Laparoscopic correction of perforated peptic ulcer: first choice?
A review of literature

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Abstract

Background Perforated peptic ulcer (PPU), despite anti-ulcer medication and Helicobacter eradication, is still the most common indication for emergency gastric surgery associated with high morbidity and mortality. Outcome might be improved by performing this procedure laparoscopically, but there is no consensus on whether the benefits of laparoscopic closure of perforated peptic ulcer outweigh the disadvantages such as prolonged surgery time and greater expense.

Methods An electronic literature search was done by using PubMed and EMBASE databases. Relevant papers written between January 1989 and May 2009 were selected and scored according to Effective Public Health Practice Project guidelines.

Results Data were extracted from 56 papers, as summarized in Tables 1–7. The overall conversion rate for laparoscopic correction of perforated peptic ulcer was 12.4%, with main reason for conversion being the diameter of perforation. Patients presenting with PPU were predominantly men (79%), with an average age of 48 years. One-third had a history of peptic ulcer disease, and one-fifth took nonsteroidal anti-inflammatory drugs (NSAIDs). Only 7% presented with shock at admission. There seems to be no consensus on the perfect setup for surgery and/or operating technique. In the laparoscopic groups, operating time was significant longer and incidence of recurrent leakage at the repair site was higher. Nonetheless there was significant less postoperative pain, lower morbidity, less mortality, and shorter hospital stay.

Conclusion There are good arguments that laparoscopic correction of PPU should be first treatment of choice. A Boey score of 3, age over 70 years, and symptoms persisting longer than 24 h are associated with higher morbidity and mortality and should be considered contraindications for laparoscopic intervention.

Keywords Laparoscopic surgery · Perforated peptic ulcer · Omentoplasty · Review

Since the late 1980s, laparoscopy has become increasingly popular. In the beginning laparoscopy was mainly used for elective surgery since it was not clear what the influence was of the pneumoperitoneum on the acute abdomen with peritonitis. However the benefits of laparoscopy with regard to the acute abdomen as a diagnostic tool have been established since, and also its therapeutic possibilities seem to be advantageous [1–3]. The rapid development of laparoscopic surgery has further complicated the issue of the best approach for the management of perforated peptic ulcer (PPU) [4]. PPU is a condition in which laparoscopic repair is an attractive option. Not only is it possible to identify the site and pathology of the perforation, but the procedure also allows closure of the perforation and peritoneal lavage, just like in open repair but without a large upper abdominal incision [5, 6]. Nonetheless, not all patients are suitable for laparoscopic repair [5]. Despite many trials (mostly nonrandomized or retrospective), the routine treatment for perforated peptic ulcer still seems to be by upper laparotomy, representing the main motive for
reviewing the literature and summarizing all (significant) results.

Materials and methods

An extensive electronic literature search was done by using PubMed and EMBASE databases. Keywords used for searching were “laparoscopic,” “correction,” “repair,” and “peptic ulcer.” All papers in English or German language published between January 1989 and May 2009 were included. Papers were scored according to Effective Public Health Practice Project (EPHPP) guidelines as advised in Jackson’s guidelines for systematic reviews [7]. Using this rating system each paper was classified as weak, moderate or strong.

Results

Fifty-six relevant articles were found by PubMed and EMBASE search. Of these, 36 were prospective or retrospective trials, 5 were review articles, 3 articles described new techniques making laparoscopic correction of PPU more accessible, and 12 were general, of which 1 was the European Association for Endoscopic Surgery (EAES) prospective randomized trials have been performed (n = 3). Still, data extracted from these papers are interesting.

Patient characteristics

Often it was mentioned that age of patients presenting with PPU is increasing, due to better medical antiulcer treatment and also because of more NSAID and aspirin usage in the elderly population [4, 17, 56]. The results in Table 2 show that the average age of patients with PPU was 48 years and that only 20% of these patients had used NSAIDs. One-third of patients had a history of peptic ulcer. Although Helicobacter pylori is known to be present in about 80% of patients with PPU, this might indicate that there are more factors related to PPU for which the pathology is not yet clear [4]. Sixty-seven percent of perforations were located in the duodenum and only 17% were gastric ulcers (Table 2), according to findings in literature [58]. In 85% there was free air visible on X-ray (Table 2), which supports the diagnosis, but free air could be caused by other perforations as well and, although the diagnosis of PPU is not difficult to make, sometimes there is a good indication for diagnostic laparoscopic to exclude other pathology [2]. In 93–98%, definitive diagnosis could be made by performing diagnostic laparoscopy in the patient with an abdominal emergency, of which 86–100% could be treated laparoscopically during the same session [1, 2].
| Study             | Design  | Study design | Number patients | Procedure | Conversion rate (%) |
|------------------|---------|--------------|-----------------|-----------|---------------------|
| Vaidya 2009      | Weak    | NRP          | 31              | Lap       | 6.5                 |
| Ates 2008        | Moderate| NRP          | 17              | Lap       | 17.6                |
| Song 2008        | Weak    | NRP          | 35              | Lap       | 5.7                 |
| Bhogal 2008      | Moderate| NRP          | 19              | Lap       | 0.0                 |
| Ates 2007        | Weak    | NRP          | 17              | Lap       | 17.6                |
| Malkov 2004      | Moderate| NRP          | 42              | Lap       | 0.0                 |
| Siu 2004         | Moderate| NRP          | 172             | Lap       | 21.5                |
| Arnaud 2002      | Weak    | NRP          | 30              | Lap       | 16.6                |
| Lee 2001         | Weak    | NRP          | 155             | Lap       | 28.5                |
| Khourseed 2000   | Weak    | NRP          | 21              | Lap       | 4.7                 |
| Kathkouda 1999   | Weak    | NRP          | 30              | Lap       | 17.0                |
| Bergamaschi 1999 | Weak    | NRP          | 17              | Lap       | 23.5                |
| Matsuda 1995     | Weak    | NRP          | 11              | Lap       | 21.4                |
| Lee 2004         | Weak    | NRP          | 30              | Lap       | 3.3                 |
| Druart 2002      | Strong  | PR           | 63              | Lap       | 14.2                |
| Siu 2002         | Strong  | PR           | 58              | Open      |                     |
| Lau 1996         | Moderate| PR           | 52              | Lap       | 23.0                |
| Bentleff 2009    | Strong  | PR           | 52              | Lap       | 7.7                 |
| Palanivelu 2007  | Weak    | R            | 120             | Lap       | 0.0                 |
| Lunevicius 2005  | Moderate| R            | 60              | Lap       | 23.3                |
| Lunevicius IV    | Weak    | R            | 60              | Lap       | 23.3                |
| Kirshtein 2005   | Weak    | R            | 68              | Lap       | 4.4                 |
| Tsumura 2004     | Weak    | R            | 58              | Lap       | 12.0                |
| Seelig 2003      | Weak    | R            | 24              | Lap       | 12.5                |
| Al Aali 2002     | Weak    | R            | 60              | Lap       | 6.6                 |
| Lee 2001 I       | Weak    | R            | 209             | Lap       | 26.8                |
| Robertson        | Weak    | R            | 20              | Lap       | 10.0                |
| So 1996          | Weak    | R            | 16              | Open      |                     |
| Johansson 1996   | Weak    | R            | 10              | Lap       | 0.0                 |
| Total            |         |              | 2788            |           | 12.4                |

*NRP* nonrandomized prospective, *PR* prospective randomized, *R* retrospective, *EPHPP* Effective Public Health Practice Project
Table 2 Demographics of patients with perforated peptic ulcer disease

|                      | Total (n = 2,784) |
|----------------------|-------------------|
| Age (years)          | 48                |
| Male (%)             | 79                |
| History of ulcer (%) | 29                |
| History of NSAID use (%) | 20              |
| Smokers (%)          | 62                |
| Alcohol use (%)      | 29                |
| ASA I (%)            | 35                |
| ASA II (%)           | 37                |
| ASA III (%)          | 20                |
| ASA IV (%)           | 9                 |
| Boey 0               | 59                |
| Boey 1               | 23                |
| Boey 2               | 16                |
| Boey 3               | 2                 |
| Shock at admission (%) | 7                |
| Duration of symptoms (h) | 13.6        |
| Free air on X-ray (%) | 85               |
| Symptoms >24 h (%)   | 11                |
| Size perforation (mm) | 5.5             |
| Manheim peritonitis index | 15.1            |
| WBC                  | 12.3              |
| Localization ulcer   |                   |
| Duodenal (%)         | 67                |
| Juxtapyloric (%)     | 23                |
| Gastric (%)          | 17                |

WBC white blood cells

Surgical technique

There seems to be no consensus on how to perform the surgical procedure, which probably means that the perfect setup has not yet been found. Forty-four percent of surgeons preferred to stand between the patient’s legs, while 33% performed the procedure at the patient’s left side. Also, the number, position, and size of trocars differed between surgeons. Placing and tying sutures was more demanding laparoscopically, and two techniques were used (Table 4). Theoretically there is a preference for intracorporeal knotting over extracorporeal suturing, because the latter is likely to cut through the friable edge of the perforation [12]. One of the disadvantages of laparoscopic correction of PPU often mentioned was the significant longer operating time, which causes more costs and may be nonpreferable in a hemodynamically unstable patient [5, 16, 18, 35, 42, 43, 45, 46]. Ates et al. presented results with simple suture repair of PPU without using pedicled omentoplasty [11]. This significantly shortened operating time, but the question remains of whether it is safe to abandon omentoplasty completely. Cellan-Jones emphasized the necessity for omentoplasty [59]. His advised technique, to prevent tearing out of sutures and prevent enlargement of the size of perforation by damaging the friable edges, is to place a plug of pedicled omentum into the “hole” and secure this with three tie-over sutures. His technique is often called the Graham patch, but Graham describes in his article the use of a free omental plug, a technique that hardly any surgeon uses nowadays [60]. It might be less confusion to use the term “pedicled omentoplasty.” The usefulness of pedicled omentoplasty has been emphasized by others, and Schein even stated: “first suturing the hole and then sticking omentum over the repair is wrong, if you cannot patch it, then you must resect” [59, 61]. Avoiding omentoplasty might shorten operating time but might be the reason for a higher incidence of leakage at the repaired ulcer side [5, 24]. Another reason for longer operating time during the laparoscopic procedure might be the irrigation procedure. Peritoneal lavage is one of the key interventions in the management of PPU [4]. Lavage was performed with 2–6 L warm saline, but even up to 10 L has been described (Table 3) [4]. By using a 5-mm or even 10-mm suction device, this part of surgery took even up to 58 min [30]. Whether generous irrigation is really necessary has not yet been proven.

Patient selection

Not all patients are suitable for laparoscopic repair, and it is important to preselect patients who are good candidates for laparoscopic surgery [5]. Boey’s classification appears to be a helpful tool in decision-making [4, 56]. The Boey score is a count of risk factors, which are: shock on admission, American Society of Anesthesiologists (ASA) grade III–V, and duration of symptoms [52]. The maximum score is 3, which indicates high surgical risk. Laparoscopic repair is reported only to be safe with Boey score 0 and 1 [16, 42]. Since the incidence of patients with Boey score 2 and 3 is low (according to Table 2, only 2% of patients were admitted with Boey score 3, 7% were in shock at admission, and 11% had prolonged symptoms for more than 24 h) and Boey 2 and 3 is associated with high morbidity and mortality rate anyway, independent of type of surgery, it is difficult to find significant foundation for this statement. Other reported contraindications are age >70 years and perforation larger than 10 mm in diameter [16, 17, 32, 33].

Reasons for conversion

Overall conversion rate was 12.4%, with a range of 0–28.5% (Table 1). The most common reason for conversion was the size of perforation, but by using an omental
patch this might not necessarily have to be a reason anymore to convert. From literature it was already known that other common reasons for conversion include failure to locate the perforation [17]. Shock at admission was associated with a significant higher conversion rate (50% versus 8%) [4]. Furthermore, time lapse between perforation

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**Table 3** Results of prospective randomized trials

|                           | Siu 2002 | Lau 1996 | Bertleff 2009 | Average |
|---------------------------|---------|----------|---------------|---------|
| **Laparoscopic correction** |         |          |               |         |
| Operating time (min)      | 42      | 94       | 75            | 70.3    |
| Nasogastric tube (days)   | 3.0     | 2.5      | 2.0           | 2.5     |
| Normal diet (days)        | 4.0     |          |               | 4.0     |
| Postoperative opiate use  | 0 injections | 1.5 days  | 1 day         |         |
| Hospital stay (days)      | 5.5     | 5.5      | 6.5           | 6.0     |
| Morbidity (%)             | 25      | 23       | 18            | 22.0    |
| Normal daily activities (days) | 10.4  |             |               | 10.4    |
| Mortality (%)             | 1.6     | 2        | 3.8           | 2.5     |
| Ileus (days)              | 0       |          |               | 0.0     |
| Wound infection (%)       |         |          |               | 0.0     |
| Leakage (%)               |         |          |               | 3.0     |
| VAS day 1                 | 3.5     | 4.0      | 3.8           | 3.8     |
| VAS day 3                 | 1.6     |          | 2.1           | 1.9     |

**Open correction PPU**

|                           | Siu 2002 | Lau 1996 | Bertleff 2009 | Average |
|---------------------------|---------|----------|---------------|---------|
| Operating time (min)      | 52.3    | 54       | 50            | 52.1    |
| Nasogastric tube (days)   | 3.0     | 2.5      | 3.0           | 2.8     |
| Normal diet (days)        | 4.0     |          |               | 4.0     |
| Postoperative opiate use  | 6 injections | 3.5 days  | 1 day         |         |
| Hospital stay (days)      | 5       | 8        | 8             | 6.5     |
| Morbidity (%)             | 50      | 22       | 36            | 36.0    |
| Normal daily activities (days) | 26.1  |             |               | 26.1    |
| Mortality (%)             | 5.2     | 4.0      | 8.1           | 5.8     |
| Ileus (days)              |         |          |               | 2.0     |
| Wound infection (%)       |         |          |               | 6.1     |
| Leakage (%)               |         | 2.2      | 0             | 1.1     |
| VAS day 1                 | 6.4     | 5.0      | 5.2           | 5.5     |
| VAS day 3                 | 3.3     |          | 3.0           | 3.2     |

*VAS visual analog scale*

**Table 4** Surgical technique (29 studies)

|                                | Siu 2002 | Lau 1996 | Bertleff 2009 | Average |
|--------------------------------|---------|----------|---------------|---------|
| Closure of perforation         | 66% omental patch | 24% mixed techniques | 10% sutures only |
| Pneumoperitoneum               | 26% Hassan trocar | 47% Veress needle | 26% mixed |
| Pneumoperitoneum pressure      | 75% 12 mmHg | 25% 11 or 14 mmHg |       |
| Camera position                | 35% supraumbilical | 35% umbilical | 30% infraumbilical |
| Number of trocars used         | 60% four trocars | 40% three trocars |       |
| Surgeon position               | 44% between legs | 33% left side patient | 16% between or left side | 6% right side |
| Irrigation fluid               | 45% generous | 55% between 2 and 6 L |       |
| Camera angle                   | 80° 30° | 10° 40° | 10° 0° |       |
| Nasogastric tubing             | 94% yes | 6% no |       |       |
| Abdominal drains               | 79% yes | 21% no |       |       |
| Suture material                | 64% resorbable | 38% nonresorbable |       |
| Knotting technique             | 64% intracorporeal | 14% extracorporeal | 14% mix |
Comparing results shows a remarkable difference in morbidity (14.3% in the laparoscopic group versus 26.9% in the open group) and mortality (3.6% versus 6.4%) (Table 6). Many trials measured the amount of postoperative opiate usage, but since this was scored in different ways (days used, number of injections, amount of opiates in mg) these data were not comparable. However, overall, many studies showed significant reduction in pain, mortality, morbidity, wound infection, resuming normal diet, and hospital stay (Tables 6 and 7). Of course there are some negative results which cannot be ignored (Table 7). Three papers reported a significant higher incidence of suture leakage, associated in one with a higher incidence of reoperations, but leakage mainly occurred in the sutureless repair group or in the group in which (pedicled) omentoplasty was not routinely used [18, 24, 32].

Overall there seems to be significant proof of the benefits of laparoscopic repair, but it is technical demanding surgery which needs a surgeon experienced with laparoscopy [4, 17]. CO2 insufflation of the peritoneal cavity in the presence of peritonitis has been shown in rat models to cause an increase in bacterial translocation [4]. This led to the assumption that laparoscopic surgery might be dangerous in patients with prolonged peritonitis. Vaidya et al. performed laparoscopic repair in patients with symptoms of PPU for more than 24 h and concluded that it was safe even in patients with prolonged peritonitis, which has been confirmed by others [4, 8, 39, 44].

**Alternative techniques**

Closing the perforation site using suture repair is challenging, which is why alternative methods have been described [5, 15, 21, 24, 25, 31]. Examples are represented by the sutureless repair of PPU, in which the perforation is closed by a gelatin sponge glued into the perforation or the perforation is closed by fibrin glue. Song et al. proposed the simple “one-stitch” repair with omental patch [9]. The automatic stapler has been used for perforation site closure, use of running suture was suggested to avoid intracorporeal or extracorporeal knotting, and combined laparoscopic–endoscopic repair has been described as well [21].

**Definitive ulcer surgery**

The need for definitive surgical management of peptic ulcer disease has markedly decreased, but 0–35% of patients admitted for PPU received definitive ulcer surgery [8, 16, 20, 56]. Definitive ulcer surgery can be performed safely with laparoscopic techniques [4, 12, 36]. Palanivelu et al. performed definitive surgery in 10% of cases admitted for PPU. All procedures (posterior truncal vagotomy and anterior highly selective vagotomy) were
performed laparoscopically without conversion or mortality [12].

Research

A few aspects regarding laparoscopic repair of PPU are still unclear, and further research on these topics would be interesting. One of the remaining questions is whether there is less formation of intra-abdominal adhesions after laparoscopic repair [4]. If this is the case, it would be another convincing reason to perform this procedure laparoscopically. Often mentioned as one of the major disadvantages of laparoscopic surgery are the high costs, caused by the need for more surgical staff and laparoscopic equipment. However, no specified calculation of per- and postoperative costs have been made so far, and also the costs saved by possible earlier return to work have to be taken into account.

To conclude, the results of this review support the statement of the EAES already made in 2006 that, in case of suspected perforated peptic ulcer, laparoscopy should be advocated as diagnostic and therapeutic tool [14].

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