report describing the usefulness of minilaparotomy for the treatment of perforated duodenal ulcer, although Okazaki *et al*[24] have reported their initial experience of minilaparotomy (skin incision, <5 cm) in 14 patients, focusing on its feasibility. The definition of minilaparotomy appears to differ depending on the operating surgeon. Practically, we believe that a 6- to 7-cm long incision would be the shortest that would allow the surgeon to insert his/her hand into the operative field for prompt control in the event of unexpected bleeding. Intraoperative lavage would also be easy to perform with a minilaparotomy using an incision of this length.

We established arbitrary indications for using the minilaparotomy approach in this series. There is no consensus yet on the optimal setup for surgery and/or the operating technique in the treatment of perforated duodenal ulcer. According to the systematic review by Lunevicius and Morkevicus,[7] shock, delayed presentation (>24 hours), confounding medical conditions, age >70 years, ASA III/V, Boey score of 3, inadequate ulcer location, friable ulcer edges, and large perforation (>6 mm or >10 mm) were high-risk factors for laparoscopic repair. Recently, a systematic review of studies including cases of perforated gastric ulcer also demonstrated that Boey score of 3, age >70 years,

*Table 5 Factors predictive of the need for extension of the minilaparotomy wound as identified by logistic regression analysis*

| Factors | Odds ratio (95% confidence interval) | *P* value |
|---|---|---|
| Intra-abdominal fluid[a] | 1.003 (1.001–1.005) | 0.012 |
| Size of perforation | 1.39 (0.06–1.18) | 0.016 |
| Preoperative serum C-reactive protein | 1.10 (1.02–1.19) | 0.013 |

[a]Independent significant factor by multivariate analysis.

and symptoms persisting for longer than 24 hours were associated with a higher mortality and morbidity, and should be considered as contraindications for laparoscopic intervention in patients with perforated peptic ulcer.[15] Some of these risk factors were included as indications for minilaparotomy in this series. Thus, our minilaparotomy approach may be applicable to a larger population base than laparoscopic repair.

Regarding the feasibility of minilaparotomy, a univariate analysis identified a large amount of intra-abdominal fluid, large size of the perforation, and an elevated preoperative serum CRP level as significant risk factors for extension of the minilaparotomy wound, whereas a multivariate analysis performed using these same factors as covariates selected only a large amount of intra-abdominal fluid as a significant risk factor. However, these results are still inconclusive because of the limited number of patients. Because the amount of intra-abdominal fluid, size of perforation, and the serum CRP level are considered to be associated with the severity or extent of the peritonitis, these factors should be evaluated again in larger series. Furthermore, it is still unknown whether minilaparotomy could also be performed safely in more obese subjects in Western populations, which also calls for additional investigations.

Less invasive methods of surgery are associated with less painful recovery. In terms of the laboratory data, the postoperative changes in the WBC count and serum CRP level in the minilaparotomy group were equivalent to those in the historic control group. These results would seem to be expected, as the severity of peritonitis, determined preoperatively, might offset the differences in the laboratory parameters obtained with the different surgical procedures. Nonetheless, it is noteworthy that the indices of minimal invasiveness, such as the frequency of analgesic use, time to first passage of flatus, and the postoperative hospital stay were all in favor of the minilaparotomy approach. It may be argued that our study was not randomized and that the lack of blinded care may have influenced the tendency toward earlier oral intake and the significantly shorter hospital stay in the minilaparotomy group. There may also be the criticism that the ''shorter'' hospital stay was actually relatively long. Japanese patients usually demand longer hospital stays than that recommended by their surgeons, which consequently results in more prolonged hospitalization than that required for the expected recovery. In addition, the families of patients tend to request a longer hospital stay for the patient. These are the factors that were responsible for the relatively long postoperative hospital stay (mean, 13.4 days) in the minilaprotomy group.

We did not include the data from cases of perforated gastric ulcer in the present analysis. Perforated gastric ulcer, although less common,[15] is associated with a greater morbidity and mortality compared with perforated duodenal ulcer. Information on perforated gastric ulcer is limited and the recommendations for its management are not clear.[25] Furthermore, the clinical profile, etiology, and surgical interventions in patients with gastric ulcers are not same as those in patients with duodenal ulcers. We thus consider that the management of perforated gastric ulcer should be analyzed in a separate study. During the present study period, we encountered 15 patients with perforated gastric ulcer. Among the 13 patients in whom surgical intervention was indicated as the first-line treatment, minilaparotomy was used in 5 patients, and successful closure of the perforation was achieved in 4 of these 5 cases (unpublished data). Thus, our minilaparotomy approach also seems to be feasible for selected cases of perforated gastric ulcer, but further collection of cases is needed to validate the findings.

In conclusion, our minilaparotomy approach appears to be a feasible, safe, and less invasive surgical approach compared with the conventional open surgical approach in selected patients with perforated duodenal ulcer. Comparison of the minilaparotomy approach with the laparoscopic approach was not undertaken in the present study, and needs to be undertaken in the future. However, it can be said that the minilaparotomy approach does not involve high expense, does not require any specialized surgical skills, and appears to be feasible for a larger population base than the laparoscopic approach. We believe that our minilaparotomy approach should continue to be used as a useful treatment alternative to laparoscopic or conventional open repair, depending on the surgeons' preference and the patients' selection.

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