

Original Research Article

Hollow viscus perforation with gas under diaphragm: a misnomer??

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Received: 11 May 2023

Revised: 07 June 2023

Accepted: 08 June 2023

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ABSTRACT

Background: Hollow viscus perforation is suspected when radiographs show the presence of gas under diaphragm and is usually an indication for surgical abdominal exploration. This is significant because in cases of hollow viscus perforation, plain radiography may be used as the first line of diagnosis. Concerns regarding diagnosing those 30% cases of hollow viscus perforation which was not detected by the plain radiography.

Methods: A bound prospective study of patients who were managed for perforated hollow abdominal viscus, when no abnormality was appreciated on radiographs, confirmation was done either on the basis of clinical examination, further investigations or by exploratory laparotomy performed on basis of selection of cases.

Results: Based on the study, 15 patients were found with no gas under diaphragm on radiographs and perforation was confirmed on the grounds of clinical, physical examination, further investigations or by exploratory laparotomy on basis of cases. The results obtained in the present study shows male predominance, duodenal perforation being the most common perforation amongst hollow viscus perforations and age group of 20-40 years were affected mainly.

Conclusions: It is important to note that not all the cases of pneumoperitoneum indicate perforated abdominal viscus or vice versa. This study highlights the difficulty in pre-operative diagnosing pneumoperitoneum with upright chest and abdominal X-rays provided its sensitivity varied from 50-98%.

Keywords: Emergency exploratory laparotomy, Gas under diaphragm, Gastrointestinal perforation, Hollow viscus perforation, Pneumoperitoneum

INTRODUCTION

Gastro intestinal perforation is a common abdominal emergency faced by general surgeon. Perforation said to occur when pathology has breached through all the layers of the hollow viscus with resultant escape of intraluminal content into the peritoneal cavity and peritoneal contamination. Gastrointestinal perforation is one ailment that exemplifies the saying that the abdomen is a Pandora's box.¹

Perforation of a hollow viscus, which can happen for a variety of reasons, accounts for the bulk of emergency

surgical admissions and emergency laparotomies. As a result of these hollow viscus perforations, pneumoperitoneum develops. However, only 50% to 70% of hollow viscus perforations on plain radiography are indicative of pneumoperitoneum.² The origin of pneumoperitoneum, and subsequently free gas under diaphragm, is due to the perforation/disruption of the wall of a hollow viscus. Detecting a sub diaphragmatic free gas in an erect chest radiograph, is the most sensitive plain radiograph for the identification of free intraperitoneal gas. Abdominal radiographs showing the diaphragms may also illustrate the air under the diaphragm.³

The relevance of a plain radiograph for detecting pneumoperitoneum has been overshadowed in the present due to the development of better diagnostic techniques like USG and CT scan. In cases of hollow viscous perforation, plain radiography may be used as the first line of diagnosis provided its sensitivity varied from 50% to 98%, depending upon the type of radiograph that has been captured. "It is important to note that not all the cases of pneumoperitoneum indicate perforated abdominal viscus (Gantt et al)".⁴

Pre-operative and intra-operative findings

We examined patients on the basis of pre-operative radiograph scans and clinical diagnosis of perforated hollow viscus were made on the behalf of history, physical examination, investigations or further by exploratory laparotomy performed.

Protocol followed

As the patient was referred to department of general surgery, full history and physical examination were performed, if required resuscitation measures were taken in emergency. Depending on the stability of the patient further decisions were carried off.

On stable patients with clinical diagnosis of hollow viscus perforation, Chest X-ray were performed and patients showing no gas under diaphragm (Figure 1) were suspected case who underwent further investigations such as Non- contrast computed tomography scan which revealed findings suggestive of or in favour of hollow viscus perforation .

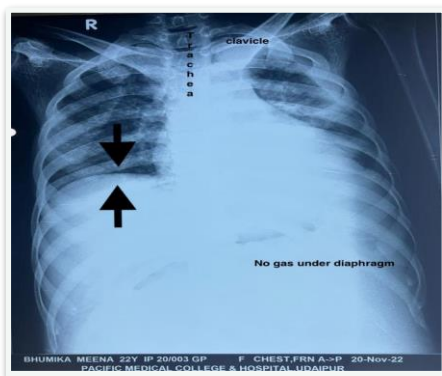


Figure 1: Chest x-ray report of same patient which signifies no gas under diaphragm in chest x-ray.

The aim of this study were to evaluate the preoperative radiographs of patients who were operated upon for perforated hollow abdominal viscus, with regards to air under diaphragm and intra-abdominal sensitivity to pneumoperitoneum indicating perforated abdominal viscus.

METHODS

This was prospective study of patients who were managed for perforated hollow abdominal viscus between January 2020 and December 2023. This study was conducted in PMCH, Udaipur, Rajasthan, which is a tertiary care hospital, catering large number of patients with general surgical and emergency practices. There were 47 patients enrolled in this study.

Study parameters: Clinical diagnosis of perforation of hollow viscus was made by history and physical examination and all these patients were advised to have an upright chest and Abdominal radiograph. When no abnormality was appreciated on radiographs, confirmation was done either on the basis of clinical examination, further investigations or by exploratory laparotomy performed on basis of selection of cases.

Inclusion criteria

All patients aged above 18 years with a clinical presentation of acute abdomen were considered for the study, patient suspicious of hollow viscus perforation as a result of underlying disease process, and patient of isolated blunt trauma abdomen (BTA) or BTA as a part of multiple injuries were included.

Exclusion criteria

Patient age <18years, patients with peritonitis, without hollow viscus perforation at surgery, patients who underwent medical line of management, patients who had undergone laparotomy or laparoscopic and hysteroscopy procedure in the previous 30 days period, and intra-abdominal gas forming organism infection without hollow viscus perforation were excluded from the study.

All patients were accessed and evaluated and decision for operative procedure was taken. Only those patients were taken who had pre-operative signs of peritonitis and confirmed hollow viscus perforation INTRA-operatively. Information was extracted from the case notes, operation notes, operation register and admission-discharge records. The information extracted included the patients age, gender, presenting symptoms, duration of symptoms before presentation, time interval between presentation and intervention, intra-operative finding/definitive diagnosis, definitive operative procedure performed, complications of treatment, duration of hospital stay and outcome of treatment. All the patients had chest and abdominal x rays. The intra-operative findings were compared with the chest/abdominal radiographs. The follow-up period was 12 months. Ethical approval was obtained from the ethics and research committee and informed consent was obtained from the patient and their caregivers. Data were expressed as percentages, median, mean, and range.

RESULTS

A total of 47 cases of perforated hollow viscus were operated upon during the study period which constituted of 26 male and 21 female patients, out of this number, 15 (31.9%) cases were incorporated for analysis who did not show gas under diaphragm on x-ray findings, out of which 8(30.7%) were males and 7 (33.3%) were females. The mean duration of symptoms before presentation was 4 days, range 1 day to 1month. The median duration from presentation to surgery was 3 days, range 2-5 days. The mean duration of hospitalization was 11 days with a range of 7-21 days.

Table 1: Sex distribution.

Sex	No. of patients	Percentages
Male	8	30.7%
Female	7	33.3%

Table 2: Presenting complaints.

Symptoms and signs	No. of patients
Pain abdomen	15
Nausea and bilious vomiting	11
Fever	4
Constipation	7
Obstipation	4
Abdominal distention	6
Loss of appetite	2
Tenderness	10
Obliterated liver dullness	12
Bowel sounds absent	10
Absent gas under diaphragm	15

In the present study all the 15 (31.9%) patients presented with absent gas under the diaphragm. All the patients had abdominal pain. Nausea, bilious vomiting was recorded in 11 (23.4%) patients. Constipation and obstipation was recorded in 7 (14.8%) and 4 (8.5%) patients respectively. Abdominal distention was observed in 6 (12.7%) patients. Fever was recorded in 4 (8.5%) patients and Loss of appetite was seen in 2 (4.2%) patients.

On palpation and auscultation 10 (21.2%) patients recorded tenderness and absent bowel sounds. Obliterated liver dullness was not a feature in 12 (25.5%) patients.

Imaging investigations

All the patients had plain abdominal and chest x ray. Free air under the diaphragm was absent in 15 (31.9%).

Most common site of perforation without gas under diaphragm was duodenum and ileum which constituted about one-third of patients i.e. 3 (6.3%) respectively. Second most common site of perforation was gastric and small bowel perforation which constituted 2 (4.2%) each of total perforation. Multiple intestinal perforation was

found in 2 (4.2%) patients. Other sites of perforation were appendix in 2 patients i.e. (4.2%) and only in 1 patients (2.12%) the perforation was found in colon.

Table 3: The intra-operative findings and definitive diagnosis.

Site	No of cases	Percentages
Gastric perforation	2	4.2
Duodenal perforation	3	6.3
Ileal perforation	3	6.3
Ileal and jejunal perforation	2	4.2
Colonic perforation	1	2.12
Multiple intestinal perforation	2	4.2
Appendicular perforation	2	4.2

Table 4: Duration.

Duration	No. of patients	Percentage
Within 24 hours	5	53.35
25-48hours	3	20
49-72hours	4	26.6
>72hours	4	26.6

About 5 (53.3%) patients presented within 24 hours and 7 (46.6%) out of 15 patients presented within 2-3 days and 4 (26.6%) patients presented with more than 72 hours of the onset of symptoms.

Table 5: Etiology.

Etiology	No. of patients
Idiopathic	4
Bands adhesions	3
Appendicular	2
Meckel's	1
Tubercular	1
Drugs (NSAIDS Induced)	2
Obstructed hernia	1
Traumatic	1

The most common etiological factor in the presentation of disease was Non- traumatic factors like bands adhesions, Meckel's, tubercular, drug induced, obstructed hernia, appendicular and idiopathic which accounted for 93.3% of the cases. The least was a traumatic cause of intestinal perforation which accounted for only 6.66% of the case.

Pre-operative diagnosis on the basis of USG/CT findings suggestive of perforation/in favour of exploratory laparotomy

In the present study all patients with hollow viscus perforation presented with absent gas under diaphragm. Further investigations were carried out to confirm with diagnosis. On the basis of Usg/CT findings maximum of

5 (33.3%) out of 15 patients were suggestive of sub acute intestinal obstruction while 9 (60%) patients represented with hollow viscus perforation, intestinal perforation and peritonitis respectively. Only 1 (6.66%) patient was suggestive of obstructive obturator hernia with intestinal adhesions (Figure 2).

Patients who were a part of this analysis received standard care. The treatment of electrolyte imbalance and preoperative resuscitation in situations of shock were followed. All subjects underwent laparotomies following preoperative care, during which the root of the problem was located and addressed appropriately.

Complications of treatment

Wound infection happened in 3 (20%) patients which healed with secondary sutures, no major morbidity was reported. There was no mortality in present study.

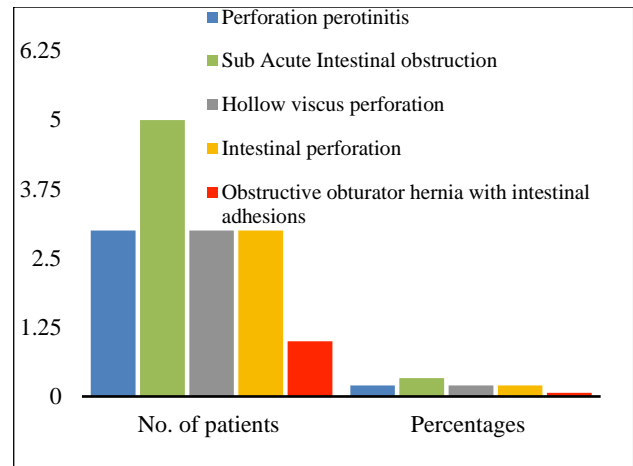


Figure 2: Pre- Operative diagnosis on the basis of USG/CT findings.

Table 7: Diagnosis and surgical procedure.

Diagnosis	Surgical procedure adopted	No of cases
Duodenal perforation	Closure of perforation with Graham's omentum patch and peritoneal lavage	4
Gastric perforation	Exploratory laparotomy f/b Graham's omentoplasty with or without feeding jejunostomy	1
Ileal perforation due to adhesive band/Meckel's diverticulum/ stricture	Exploratory laparotomy, excision of distal ileal segment containing perforation and meckels diverticulum with Adhesiolysis with end to end ileoileal anastomosis with appendectomy with peritoneal lavage	2
Ileal perforation due to tubercular stricture	Exploratory laparotomy, with side to side ileo ileal anastomosis.	1
Appendicular perforation with intestinal obstruction	Exploratory Laparotomy With appendectomy with peritoneal lavage	2
Small bowel ILEAL perforation due to left obstructed obturator Hernia/adhesions	Diagnostic lap. With mini exploration laparotomy with end to end/side to side ileo-ileal resection and anastomosis with/without appendectomy	2
Colonic perforation	Exploratory laparotomy with right colectomy with ileo-transverse anastomosis with placement of two abdominal drains.	1
Traumatic ILEAL perforation	Exploratory laparotomy, with resection and side to side ileo ileal anastomosis.	1
Multiple intestinal perforation	Ilio ileal end to end anastomosis, jejunal proximal end to end anatomisis	1

DISCUSSION

The term acute abdomen refers to the signs and symptoms of abdominal pain and tenderness.^{1,5} This situation often represents an underlying surgical problem that requires prompt diagnosis and surgical treatment. "Hollow viscus perforation accounts one of the important cause of abdominal pain in adults. More than seven million people visit the emergency department every year for abdominal discomfort, and up to 40% of all emergency-surgical hospital admissions involve the acute abdomen (John et al).⁶ In our study 15 (31.9%) patients

were diagnosed with hollow viscus perforation who underwent exploratory laparotomy and intra-operative findings confirmed the diagnosis of hollow viscus perforation (Figure 3).

In surgical practice, pneumoperitoneum commonly occurs following gastrointestinal perforation or as residual air following laparotomy^{2,3,4} "It is suspected when radiographs show the presence of gas under diaphragm. Free air under the diaphragm is seen as an area of lucency under the right or left hemi-diaphragm or at the mid portion of the diaphragm under the central tendon (Cupola sign) (Marshall, 2006).³ On an erect chest

x ray, especially on the right side, as little as 1 ml to 2 mls of air can be seen as air under the diaphragm

(Hokama et al)^{3,7} Various causes of pneumoperitoneum (Table 8).

Table 8: Various causes of pneumoperitoneum.

Cause of pneumoperitoneum	Perforation with peritonitis	Perforation without peritonitis	Abdominal causes	Female pelvic/others causes
-	Perforated hollow viscus	Pneumomediastinum/pneumothorax	Post laparotomy	Instrumentation
-	Necrotising enterocolitis	Chronic obstructive airways disease	Jejunal diverticulosis	Oro-genital intercourse
-	Bowel infarction	Positive pressure ventilation	Endoscopy	Vaginal douching
-	Penetrating abdominal injuries	-	Paracentesis/peritoneal dialysis	Coitus
-	-	-	Pyloric stenosis	Post-partum pelvic examination
-	-	-	Scleroderma and Whipple's disease	

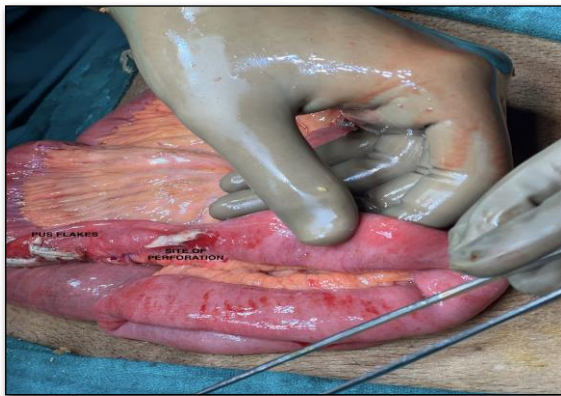


Figure 3: Intra-operative findings of hollow viscus perforation.

Age incidence

Maximum incidence of enteric perforation occurs in 3rd decade of life in study as compared to series ARK Adensunkunmi et al, Mock et al in which maximum number of cases occur in 2nd decade of life.^{8,9}

Sex incidence

In our study male preponderance is seen, with male to female ratio 1:1.1428.

Majority number of cases occur in 2nd decade of life of patients in our study constituted duodenal perforation which accounts for the most common gastro-intestinal perforation. It is noted that perforation is common in the

first part of duodenal and most common in males. This is consistent with the previous studies Shah HK, Trivedi VD in his study of peritonitis of 110 cases stated that gastro duodenal perforation is the most common perforation.¹⁰

Bhansali et al, in his study of gastrointestinal perforation comprised that the duodenal perforation happens to be the most common and the small bowel perforation accounts for second most common perforation.¹¹

Chen et al, in his study of accuracy of ultrasonography in the diagnosis of peritonitis compared with the clinical impression of the surgeon, ultrasonography is a more sensitive technique than clinical judgment in diagnosing peritonitis.¹²

GI hollow viscus perforation constitute one of the important cause of abdominal pain in adults. Duodenal ulcer perforation was the most common cause.^{1,4} Duodenal ulcer perforation is common in the first part of duodenum and most common in males.

Appendicular perforation is 13.33%. This is consistent with other previous studies like Sharma et al and Chen et al.^{12,13}

Symptoms and signs

Abdominal pain was a constant symptom in all the patients. There are certain abdominal pathologies that cause hollow viscus perforation which are responsible for intra-abdominal pain such as tuberculosis, peptic ulcer

disease, colitis, malignancy and hence, the origin of the abdominal pain.

Sengupta et al, in his study of visceral pain, the neurophysiological mechanism compared the mechanism of visceral pain to somatic pain, in which he comprised that because of the distension of hollow viscus, sensitised by the primary sensory afferents is possibly the determinant of the nature of visceral pain.¹⁴

Mehta et al in his study of abdominal pain constituted that visceral pain is felt by the stretching of the wall of the abdominal hollow viscus.⁵

The pain of perforated hollow viscus is described as acute, of sudden onset and of intense severity. Other symptoms may be present depending on the pathology. In our study other symptoms noted were nausea, bilious vomiting was recorded in 11 (73.3%) patients. Constipation and Obstipation was recorded in 7 (44.6%) and 4 (26.6%) patients respectively.

On palpation and auscultation 10 (66.6%) patients recorded tenderness and absent bowel sounds. Obliterated liver dullness was not a feature in 12 patients.

In our study, abdominal distention was observed in 6(40%) patients. Abdominal distention was quite predominant in the study by Yadav et al who reported 73.6% of the subjects to have abdominal distention.¹⁵

Fever was recorded in 4 (26.6%) patients. The other studies quoted here showed a consistent presentation of fever who reported quite less number of patients with fever as compared to this study.^{13,16}

Imaging

In the present study, on imaging, majority of the patients with hollow viscus injury had no air under the diaphragm; only about Two-third of the patients showed air under the diaphragm. Similar findings were found in a research study from Ghana that reported that only about 55% of the patients with bowel perforation showed air under the diaphragm (Abantanga et al).¹⁷

However, according to Sahu et al, pneumoperitoneum is a indication of perforation of a hollow viscus in 90 percent of cases (van Gelder et al).¹⁸

Sureka et al, stated “It is pertinent to note that the most common cause of pneumoperitoneum is perforation/ disruption of the wall of a hollow viscus”.²

A perforated hollow viscus containing air is expected to release air into the peritoneum cavity causing pneumoperitoneum. Additionally, there is a surgical paradigm that suggests abdominal exploration when pneumoperitoneum appears on imaging as a result of perforation of a hollow viscus (Shinall et al).¹⁹

The variations in percentages of the pneumoperitoneum may be accounted for by the quantity of free air released, rate of systemic absorption of the free air and the perforated organ. For instance, in perforated appendix, free air under the diaphragm may be a rare presentation (Cizneli et al).²⁰

In our study, all patients had plain abdominal and chest x-ray. Pneumoperitoneum was absent in 15 (31.9%) of cases on chest x-ray (Figure 4) whereas Abdomen standing X-ray of patients showed dilated bowel loops (Figure 5).

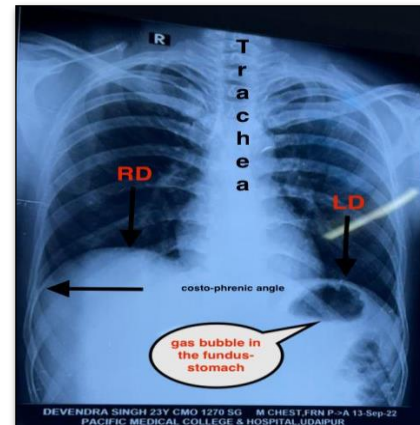


Figure 4: Chest X-ray of a patient PA view, showing no gas under diaphragm who was diagnosed with hollow viscous perforation intra-operatively.

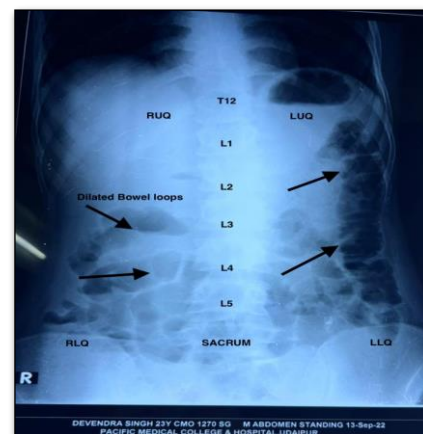


Figure 5: Views X-ray abdomen standing of same patient showing dilated bowel loops.

Site of perforation

The site of perforation was one of the most important parameters of all the studies.

In our study, the most common site of perforation was duodenum which constituted about one-third of patients i.e. 5 (33.3%) of total patient. Second most common site

of perforation was ileum which constituted 3 (20%) of total perforation (Figure 6).



Figure 6: Gastro-intestinal perforation showing site of perforation.

Doraijan et al did a study in 1995, where he took 250 subjects for his study and he studied them according to sites of perforation, the etiology of perforation and the respective mortality.²¹ In contrast with the study by Khan et al, who studied these parameters in 54 patients in 2004.²² The most common site of perforation was seen to be at the gastro-duodenal region.

The gastric perforation was recorded in 2 patients at pyloric and pre-pyloric site. The data is not consistent with any other study. The perforation of proximal gastrointestinal tract were six times as common as perforation of distal gastrointestinal tract as has been noted in earlier studies.^{23,24}

Small bowel and multiple intestinal perforation was found in 2 (13.3%) patients respectively. Other sites of perforation were appendix in 2 patients i.e. 13.33% (Figure 7) and only in 1 patients (6.66%) the perforation was found in colon.

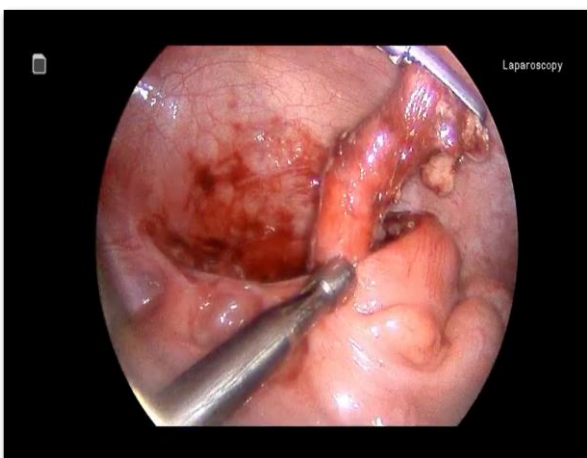


Figure 7: Perforated appendix at the tip.

The colonic perforation is very rare perforation is consistent with other previous studies like Sharma et al, Dandapat et al.^{13,25}

Etiology

In our study, the most common etiological factor in the presentation of disease was Non- traumatic factors like bands adhesions, meckel's, tubercular, drug induced, obstructed hernia, appendicular and idiopathic which accounted for 93.3% of the cases. The least was a traumatic cause of Intestinal perforation which accounted for only 6.66% of the case similar to the previous studies whereas majority of traumatic perforations are caused by road traffic accidents.^{26,27}

Management

Following a clinical diagnosis of perforation peritonitis and sufficient resuscitation in an emergency scenario, an exploratory laparotomy was performed. Surgical management includes closure of perforation with Graham's omentoplasty, feeding jejunostomy, resection with or without anastomosis, appendectomy and definitive procedures were carried out. Although, according to our experience and also techniques addressed in previous series, which are consistent and stated simple closure of perforation using a pedicle omental patch gives good results even in larger perforation. Exteriorization of perforation as loop ileostomy/colostomy is safe procedure to be done in emergency situation followed by elective closure 6-8 weeks later, as consistent with previous studies done by Mock et al, Sharma et al, Hermansson et al and Tonnessen et al.^{9,13,28,29}

Also, In our study, surgical site infection was seen in only 3 patients which is markedly lower as compared to other studies. Post operative complications accounts for 28% in the study of Jhobta et al and 20% in Afridi et al. There was no mortality documented in the current study. In the previous study by Yadav et al had a mortality rate of 13%.^{30,31}

The limitations of the study was that we were not able to comment on the misnomer as the sample size was not adequate.

CONCLUSION

Hollow viscus perforation is suspected when radiographs show the presence of gas under diaphragm and is usually an indication for surgical abdominal exploration. However, in the present study 15 patients were found with no gas under diaphragm on radiographs and perforation was confirmed on the grounds of clinical, physical examination, further investigations or by exploratory laparotomy on basis of cases. This study highlights the difficulty in pre-operative diagnosing

pneumoperitoneum with upright chest and abdominal X-rays. The results obtained in the present study are:

Duodenal perforation is the most common perforation amongst hollow viscus perforations. Age group of 20-40 years were affected mainly. Male predominance is seen. Signs and symptoms of acute abdomen like acute abdominal pain vomiting fever may present tachycardia, hypotension, abdominal tenderness guarding/rigidity with obliteration of liver dullness and absence of bowel sounds and absolute constipation were predominant signs. Hollow viscus perforation is the common cause of acute abdomen needing immediate effective surgical attention. In this study except for wound dehiscence in 3 cases which needed secondary suturing no major morbidity noted. No mortality noted in the present study.

ACKNOWLEDGEMENTS

Authors would like to thank Dr. Gaurav Wadhawan, Dr. H. P. Gupta for assisting with the research work.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

- Kemparaj T, Khadri S. Gastrointestinal perforations-our experience. Internet J Surg. 2012;28(2):1-6.
- Sureka B, Bansal K, Arora A. Pneumoperitoneum: What to look for in a radiograph?. Fam Med Prim Care. 2015;4(3):477.
- Marshall GB. The cupola sign. Radiol. 2006;241(2):623-4.
- Gantt Jr CB, Daniel WW, Hallenbeck GA. Nonsurgical pneumoperitoneum. Am J Surg. 1977;134(3):411-4.
- Mehta H. Abdominal pain. Clin Pathw Emerg Med. 2016;22:29-345.
- Langell JT, Mulvihill SJ. Gastrointestinal perforation and the acute abdomen. Med Clin North Am. 2008;92(3):599-625.
- Hokama A, Nakamura M, Kobashigawa C, Chinen H, Kishimoto K, Nakamoto M, et al. (2009). Education and imaging. Gastrointestinal: Signs of pneumoperitoneum. J Gastroenterol Hepatol. 2009;24(3):497.
- Edino ST, Yakubu AA, Mohammed AZ, Abubaka IS. The prognostic factors in typhoid ileal perforation: a prospective study of 50 patients. J Natl Med Assocv. 2007;99(9):1042-5.
- Mock CN, Amaral J, Visser LE. Improvement in survival from typhoid ileal perforation results of 221 operative cases. Ann Surg. 1992;215(3):244-9.
- Shah HK, Trivedi VD. Peritonitis a study of 110 cases. Indian Pract. 1988;41:855-60.
- Bhansali SK. Gastrointestinal perforations-a clinical study of 96 cases. J Postgrad Med. 1967;13:1-12.
- Chen SC, Lin FY, Hsieh YS, Chen WJ. Accuracy of ultrasonography in the diagnosis of peritonitis compared with the clinical impression of the surgeon. Arch Surg. 2000;135(2):170-3.
- Sharma L, Gupta S. Generalized peritonitis in India-the tropical spectrum. Jpn J Surg. 1991;21(3):272-7.
- Sengupta JN. Visceral Pain: The Neurophysiological Mechanism. Handbook of experimental pharmacology; 2009:31.
- Yadav D, Garg P. "Spectrum of perforation peritonitis in Delhi: 77 Cases Experience." Indian J Surg. 2013;75(2):133-7.
- Thal ER. "Abdominal trauma". The surgical clinics of north America, W.B. Saunders Co.; 1990:517-575.
- Abantanga FA, Wiafe-Addai BB. Postoperative complications after surgery for typhoid perforation in Ghana. Pediatr Surg Int. 1998;14(1-2):55-8.
- van Gelder HM, Allen KB, Renz B, Sherman R. Spontaneous pneumoperitoneum. A surgical dilemma. Am Surg. 1991;57(3):151-6.
- Shinall Jr MC, Ehrenfeld JM, Gunter Jr OL. Non-operative Management of Perforated Hollow Viscera in a Palliative Care Unit. Ann surg. 2018;268(1):e1.
- Cizmeli MO, Demirag A, Durmus O, Ilgit ER. Acute appendicitis associated with pneumoperitoneum. Brit J Clin Pract. 1990;44(12):646-7.
- Dorairajan LN, Gupta S, Deo SV, Chumber S, Sharma LK. Peritonitis in India--a decade's experience. Trop Gastroenterol: Dig Dis Found. 1995;16(1):33-8.
- Khan S, Khan IU, Aslam S, Haque A. Retrospective analysis of abdominal surgeries at Nepalgunj Medical College (NGMC), Nepalgunj, Nepal: 2 year's experience. KUMJ. 2004;2(4):336-43.
- Washington BC, Villalba MR, Lauter CB. Cefamandole- erythromycin-heparin peritoneal irrigation. An adjunct to the surgical treatment of diffuse bacterial peritonitis. Surg. 1983;94:576-81.
- Nomikos IN, Katsouyanni K, Papaioannou AN. Washing with or without chloramphenicol in the treatment of peritonitis: a prospective, clinical trial. Surg. 1986;99(1):20-5.
- Dandapat MC, Mukherjee LM, Mishra SB, Howlader PC. Gastrointestinal perforations. Indian J Surg. 1991;53:189-93.
- Espinoza R, Rodríguez A. Traumatic and nontraumatic perforation of hollow viscera. Surg Clin North Am. 1997;77(6):1291-304.
- Torpy JM, Lynn C, Golub RM. Peptic ulcer disease. JAMA. 2012;307(12):1329-.
- Tonnessen T, Carlsen E. Perforated ulcer. Tidsskr Nor Laegeforen. 2001;121(7):790-2.

29. Hermansson M, Holstein SC, Zilling T. Surgical approach and prognostic factors after peptic ulcer perforation. *Eur J Surg.* 1999;165(6):566-72.
30. Jhobta RS, Attri AK, Kaushik R, Sharma R, Jhobta A. Spectrum of perforation peritonitis in India-review of 504 consecutive cases. *World J Em Surg.* 2006;1(1):1-4.
31. Afridi SP, Malik F, Rahman SU, Shameen H, Samo KA. 2008. "Spectrum of perforation peritonitis in

Pakistan: 300 cases eastern experience". *World J Emer Surg.* 2008;3(1):1-5.

Cite this article as: Dutta P, Wadhawan G, Arora R, Sharma S. Hollow viscus perforation with gas under diaphragm: a misnomer??. *Int J Res Med Sci* 2023;11:2590-8.