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Original Research Article

Ray's rule of half - governs deployment of tube duodenostomy - a lifesaving procedure to manage stale and macerated duodenal perforation: a prospective study of 22 cases in 20 years

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ABSTRACT

Background: Tube decompression of the duodenum is an old but an underutilized technique known to decrease morbidity and mortality in patients with difficult to manage duodenal perforation. Tube duodenostomy surpasses all other elaborate and risky techniques of management of perforation or breach of duodenum in very sick patients.
Methods: We have used tube duodenostomy in 22 cases over 20 years, as a desperate mode of management, in large, old macerated duodenal perforation. All our cases had >0.5 cm, macerated, more than 12 hours old perforation in the second part of duodenum. We observed an interesting pattern that duodenal perforation more than half a centimetre in diameter and more than half a day old were best managed by just tube duodenostomy. Same lesion of duodenum were managed by Graham's omental patch, by other hospital elsewhere, had life threatening complication (duodenal blow out) which invariably ended in fatality.
Results: Patients with large and old macerated duodenal perforation often present with hemodynamic instability and sepsis. Complex procedures in an unstable patient are associated with adverse outcomes. In patients with significant comorbidities and instability the damage control principle of trauma surgery is gaining popularity. Tube duodenostomy technique described in this paper 'click-fits' well with that principle-it is a life saver and a game changer.
Conclusions: Application of tube duodenostomy, instead of executing complex procedures involving surgical gymnasties, in an unstable patient provides an opportunity to stabilize the patient, converting an impending catastrophe to a future scheduled surgery, which has favourable outcomes.

Keywords: Tube duodenostomy, Duodenum, Perforation, Modified Graham's omental patch, Pancreaticoduodenectomy

INTRODUCTION

Primary repair or an omental patch can be used to treat simple duodenal perforations, which are typically caused by peptic ulcer disease or endoscopic procedures, which is popularly known as Modified Graham's omental patch.[1] On one hand, a variety of methods from pancreatico-duodenectomy to drainage with pyloric exclusion have been reported for extensive duodenal perforations.[2-5] These surgeries are not ideal for patients who manifest with sepsis, are unstable hemodynamically, and in the process of manifesting shock pathophysiology by the time the diagnosis is made, even though the majority of them may be tactically effective. Many of these procedures are also technically and strategically demanding, which demands a lengthy operative time even when performed by an experienced surgeon.[6,7] An ideal repair should be straightforward, easy to learn, and capable of being performed rapidly in a damage-control setting by any surgeon, regardless of location or circumstances. Initially,

tube decompression of the duodenum was used following gastrectomy to prevent rupture at the duodenal stump's suture line.[8] Complex injuries to the duodenum present a major challenge for general surgeons. These injuries are uncommon, so most surgeons have limited hands-on experience treating them. However, if not properly repaired, the outcomes can be severe, including delayed leaks, extensive abdominal contamination, sepsis, and even death.[9-11] Over the years, tube duodenostomy has demonstrated its reliability and safety as a method for managing complex duodenal injuries and large perforations.[12] Although this technique is straightforward and yields favorable results, it has not been widely adopted and remains underused. This may be due to the enduring appeal of more complex procedures across generations. Recently, a few case series have emerged highlighting the use of tube duodenostomy in treating large duodenal ulcer perforations and traumatic duodenal injuries.[12-15] This publication has reviewed 22 cases of duodenal perforation treated with tube duodenostomy, in which this method was used. All cases were successfully managed by just tube duodenostomy alone, without any added "surgical gymnastics", thus highlighting the broad applicability of this simple yet rapidly deployable technique, easy to learn by any surgeon in managing life-threatening surgical problems of this nature, just about anytime and anywhere.

Aim

The aim of this study was to show the effectiveness of tube duodenostomy in all duodenal perforations that are more than half a centimeter in diameter and more than half a day old (>12 hours old).

METHODS

Type of study

It is an original research and prospective study spread over 20 years.

Study place

The cases were prospectively studied in different Military Hospitals where the lead author served as an Army surgeon, dealing with 28 cases over 20 years.

Study period

The duration of the study was from 2004 to 2024.

Inclusion criteria

All patients with duodenal perforation size more than 0.5 cm, and more than 12 hours old were included.

Exclusion criteria

Patients not fulfilling the inclusion criteria were excluded.

Operative technique

Tube duodenostomy is a minimally invasive technique that does not require bowel anastomosis and can easily be performed by almost any surgeon, even by the newly inducted "rookie surgeon". The patient under endo-tracheal general anaesthesia. The abdomen is entered by an "umbilicus skirting" midline incision (the so called vertical omega incision commiserating with patient's body habitus and at the same time satisfying the "surgeon's comfort zone". After mobilization of the right colon and bringing down the hepatic flexure (Cattell-Braasch manoeuvre) (Figure 2), to expose and mobilize the lateral and anterior walls of the duodenum (D) (D2, D3 and D4) by Kocherization, to achieve a good visualization, and at the same time define the extent of the defect in the duodenum. A punch biopsy from the edge of the perforation is mandatorily taken. Next a 22F three way Foley catheter without inflating the bulb is inserted through the lateral abdominal wall, through a generous wad of omentum (which will act as a natural sealant of peri-catheter leaks) into the duodenum, to decompress the lumen. No attempt is made to close or approximate the walls of perforation around the Foley catheter, rather a purse string suture (2/0 black silk on round body) is gently laid all around the perforation with Foley catheter in situ and snugly tied. In some cases, instead of a "wad" of omentum, a tongue of "live" omentum may be wrapped around the Foley catheter to seal the peri-catheter residual defect. Omentum is a freely mobile and freely available lympho-vascular "express-highway". It is a patient and surgeon "forgiving organ" ,that forgives all the technical short comings of most ordinary surgeons and runs in, to cordon off or seal any leak, there by premptively avoids duodenal leak and its' attendant fatal peritoneal sepsis. No wonder the omentum it is called "The policeman of the abdomen". Infact omentum is "a friend of the surgeon inside the abdomen", which due to ignorance, is underutilized. In all our cases before creating tube duodenostomy we have used three-32F abdominal drain – one suprahepatic in sub hepatic space, one in pelvis and secured to the skin by "Roman sandal pattern" of tube fixing with 01/0 black silk on curved cutting needle. This placement of supra and sub hepatic and pelvic drains before tube duodenostomy is done to avoid "man-handling" of tube duodenostomy later on, resulting in its disruption. While closing as a self-fabricated multi-perforated 32F abdominal drain is placed in subcutaneous space (we use double action bone nibbler to achieve this 'machine-finished' multiperforated subcutaneous drain) as shown in the figure. The pelvic and subcutaneous drain were removed by 04th to 06th post op day, and sub hepatic drain was removed by the end of 02nd post op week.

The duodenal Foley catheter was mandatorily required for a minimum period of 06 weeks, to ensure formation of a well-defined Foley catheter track, which will ward off contamination of peritoneum with duodenal leak if any. Omental flap was wrapped around the exit site of the tube in the duodenum and its aim was to prevent leakage around

the tube site and ensuring security of the catheter in place and help form a well-defined tract by the end of 06 weeks. This Foley catheter is a "life line" of the patient and should not be removed prematurely (before 06 weeks). If done so, before a well-defined tract around the Foley catheter could develop, deadly duodenal content (The 04 deadly juices - Hydrochloric acid from stomach, bile from liver, succus pancreaticus from pancreas and succus entericus from the gut) will spread all over the peritoneum causing acute and severe peritonitis, sepsis, that invariably will end in fatality. Patient was allowed early enteral feeding–liquids (plain water, curd based drinks) by 02nd post op day, believing in the premise that "when there is gut, why not feed it!" and also to follow the guidelines of enhanced recovery after surgery (ERAS).

Subsequently curd based semi-solid diet (curd rice, khichdi, and dal rice). At the end of 06 weeks when the patient is "eating well and passing well"-a tube duodenogram is obtained using gastrografin. If there is no pericatheter leak and a good duodenogram with run-off jejunogram is seen, then the Foley catheter is removed, patient observed in casualty for 02 hours for any untoward events due to Foley catheter removal and then discharged to home (DTH), with advice to come for review after 03 months for one year.

Figure 1: Cattell-Braasch manoeuvre to bring down the hepatic flexure of colon to visualize the complete duodenum (D1, D2, D3, and D4) before commencing cocherisation of duodenum.

Figure 2: Foley catheter (32 F) inserted through a "wad of omentum" into the purse - stringed duodenal perforation. Outside on the skin the Foley catheter is anchored as a "jalebi" to avoid accidental traction removal of the duodenostomy tube.

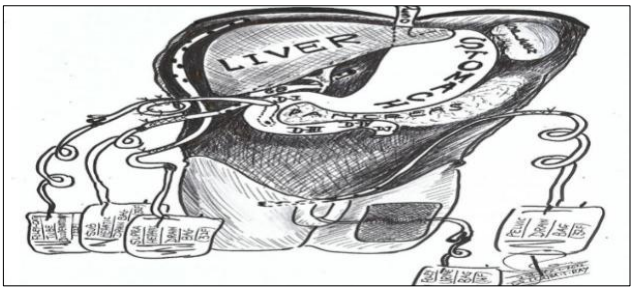

Figure 3: Placement of 32F drains in potential drainage sites - suprahepatic, subhepatic and pelvic places. All drains secured to the skin by "Roman sandal pattern" of fixation.

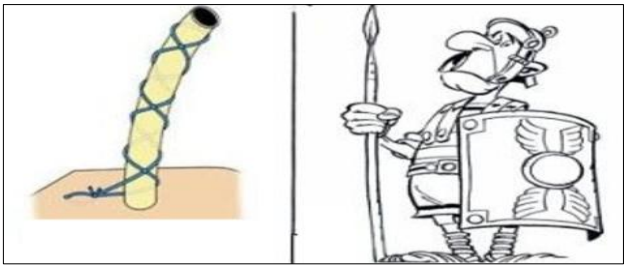

Figure 4: Roman sandal pattern of drain fixation. There is "beading" in between the entwinning ligatures that avoids accidental removal of drain due to inadvertent traction on it.

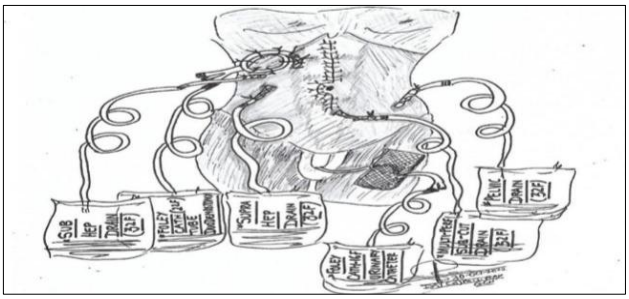

Figure 5: End of surgery scenario- tube duedenostomy and 04 drains – "suprahepatic", "subhepatic" (below liver- hepatorenal pouch), pelvic and subcutaneous drain.

Figure 6 (a and b): Partial cholecystectomy done for Mirizzi type III and duodenal end of fistula (02cm defect in duodenum) was managed by tube duodenostomy using Foley catheter 22F.

Figure 7: Tube duodenostomy in situ on the right and our technique of "gastro- duodeno-jejunal" feeding tube using 18F Ryle's tube on the left.

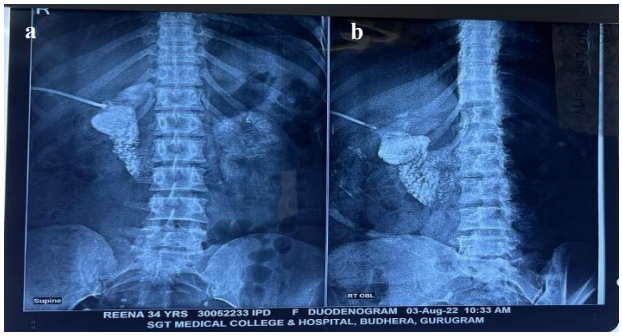

Figure 8 (a and b): Tube duodenogram.

RESULTS

Out of 22 case, 04 had surgical site infection (SSI) - infection in the subcutaneous plain, which were managed by removal of few sutures at the pus discharging site and flushing the whole length of the wound with Edinburgh University Solution of Lime (EUSOL), once a day and finishing with light ventilated gauze dressing. All the 04 cases healed by secondary intention by 07-10 days. Peri Foley catheter skin leak (05 cases) – were managed by dressing and gentle flushing of tube duodenostomy.

Blockage of tube duodenostomy was managed by flushing with soda bicarbonate ($NaHCO_3$) solution, and subsequently the tube was flushed with 20 ml of soda bicarb solution 08 hours. Mild features of sub-acute intestinal obstruction (SAIO) manifested as upper abdominal distention and vomiting in 03 cases, seen in second post op week. Scout film abdomen, erect, and supine were taken to establish radiological evidence of SAIO. All 03 cases were managed successfully by "drip and suck" method (nil orally +NG 16F -02 hourly aspiration alternating with free flow + i/v fluids 05-06 pints with 60 mEq of KCl and MVI in one pint of I/V fluid + proton pump inhibitor (PPI) – i/v pantoprazole + i/v antibiotics "CAM" prophylactically Ciprofloxacin, Amikacin and Metrogyl).10 patients had uneventful recovery and were DTH by 15th post op day. Patient with complications, as sited above, had a longer hospital stay of 03-04 weeks. In our study we had no mortality.

Table 1: Patient demographics and tube duodenostomy outcomes.

Categories	No. of cases	Management/notes
Gender distribution		
Male	06	Adults aged 20–60 years
Female	16	
Complications of tube duodenostomy		
Surgical site infection	04	Conservative
Peri-catheter leak	05	Conservative
Intestinal obstruction	03	Conservative
No complication	10	Discharged in 10–15 days

DISCUSSION

Even though there is a decrease in elective surgery for duodenal ulcer disease, still perforation in duodenal ulcers is a common surgical emergency in developed and developing countries. Factors such as old age, comorbid conditions, shock at presentation, large size of perforation, and delay in presentation and treatment, have been identified as adverse factors in the management of this condition.[16,17] The ideal time for conducting a definitive radical procedure is the first 24 hours after onset for patients who are hemodynamically stable and have minimal contamination, and our patients did not meet this criterion. Giant duodenal ulcer (>02 cm) and any duodenal ulcer perforation more than half a cm in diameter and more than 12 hours' old has higher chances of leakage, has higher morbidity and even mortality. This surgical condition has not got any definite protocols for management and has been under reported. Conventional repair techniques like omental patch repair are inefficient in GDUP cases because of tissue loss which is extensive and there is surrounding inflammation. So such cases are to be managed by special techniques like Tube duodenostomy. "Giant duodenal ulcer (GDU)" and "giant duodenal ulcer perforation (GDUP)" are two different entities and should not be used interchangeably. Here we talk about the latter, for which various investigators have used different criteria, some defining GDU perforation as >01 cm, some >02 cm and others >2.5 cm in size.[18-20] Giant duodenal ulcers (size >02 cm), this term has been used as a threshold in our study. This threshold criterion prevents smaller perforations from being over-treated and provides adequate and more aggressive treatment to larger and complex perforations. GDU perforation is considered hazardous because of extensive duodenal tissue loss and surrounding inflammation and edema, precluding simple

closure using omental patch i.e. Graham's omental patch repair (omentopexy).[21,22] Although an omental patch (Graham's repair or omentopexy) remains an effective treatment for repair of small relatively fresh perforations, but when used for giant ulcer perforations or repair after releakage, the failure rates reported in literature are high with invariable fatal outcome.[18,20-22]

In our experience any duodenal perforation more than half a cm in diameter (with added mandatory punch biopsy of the perforation, the diameter of perforation enlarges) and more than half a day old (>12 hours old) with maceration, high friability and peritoneal soiling, we have found that following the traditional method of repair of perforation by Graham's omental patch has leakage, duodenal blow-out, florid sepsis and which often ended in death of the patient. We have developed a "rule of thumb of management of these cases as duodenal perforation that are more than half a centimetre and more than half a day old, should mandatory be managed by tube duodenostomy, irrespective of the time of presentation to the hospital."

Different surgical techniques have been implemented for repair of giant duodenal perforations such as- partial gastrectomy, jejunal serosal patch, free omental plug, jejunal pedicle graft and gastric disconnection. Leakage after duodenal ulcer repair is not uncommon (02% to 10%) and is associated with high mortality (10% to 35%), which increases with delay in re-exploration.[27-29] Cranford et al advocated gastric disconnection with truncal vagotomy, antrectomy, and triple-tube-ostomy and managed 4 patients successfully using these techniques.[26] Recently, a novel technique using pedicled rectus abdominis muscle flap was described for repair of postsurgical leakage after duodenal ulcer perforation repair.[30] Not all hospitals have surgical facilities and settings available as required by these cases.

Morbidity increases with leakage and coupled with pre-existing co morbidity, they are made precariously hemodynamically unstable with very poor tolerance for any surgical adventurism. All of these procedures have chances of leakage post-surgery, which is the main concern against using omental patch for the repair of GDU or old macerated duodenal perforation.[21,22] Management protocols for GDU perforation have been discussed either as small series or as case reports with high morbidity and/or mortality.[18,20-22,25,26] Controlled-tube duodenostomy as a surgical procedure has been described classically for duodenal trauma and is specially designed for large tears in duodenum.[31] Retrograde duodenostomy, feeding jejunostomy and gastrostomy, which is a triple ostomy procedure is an effective emergency surgical procedure but is an extremely surgeon taxing procedure to execute in emergency situation in a primary, secondary or tertiary care hospital manned by a novice surgeon. Our procedure of tube duodenostomy confirms to the basic surgical principle of minimalistic surgical solution, doing the most minimum to achieve the most maximum in dire emergency situation to "fire fight" a deadly life threatening situation in hand, to save the patient's life. Also, with the availability of better anti-ulcer drugs, all patients might not require definitive ulcer surgery in the long run.[32] Success of tube duodenostomy depends on several steps in the technique, such as Cattell Braasch manouvere to bring down the hepatic flexure of colon to expose duodenum properly by Kocherization of duodenum, which collectively ensures tension-free insertion of 22F Foley catheter through the perforation and thread it through D2, D3 and D4 part of duodenum.

Thus, the main aim of the procedure is to keep the duodenum empty and also keeping it tension-free by decompressing and evacuating 04 deadly fluids (HCl, bile, pancreatic juice, and succus entericus) and gas that either enter or are secreted, created or swallowed by the patient. All of the drains, especially the duodenostomy tube in the duodenum, should drain abundantly and freely all the time. A dry drainage tube should not be accepted under any circumstances, because this tube is in the region of the ampulla, and the ampullary region has a high output of the above-mentioned 04 deadly juices. A clot can block the previously draining tube, or a plug of thick gastric contents obstructing the eye of the Foley catheter by a mucus plug or liquid feed debris, and this will require mechanical cleansing with forceful flushing with Soda Bicarb solution. A reduction in the quantity of the aspirate from this tube, which is "life line" for the patient, should never be attributed to fluid deficit, because this is never the case. The success of the present surgery is illustrated in this present series in managing this difficult surgical emergency condition, where concomitantly performed conventional surgeries elsewhere in a matched subset of patients were fraught with a higher chance of postsurgical leakage of repair and higher mortality. The fact that none of the patients in our study group had a failure of repair stands out in stark contrast to the published data in the world literature, as perhaps this may be the solution we have been waiting for this long!

We believe that patients with our specified duodenal perforation status, dimension, and temporal lapse are the ideal candidates for this procedure, and tube duodenostomy remains "the first line of management of these duodenal perforations".

In patient with old infected duodenal ulcer with sepsis, an average hospital stay of 03 weeks to 04 weeks is acceptable after tube duodenostomy, considering the dismal results and complications associated with either the traditional repairs or alternative approaches described in the literature, both of which increase the hospital stay much beyond 03 to 04 weeks and at the same time also increase patient morbidity and mortality exponentially.[26,29,30] Based on our experience in successful management of this extremely challenging condition in the present series of 22 patient over 20 years, we recommend controlled-tube duodenostomy as the primary and definitive management of specified duodenal perforation. We believe that the success of the above stated procedure

lies in the sound surgical knowledge and clinical expertise on which the procedure is based. The procedure is safe, reliable, and easy to learn and can be performed by the average surgical trainee and trained surgeon alike.

CONCLUSION

Surgeons through the ages have been cautioned about the unforgiving enemies within the abdomen, namely colon, pancreas and duodenum. They tolerate insults poorly and are extremely vindictive in their nature. Hence, exercising tube duodenostomy instead of a complex procedure in an unstable patient provides a chance to stabilize the patient, converting an impending catastrophe to a future scheduled surgery, this is the "game-changer" that converts a doomed surgical case with definit fatality into a "living chance". One of the basic tenets of surgery is "in emergency do as much as necessary and as little as possible". This is true in old macerated duodenal perforation or laceration. Lastly we rest the case saying "in life, often the solution to the most complex problem lies in a simple key - so also in surgery! For complex situation hunt for simple solution".

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