Does omental plugging provide a better surgical treatment outcome than the omentopexy technique in the management of giant peptic ulcer perforation? A meta-analysis of comparative studies

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Abstract

Introduction: Giant perforation (size > 2cm) is a catastrophic complication of peptic ulcer disease which is difficult to repair and leads to postoperative leakage and consequently 60% of morbidity and 48.2% of mortality. The objective of this meta-analysis was to compare the postoperative outcomes of omental plugging and omentopexy in the treatment of giant ulcer perforation.

Material and Methods: The dataset was defined by searching for articles published until December 2020 from PubMed, EMBASE, Google Scholar, and the Cochrane database. The search terms included were giant peptic ulcer, peptic ulcer perforation, omentopexy, and omental plug. The data analysis included a study published in English that evaluated the surgical outcomes of omental plugging and omentopexy in the management of giant peptic ulcer perforation patients. Meta- analysis was performed using Review Manager Software version 5.4.1.

Results: A total of 175 articles were identified during the initial search. Eight articles were found

to be suitable for inclusion in the meta-analysis after being reviewed. A total of 367 patients were included in the final analysis. The findings demonstrate that when compared to the omentopexy group, the omental plugging technique significantly reduced overall postoperative complications (OR = 0.29, 95% CI = 0.18– 0.47, P = 0.0001) and bile leakage rate (OR = 0.18, 95 % CI = 0.07–0.46, P = 0.0003), resulting in a significantly lower postoperative mortality rate (OR = 0.35,95% CI = 0.17 – 0.69, P= 0.003). However, there was no significant difference in intraabdominal collection, respiratory tract, and wound infection rates between each surgical treatment group. **Conclusion:** Omental plugging is a simple surgical procedure which has been associated with fewer postoperative complications and mortality than omentopexy. For peptic ulcer perforations larger than 2 centimeters, this technique is a safe surgical treatment option.

Keywords: Giant peptic perforation; Peptic ulcer; Omental plugging; Omentopexy; Leakage; Mortality

Introduction

Peptic ulcer perforation (PUP) is a life-threatening surgical condition that occurs in 2- 20% of peptic ulcer disease patients and which may increase mortality by up to 24- 30% [1,2]. Giant peptic ulcer perforation (Giant PUP) is defined as a perforation equal to or larger than 2 cm, resulting in extensive tissue loss and severe tissue inflammation of the gastric or duodenal wall. [3,4] These effects may preclude the ulcer from healing following surgical repair and lead to increased postoperative morbidities (such as bile leakage, intraabdominal collection) and mortality[5,6].

Open surgical repair by simple interrupted sutures for closure of the perforation combined with a free omentum patch sutured on top of the repair (omentopexy) is a technique described by Graham which has become a standard treatment for peptic ulcer perforation [7]. However, omentopexy repair in giant perforated ulcers is associated with an increased risk of omental patch failure, resulting in higher overall morbidity than in smaller perforations [8].

In order to secure the perforation and achieve maximum ulcer healing, antrectomy with vagotomy should be considered in the management of giant ulcer perforations. Nevertheless, the effectiveness of this technique may be limited by the following features: 1) greater morbidity (50-60%) and mortality (10-fold increase) than the simple closure technique; 2) many surgeons practicing today have limited experience with the procedure; and 3) nearly all giant PUP patients are critically ill, putting them at a higher surgical risk. [9,10,11].

Karanjia first described the omental plugging technique in 1993, which is a simple procedure with a short operating time and learning curve. This technique appears to be appropriate to be used in critically ill patients as an effective treatment for PUPs larger than 2 cm. [12, 13].

Several studies report that omental plugging is associated with lower morbidity but has no benefit on mortality compared to the omentopexy technique, but these findings are limited since most such studies are non-randomized and include small sample sizes. The present study therefore conducts a meta-analysis to compare postoperative outcomes, including mortality and postoperative complications, between omental plugging and the omentopexy technique in the management of giant PUP.

Material and methods

Data sources and search strategies

Electronic literature searches were performed on PubMed, Embase, Google Scholar, and the Cochrane database. The search terms ‘giant peptic ulcer’, ‘peptic ulcer perforation’, ‘omentopexy’, and ‘omental plug’ were used as keywords to identify all English-language studies published through to December 2020 in order to identify all relevant studies. Meta- analysis was performed according to the PRISMA 2020 statement, a guideline for reporting systematic reviews [14]. The protocol of this meta-analysis was registered on PROSPERO (CRD42021258704): https://www.crd.york.ac.uk/prospero/#recordDetails

Study selection and eligibility criteria

The study inclusion criteria was as follows: (1) studies published in English; (2) peptic ulcer perforation proven by the clinical and radiologic diagnosis; (3) clarification of giant PUP as gastric or duodenal ulcer perforation size equal or larger than 2 centimeters (cm); (4) studies which compare outcomes of surgical treatment techniques between omental plug and omentopexy group; and (4) outcomes must evaluate perioperative mortality and postoperative complication rate.

Omental plug is defined as the pedicle of the greater omentum was transfixed with 3-4 sutures that pass through the perforation inside the lumen, then the sutures are tied to pull the omental pedicle into the lumen forming an effective plug for closure of the perforation site [15].

Another omental plugging technique is described as the free edge of greater omentum which is transfixed by 1-0 or 2-0 rapid absorbable sutures to the tip of a nasogastric tube that pass through the perforation site. The tube is then withdrawn until 5-6 cm of the omentum occludes the

perforation, and an additional 5–6 interrupted stitches are taken between the omentum and serosa of healthy duodenum and/or stomach.

The omentopexy group is defined by the perforation site being repaired by three interrupted Lambert sutures with 2-0 polyglactin or silk using a patch of omentum pedicle to reinforce the suture line (Graham's patch). This procedure was modified by passing the suture between the perforation's edges and tying to close the perforation, then introducing the pedicle of omentum between these sutures and tying these sutures again with a pedicle of omentum between knots over the perforation (Modified Graham's patch). [7]

Postoperative mortality rate is defined as a death that occurred during the 30-day postoperative period. Finally, postoperative complication is defined as overall postoperative complication, wound infection, respiratory tract infection, intraabdominal collection, and bile leakage.

The exclusion criteria was as follows: (1) non-English language articles; (2) review articles or case reports; (3) studies involving pediatric patients (aged < 15 years); and (4) non comparative studies. The Newcastle-Ottawa scale was used to assess the quality of the studies included in the meta-analysis, which evaluates case selection methods, research design to account for comparative variables, and method for assessing outcomes. The maximum possible score is 9 points which represents the highest methodological quality. [16]

Statistical analysis

The two reviewers independently extracted the following information from the selected studies: author names, country of origin, year of publication, study design, number of patients,

patient characteristics, surgical treatment methods, and postoperative outcomes. Extracted data was cross-checked to reach consensus and then entered into a computerized spreadsheet for analysis.

Meta-analysis was performed using Review Manager software, version 5.4.1 which was provided by the Cochrane Collaboration (Nordic Cochrane Center, Cochrane Collaboration, Copenhagen, Denmark). Cochrane's chi-square-based Q-statistic test was applied to assess between-study heterogeneity. An I^2 statistic was used to test for heterogeneity between the included studies ($p < 0.05$ is considered for significant heterogeneity).

The postoperative mortality and complication rates of the patients were analyzed using the Mantel-Haenszel method to generate a pooled odds ratio (OR) with 95% confidence intervals (95%CI) in order to compare the mortality and postoperative complications between the omental plug and omentopexy groups. OR was considered statistically significant at the $p < 0.05$ level and the 95% confidential interval (CI) did not include the value 1.

The fixed-effect model was adopted to calculate ORs. However, where significant evidence of heterogeneity was detected, the random-effected model is used to access a weighted average of the effects reported in different studies to calculate levels of association. Publication bias was assessed by visual examination of a funnel plot, while asymmetry was formally assessed using both Egger's linear regression test and the rank correlation test (Begg's test).

Results

The initial search identified a total of 175 potential articles. After screening, eight articles (four prospective non-randomized studies, three prospective randomized studies, and one

retrospective study) that matched the research criteria were deemed suitable for inclusion in the meta-analysis [17-24]. The PRISMA diagram used in the search process is shown in **Figure 1**.

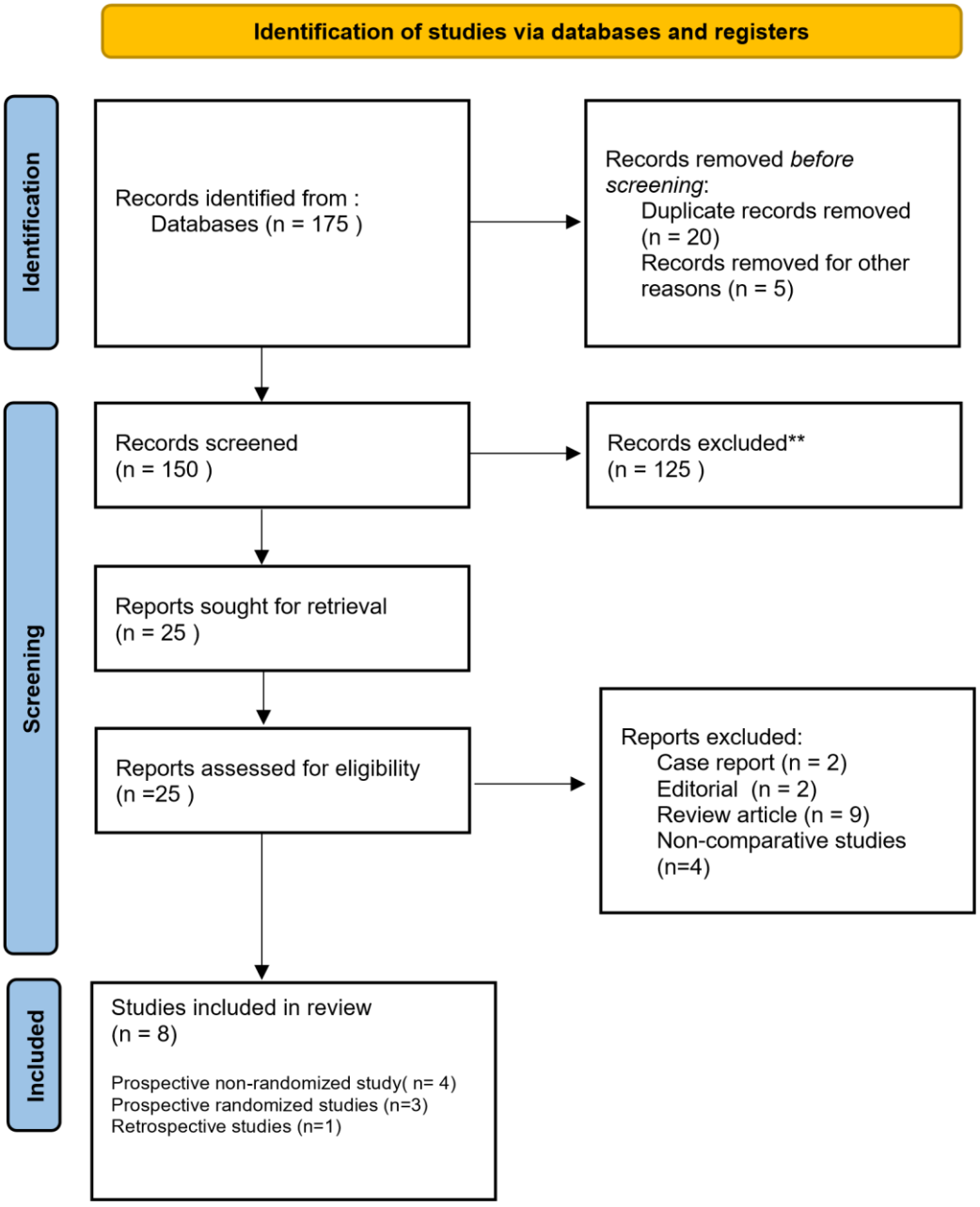


Figure 1: Selection process of studies for inclusion in the meta-analysis.

The two reviewers showed 100% agreement with the final dataset. The pooled studies included 367 patients which were used to investigate the association between the omental plug and omentopexy with the postoperative complication and mortality rate.

Omental plug was performed in 179 patients (48.8%) and omentopexy was performed in 188 patients (51.2%). The Newcastle-Ottawa scale found that all the studies included in the meta-analysis were of moderate to good quality (6–7 stars). The characteristics of the eight included studies are shown in **Table 1**.

Table 1: Characteristics of the 8 studies included in the meta-analysis regarding the association between omental plug and omentopexy with the postoperative outcomes.

- *Mortality*

The main purpose of this study was to compare the postoperative mortality rate between the omental plug and omentopexy groups. Eight studies which involved 367 patients reported the association between each surgical technique with mortality as an outcome [17-24]. The overall mortality rate was 12.3% (45/367), in which the postoperative mortality in the omental plug and omentopexy groups were 6.7% (12/179) and 17.6% (33/188), respectively.

The pooled analysis demonstrated that the postoperative mortality rate in the omental plug group was significantly lower than the omentopexy group (OR = 0.35,95% CI = 0.17 – 0.69, P= 0.003). There was no significant heterogeneity between studies (I^2 = 0%, p= 1.00). The pooled analysis also represent an absolute risk difference of 0.12 and number need to treat of 8.3.

A forest plot displaying the association between omental plug and omentopexy with the postoperative mortality is illustrated in **Figure 2**. No evidence of publication bias was observed by either Egger's test (P = 0.052) or the rank correlation test (P = 0.216). **Figure 3** presents a funnel plot of the meta-analysis with a symmetrical distribution.

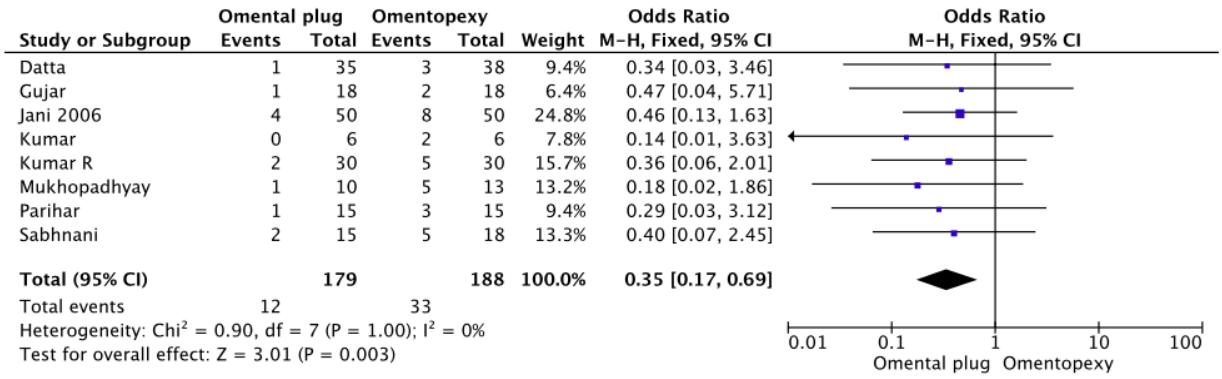
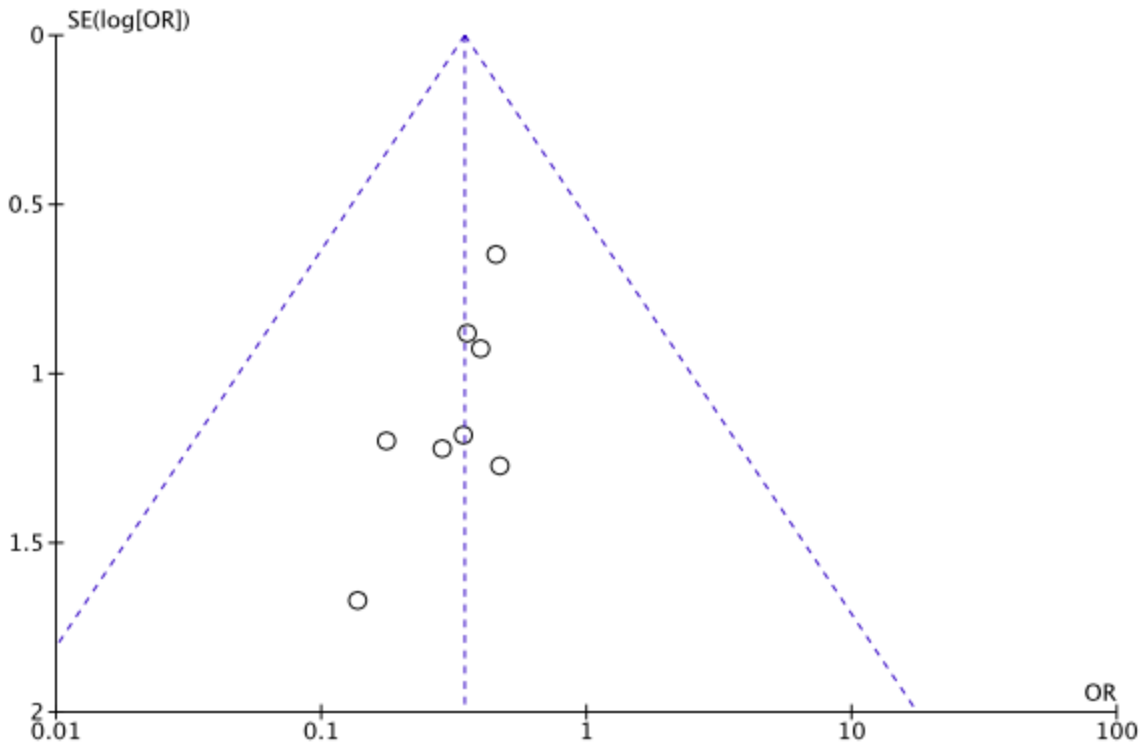


Figure 2: Forest plot of the association between omental plug and omentopexy with the perioperative mortality.



Funnel 3: Funnel plot of the association between omental plug and omentopexy with the perioperative mortality.

- *Postoperative complication*

Eight studies reported an association between overall postoperative complication and the surgical treatment techniques [17-24]. The overall postoperative complication rate was 30.2% (54/179) and 69.8% (105/188) in the omental plug and omentopexy groups, respectively. The pool analysis demonstrates that the overall postoperative rate was significantly higher in the omentopexy group (OR = 0.29,95% CI = 0.18 – 0.47, P < 0.0001). The pooled analysis represent

an absolute risk difference of 0.26 and number need to treat of 3.8 without evidence of heterogeneity between studies (I^2 = 0%, p= 0.69). Evidence of publication bias was not observed by both Egger's test (P = 0.276) and the rank correlation test (P = 0.322).

Wound infection occurred in 14.7% (19/129) of patients in the omental plug group compared to 21% (29/138) in the omentopexy group. The pooled analysis of seven studies [17-23] demonstrated no significant difference in the wound infection rate between each surgical treatment group (OR = 0.66, 95% CI = 0.35 – 1.26, P = 0.21). The pooled analysis represented absolute risk difference of 0.07 and number need to treat of 14.3. There was no significant heterogeneity between studies (I^2 = 0%, p= 0.94) and no evidence of publication bias was observed by both Egger's test (P = 0.532) and the rank correlation test (P = 0.453).

The rate of respiratory tract infection was 12.4% (16/129) in the omental plug group compared to 17.4% (24/138) in the omentopexy group. The pooled analysis of seven studies [17-23] demonstrated no significant difference in the respiratory tract infection rate between each surgical treatment group (OR = 0.68,95% CI = 0.34 – 1.36, P = 0.28). The pooled analysis represented absolute risk difference of 0.05 and number need to treat of 20 . No evidence of heterogeneity (I^2 = 0%, p=1.00) or publication bias was observed in this analysis (Egger's test [P = 0.336], rank correlation test [P = 0.710]).

The pooled analysis from seven studies [17-23] demonstrated that the incidence of the intraabdominal collection was not significantly different in both surgical treatment groups (6.2% and 9.4% in the omental plug and omentopexy group); OR = 0.68,95% CI = 0.28 – 1.64, P = 0.39. The pooled analysis represented absolute risk difference of 0.03 and number need to treat of 33.3.

There was no evidence of either heterogeneity (I^2 = 0%, p=0.96) or publication bias in this analysis (Egger's test [P = 0.262], rank correlation test [P = 0.176]).

The final analysis was conducted from seven studies [17,18,19,21-24] to evaluate the association between the incidence of bile leakage and surgical treatment techniques. The pooled analysis demonstrated that the bile leakage rate in the omental plug group was significantly lower than the omentopexy group (1.8% versus 15%); OR = 0.18 ,95% CI = 0.07 – 0.46, P = 0.0003. The pooled analysis represented absolute risk difference of 0.13 and number need to treat of 7.7. There was also no evidence of heterogeneity (I^2 = 0%, p= 0.89) and publication bias observed in this analysis (Egger's test [P = 0.127], rank correlation test [P = 0.881]). A forest plot displaying the association between omental plug and omentopexy with postoperative complication is illustrated in **Figure 4.**

Figure 4: Forest plot of the association between omental plug and omentopexy with the perioperative complications.

Discussion

The literature reports an incidence of giant peptic ulcers of about 14% and 2.4% for gastric and duodenal ulcers, which have a high risk for developing catastrophic perforation (3.2- 9%) [24,25]. Giant perforations are difficult to repair due to severe tissue inflammation concomitant with a high intraluminal pressure that tends to disrupt the suture line, causing bile leakage, generalized peritonitis, and bursting of the abdomen, resulting in a 26.6-48.2% mortality rate [26,27].

The omentum is an intraperitoneal organ contained with large adipose tissue that provides biological properties included neovascularization, hemostasis, and tissue healing. Thus, omentum has been applied in gastrointestinal surgery to wrap around the sites of the gastro-duodenal perforation for the purpose of promoting fibrosis and regeneration of the duodenal wall to prevent leakage. [28,29]

The incidence of omental flap failure for omentopexy in giant ulcer perforation is reported to be 12% [24]. Thus, the omental plugging technique has been developed to improve surgical outcomes. This technique is simple and does not require a level of surgical expertise that may be unavailable in an emergency. The World Society of Emergency Surgery's guideline for the management of perforated and bleeding peptic ulcers suggested an omental plugging technique as a surgical option in the management of giant duodenal ulcer perforation. [30]

The pooled results indicate that omental plugging is associated with a significant reduction in the overall complications (30.2 % versus 69.8 %). Subgroup analysis of the postoperative complication outcome was conducted to attempt to clarify the effectiveness of this technique, and it was established that the omental plugging group had a lower incidence of bile leakage than the omentopexy group (1.8 % versus 15%).

The omentopexy group seemed to have a greater incidence of respiratory tract infection, wound infection, and intraabdominal collection. However, no significant difference in surgical site infection rates was found between the surgical technique groups. The pooled analysis in this study revealed that the incidence of surgical site infection was less than 20%, which could be attributed to the fact that 1) all of the patients received a broad spectrum antibiotic before surgery and 2) almost all of the patients would have emergency surgery within 24 hours of the onset of the

symptom.These findings correspond with the results of several previous studies.[19,21,31] In contrast, Hasting, et al. reported that respiratory tract and wound infections were the most common postoperative problems, occurring in more than 24% of patients. [32].

The main purpose of the meta-analysis was to investigate the association between mortality and surgical techniques. On account of leakage, the pancreatic enzyme and bile initiate the process of autodigestion, a consequence of uncontrolled intraabdominal infection, and septicemia, leading to patient mortality [33,34]. The omental plugging group had a significantly lower risk of postoperative mortality (6.7 % versus 17.6 %), which could be attributable to the fact that the omental plug was demonstrated to benefit in occlusing and sealing the perforated site, resulting in a lower rate of bile leakage.

The results are somewhat limited due to the risk of publication bias, for instance: 1) the majority of included studies were retrospective or non-randomized studies; 2) the inclusion of only English language publications; and 3) most of the patients in this analysis were from Asian countries and do not represent a global clinicopathological association between postoperative outcomes and surgical techniques.

Regardless of the fact that all of the research analyzed was conducted in India, statistical analysis and funnel plot distribution did not reveal significant evidence of publication bias. The fact that the major etiologies of peptic ulcer perforation are similar around the world due to the high prevalence of Helicobacter Pylori infection and the use of nonsteroidal anti-inflammatory drugs may help to clarify this finding (NSAIDs). [35,36]

Additionally, the results are somewhat complicated by the risk heterogeneity attributed to: 1) difference in the time from diagnosis to operation, which vary from 1 hour to more than 48 hours; 2) patients in some studies presented with septic shock; and 3) four of the included studies only reported outcomes for perforated duodenal ulcer. Yet the evidence of heterogeneity between studies was not observed in this meta-analysis.

Given that this research focused exclusively on studies where omental plugging or omentopexy was performed with the open surgical technique, it may be beneficial for future studies to examine the association between minimally access surgery in combination with the laparoscopic and endoscopic assisted in the management of giant peptic ulcer by omental plugging technique [**37**], which could help improve treatment outcomes.

Conclusion

Giant perforation is a catastrophic complication of peptic ulcer disease that is difficult to repair and is associated with substantial of morbidity and mortality.Omental plugging is associated with fewer overall surgical complications and bile leakage rates than the omentopexy technique, which results in improved patient survival. For peptic ulcer perforations larger than 2 cm, this procedure is a safe surgical treatment option.

Reference

1. Bertleff MJ, Lange JF. Perforated peptic ulcer disease: a review of history and treatment. Dig Surg. 2010 Aug;27(3):161-9.

2. Wang A, Yerxa J, Agarwal S, Turner MC, Schroder V, Youngwirth LM, et al. Surgical management of peptic ulcer disease. Curr Probl Surg. 2020;57(2):100728.
3. Feliciano DV, Bitondo CG, Burch JM, Mattox KL, Jordan GL Jr, DeBakey ME: Emergency management of perforated peptic ulcers in the elderly patient. Am J Surg 1984;148:764–767.
4. Hennessy E. Perforated peptic ulcer mortality and morbidity in 603 cases. Aust NZ J Surg., 1969; 38: 243.
5. Karanjia ND, Shanahan DJ, Knight MJ. Omental patching of a large perforated duodenal ulcer: a new method. Br J Surg. 1993;80(1):65.
6. Chaudhary A, Bose SM, Gupta NM, Wig JD, Khanna SK. Giant perforations of duodenal ulcer. Indian J Gastroenterol. 1991;10(1):14-5.
7. Graham RR., The treatment of perforated duodenal ulcers. Surg Gynecol Obstet. 1937;64:235-8.
8. Gupta S, Kaushik R, Sharma R, Attri A. The management of large perforations of duodenal ulcers. BMC Surg. 2005;5:15.
9. Sachdeva AK, Zaren HA, Sigel B. Surgical treatment of peptic ulcer disease. Med Clin North Am. 1991 Jul;75(4):999-1012.
10. Hill AG. Management of perforated duodenal ulcer. In: Holzheimer RG, Mannick JA, editors. Surgical Treatment: Evidence-Based and Problem-Oriented. Munich: Zuckschwerdt; 2001. Available from:https://www.ncbi.nlm.nih.gov/books/NBK6926/
11. Harbison SP, Dempsey DT. Peptic ulcer disease. Curr Probl Surg. 2005;42(6):346-454.
12. Karanjia ND, Shanahan DJ, Knight MJ. Omental patching of a large perforated duodenal ulcer: a new method. Br J Surg. 1993 Jan;80(1):65.

13. Raj BR, Subbu K, Manoharan G. Omental plug closure of large duodenal defects—an experimental study. Trop Gastroenterol. 1997 Oct-Dec;18(4):180-2.
14. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Int J Surg.2021; 88:105906. doi: 10.1016/j.ijsu.2021.105906
15. Sharma D, Saxena A, Rahman H, Raina VK, Kapoor JP. 'Free omental plug': a nostalgic look at an old and dependable technique for giant peptic perforations. Dig Surg. 2000;17(3):216-8.
16. G. Wells, B. Shea, D. O'Connell, Peterson J, Welth V, Losos M, et al. The Newcastle- Ottawa Scale (NOS) for Assessing the Quality of Nonrandomised Studies in Meta- analyses, Ottawa Health Research Institute, Ottawa (ON), 2010.
17. Kumar R, Kiran S, Hariaudh S. Giant peptic ulcer perforation- omentopexy versus omental plugging: a comparative study. Int Surg J. 2020;7(3):787-790.
18. Sabhnani G, Tomar S. Giant peptic ulcer perforation: Omentopexy versus omental plugging - A study. IAIM, 2016; 3(11): 78-82.
19. Mukhopadhyay M, Banerjee C, Sarkar S, Roy D, Rahman QM. Comparative study between omentopexy and omental plugging in treatment of giant peptic perforation. Indian J Surg. 2011;73(5):341-345.
20. Parihar S, Mathur PN, Joshi CP. Evaluation of large duodenal ulcer perforation with special reference to omentopexy and omental plugging. Int Surg J. 2016;3(3):1229-1233
21. Kumar R, Walia JS, Attri A, Singh S, Goyal S. Closure of peptic ulcer perforation by Grahm's patch with omentopexy versus plugging with omentopexy. International Journal of Surgery and Medicine. 2020;6(6):1-5.

22. Gujar N, Garag SP, Mudhol SA, Karnul AA, Sachin S. Comparative study between omentopexy and omental plugging for giant duodenal ulcer perforation. International Journal of Current Research. 2014;6(5): 6852-6855.
23. Datta PK, Das AK, Mondal D. A comparative study between omentopexy and omental plugging in treatment of duodenal ulcer perforation. J of Evolution of Med and Dent Sci.2015;4(87):15153-15158.
24. Jani K, Saxena AK, Vaghasia R. Omental plugging for large-sized duodenal peptic perforations: A prospective randomized study of 100 patients. South Med J. 2006;99(5):467-71.
25. Csendes A, Becker P, Valenzuela J, Braghetto I, Csendes P. Clinical characteristics of patients with multiple or giant peptic ulcers. Rev Med Chil. 1991;119(1):38-44.
26. Hussain Z, Malik SM. Surgical Outcome of Large and Giant Duodenal Ulcers Perforations. JK Science.2015;17(3):131-134.
27. Maghsoudi H, Ghaffari A. Generalized peritonitis requiring re-operation after leakage of omental patch repair of perforated peptic ulcer. Saudi J Gastroenterol. 2011;17(2):124- 128. doi:10.4103/1319-3767.77243
28. Di Nicola V. Omentum a powerful biological source in regenerative surgery. Regen. Ther., 2019;11: 182-191.
29. Madiba TE, Nair R, Mulaudzi TV, Thomson SR. Perforated gastric ulcer reappraisal of surgical options. S Afr J Surg. 2005;43(3):58-60
30. Tarasconi A, Coccolini F, Biffl WL, Tomasoni M, Ansaloni L, Piceti E, et al. Perforated and bleeding peptic ulcer: WSES guidelines. *World J Emerg Surg*. 2020;15:3.

31. Mondal D, Mukherjee A. A randomized comparative study between omentopexy and omental plugging in treatment of duodenal perforation. Int Surg J. 2019;6(10):3662-3666.
32. Hastings N, Machida R. Perforated peptic ulcer: results after simple surgical closure. Am J Surg.1961;102:136-42.
33. Walley BD, Goco I. Duodenal patch grafting. Am J Surg. 1980 Nov;140(5):706-8
34. Testini M, Portincasa P, Piccinni G, Lissidini G, Pellegrini F, Greco L. Significant factors associated with fatal outcome in emergency open surgery for perforated peptic ulcer. World J Gastroenterol. 2003;9(10):2338-40.
35. Al-Saeed A. Gastrointestinal and Cardiovascular Risk of Nonsteroidal Anti-inflammatory Drugs. Oman Med J. 2011;26(6):385-391.
36. Wang A, Yerxa J, Agarwal S, Turner MC, Schroder V, Youngwirth LM, et al. Surgical management of peptic ulcer disease. Curr Probl Surg. 2020;57(2):100728.
37. Pescatore P, Halkic N, Calmes JM, Blum A, Gillet M. Combined laparoscopic- endoscopic method using an omental plug for therapy of gastroduodenal ulcer perforation. Gastrointest Endosc. 1998;48(4):