

A Prospective Clinical Study on Gastric Perforation**Venkata Ramesh Kalluri¹, Gopalam Padmajarani², P. Himabindu³, U. Jagadeeshwar⁴**¹Post Graduate, Department of General Surgery: SV medical College, Tirupati, Andhra Pradesh, India²Assistanat Professor, Department of General Surgery: SV medical College, Tirupati, Andhra Pradesh, India³Associate Professor, Department of General Surgery: SV medical College, Tirupati, Andhra Pradesh, India⁴Senior Resident, Department of General Surgery: SV medical College, Tirupati, Andhra Pradesh, India

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Abstract**Aims:** A prospective clinical study was carried out on gastric perforation to study its incidence, etiology and outcome.**Materials and methods:** It is a prospective study in 100 cases of gastric perforation which have been admitted in department of General surgery. The present study done to analyse the etiological factors, incidence & outcome of gastric perforation. The provisional diagnosis was established by clinical features & radiological evidence in the emergency department & the definitive diagnosis was made during surgery.**Results:** Higher incidence was observed among 41 – 60year age group individuals and among male sex. Most of the subjects belongs to low socioeconomic status (95%) and resides in rural areas. (66%). Alcohol consumption (34%), cigarette smoking (24%), regular use of NSAIDs (86%) and past history of PUD (81%) are significant risk factors for gastric perforation. Abdominal pain (100%) was found to be a constant complaint among gastric perforation followed by abdominal distension (76%) and vomiting. (75%) Examination findings such as abdominal tenderness (97%) is consistent with the gastric perforation. Most (87%) of the subjects presented within 12hours of onset of symptoms. Mostly antrum (85%) was involved in perforation. Regarding the size of perforation, most of the subjects were between 0.5 – 1cm (77%). Diagnosis was made based on radiologic findings in chest and abdominal radiography, with pneumoperitoneum in most (90%) of the subjects. Most of the cases had Graham's patch repair (86%) and a few had distal gastric resection (14%) with gastrojejunostomy.**Conclusion:** Different types of post-operative complications were observed in significant percentage of subjects. PUD was the most leading etiology causing gastric perforation in the present study, followed by chronic gastritis and malignancy. Overall, 14% subjects had expired following treatment, in the present study.**Keywords:** Gastric perforation, Post-operative complications, Pneumoperitoneum.

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Introduction

Gastric perforation is a full thickness injury in the layers of the stomach. As the stomach is lined by peritoneum on all surfaces, the perforation of the gastric wall results in direct communication between the contents of the stomach & the peritoneal cavity. In case of acute gastric perforation, the gastric contents enter the peritoneal cavity, resulting in chemical peritonitis, initially and later bacterial peritonitis. In case of chronic gastric perforations, the perforated injury can be sealed off by the adjacent viscus or inflammation. The gastric perforation may be suspected depending on the patient's clinical presentation and the diagnosis can be made with help of the radiological imaging findings indicating free intraperitoneal air most commonly under diaphragm. Gastric perforations are treated by primarily closure or by omental patch

repair or by resection of the stomach with reconstruction. Gastric perforation has high morbidity and mortality if left untreated. Perforation peritonitis is the most common surgical emergency, of which gastric perforation accounts for few cases. Due to increased use of NSAIDs and PPIs, the incidence of PUD (the most common cause of gastric perforation) and its threatened complications has been changing. Even with the developed infrastructural facilities for diagnosing, treating and rehabilitating the case of gastric perforation, the morbidity & mortality rates of the gastric perforation have remained to be high because of the *Helicobacter pylori* infection and gastric malignancy.[1,2]. The present study aims to provide the current information regarding the changes in

incidence, changes in etiological factors, changes in outcome of gastric perforation.

MATERIALS AND METHODS

Formal institutional ethical committee approval was sought for this prospective study. During the study duration, 100 cases of gastric perforation which have been admitted in Government RUIA hospital, Tirupati were observed and studied. The present study was conducted on these cases, prospectively to analyse the etiological factors, incidence & outcome of gastric perforation. The provisional diagnosis was established by the On DUTY Surgeon, depending upon the clinical features & radiological evidence in the emergency department & the definitive diagnosis was made during surgery.

Inclusion Criteria: All confirmed cases of age >14 years with gastric perforation.

Exclusion Criteria: Confirmed cases of duodenal perforation, small intestinal perforation and large intestinal perforation.

The detailed information of subjects who are suspected with gastric perforation, regarding their demographic data, clinical history, past & personal history & examination findings were noted. All relevant radiological & blood investigations were performed. The evidence of intraperitoneal free air, in either an erect chest radiography or a abdominal radiography in left lateral decubitus position indicates hollow viscus perforation with the most leading cause being perforated peptic ulcer in duodenum & stomach. In chest/abdominal radiograph in erect position small amount of air is easily detectable under the right hemidiaphragm, but on left sided hemidiaphragm it is difficult to distinguish free intraperitoneal air from gastric fundic gas shadow and colonic gas. An abdominal radiography in left lateral decubitus position will

resolve the present problem by demonstrating gas between liver and the abdominal wall.

CT abdomen is the most sensitive and best investigation for detection of intra-peritoneal free air. Free peritoneal air can be seen over the liver and anteriorly in the mid abdomen. Immediate preoperative resuscitation was done by securing large bore Intra Venous (IV) cannula and infusion of Intravenous fluids, gastric decompression by nasogastric intubation, monitoring urine output by urinary catheterisation, administering empirical antibiotic therapy, Oxygen therapy & correction of electrolyte imbalances. All subjects were operated as soon as possible. Various operative procedures were done based on site & size of perforation. All intraoperative findings were noted. Biopsy from the edges of the gastric perforation were sent for histopathological examination. During immediate postoperative period, the subjects were given intensive unit care & continuously monitored with vital data. Required blood & radiological investigations were performed based on need. Appropriate treatment was administered to the subjects as needed. The subjects were discharged only after they were tolerable to oral diet, able to void urine & had adequate analgesia with oral analgesics. All postoperative complications during & after discharge were noted & treated accordingly. All subjects with peptic ulcer disease were advised Helicobacter pylori eradication regimen postoperatively after being discharged from the hospital. All the subjects were followed up once in every month for 6 months. This data was gathered using a thorough, comprehensive and standardised proforma. Tables and charts were used to discuss the findings and compare them to published material that was at hand.

RESULTS

Table 1: Distribution of cases by patient details

Age category (in years)	Number	Percent
≤20 years	7	7%
21 – 40 years	17	17%
41 – 60 years	45	45%
61 - 80 years	29	29%
>80 years	2	2%
Total	100	100%
Gender		
Male	82	82%
Female	18	18%
Socio-economic status		
Middle	5	5%
Low	95	95%
Area of residence		
Urban	34	34%
Rural	66	66%
Occupation		
Dependent	26	26%

Semi-skilled	14	14%
Skilled	16	16%
Unskilled	44	44%

In the present study, 45% of the cases were in the age group of 41 – 60 years followed by 29%, 17%, 7% and 2% in the age group of 61 – 80 years, 21 – 40 years, ≤20 years and >80 years respectively. The mean age of the cases was 50.75 years with a standard deviation of 16.42 years. In the present study, 82% of the cases were males and 18% of the cases were females. In the present study, 95% of the

cases belonged to low socio-economic status and 5% of the cases belonged to middle class. 66% of the cases resided in rural areas and 34% of the cases resided in urban areas. Majority i.e., 44% of the cases were unskilled workers followed by 16% and 14% of skilled and semi-skilled workers. 26% of the cases were dependent.

Table 2: Distribution of Cases by Personal History

Personal history	Number	Percent
Habits		
Alcohol	15	15%
Smoking	5	5%
Alcohol + smoking	19	19%
None	61	61%
History of PUD		
Yes	19	19%
No	81	81%
History of NSAID use		
Yes	14	14%
No	86	86%

19% of the cases had history of both alcohol intake and smoking while 15% of the cases had history of alcohol consumption and 5% of the cases had history

of smoking. 19% of the cases had peptic ulcer disease history. 14% of the cases had history of non-steroidal anti-inflammatory drugs (NSAID) use.

Table 3: Distribution of cases by frequency of symptoms and signs

Symptoms	Number	Percent
Abdominal pain	100	100%
Abdominal distension	76	76%
Vomiting	75	75%
Constipation	64	64%
Fever	60	60%
signs		
Abdominal tenderness (On palpation / rebound tenderness)	97	97%
Guarding & rigidity	60	60%
Bowel sounds absent	82	82%

In the present study, pain abdomen was the most common symptom seen in 100% of the cases followed by abdominal distension, vomiting, constipation and fever in 76%, 75%, 64% and 60%

of the cases respectively. per abdominal tenderness (on palpation or rebound tenderness) was the sign seen in 97% of the cases followed by guarding & rigidity and absent bowel sounds in 60% and 82% of the cases respectively.

Table-4: Distribution of cases at the time of presentation

Shock on admission	Number	Percent
Present	18	18%
Absent	82	82%
Time of presentation		
≤12 hours	87	87%

13 – 24 hours	11	11%
>24 hours	2	2%
Site of perforation		
Antrum	85	85%
Greater & lesser curvature	8	8%
Body	7	7%
Size of perforation		
0.5 – 1cm	77	77%
>1cm	33	33%

In the present study, 18% of the cases presented with shock at the time of admission. Time of presentation was ≤12 hours in 87% of the cases followed by 13 – 24 hours in 11% and >24 hours in 2% of the cases. Most common site of perforation was antrum in 85%

of the cases followed by greater & lesser curvature in 8% of the cases and body/anterior or lateral wall in 7% of the cases respectively. The size of perforation in 77% of the cases was between 0.5 – 1 cm and >1 cm in 33% of the cases.

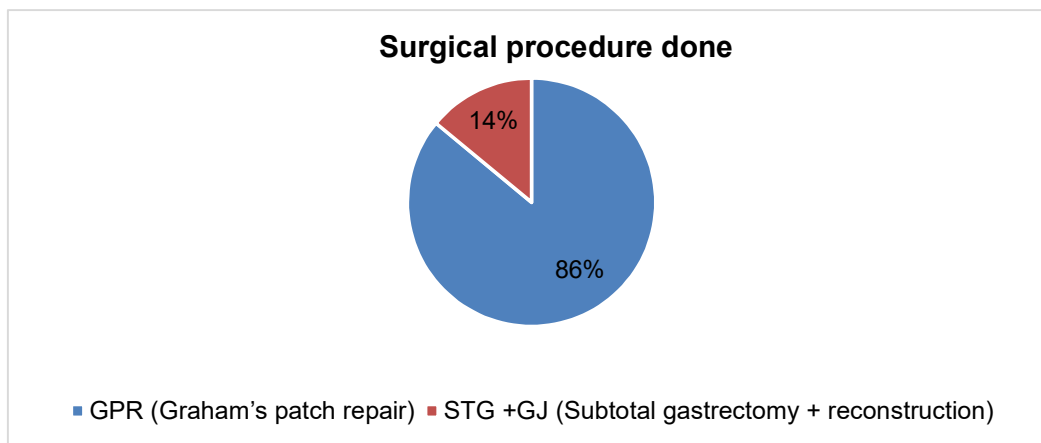
Table-5: Distribution of cases by frequency of pneumoperitoneum in Radiographic imaging

Pneumoperitoneum in chest X-ray	Number	Percent
Present	90	90%
Absent	10	10%
CT findings		
Free intraperitoneal air	99	99%
Free fluid in peritoneum	98	98%
Water soluble contrast study	60	60%

In the present study, 90% of the cases had pneumoperitoneum in chest X-ray. CT abdomen were free intraperitoneal air in 99% of the cases

followed by free fluid in peritoneum in 98% and water-soluble contrast in 60% of the cases respectively.

Figure-1: Distribution of cases by surgical procedure done



In the present study, Graham's patch repair was the surgical procedure done in majority of the cases and subtotal gastrectomy + gastro-jejunostomy was done in 14% of the cases.

Table-6: Distribution of cases by delay in surgery and duration of hospital stay

Delay in Surgery	Number	Percent
1 – 6 hours	79	79%
7 – 12 hours	21	21%
Total	100	100%

Duration of hospital stay		
1 – 7 days	11	11%
8 – 14 days	83	83%
14 – 21 days	6	6%

In mean delay in surgery is 4.8 hours with a standard deviation of 2.06 hours. In mean duration of hospital stay is 9.5 days with a standard deviation of 3.2 days.

Table-7: Distribution of cases by Post-Operative complications

Post OP complications	Number	Percent
Surgical site infection	50	50%
Sepsis	17	17%
Lower Respiratory Tract Infection (LRTI)	15	15%
SIRS	11	11%
MODS	9	9%
Deep Organ space infection	4	4%
Burst abdomen	4	4%
Acute Kidney Injury (AKI)	3	3%
Ileus	3	3%
Incision hernia	3	3%
Enterocutaneous fistula	2	2%
Electrolyte & metabolic disturbances	2	2%
Others (CKD, DVT, Intra-abdominal abscess, MI, Pneumonia, Post OP adhesions)	6	6%

In the present study, the most frequent complication was surgical site infection 50% of the cases followed by sepsis, LRTI, SIRS and MODS in 17%, 15%, 11% and 9% of the cases respectively. Other post-

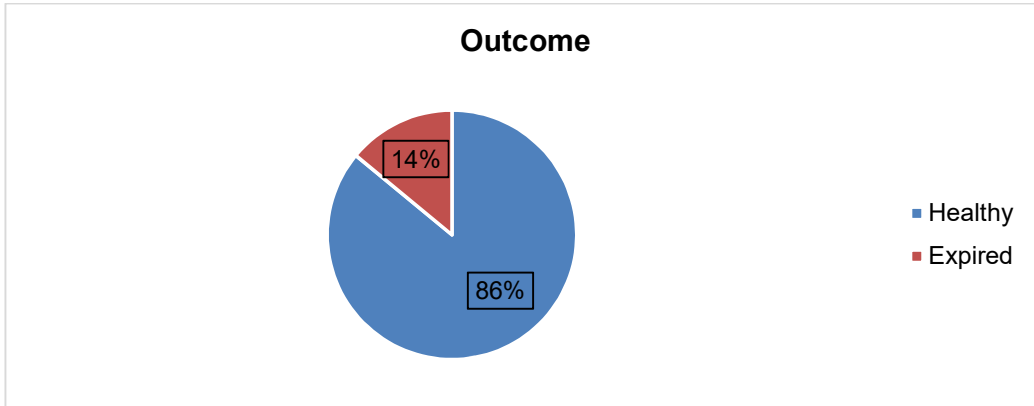
operative complications included Deep Organ space infection, Burst abdomen, Ileus, AKI, Incision hernia, Enterocutaneous fistula and Electrolyte & metabolic disturbances in 4%, 4%, 3%, 3%, 3%, 2% and 2% of the cases respectively..

Table-8: Distribution of cases by findings on Biopsy

Biopsy findings	Number	Percent
CNSU (Chronic Non-Specific Ulcer)	86	86%
Chronic gastritis	7	7%
Adenocarcinoma	3	3%
Necrosis	1	1%
Autolysis	1	1%
<1 cm	2	2%
Total	100	100%

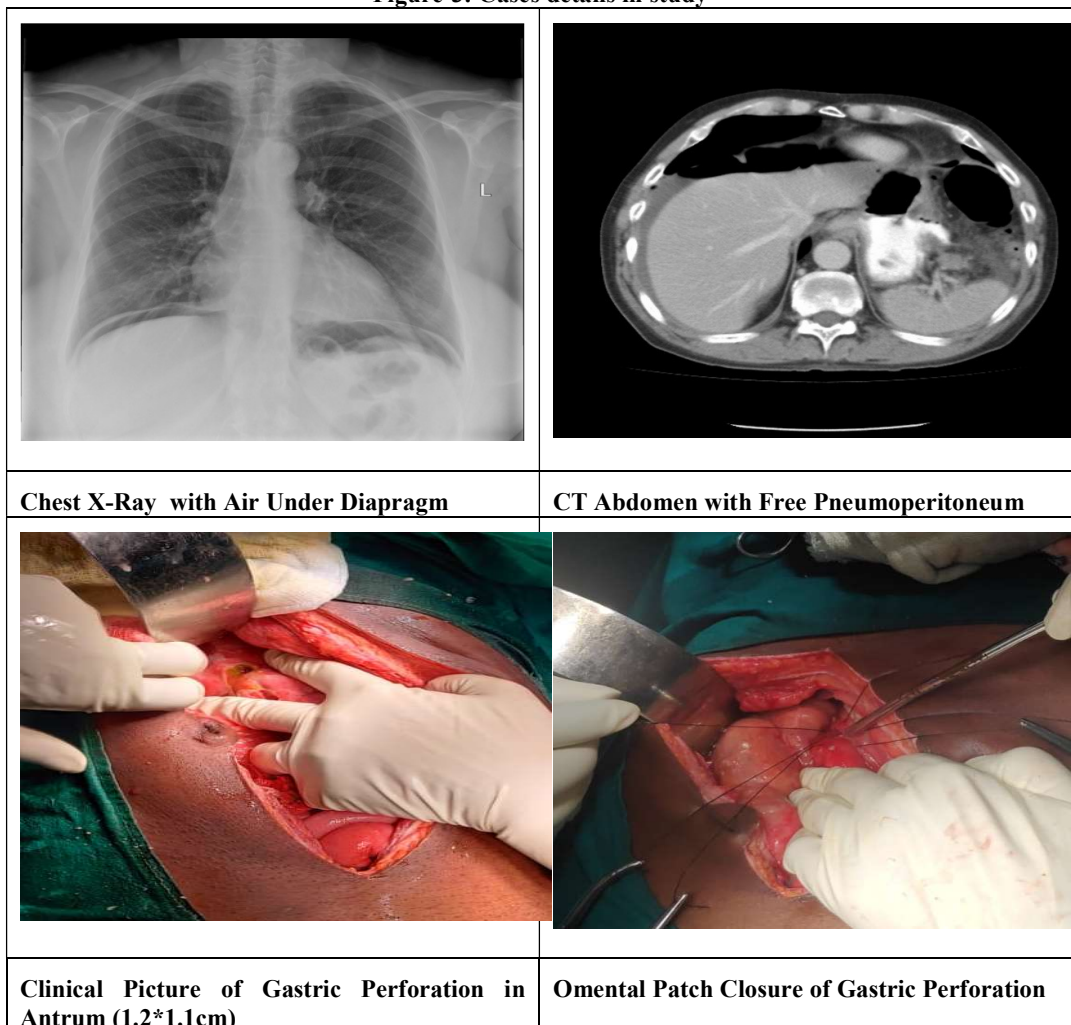
In the present study, Chronic Non-Specific Ulcer suggestive of PUD, was the most frequent biopsy finding in 86% of the cases followed by chronic gastritis, adenocarcinoma, necrosis and autolysis in 7%, 3%, 1% and 1% of the cases respectively.

Figure-2: Distribution of cases by Outcome



In the present study, the outcome was healthy in 86% of the cases and death/expired in 14% of the cases.

Figure-3: Cases details in study



DISCUSSION

Gastric perforation is one the common surgical emergency. In the present study, the youngest subject was 16 years old and the oldest subject was

83 years old & the mean age was 50.75 years, with standard deviation of 16.42 years, compared to the mean age of 63 years in study by J Wilson-

Macdonald et al(3) & 69.1 years in a study on by Kai Siang Chan et al on benign gastric ulcer perforation.(4) In a study by R M Hodnett et al(5) on perforated gastric ulcers, the mean age was 55 years with a range of 2 days to 99 years.(5) In a study by Madiba et al(6) on perforated gastric ulcers, mean age was 43 years.(6) In a retrospective study by M

Schein et al on perforated gastric ulcers, mean age was 58.7 years.(7) The overall mean age (50.75years) in the present study correlates well the earlier studies. In the present study, mean age among males was 50.97 years and mean age among females was 50.63 years.

Table-9: Comparison of Mean Age and gender between Various Studies

Mean Age	
J Wilson-Macdonald et al(3)	63 years
Kai Siang Chan et al(4)	69.1 years
R M Hodnett et al(5)	55 years
Madiba et al(6)	43 years
M Schein et al (7)	58.7 years
Present study	50.75 years
Male to Female Ratio	
J Wilson Macdonald et al(3)	1:1.26
R M Hodnett et al(5)	1.97:1
Madiba et al (6)	6.2:1
Leeman et al(8)	1.31:1
Present study	4.5:1

In the present study, male to female sex ratio was 4.5:1, with males being 82 in number and females being 18 in number, compared to 15:19 as in study b J Wilson-Macdonald et al(3). In a study by R M Hodnett et al(5) on perforated gastric ulcers, male to female ratio was 1.97:1. (males-134, females-68). In a study by Madiba et al(6) on perforated gastric ulcers, male to female ratio was 6.2:1. (62-males,10-females)(In a study by Leeman M et al(8) on perforated gastric ulcers, 44 subjects were studied, male to female ratio was found to be 1.31:1. (25-male,19-female). In the present study, incidence of gastric perforation was more among male sex rather than female sex. This might be because of presence of confounding risk factors such as history of alcohol consumption and tobacco smoking more frequently with male sex.

In the present study, urban : rural population ratio was 0.51:1, suggesting that incidence of the gastric perforation was more common among rural population. In the present study, the ratio among different occupation individuals was, Skilled : semi-skilled : unskilled : dependant = 16 : 14 : 44 : 26. Incidence among familial persons was not observed in the present study.

In the present study, all the subjects had presented with generalized peritonitis following the gastric perforation except one individual which had presented with sealed off perforation with localized

abdominal tenderness. None had presentation of only localized abscess/collection without features of peritonitis. All subjects had abdominal pain as the presenting complaint i.e., 100% subjects. In a study by R M Hodnett et al(5) on perforated gastric ulcers, 93% had abdominal pain, 76% subjects had abdominal distension and 75% subjects had vomiting and 57% had no complaints related to gastric ulcer or perforation. In the present study, the mean duration of presentation was 9.36 hours with a standard deviation of 4.83 hours, compared to a mean of 40.32 hours in a study by Dr.S.Venkatesan et al(9) on clinical outcome of gastric ulcer perforation. The reason for the above observed variation was that few cases were initially treated at various peripheral primary health centres, clinics and later referred to their hospital, as described in their study. The range of duration of presentation of subjects to the hospital after initiation of abdominal pain has varied from minimum of 2 hours to maximum of 34 hours. Delayed presentation (>24 hours) was associated with increased morbidity and mortality rates, in case of gastric perforation, as observed with any other hollow viscus perforation peritonitis. In the present study, 3(3%) subjects had presented at/> 24 hours from onset of abdominal pain, compared to 38.2% in a study by Kai Siang Chan et al.(4) With delay in presentation, the peritonitis spreads resulting in increased preoperative complications such as SIRS, sepsis,

AKI, coagulopathy etc. In a study by similar person C Svanes et al(10) on rhythmic patterns in incidence of peptic ulcer perforation, it was described that gastric ulcer perforations exhibit circasemidian rhythm with a primary peak at noon and a secondary peak at midnight with a 12hour gap. No such diurnal variations and circadian rhythms were noted in the incidence of gastric perforation secondary to peptic ulcer disease in the present study. In the present study, none of the subject was hospitalized at the time of the gastric perforation. In the present study, there were no recurrent cases. With presence of a comorbidities, the risk of morbidity and mortality of the subject increases. All the comorbidities were observed only after 40 years of age in the present study. 12 subjects had only diabetes mellitus, 6 subjects had both diabetes mellitus & hypertension, 1 subject had diabetes mellitus & CAD and 1 subject had diabetes mellitus & CKD. 15 subjects had only hypertension, whereas 1 subject had hypertension & CAD and 1 subject had hypertension, CAD & CKD. 1 subject had only hypothyroidism.1 subject had only COPD.1 subject had only CKD. In case of subjects with Diabetes mellitus & Hypertension, decreased fall of systolic blood pressure when compared to subjects without the above comorbidities were observed. The risk of morbidity

(post operative complications) and mortality rates are high with presence of comorbidities. In the present study, 14 subjects had history of PUD only compared to 26% subjects in a study by R M Hodnett et al (5) on perforated gastric ulcers. 9 subjects had history of regular use of NSAIDS only as compared to 50% cases in study by J Wilson-Macdonald et al.(3) 5 subjects have had history of both, regular use of NSAIDS & PUD compared to 35% as observed in study by J Wilson-Macdonald et al.(3) In a study by Dr.S.Venkatesan et al(9) on clinical outcome on gastric ulcer perforation, 30% had history of PUD & 32% had history of regular use of NSAID. In a study by R M Hodnett et al(5) on perforated gastric ulcers, 6% subjects had history of use of aspirin. Regarding habits associated with gastric perforation alcohol consumption & cigarette smoking are more notorious to cause gastric perforation. In the present study, 15 subjects have a habit of alcohol consumption regularly, compared to 44% in a study by R M Hodnett et al(5) on perforated gastric ulcers. 5 subjects have a habit of cigarette smoking, compared to 86% in a study by R M Hodnett et al (5) on perforated gastric ulcers. 19 subjects have the habit of both consumption of alcohol & cigarette smoking. The subjects with the above described high risk habits are all males.

Table -10: Incidence of History of Risk Factors in various Studies

Study	History of PUD	History of use of NSAIDs	History of Alcohol consumption	History of Cigarette smoking
J Wilson Macdonald et al(3)	35%	85%	-	-
R M Hodnett et al(5)	26%	6%	44%	86%
Present study	19%	14%	34%	24%

History of blunt injury to the abdomen, leading to abdominal pain with gastric perforation was found among 5 subjects. Among these, 2 subjects presented under the influence of alcohol. Timing of presentation, time elapsed since the last meal & concomitant injuries were most important prognostic factors. There were no cases of gastric perforation following foreign body ingestion & upper gastrointestinal tract instrumentation in the present study. No case was had preoperative suspicion or confirmed case of malignancy. In the present study, no individual was hospitalized during the at the time of gastric perforation. On examination, the absolute signs of shock with non-palpable pulse & systolic blood pressure of < 90mm Hg was found in 1 subject. Mean pulse rate was observed to be 100.54/minute with a standard deviation of 14.74/minute. The pulse rate ranges from a minimum of 80/minute to maximum of 124/minute. Of all the subjects in the study, 59 patients had tachycardia (PR > 100/minute). Mean

blood pressure was 99.14/69.66 mm Hg with a standard deviation of 12.85/5.96 mmHg. Range of blood pressure values are as follows, 60 to120 mm/Hg for SBP & 56 to 90 mm/Hg for DBP. 18 subjects had hypotension (systolic blood pressure < 90mmHg) & among these 18 subjects, 16 had tachycardia too. In a study by R M Hodnett et al(5) on perforated gastric ulcers, 18% had preoperative shock. Shock at the time of presentation was found to be important risk factor associated with fatal outcomes following emergency surgery. Among young individuals with early presentation, fall in blood pressure or hypotension or shock was found to be rare. In the present study, presence of guarding and rigidity at the time of presentation was found to be in 64 subjects, compared to 66% in a study by R M Hodnett et al(5) on perforated gastric ulcers. In the present study, preoperatively bowel sounds were absent on abdominal auscultation in 82% patients, compared to 54% in a study by R M Hodnett et al(5) on perforated gastric ulcers, but in their study only 86.6% subjects (175/202 patients) were examined

for bowel sounds and results from these examined subjects only were reported. In the present study, 69% subjects had leucocytosis at the time of presentation, 11% subjects had abnormally raised renal function test values and 18% subjects had hypoglycaemia and 19% had hyperglycaemia, of which 18% subjects were known subjects of Diabetes mellitus. Of all 100 subjects, 90 subjects had pneumoperitoneum in abdominal radiography, specifically with air under diaphragm, with 12 subjects requiring the air insufflation into stomach with nasogastric intubation. In a study by Dr.S.Venkatesan et al(9) on clinical outcome of gastric ulcer perforation, similar to present study, 90% subjects (45 subjects) had pneumoperitoneum in abdominal radiography. In a study by R M Hodnett et al(5) on perforated gastric ulcers, 76% subjects had pneumoperitoneum in radiography. Remaining 10 subjects had no pneumoperitoneum in their abdominal radiography. Of these 10 subjects, 9 had presented to the hospital within 6 hours of onset

of abdominal pain & later diagnosed with the help of CECT abdomen. And 1 elderly male subject had delayed presentation with sealed off perforation which was observed in CECT abdomen & confirmed intraoperatively.

In the present study, antrum (85%cases) was found to be the most common site to be involved in the gastric perforation and greater curvature (2 cases) being the least common to be involved. 98% subjects had perforation on anterior wall and only 2% had perforation on posterior wall. In a study by R M Hodnett et al(5) on perforated gastric ulcers, 91% subjects had perforation on anterior wall and 9% had perforation posterior wall of stomach. In a study by J Wilson-Macdonald et al, antrum was involved in 47% cases.(3). In a study by Madiba et al (6)on perforated gastric ulcers, 47% subjects had perforation at incisura angularis on the lesser curvature and 53% subjects had perforation at gastric antrum.

Table-11: Site of the Gastric Perforation in Various Studies

Study	Site of the Perforation
J Wilson Macdonald et al(3)	Antrum – 47% subjects
R M Hodnett et al(5)	Anterior wall – 91% subjects, Posterior wall – 9% subjects.
Madiba et al (6)	Lesser curvature – 47% subjects, Gastric antrum - 53% subjects.
Present study	Antrum – 85% subjects, Greater and Lesser curvature – 8% subjects, Rest of the body – 7% subjects.

Size of perforation ranges from a minimum of 0.7cm to a maximum of 4cm with an average of 1.02cm. In a study by R M Hodnett et al(5) on perforated gastric ulcers, 7cm was the largest size reported. Larger sized perforations were found more commonly in areas other than antrum. Only 6 cases of giant gastric perforations (defined as >2.5cm in size) were reported in the present study, compared to 1.2% in a study by Nitin Vashistha et al(11) on giant gastric ulcer perforations. In the present study, subjects were taken up for surgery, as soon as possible. A duration of 4 hours was earliest possible and at least necessary time period required to evaluate and prepare the subject for the surgery. 11 hours was the longest duration of time period prior to surgery. The mean was 5.66 hours with a standard deviation of 1.43 hours, compared to a mean of 2.22 hours in a study by Dr.S.Venkatesan et al(9) on clinical outcome on gastric ulcer perforation. The delay in time period corresponds to timing of presentation of the subject, preoperative blood pressure and associated comorbidities. Delay in surgery increases mortality and morbidity rates. In the present study, all the subjects have undergone operative management, none have undergone conservative, non-operative management. Of all proposed surgeries for different types of gastric perforation, only 2 different types were done in the present study.

They were Graham’s patch repair, done in 86% cases & Subtotal gastrectomy + Roux en Y gastrojejunostomy, done in 14% cases. Graham’s patch repair was done when size of the perforation was in antrum with size <1.2cm. Subtotal gastrectomy + Roux en Y gastrojejunostomy was done in larger sized perforation or involvement of lesser curvature/greater curvature high up or in a case of suspected malignancy. In suspected malignancy with perforation, management has dual purpose; to treat peritonitis and for curative resection. In a study by Dr. C. Laang et al(12) on benign gastric perforations, simple closure was performed in 83 % of the patients & gastric resection in 14 %. In a study conducted by Kai Siang Chan et al.(4) over benign gastric perforations, 47% had undergone omental patch repair & 53% had undergone resection, but in the present study of all confirmed benign gastric perforations (93 subjects), 88.17% has undergone Graham’s patch repair & 11.8% subjects had undergone resection (STG+GJ). In a study by Dr.S.Venkatesan et al(9) on clinical outcome on gastric ulcer perforation, 98% subjects had simple closure & only 2% subjects underwent gastric resection with reconstruction. Emergency gastrectomy for either benign or malignant gastric perforations, has poor outcome in case of age > 65 years, Hemoglobin < 10gm/dl & shock at

presentation. In a study by G Coluccio et al(13) on surgical treatment on perforated gastric and duodenal ulcers, 14 cases of gastric perforation were reported of which 78.57% subjects had undergone simple suturing and 14.28% subjects underwent definitive procedures for peptic ulcer disease along with simple suturing and 7% subjects had undergone resection & reconstruction. In a study by Madiba et al(6) on perforated gastric ulcers, 25% subjects had simple closure, 37.5% subjects had complete excision of ulcer and 37.5% subjects had gastric partial resection. In a study by Leeman et al(8) on perforated gastric ulcers, 91% subjects had

Graham's patch repair, 4.5% subjects had simple closure, 4.5% subjects had distal gastrectomy. In a meta-analysis by Clara Zhun et al.(14) on retrospective analysis from nine single institutions, reported 67.92% subjects had ulcer repair and 32.07% subjects had gastric resection done. But, in this study surgical strategies were often chosen in non-randomised manner. In a study by W W Turner Jr et al(15) on perforated gastric ulcers, the different surgical procedures are listed in the below table, along with other studies. In the present study, simple primary closure of gastric perforation was not done.

Table-12: Types of Surgical Procedures Done in Various Studies

Authors of Study	Simple Closure	Omental Patch Closure	Gastric Resection and Reconstruction	Others
Dr.C.Laang et al(12)	83%	-	14%	3%
Kai Siang Chan et al(4)	-	47%	53%	-
Dr.S.Venkatesan et al(9)	98%	-	2%	-
G Coluccio et al(13)	93%	-	7%	14.28%
Madiba et al(6)	25%	-	37.5%	37.5%
Leeman et al(8)	4.5%	91%	4.5%	-
Clara Zhun et al(14)	67.92%		32.07%	-
W W Turner Jr et al(15)	12.1%	75.7%	10.2%	1.8%
Present Study	-	86%	14%	-

Damage control surgical approaches such as drain placement with subsequent definitive surgical procedure was not done in any case, in the present study. In the present study, among gastric perforation cases secondary to peptic ulcer disease, only primary pathology of peritonitis was dealt, definitive surgical management for peptic ulcer disease were not performed. In the present study, all the surgeries were open exploratory laparotomy procedures. Laparoscopic procedures were not done in the present study. In case of gastric resection, reconstruction was performed in Roux en Y gastro – jejunostomy fashion among all cases. Total gastrectomy was not performed for any case in the present study. In the present study, duration of hospital stay ranged from 2 days at the minimum to 18 days at the most. Mean duration of hospital stay was 9.52 days with a standard deviation of 3.21 days. In a study by Dr.S.Venkatesan et al(9) on clinical outcome on gastric ulcer perforation, mean duration of hospital stay was 9.36 days. Duration of hospital stay increased with occurrence of postoperative complications, in order to manage the complications prior to discharge from the hospital. Mean duration of hospital stay without postoperative complications was 8.8 days and with postoperative complications and without mortality was 10.6 days. In a study by Leeman M et al(8) on perforated gastric ulcers, mean duration of hospital stay was 10 days with a range of 4 - 56 days. In the present study, the edges of the perforated part or ulcer were sent to

histopathological examination in our hospital. Chronic non-specific ulcer suggestive of peptic ulcer disease was the most common finding seen in 86 subjects among the 100 subjects in the present study. Among these 86 subjects, 11 subjects had previous history of peptic ulcer disease & 9 had history of regular NSAIDs use. Biopsy of 7 subjects showed chronic gastritis, of which 6 had past history of peptic ulcer disease & 5 had history of regular usage of NSAIDs. Only 3 subjects had malignancy, compared to 20% subjects with malignancy as seen in a study by Hironori Tsujimoto et al(13) & 2% in a study by Dr.S.Venkatesan et al(9) on clinical outcome of benign gastric ulcer perforation. In a study by R M Hodnett et al(5) on perforated gastric ulcers, 7.2% subjects had malignancy in histopathological examination, but in this particular study biopsy was sent in only 65.3% subjects (132/202 patients), which have suspicion of malignancy. In a study by Leeman M et al(8) on perforated gastric ulcers, malignancy associated perforations were reported in 8.8% of subjects. Of these 3 malignancy proven subjects, 2 had past history of peptic ulcer disease. In a study by Emre Ergul et al(16) on emergency spontaneous gastric perforations, 13.06% of cases were due to gastric carcinoma, but in this particular study gastric perforations due to trauma and iatrogenic causes have been excluded. For 4 subjects, histopathological examination was not possible because of sampling errors.

In the present study, 32% subjects had no complications compared to 40% subjects with operative management, in a study by R M Hodnett et al(5) on perforated gastric ulcers. In the present study, 68% subjects had experienced one or the other post-operative complication. 16 subjects had only SSI. 2 subjects had SSI & burst abdomen. 3 subjects had SSI & incisional hernia. 1 subject had SSI, burst abdomen & incisional hernia. 1 subject had only LRTI. 12 subjects had SSI & LRTI. 2 subjects had SSI, LRTI & Sepsis. 1 subject had SSI, LRTI, Sepsis & AKI. 1 subject had SSI, burst abdomen & LRTI. 1 subject had only SIRS. 1 subject had SIRS, Sepsis & AKI. 1 subject had SIRS, Sepsis & CKD. This subject is a known case of CKD. 6 subjects had SIRS, Sepsis & MODS. 1 subject had SIRS, Sepsis, MODS, SSI & LRTI. 1 subject had SSI & Sepsis. 2 subjects had SSI, Sepsis & MODS. 1 subject had SSI, Sepsis, MODS & Electrolyte imbalance. 1 had only electrolyte imbalance. 2 subjects had only ileus. 1 had SSI & ileus. 1 subject had only post-operative adhesions leading to partial obstruction. 1 subject had only intraabdominal abscess, 5 subjects had SSI & Deep organ space infection. 2 subjects had SSI & Enterocutaneous fistula, In a study by Kai Siang Chan et al(4), on benign gastric perforations, incidence of intra-abdominal collection & post-

operative leakage was 16.4% & 11.8%, respectively. 1 subject had only MI which lead to death of the subject. 1 subject had SSI & DVT. MI, DVT, partial small bowel obstruction due to post-operative adhesions were the least common complications affecting only 1 subject each. In the present study, SIRS, SEPSIS, MODS and MI were most lethal complications. In the present study, SSI was found to be the most common post-operative complication, observed in 50% subjects,. Similarly in a study by Dr.S.Venkatesan et al(9) on clinical outcome on gastric ulcer perforation, SSI was found to be the most common complication. But in a study by R M Hodnett et al(5) on perforated gastric ulcers, atelectasis was found to be the most be the most common postoperative complication in their study. Even in a study by Bishnu prasad kandel et al(17) on perforated gastric cancer, SSI was found to be the most common postoperative complication affecting 45.5% individuals. MI, DVT, partial small bowel obstruction (subacute small bowel obstruction) due to post-operative adhesions were the least common complications affecting only 1 subject each. In the present study, SIRS, SEPSIS, MODS and MI were most lethal complications. In a study by Leeman M et al(8) on perforated gastric ulcers, morbidity rate was 54.5% [68].

Table-13: Incidence of in the Present Study

Percentage of Malignancy	Percentage
R M Hodnett et al(5)	7.2% subjects
Leeman et al(8)	8.8% subjects
Erme Ergul et al(16)	13.06% subjects
Hironori Tsujimoto et al(18)	20% subjects
Present study	3% subjects
Complications	
NONE	32%
SSI	16%
SSI & Burst Abdomen	2%
SSI & Incisional hernia	3%
SSI, Burst Abdomen & Incisional hernia	1%
LRTI	1%
SSI & LRTI	12%
SSI, LRTI & SEPSIS	2%
SSI, LRTI, SEPSIS & AKI	1%
SSI, Burst Abdomen & LRTI	1%
SIRS	1%
SIRS, SEPSIS & AKI	1%
SIRS, SEPSIS & CKD	1%
SIRS, SEPSIS & MODS	6%
SIRS, SEPSIS, MODS, SSI & LRTI	1%
SSI & SEPSIS	1%
SSI, SEPSIS & MODS	2%
SSI, SEPSIS, MODS & Electrolyte Imbalance	1%
Electrolyte Imbalance	1%

Ileus	2%
SSI & Ileus	1%
Intestinal obstruction 2° to Post op adhesions	1%
Intraabdominal abscess	1%
SSI & Deep Organ Space Infection	5%
SSI & Enterocutaneous fistula	2%
SSI & DVT	1%
MI	1%
Type of Procedure and Mortality Rate	
SIMPLE PATCH CLOSURE	5%
ULCER EXCISION and SUTURING	19%
GASTRECTOMY	26%
Gastric Perforation and Mortality Rate	
J Wilson Macdonald et al(3)	20%
R M Hodnett et al (5)	26%
Leeman et al(8)	15.90%
Madiba et al (6)	16.60%
W W Turner Jr et al(15)	32.75%
Kai Siang Chan et al(4)	19.10%
Matteo Melloni et al(12)	6.85%
Sara di Carlo et al (11)	2 – 46 %
Y Adachi et al(10)	40%
Dr.S.Venkatesan et al(9)	6%
Dr.C.Laang et al(12)	20%
Present Study	14%

In the present study, the mortality rate was 16% with 16 subjects being expired during the post operative period, compared to 20% as observed in a study by J Wilson-Macdonald et al(3) & 24% as observed in a study by G S McGee et al.(84) In a study by Dr.S.Venkatesan et al(9) on clinical outcome of gastric ulcer perforation, mortality rate was found to be 6%. In a study by R M Hodnett et al(5) on perforated gastric ulcers, overall mortality rate among all subjects including subjects without treatment was 26% and mortality rate in subjects treated either conservatively or surgically was 22% and mortality rate in subjects treated surgically was 18%. Among these 16 subjects, 8 subjects expired in early postoperative period (POD-3), remaining 8 subjects expired during the latter period. Among these 16 subjects, 3 subjects had biopsy proven malignancy which increased risk of mortality among these 3 subjects. In the present study, the mortality rate among malignancy associated gastric perforations was 100%, i.e., 3/3 subjects, compared to 40% in a study by Y Adachi et al (19) on perforated gastric carcinoma. In a study by Sara Di Carlo et al(20) on perforated gastric cancers, the mortality ranges from 2% to 46%. In a study by Matteo Melloni et al (21) on perforated gastric cancers, mortality rate varied based on surgical approach; in 1-staged procedure 11.8% and 1.9% in 2-staged procedure. Curative treatment by omental patch repair followed by staged gastrectomy yielded

acceptable rates of 5year survival ability in that study. 1 subject with malignancy in histopathological examination, had expired after discharging from the hospital during the follow up period 104 days after surgery compared to 195 days in a study by Hironori Tsujimoto et al.(18) Among these 16 expired subjects, 13 subjects showed benign pathology, which indicates a 13.9% mortality rate among benign gastric perforations. In a study by Dr.C.Laang et al(12) post operative mortality in benign gastric perforations was 20%. Click or tap here to enter text. In a study by Kai Siang Chan et al(4) on benign gastric perforations, mortality rate was 19.1%. In the present study, the mortality rate among subjects presented with preoperative shock was 55% (10/18 subjects) compared to 52.8% in a study by R M Hodnett et al (5) on perforated gastric ulcers. Among these 16 expired subjects, 9 had post operative complications of SIRS, Sepsis, MODS. In a meta-analysis by Clara Zhu et al(14) on comparison between omental patch repair & gastric resection on outcome of perforated gastric ulcer, there was no difference of mortality rates among the 2 cohorts based on type of surgical procedure. But in a study by Madiba et al(6) on perforated gastric ulcers, the mortality rates were different with different surgical procedures. In the present study, mortality rate among subjects with Graham's patch repair was 35.7% and among subjects with gastric resection was 12.7%. In a study by Leeman M et al(8) on perforated gastric ulcers, mortality rate was

15.9%. In a study by M Schein (7) on perforated gastric ulcers, mortality rate was 21.8%.

LIMITATIONS OF THE STUDY

In the present study, the sample size is one of the drawback. The results may be further supported by a randomised controlled prospective study of a significantly larger population which may also show variations that were not observed in the present study. The global Covid pandemic during the study, affected the hospital admission rates of gastric perforation which might have had a significant effect on the results and findings in the present study. In the present study, 95% subjects belong to low socioeconomic status which reduced the unit of randomization. Due to lack of multimodal oncological management facilities in the present institution, subjects with gastric malignancy were not followed to the full extent.

CONCLUSION

Gastric perforation is one of the cause of the peritonitis. According to the results in the present study, gastric perforation can occur in any age group. Gastric perforation has higher incidence among male individuals than compared to female individuals. Sudden onset of epigastric or generalized abdominal pain should alert the physician to include gastric perforation in the differential diagnosis. Abdominal pain and abdominal distension are the most consistent clinical findings with gastric perforation. According to the results in the present study, PUD is the most common cause of the gastric perforation in the present population. Gastric perforation has a higher morbidity and mortality than duodenal perforation. Although this was reported in earlier studies, it has not received appropriate focus and attention because most authors have discussed both gastric and duodenal perforations as a single entity. In the present study, the outcome of only isolated gastric perforation was dealt, which showed significant morbidity and mortality rates. According to the

results in the present study, delayed presentation and delayed surgical management were associated with increased risk of morbidity and mortality in case of gastric perforation with generalized peritonitis. Delayed presentation can be prevented by proper health education, proper referral mechanism. Gastric perforation, as with other abdominal hollow viscus perforation can readily be diagnosed with the help of abdominal and chest radiography in most of the clinical scenarios. In benign gastric perforations, type of surgical procedure for primary repair depends on size and site of perforation.

In case of gastric perforation secondary to PUD, there was no advantage with only simple closure or omental patch closure of a perforated peptic ulcer in the stomach. Definitive procedures of perforated peptic ulcers of stomach were associated with lower recurrence of perforation with reduction in pathological cause of gastric acidity and therefore can be advocated to treat gastric perforation secondary to PUD. In the present study, a few cases of gastric perforation were secondary to gastric malignancy. In a case of resectable malignancy with good general condition, such as no preoperative shock and localized peritonitis, radical gastrectomy along with extensive lymphadenectomy can be performed at the time of perforation. If general condition is good, but the tumour is unresectable as observed in advanced stage, a palliative gastrectomy can be performed. If general condition is poor but a curative resection is possible, two-stage radical gastrectomy with lymphadenectomy can be performed, though these surgical approaches were not performed in the present study. Overall, gastric perforation secondary to malignancy has poor prognosis. Risk of morbidity and mortality can be reduced to minimum with few precautions such as, early presentation and early diagnosis, effective preoperative resuscitation, addressing the comorbidities as needed, opting the most effective procedure and approach and performing them effectively, and in the end good ICU care.

References

1. Sigmon DF, Tuma F, Kamel BG, Cassaro S. Gastric Perforation. 2023 Jun 26. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. PMID: 30137838.
2. Lanas A, Chan FKL. Peptic ulcer disease. *Lancet*. 2017 Aug 5;390(10094):613-624. doi: 10.1016/S0140-6736(16)32404-7. Epub 2017 Feb 25. PMID: 28242110.
3. Wilson-Macdonald J, Mortensen NJMC, Williamson RCN. Perforated gastric ulcer. *Postgrad Med J* [Internet]. 1985 [cited 2022 Nov 11];61(713):217-20. Available from: <https://pubmed.ncbi.nlm.nih.gov/3983056/>
4. Chan KS, Wang YL, Chan XW, Shelat VG. Outcomes of omental patch repair in large or giant perforated peptic ulcer are comparable to gastrectomy. *European Journal of Trauma and Emergency Surgery* 2019 47:6 [Internet]. 2019 Oct 14 [cited 2022 Nov 13];47(6):1745-52. Available from: <https://link.springer.com/article/10.1007/s00068-019-01237-8>
5. Hodnett RM, Gonzalez F, Chapman Lee W, Nance FC, Deboisblanc R. The need for definitive therapy in the management of perforated gastric ulcers. Review of 202 cases. *Ann Surg* [Internet]. 1989 [cited 2022 Nov 14];209(1):36-9. Available from: <https://pubmed.ncbi.nlm.nih.gov/2910214/>

6. Madiba TE, Nair R, Mulaudzi TV, Thomson SR. Perforated gastric ulcer--reappraisal of surgical options. *S Afr J Surg*. 2005 Aug;43(3):58-60. PMID: 16180387.
7. Schein M, Saadia R, Jamieson J, Decker GA. Perforated gastric ulcers. A retrospective study of 32 patients. *Am Surg*. 1986 Oct;52(10):551-4. PMID: 3767142.
8. Leeman MF, Skouras C, Paterson-Brown S. The management of perforated gastric ulcers. *International Journal of Surgery*. 2013 May 1;11(4):322-4.
9. Dr.S.Venkatesan : Clinical outcome of gastric ulcer perforation - a prospective study : Madras medical college ragiv gandhi government general hospital :2013
10. Svanes C, Sothorn RB, Sørbye H. Rhythmic patterns in incidence of peptic ulcer perforation over 5.5 decades in Norway. *Chronobiol Int [Internet]*. 1998 [cited 2022 Nov 14];15(3):241-64. Available from: <https://pubmed.ncbi.nlm.nih.gov/9653578/>
11. Vashistha N, Singhal D, Makkar G, Chakravarty S, Raj V. Management of Giant Gastric Ulcer Perforation: Report of a Case and Review of the Literature. *Case Rep Surg [Internet]*. 2016 [cited 2022 Nov 14];2016:1-3. Available from: <https://pubmed.ncbi.nlm.nih.gov/28050305/>
12. Lanng C, Hansen CP, Christensen A, Thagaard CS, Lassen M, Klærke A, et al. Perforated gastric ulcer. *Br J Surg [Internet]*. 1988 [cited 2022 Nov 11];75(8):758-9. Available from: <https://pubmed.ncbi.nlm.nih.gov/3167522/>
13. Coluccio G, Fornero G, Rosato L. La nostra esperienza nel trattamento chirurgico dell'ulcera peptica perforata [Our experience in the surgical treatment of perforated peptic ulcer]. *Minerva Chir*. 1996 Dec;51(12):1035-8. Italian. PMID: 9064570.
14. Zhu C, Badach J, Lin A, Mathur N, McHugh S, Saracco B, et al. Omental patch versus gastric resection for perforated gastric ulcer: Systematic review and meta-analysis for an unresolved debate. *Am J Surg [Internet]*. 2021 May 1 [cited 2022 Nov 16];221(5):935-41. Available from: <https://pubmed.ncbi.nlm.nih.gov/32943177/>
15. Turner WW, Thompson WM, Thal ER. Perforated gastric ulcers. A plea for management by simple closures. *Arch Surg [Internet]*. 1988 [cited 2022 Nov 16];123(8):960-4. Available from: <https://pubmed.ncbi.nlm.nih.gov/3395239/>
16. Ergul E, Gozetlik EO. Emergency spontaneous gastric perforations: ulcer versus cancer. *Langenbecks Arch Surg [Internet]*. 2009 Jul [cited 2022 Nov 14];394(4):643-6. Available from: <https://pubmed.ncbi.nlm.nih.gov/18418626/>
17. Kandel BP, Singh Y, Singh KP, Khakurel M. Gastric cancer perforation: experience from a tertiary care hospital. *JNMA J Nepal Med Assoc*. 2013 Jul-Sep;52 (191):489-93. PMID: 24907957.
18. Tsujimoto H, Hiraki S, Sakamoto N, Yaguchi Y, Horio T, Kumano I, et al. Outcome after emergency surgery in patients with a free perforation caused by gastric cancer. *Exp Ther Med [Internet]*. 2010 Jan [cited 2022 Nov 11];1(1):199-203. Available from: <https://pubmed.ncbi.nlm.nih.gov/23136615/>
19. Adachi Y, Mori M, Maehara Y, Matsumata T, Okudaira Y, Sugimachi K. Surgical results of perforated gastric carcinoma: an analysis of 155 Japanese patients. *Am J Gastroenterol [Internet]*. 1997 Mar [cited 2022 Nov 14]; 92(3):516-8.
20. di Carlo S, Franceschilli M, Rossi P, Cavallaro G, Cardi M, Vinci D, et al. Perforated gastric cancer: a critical appraisal. *Discover Oncology [Internet]*. 2021 Dec 1 [cited 2022 Nov 14]; 12(1). Available from: <https://pubmed.ncbi.nlm.nih.gov/35201463/>
21. Melloni M, Bernardi D, Asti E, Bonavina L. Perforated Gastric Cancer: A Systematic Review. *J Laparoendosc Adv Surg Tech A [Internet]*. 2020 Feb 1 [cited 2022 Nov 15]; 30(2):156-62.