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Resolution of free air in the peritoneal cavity after laparotomy for bowel perforation in children: how long does it take?

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Abstract

Preoperatively, the presence of free air in the peritoneal cavity (pneumoperitoneum) is indicative of a gastrointestinal perforation and laparotomy exposes the peritoneal cavity and bowel to atmospheric air. The aim of this study was to evaluate how long (in days) it takes for free air in the peritoneal cavity to disappear following laparotomy in children.

This was a prospective study of children aged 15 years and younger who had laparotomy for bowel perforation at the pediatric surgery unit of a teaching hospital in Enugu, Nigeria. This study covered a 5-year period. The patients were followed up postoperatively to evaluate which day post-op the free air in the peritoneal cavity resolves.

A total of 112 cases of perforated bowel had laparotomy during the study period. Amongst this number, 37 (33%) patients showed pneumoperitoneum on their preoperative radiographs, and form the basis of this report. There was male predominance. Abdominal pain is a consistent symptom in all patients. The majority of the patients had typhoid intestinal perforation with single ileal perforation and primary intestinal repair was the most performed procedure. Wound infection was the most common post-operative complication and the general outcome was fair. Overall, the mean time for the pneumoperitoneum to disappear was 5.5 days postoperatively.

Bowel perforation results mostly from infective/inflammatory processes such as typhoid intestinal perforation. Laparotomy is required for the repair of these perforations and it takes an average of 5.5 days for the free peritoneal air to resolve.

Keywords: *Children, bowel perforation, free air, pneumoperitoneum, laparotomy.*

Introduction

In the preoperative state, the presence of free air in the peritoneal cavity (pneumoperitoneum) is indicative of gastrointestinal perforation or any other perforated hollow viscus [1]. Laparotomy for the repair of the perforated viscus also exposes the bowel and peritoneal cavity to atmospheric air. Air may be introduced into the peritoneal cavity during abdominal surgery or during the insertion of peritoneal drains [2]. Post-operatively, in patients who had intestinal resection and anastomosis, pneumoperitoneum may signify an anastomotic leak [3]. It is pertinent to differentiate physiologic free air following laparotomy from pathologic free air resulting from disruption in the gastrointestinal tract such as anastomotic leak: This is because the approach to their treatment is different. The pneumoperitoneum is usually demonstrated on plain radiographs. In terms of radiological precision in detecting pneumoperitoneum, computed tomography (CT) scan has better resolution than plain radiographs [4]. However, non-affordability, non-availability, and non-accessibility limit the use of CT scans. Moreover, radiation exposure when using CT scans is of concern in children [5]. The presence of free intra-peritoneal air following laparotomy in

children and its time of disappearance/resolution is a subject of controversy and speculation. Opinions are divided with regard to the time of disappearance of the post-operative air [6].

The aim of this study was to evaluate how long (in days) it takes for free air in the peritoneal cavity to resolve following laparotomy in children.

Materials and Methods

This was a prospective study of children aged 15 years and younger who had laparotomy for perforated bowel between January 2016 and December 2020 at the pediatric surgery unit of Enugu State University Teaching Hospital (ESUTH) Enugu, Nigeria. All consecutive children who had laparotomy during the study period were recruited into the study. Both elective and emergency laparotomies were considered. The indications for the laparotomy and the clinical presentations were varied. Children who had laparotomy in a peripheral hospital before presentation to ESUTH for further care were also recruited into the study. However, patients older than 15 years of age and those with complications such as enterocutaneous fistula were excluded from the study. ESUTH is a tertiary hospital located in Enugu, South East Nigeria. The hospital serves the whole of Enugu State, which according to the 2016 estimates of the National Population Commission and Nigerian National Bureau of Statistics, has a population of about 4 million people and a population density of 616.0/km2. The hospital also receives referrals from its neighboring state.

Pre-operative protocol

On presentation to the Children's Emergency Room (CHER), the patients were evaluated and sent for plain chest and abdominal X-rays. The cases were resuscitated and optimized before sending them for the x rays. The X-rays were evaluated for free air in the peritoneal cavity (pneumoperitoneum) or air under the diaphragm. Patients' caregivers/parents were counseled and informed consent was obtained. The x-ray machines used were commercially available YSX500D High-frequency 50KW 500Ma Medical Digital flat Panel Detector x-ray Machine and YSX101D 5KW High-Frequency Mobile X-ray Machine (manufactured by Guangzhou Yueshen Medical Equipment Co., Ltd).

Operative procedure

Under general anesthesia and endotracheal intubation, the abdominal cavity was accessed through the appropriate incision (infra-umbilical/supraumbilical) depending on the choice of the surgeon. The definitive operative procedure performed depended on the pathology. The surgical site was closed in layers following the conclusion of the surgical procedure.

Post-operative protocol

The patient was placed on nasogastric decompression, intravenous fluids, analgesics, and antibiotics. Oral intake was commenced when bowel function returned. Repeat chest and abdominal x-rays were taken on the following post-operative days (3rd, 5th, 6th, and 7th, etc). Again, the X-rays were checked for free air in the peritoneal cavity (pneumoperitoneum) or air under the diaphragm. The presence or absence of pneumoperitoneum was noted.

Data collection

The information collected included the gender and age of the patient, presenting symptom, clinical diagnosis, duration of symptoms before presentation, time interval between presentation and laparotomy, intra-operative finding, operative procedure performed, post laparotomy complications, the post-op day the pneumoperitoneum became absent on x-ray, duration of hospital stay and outcome of treatment. Statistical Package for Social Science (SPSS) version 21 (manufactured by IBM Corporation Chicago Illinois) was used for data entry and analysis. Data were expressed as percentages, median, mean, and range.

Results

Patients' demographics

A total of 112 cases of perforated bowel had laparotomy during the study period. Amongst this number, 37 (33%) patients showed pneumoperitoneum on their preoperative radiographs and form the basis of this report. There were 25 (67.6%) males and 12 (32.4%) females. The mean duration of symptoms before presentation to the hospital was 5 days, range 3-14 days. The median duration from presentation to surgery was 2 days, range 1-4 days. The mean duration of hospitalization was 13 days with a range of 7-21 days.

Presenting symptoms (n=37)

All the patients had abdominal pain. Fever was recorded in 31 (83.8%) patients, bilious vomiting occurred in 21 (56.8%) and abdominal distension was present in 9 (24.3%) patients.

Clinical diagnosis and mean time (days) of peritoneal free air disappearance (n=37).

The diagnosis and time of free air disappearance made clinically are shown in Table 1. The overall

mean time for the pneumoperitoneum to disappear was 5.5 days.

Table 1: Clinical diagnosis

Clinical diagnosis	*Number of patients(%)*	*Time of air disappearance (mean)*
Typhoid intestinal perforation	*24 (64.9)*	*6 days*
Ruptured appendix	*13 (35.1)*	*5 days*

Intra-operative findings and operative procedures performed

The typhoid intestinal perforations were single ileal perforations and repair/closure of the ileal perforations were carried out with cleaning of the peritoneal cavity. For children with a ruptured appendix, appendectomy is performed with cleaning of the peritoneal cavity.

Post-operative complications

The postoperative complications recorded in the patients are shown in Table 2.

Table 2: *Post-operative complications (n=37)*

Post-operative complication	*Number of patients(%)*
Wound infection	6 (16.2)
Enterocutaneous fistula	3 (8.1)
Adhesive intestinal obstruction	2 (5.4)
Incisional hernia	2 (5.4)
Burst abdomen	1 (2.7)

Treatment outcome

Thirty-three (89.2%) patients recovered fully and were discharged home. However, 3 (8.1%) children expired secondary to severe sepsis. One (2.7%) patient signed out against medical advice.

Discussion

In the early twentieth century, the radiologic technique of demonstrating pneumoperitoneum was first described by Hugo Popper [5]. Free air in the peritoneal cavity following abdominal surgery is not uncommon and can be detected clinically or radiologically [7, 8]. Plain radiography is the standard method for the confirmation of free air in the peritoneal cavity [9]. As little as 1-2 milliliters of pneumoperitoneum can be detected radiologically if the radiograph is properly taken. The patient should be positioned for at least 10 minutes in the left lateral decubitus position or upright position before the radiograph is taken [10].

In the present study, more males were involved. The exact reason for the gender discrepancy is not known. However, the higher incidence of typhoid intestinal perforation may explain it. In fact, one study from Tanzania reported that males were affected twice more than female with regard to typhoid intestinal perforation [11]. It took an average of some 5 days before the patients presented to the hospital for treatment. Delayed presentation of patients is a consistent experience in low/middle income countries. Paucity of funds and low level of parental awareness may have influenced the late presentation. The time was required for patients' investigations, resuscitation and optimization before surgery. This may explain the 2 days interval between the time of presentation and time of operative treatment. The duration of hospitalization may vary from one patient to the other. The primary pathology, extent of operative procedure carried out and the post-operative course may have an influence on the duration of hospital stay.

Abdominal pain is a consistent presenting symptom in the patients. The bowel distension and subsequent perforation may explain the abdominal pain. The fever comes from contamination of the peritoneal cavity by intestinal contents and bacteria following perforation. Failure of the antegrade progression of the intestinal contents associated with intra-abdominal sepsis accounted for the bilious vomiting, constipation and abdominal distension.

Bowel perforation is characterized by loss of gastrointestinal wall integrity with subsequent leakage of enteric contents. Typhoid intestinal perforation was the most common pathology causing bowel perforation in the current series. This finding is consistent with the report of Chukwubuike et al [12]. Typhoid fever is a multisystem infection caused by the gram-negative bacilli, Salmonella enterica

serovar typhi and Salmonella enterica serovar paratyphi A and B which are transmitted through fecal-oral route by ingestion of contaminated food and/or water [13]. Typhoid intestinal perforation results from ulceration of the Peyer's patches at the terminal ileum resulting in bowel perforation. The perforated appendix may also give rise to pneumoperitoneum. One study from Turkey reported perforated appendix as a rare cause of pneumoperitoneum [14]. The rate of perforation of acute appendicitis is about 20% and the rate of co-existence with pneumoperitoneum is about 0 to 7% [14].

It took an average of 6 days and 5 days for the free peritoneal air to resolve in typhoid intestinal perforation and ruptured appendix patients respectively. The rate of free air disappearance may be related to the quantity of free air released from the perforated bowel and/or the rate of free air absorption. For instance, more free air is more likely to be released in typhoid intestinal perforation than in perforated appendix since the intestinal defect in typhoid intestinal perforation is wider.

Single ileal perforation was mostly noticed intraoperatively. Single ileal perforation is the most common type of typhoid intestinal perforation. This is in line with the report of Chalya et al [11]. Excising the edges of the perforation and its primary closure, transversely, was the most performed surgical procedure in the index study. However, segmental ileal resection and anastomosis are other options of treatment [15]. In a background of gross peritoneal contamination, exteriorizing (ileostomy) the bowel may be a good option for treatment. The specific surgery carried out in children with typhoid perforation is relative to the experience and preference of the surgeon.

Amongst the patients that developed complications, wound infection was the most common. A study from Kaduna, Nigeria reported high wound infection rates following laparotomy for peritonitis in children [16]. Another study from Kumasi, Ghana documented wound infection as the most frequent complication of typhoid perforation [17]. A dirty surgical wound is associated with a high wound infection rate [18]. There may be long-term problems that may follow wound infection including long hospital stays and extra costs [19]. Enterocutaneous fistula results from the breakdown of intestinal repair/anastomotic site postoperatively. Abantangaet al reported enterocutaneous fistula as the most serious complication of typhoid perforation of the ileum [17].

The general outcome of laparotomy for intra-abdominal hollow viscus perforation is fair. However, late presentation with the resultant severe sepsis is a cause of mortality. Pujar et al reported that early recognition, timely surgical intervention with appropriate surgery/antibiotics, and effective peri-operative care reduces the mortality in hollow viscus perforation [20].

Conclusion

Bowel perforation results mostly from infective/inflammatory processes such as salmonellosis. Laparotomy is required for the repair of these perforations and it takes an average of 5.5 days for the free peritoneal air to resolve. The clinical significance of this is that the prolonged presence of free air beyond this period may suggest other problems such as intestinal repair/anastomotic leak.

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