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ORIGINAL ARTICLE

Prospective Study

Triple tube drainage for "difficult" gastroduodenal perforations: A prospective study

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Abstract

AIM

To prospectively study the outcome of difficult gastroduodenal perforations (GDPs) treated by triple tube drainage (TTD) in order to standardize the procedure.

METHODS

Patients presenting to a single surgical unit of a tertiary hospital with difficult GDPs (large, unfavourable local and systemic factors) were treated with TTD (gastrostomy, duodenostomy and feeding jejunostomy). Postoperative parameters were observed like time to return of bowel sounds, time to start enteral feeds, time to start oral feeds, daily output of all drains, time to clamping/removal of all drains, time for skin to heal, complications, hospital stay, and, mortality. Descriptive statistics were used.

RESULTS

Between December 2013 and April 2015, 20 patients undergoing TTD for GDP were included, with mean age of 44.6 ± 19.8 years and male:female ratio of 17:3. Mean pre-operative APACHE Ⅱ scores were 10.85 ± 3.55; most GDPs were prepyloric (9/20; 45%) or proximal duodenal (8/20; 40%) and mean size was 1.83 ± 0.59 cm (largest 2.5 cm). Median times of resumption of enteral feeding, removal of gastrostomy, removal of duodenostomy,

removal of feeding jejunostomy and oral feeding were 4 d (4-5 IQR), 13 (12-16.5 IQR), 16 (16.25-22.25 IQR), 18 (16.5-24 IQR) and 12 d (10.75-18.5 IQR) respectively. Median hospital stay was 22 d (19-26 IQR) while mortality was 4/20 (20%).

CONCLUSION

TTD for difficult GDP is feasible, easy in the emergency, and patients recover in two-three weeks. It obviates the need for technically demanding and riskier procedures.

Key words: Peptic ulcer; Perforation peritonitis; APACHE; Triple tube drainage; Duodenostomy

Core tip: Generalised peritonitis secondary to hollow viscous perforation is common in India, with poor outcomes in many patients. Gastroduodenal perforations (GDPs), commonly treated by pedicled omental patch repair, have high leak rates and consequent high mortality, especially with advancing age, large perforations, and other systemic insults. Described strategies for leakage like jejunal patches or grafts, or pyloric exclusion are actually fraught with more risk. To emphasize minimizing time and skill, the concept of damage control from trauma is extrapolated and triple tube drainage is proposed for sick and difficult GDP patients. This study is prospective and demonstrates the ease and utility of this procedure, in an attempt to standardize it.

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INTRODUCTION

Generalised peritonitis secondary to hollow viscous perforation continues to be one of the most common surgical emergencies in India. In fact, the most common cause of exploratory laparotomy in the emergency setting is intestinal perforation peritonitis[1,2]. In most Indian series, small bowel and gastroduodenal perforations are the predominant causes[1,3]. Gastroduodenal perforations (GDPs) in India occur in younger patients and have a worse outcome than in developed countries[1,3,4]. The most common and easily performed procedure for GDP is the pedicledomental patch repair[4,5].

The leak rates after patch repair are 8%-10% in Indian series, while the mortality rates are also high (10%-15%). Leakage leads to a significant increase in morbidity and mortality[1,5,6]. The factors reported to be associated with high leak rates and mortality in gastroduodenal perforations are advancing age, large perforation size (≥ 1.5 cm diameter), presence of malignancy or immunocompromised status, delay in treatment, pre-operative hypotension, and raised serum creatinine levels[4,7]. Up to 25% of GDPs are more than 1 cm in size; about 2%-3% are more than 2 cm. These are particularly predisposed to leakage[5,6]. In our hospital, almost 20% of patients of GDPs have two or more of these adverse factors.

Operative strategies to treat or prevent leakage have included jejunal serosal patch, jejunal or omental pedicle graft, pyloric exclusion with gastrojejunostomy, gastrectomyand vagotomy, and, novel techniques like myocutaneous flaps or gastric disconnection[5,6,8,9]. However, many authors now feel that adding more suture lines in these sick and septic patients is fraught with more risk and poorer results. These procedures need high degree of surgical expertise and may prolong operative time, and none of the above technique is immune to postoperative leak[6]. The emphasis should be on minimizing time and surgical skill.

The concept of damage control surgery for the treatment of complex pancreatico-duodenal injuries has led to the acceptance of diversion and decompression of all enteric secretions. This is mostly performed as "triple tube ostomy" or "triple tube drainage (TTD)". The components are tube gastrostomy, retrograde tube duodenostomy, and, feeding jejunostomy[10,11].

Duodenal decompression is also recommended for the protection of the duodenal stump after gastrectomy for malignancy[12]. Some authors have extrapolated the concept of damage control for GDPs, especially the large or "giant" subtypes and in re-operations after leakage. However, the reported experience of TTD for GDP is small, with only a few case series. There is only one study from India, despite the high prevalence of the condition here. The proponents of TTD feel it to be a significantly underutilized procedure[6,12-14].

This prospective observational study was performed as a pilot study in patients with difficult GDPs treated by triple tube drainage, to study outcomes and standardize this procedure.

MATERIALS AND METHODS

This prospective observational pilot study was conducted in the department of surgery of a teaching tertiary hospital in north India, from December 2013 to April 2015, after getting clearance from the institutional ethics committee. Patients undergoing triple tube drainage for difficult duodenal perforation were included in the study. Difficult gastroduodenal perforations, for the purpose of our study, were defined as cases with two or more of the following features: Perforation size ≥ 1.5 cm, late presentation (≥ 3 d), unfavorable systemic factors (APACHE Ⅱ score ≥ 10), unfavorable local factors (copious pus, friable bowel, indurated or friable margins), and, re-operated patients (leakage after omental patch repair).

The aim of the study was to observe the postoperative

Table 1 Mean/median hematological/laboratory parameters (n = 20)

Parameter	Mean/median ± SD	IQR (1st to 3rd)
Haemoglobin (g/dL)	11.76 ± 2.59	
Total leukocyte counts (/mm^3)	12550	4675 - 19425
Platelet (× 10^5/mm^3)	1.80 ± 1.05	
Blood urea (mg/dL)	47.15	39.75- 67.5
Serum creatinine (mg/dL)	1.49 ± 0.68	
Serum sodium (meq/L)	135.7 ± 7.70	
Serum potassium (meq/L)	4.33 ± 0.90	
pO_2 (mmHg)	93.8 ± 33.20	
pH	7.37 ± 0.07	

IQR: Inter quartile range.

course and outcome of patients undergoing triple tube drainage for difficult gastroduodenal perforations. The primary outcome variables were: Time to oral feeding, time to removal of drains, hospital stay, complications (leakage, surgical site infections, and respiratory complications), and, mortality. As a secondary objective, this was proposed as a pilot study to compare two techniques of duodenal decompression, namely T-tube duodenostomy and retrograde duodenostomy in terms of hospital stay and leak rate.

Flow of study

After a provisional diagnosis of gastroduodenal perforation peritonitis in the emergency room, the patients were admitted for investigations and treatment. Informed written consent was obtained from the patients. The relevant biochemical, haematological and radiological tests were performed; the APACHE Ⅱ score was recorded. After optimization, exploratory laparotomy was performed. Copious lavage with normal saline was followed by identification of perforation site, and assessment of suitability for patch repair. In patients who fulfilled the inclusion criteria for difficult gastroduodenal perforations, the gastroduodenal perforation was first repaired using the standard omental patch technique. This was followed by TTD, consisting of: (1) Gastric decompression using 12-14 Fr tube brought out as gastrostomy; (2) duodenal decompression by retrograde duodenostomy (RD) using 12-14 Fr tube brought out through the jejunum, 10 cm from duodeno-jejunal flexure; and (3) feeding jejunostomy (FJ) using 10-12 Fr tube introduced into jejunum 20 cm from duodeno-jejunal flexure.

All tubes were fixed internally to parietal peritoneum by double purse-string absorbable polygalactin (Vicryl) 2-0 sutures, and fixed externally using purse-string suture with silk No.1. Polydiaxanone sutures would offer less friction, but are more expensive. The feeding jejunostomy and gastrostomy tubes were pulled up till the parietal wall and bowel sutured to peritoneum to ensure a controlled fistula. A sub-hepatic drain (28-32 Fr) was placed near the duodenostomy tube to act as a sump drain.

The abdomen was closed using interrupted far-near technique with polypropylene No. 1 suture. Skin was sutured loosely with packs soaked in antiseptic solution.

Table 2 Pre-operative physiological profile

Parameters	Mean ± SD
Temperature (℃)	37.46 ± 0.87
Mean arterial pressure (mmHg)	78.40 ± 18.60
Pulse rate (beats/minute)	116.7 ± 20.63
Respiratory rate (/minute)	22.3 ± 2.77
Pre-op APACHE-II score	10.85 ± 3.55

Postoperative assessment

Patients were assessed on daily basis in the postoperative period using the following outcome parameters: time to return of bowel sounds, time to start enteral feeds, time to start oral feeds, daily output of all drains, time to clamping/removal of all drains, time for skin to heal, complications, hospital stay, and, mortality. All outcome parameters were analysed using descriptive statistics with SPSS software.

RESULTS

Between December 2013 and April 2015, 20 patients undergoing TTD for difficult gastroduodenal perforation were included in the study. Mean age of the patients was 44.6 ± 19.8 years (range: 10-73 years) with a male: female ratio of 17:3. Table 1 shows the mean/median hematological and laboratory parameters for the 20 patients.

Five patients (25%) were anaemic (Hb < 10 g/dL) at presentation, while five (25%) had total leukocyte counts within the normal range (4000/mm^3-11000/mm^3). Most had leukocytosis, while 4 (20%) had leucopenia. The slightly deranged mean renal functions reflect the state of prerenal/renal azotemia secondary to sepsis. Table 2 reflects the common physiological parameters and mean APACHE-II scores.

Intra-operative findings

Peritoneal contamination with more than 1.4 L of purulent fluid was present in all the cases. The perforation was prepyloric in 9 patients (45%), in the first part of duodenum (D1) in 8 (40%), present in the body of stomach in 2 (10%), and, in the duodenum distal to D1 in 1 (5%). Friable irreparable edges were noted in 11 (55%) perforations (excluding the 2 cases where the patients were re-explored after leak). The mean diameter of the perforations in our cases was 1.83 ± 0.59 cm (largest 2.5 cm).

Seven patients (35%) with perforation size of 0.5 cm were included, due to fulfillment of other inclusion criteria. All patients underwent TTD with the retrograde duodenostomy technique, as none were found suitable for T-tube duodenostomy. The reasons were: friable and edematous duodenal wall (8), and, dense adhesions around lateral duodenal wall (13).

Table 3 Postoperative course (n = 20)

Observations	Postoperative days (mean/median)	Standard deviation OR IQR (1st-3rd)
Time to return bowel sounds	3.53	± 0.91
Time to start feeding *via* FJ	4	4-5
Time to start oral feed	12	10.75-18.5
Time of clamping of Gastrostomy	9.87	± 3.75
Time of clamping of RD	13	± 4.18
Time of removal of Gastrostomy	13	12-16.5
Time of removal of RD	16	16.25-22.25
Time of removal of FJ	18	16.5-24
Total hospital Stay	22	19-26
Wound healing time	15.75	± 1.91

IQR: Inter quartile range; FJ: Feeding jejunostomy; RD: Retrograde duodenostomy.

Table 4 Postoperative outcomes/complications n (%)

Outcomes/complications	n = 20
Surgical site infection	9 (45)
Respiratory complications	4 (20)
Peritubal leakage	4 (20)
Peritubal excoriation	2 (10)
Burst abdomen	5 (25)
Bed sore	2 (10)
Postoperative leak	1 (5)
Mortality	4 (20)

Postoperative course

All patients were observed till discharge or death, in terms of parameters listed in Table 3.

The gastrostomy tube was accidentally pulled out in one patient, while the retrograde duodenostomy came out in two patients. These patients were excluded for the determination of time of removal of tubes.

The total hospital stay ranged from 17 to 139 d. Out of 20 patients included in the study, four (20%) died in the postoperative period. One patient underwent Whipple's procedure on postoperative day (POD) 29 for duodenal neuroendocrine tumor reported on histopathological examination of the perforation edge. Table 4 lists the various complications in the postoperative period.

DISCUSSION

Despite the proven advantages of TTD in pancreatico-duodenal trauma, it is an underused strategy for peptic perforations. This is despite the high morbidity (> 30% mortality; up to 50% leak rates) of certain types of peptic perforations. Less than 5 case series (largest about 40 patients) have been published on triple tube drainage for gastroduodenal perforations; most published data is retrospective. There is no standardization regarding postoperative management[6,11-14].

Though classical pedicled omental patch repair remains gold standard for the gastro-duodenal perforations[5,6], patients with difficult gastro-duodenal perforations are associated with poor outcome in terms of postoperative complications, postoperative leak, morbidity and mortality. Most authors have labeled large (> 1.5-2.5 cm) GDPs as difficult; however, we have included poor physiological performance also as "difficult" due to the known propensity for leak and mortality (vide infra). In our study, we have prospectively observed 20 cases of difficult gastroduodenal perforation undergoing triple tube drainage (Cellan-Jones omental patch repair with gastrostomy, retrograde duodenostomy and feeding jejunostomy) during December 2013-April 2015. Lal *et al*[6] compared 20 cases of controlled tube duodenostomy (primary repair of perforation with nasogastric tube or gastrostomy, retrograde duodenostomy and feeding jejunostomy) with 20 cases of classical omental patch repair over a period of 10 years. Fujikuni *et al*[13] studied 3 patients over 18 mo (between November 2009 and March 2011) undergoing triple-tube-ostomy for iatrogenic duodenal perforations. The higher number of patients in the present study could possibly be due to increased occurrence of difficult duodenal perforations in the study group or due to different inclusion criteria, which were not limited only to the size of perforation.

The higher mean age of patients in the present study is consistent with results of Svanes *et al*[15] who have shown that median age of the patients has increased from 38 years in 1935-44 to 60 years in 1985-90 for men and 55 to 69 years for women (Table 5). The authors have also observed that the relative incidence of duodenal perforation as has decreased, while pyloric and prepyloric perforations have increased from 1935-1990 in 1483 patients[15]. Male predominance in the cases is also consistent with available literature, which can be attributed to the higher incidence of smoking in males.

There is no clear-cut definition of giant gastroduodenal perforation in literature; it has varied from 1.5 to 3 cm[5,6,16]. Most authors would accept that a perforation of > 2 cm is fraught with more risk of leakage and mortality, and needs more specific intervention that just primary closure. Many of our patients are referred from far-off hospitals and present late; we have added physiological scoring (APACHE-Ⅱ) along with perforation size to improve the accuracy of the risk assessment. This has been shown to be consistent for prediction of outcome in GDPs[17,18].

In our view, the most crucial part of the procedure is the adequate decompression of the duodenal C-loop, as it is retroperitoneal in position and cannot be brought out as a stoma. The duodenum is also an unfriendly organ in terms of repair, as it lacks a proper serosal wall. Hence, in our mind, tube decompression of right side of the duodenal segment seemed like the most attractive option, as demonstrated by a few authors[11-14]. A T-tube, as used by Isik *et al*[12] seems ideal. Unfortunately, in our patients, extensive inflammation in the right upper quadrant precluded the use of this technique, and we used the retrograde duodenostomy inserted more

Table 5 Comparison between age, gender, and intra-operative findings

Study	Most common age group (yr)	Gender distribution (M:F)	Size of perforation	Site of perforation
Present study	46-70	5.6:1	1.83 ± 0.59	Prepyloric 45%, Duodenal 40%
Lal *et al*[6]	30-50	4:1	60% 2 to 3 cm; 40% > 3 cm	
Jani *et al*[16]	21-50	7.3:1	> 2 cm	
Menekse *et al*[17]	39-62	6.1:1	13% with > 1 cm	
Berleff *et al*[19]	40-50	3.7:1		
Chaudhary *et al*[20]	18-40	4.3:1	> 1 cm in 7.29%	Duodenal 69.7%, Gastric 30.2%

distally. The latter technique is limited by the maximum calibre possible though such a circuitous route, and is more prone to blockage and failure. We actively endeavoured to keep it patent with frequent flushes, and would prefer to perform T-tube decompression when possible.

Postoperative course

It is evident that a reliable inpatient protocol should be in place to manage these multiple tubes without complications. Unfortunately, due to the scant research on the subject, no clear guidelines are available. The prospective study which most closely resembles our design was conducted by Lal *et al*[6] at a nearby center. The postoperative course in the two studies has been compared. In present study, mean time of return of bowel sounds was 3.53 ± 0.91 d. Lal *et al*[6] observed that bowel sounds returned in 72 h, after which enteral feed could be attempted through the jejunostomy tube. It is consistent with other emergency procedures that small bowel peristalsis returns in 48-72 h. We clamped the gastrostomy and retrograde duodenostomy tubes at was 9.87 ± 3.75 d and 13 ± 4.18 d respectively, while it was 7 d and 9-10 d respectively in the Lal study. These tubes are safely removed once the patient resumes a normal oral diet 3-4 d later. The removal of tubes may vary by 24-72 h, at the discretion of the treating physician.

It would be needless to emphasize the importance of fluid and electrolyte balance during the recovery period. Our patients are thin-built and nutritionally poor; the high output from controlled fistulae can be the "tipping point" towards a poorer outcome. It is also imperative to ensure the patency of the tubes too, as any undrained collections could cause crippling sepsis. Since the entire assembly works as a proximal diversion of gastric, duodenal and pancreatic secretions (at least 2-2.5 L/d), patency is important (vide supra).

Damage control procedures are performed in the most critical patients. In the present study, median hospital stay was 22 d (17-139 d) while the mortality was 20%. The incidence of postoperative complications was also higher than similar series[6,15-17,19,20]. Poorer outcomes can be explained by the fact that all the patients included in our study had "difficult" gastroduodenal perforations in the truest sense, with higher predicted deaths.

We have thus shown in a prospective group of patients that TTD is feasible, easy to perform in the emergency setting, and is followed by two-three weeks of easy convalescence. The patients usually accept oral diet after the second week.

Limitations

Some limitations are evident in our study. A larger sample size over a longer duration would allow better recommendations to be put forward. We had hypothesized before the start of our study that TTD would be useful in both GDPs and also some very proximal jejunal perforations with tuberculous etiology. The latter are commonly seen in our scenario; and are difficult to treat due to high leak rate and an unmanageable short bowel if exteriorized. However, in the present study, we did not include such patients in order to enable comparison of "like with like". Also, a well-described technique of TTD, namely, T-tube decompression of the lateral wall of the duodenum, could not be evaluated as all our patients demonstrated intense fibrosis in that area. With a larger study duration and more number of patient, the next stimulus for research would be a more analytical study comparing the two types of TTD.

COMMENTS

Background

Generalised peritonitis secondary to hollow viscous perforation continues to be one of the most common surgical emergencies in India. In fact, the most common cause of exploratory laparotomy in the emergency setting is intestinal perforation peritonitis.

Research frontiers

Operative strategies to treat or prevent leakage have included jejunal serosal patch, jejunal or omental pedicle graft, pyloric exclusion with gastrojejunostomy, gastrectomyand vagotomy, and novel techniques like myocutaneous flaps or gastric disconnection.

Innovations and breakthroughs

In authors' mind, tube decompression of right side of the duodenal segment seemed like the most attractive option, as demonstrated by a few authors. A T-tube, as used by Isik *et al* seems ideal. Unfortunately, in the patients, extensive inflammation in the right upper quadrant precluded the use of this technique, and the authors used the retrograde duodenostomy inserted more distally. The latter technique is limited by the maximum calibre possible though such a circuitous route, and is more prone to blockage and failure. The authors actively endeavoured to keep it patent with frequent flushes, and would prefer to perform T-tube decompression when possible.

Peer-review

This is a very comprehensive review of the literature on NETs, also being very well written.

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