

Diagnosis and treatment of pediatric benign pneumoperitoneum

A case report series of 9 patients

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Abstract

Introduction: Benign pneumoperitoneum (BPPT) is defined as asymptomatic free intraabdominal air or as pneumoperitoneum without peritonitis. Symptomatic free air requires surgical management, but management of asymptomatic pneumoperitoneum is controversial. In this study, we investigate the diagnosis and treatment of BPPT in children.

Clinical Findings: The clinical data of 9 pediatric patients with BPPT who were admitted to our hospital from January 2000 to January 2015 were retrospectively analyzed to summarize the diagnosis and treatment. Overall, 9 cases were included with 8 males and 1 female, aged from 4 days to 4 years. Among them there were 6 newborns (including 1 premature infant). Patients were all admitted to hospital with the major clinical symptom of abdominal distension, including 2 cases accompanied by tachypnea, 2 cases with vomiting, 1 case with diarrhea, and 2 cases with fever. No previous constipation or obstructive defecation existed. Six newborns had meconium defecation within 24 hours after birth. Physical examination revealed all patients with relaxed abdominal wall except 1 patient with abdominal distension had slight muscle stiffness and hyperactive bowel sounds. Abdominal X-ray suggested free air under the diaphragm in all cases.

Interventions/Outcomes: All patients except for one case of laparotomy were conservatively treated and cured with fasting, infection prevention, rehydration, abdominocentesis, and close observation. Nine cases of patients were all discharged with no death occurrence. After discharge follow-up of 7 months to 6 years was conducted. There was no recurrence of similar symptoms, and children were in good growth and development.

Conclusion: The diagnosis of BPPT mainly relies on clinical symptoms in patient, careful abdominal examination, abdominal X-ray combined with abdominocentesis, and the exclusion of gastrointestinal perforation for confirmation. Conservative treatment can cure the disease. Attention should be paid to distinguish with surgical pneumoperitoneum to avoid unnecessary surgical exploration.

Abbreviations: BPPT = benign pneumoperitoneum, CRP = C-reactive protein.

Keywords: benign, conservative, pedia, pneumoperitoneum

1. Introduction

Pediatric pneumoperitoneum is an important clinical symptom in pediatric abdominal emergencies and more than 90% of

occurrences are caused by perforation of the gastrointestinal tract and other hollow viscera. Clinical manifestations are mainly peritonitis and sepsis, improper handling will endanger the lives of pediatric patients. However, in clinical practice, quite few patients with pneumoperitoneum have the X-ray presence of free intraperitoneal air, but the whole body is in good condition with the absence of signs of peritoneal irritation in abdomen. Even through exploratory laparotomy, no visceral perforation, or other serious diseases can be found. Thus, it is called benign pneumoperitoneum (BPPT), or spontaneous idiopathic pneumoperitoneum, nonsurgical pneumoperitoneum, and unexplained pneumoperitoneum.^[1] During the past 15 years, 9 patients with BPPT were admitted to our hospital. This study analyzes its diagnosis, differential diagnosis, and treatment, in order to avoid unnecessary exploratory laparotomy.

2. Materials and methods

Institutional Review Board Approval for this study was obtained from the Ethics Committee and Institutional Review Board of the authors' institution (No. 2016-17).

A total of 9 cases were included with 8 males and 1 female, aged from 4 days to 4 years. Among them there were 6 newborns (including 1 premature infant). Patients were all admitted to hospital with the major clinical symptom of abdominal distension, including 2 cases accompanied by tachypnea, 2 cases

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Table 1**The detailed information of patients.**

No.	Gender	Age	Fever	Concomitant symptom	Abdominal sign	Leukocytosis	C-reactive protein	Surgery	Pneumoperitoneum disappear time
1	Male	6D	Normal	None	Softness	Normal	Normal	No	3D
2	Male	13M	Normal	Vomit	Softness	Normal	Normal	No	4D
3	Male	4D	Normal	Tachypnea	Softness	Normal	Normal	Abdominocentesis	6D
4	Male	25D	Normal	None	Softness	Normal	Normal	No	3D
5	Male	27M	High	Vomit	Stiffness	High	Normal	Laparotomy	–
6	Female	19D	Normal	Tachypnea	Softness	Normal	Normal	Abdominocentesis	8D
7	Male	23D	High	Diarrhea	Softness	High	High	No	4D
8	Male	54M	Normal	None	Softness	Normal	Normal	No	2D
9	Male	23D	Normal	None	Softness	Normal	Normal	No	5D

D=days, M=months.

with vomiting, 1 case with diarrhea, and 2 cases with fever (the highest temperature $\leq 38.5^{\circ}\text{C}$). No previous constipation or obstructive defecation existed. Six newborns had meconium defecation within 24 hours after birth. Physical examination: when admitted to hospital, 1 patient with abdominal distension had slight muscle stiffness and hyperactive bowel sounds. Other patients showed a bulge abdomen and relaxed muscle with no peritonitis signs of swelling on the abdominal wall, tenderness, or rebound tenderness. They had a tympanic percussion note, negative shifting dullness, and normal bowel sounds. Auxiliary examination: abdominal X-ray suggested free air under the diaphragm with no abnormality in chest X-ray. One case with abdominal distension accompanied by vomiting had increased leukocyte count at hospital admission, while neutrophil granulocyte percentage and C-reactive protein (CRP) were normal. One case with abdominal distension accompanied by diarrhea had increased leukocyte count at hospital admission, with increasing ratio of lymphocyte and increasing CRP. The rest cases had normal blood routine examination and CRP. Two cases of neonates were given abdominocentesis due to obvious abdominal distension and affected breathing, and there was no liquid but some air extracted. The group of 9 cases were eventually diagnosed as BPPT, 8 cases of which were conservatively treated and 1 case underwent laparotomy. Detailed information for each case is shown in Table 1.

3. Results

One patient taken X-ray revealed free air under the diaphragm at hospital admission, on physical examination, the patient had slight abdominal muscle stiffness, which is accompanied by vomiting, fever, and increase of leukocyte. A perforated hollow of abdominal viscus was suspected, so exploratory laparotomy was performed. During the surgery, there was no perforation or pus but only a small amount of clear liquid. BPPT was then diagnosed after surgery. Two patients with abdominal distension and diarrhea showed pneumoperitoneum under X-ray. Enteritis complicated by intestinal perforation was initially considered, but the abdominal muscle was soft with no liquid extraction through abdominocentesis. Fasting, infection prevention, correcting electrolyte imbalance, and nutrition supportive treatments were given. Distension was greatly relieved after 48 hours. Multiple examination of abdominal X-ray showed gradual disappearance of free air under the diaphragm (Fig. 1). Thus, it was diagnosed as BPPT. For the remaining 6 cases with abdominal distension, abdominal X-ray showed free air under the diaphragm. Gastrointestinal perforation was initially

considered, there was no abdominal muscle tension under abdominal examination. After gastrointestinal decompression, fasting, infection prevention, rehydration, close observation of abdominal signs, and other conservative treatments, patients recovered who were finally diagnosed as BPPT (Fig. 2). Nine patients in this study were all cured and no death occurred. The hospitalization time ranged from 6 to 10 days. After discharge follow-up of 7 months to 6 years was conducted. There was no recurrence of similar symptoms, and children were in good growth and development.

4. Discussion

Clinically more than 90% of pneumoperitoneum are caused by visceral perforation. But for the BPPT caused by nongastrointestinal perforation, it is easily misdiagnosed if it is not carefully analyzed. In the 9 cases of this study, 6 cases were newborns, suggesting that neonates may have high risk of BPPT. Some experts have reported that among neonatal pneumoperitoneum, pneumoperitoneum with no clear cause accounted for 7.8% (7/89).^[2] The causes of BPPT are not yet clear. Most experts believe that it is highly possible that air leaks from the chest. There are also related reports of secondary occurrence of pneumoperitoneum caused by pulmonary diseases, by surgery, or by gynecology diseases through reproductive tract.^[3–5] In addition, it can be caused by cardiopulmonary resuscitation, mechanical ventilator support, blunt abdominal trauma, and other reasons.^[6] No related diseases or incentives were found in the 9 cases of patients in this study, thus the actual cause could not be determined.

Distinguish with surgical pneumoperitoneum, the main clinical manifestations of BPPT are abdominal distension, soft abdomen, no redness on abdominal wall, no systemic poisoning symptom and peritonitis sign, and air without liquid extraction through abdominocentesis. Diagnosis is mainly based on patient's disease history, body signs, and abdominal X-ray, which can be confirmed after the exclusion of perforated hollow viscus. In this study, exploratory laparotomy was performed on 1 patient due to suspected perforation of hollow viscus. Abdominocentesis was performed on 2 patients with abdominal distention combined dyspnea. No surgical procedure was taken on the remaining 6 cases. We closely observed during the process of conservative treatment, and diagnosed as BPPT after excluding pneumoperitoneum from other causes. Combined with related literatures,^[1,7,8] we believe that the diagnosis of BPPT should have at least the following points: abdominal X-ray shows signs of pneumoperitoneum, patient is generally in good condition,

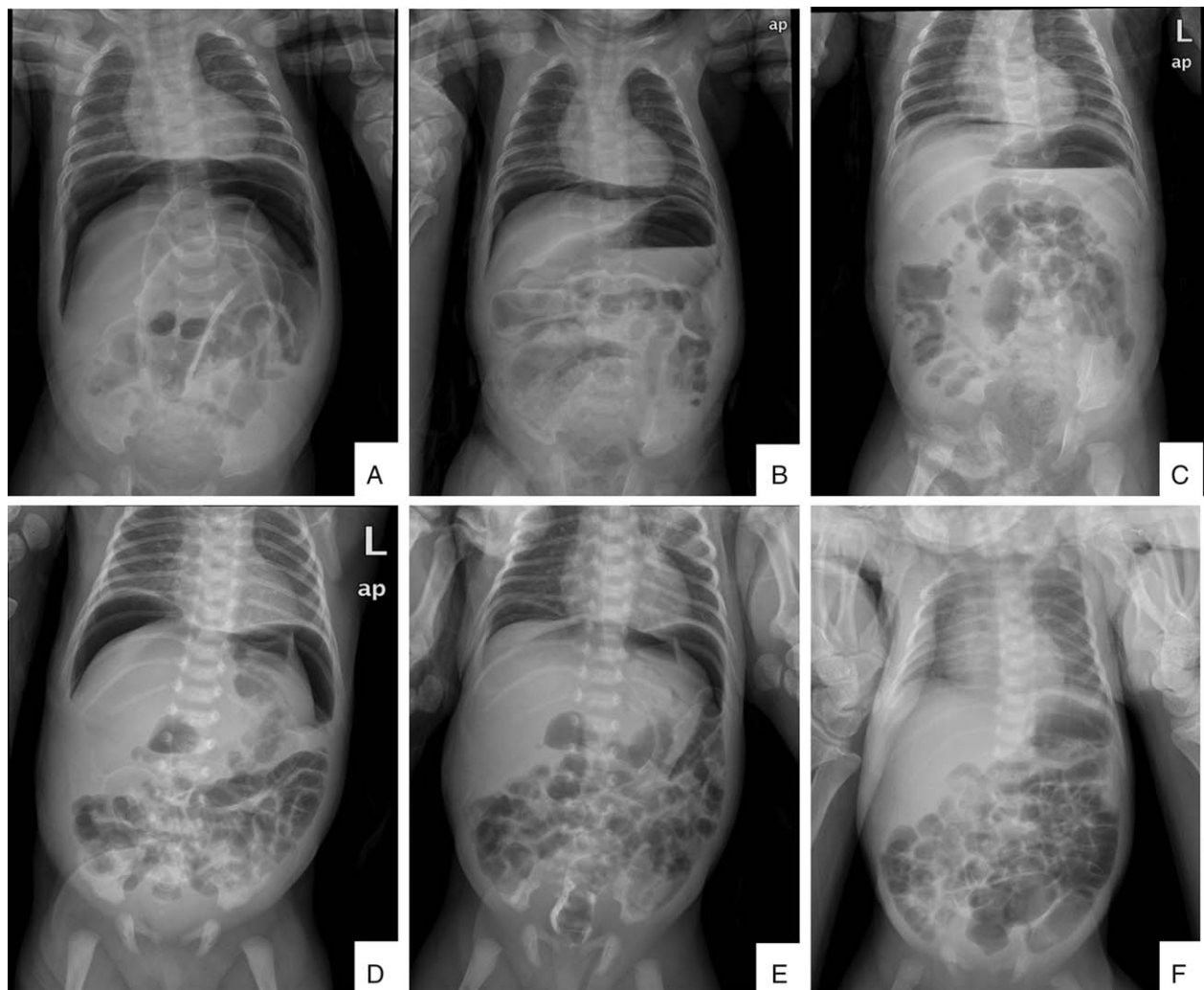


Figure 1. The patients of No. 6 and No. 3. (A, D) Radiographs revealing the pneumoperitoneum at hospital admission. (B, E) Radiographs revealing gradual decrease of free air under the diaphragm after 48 hours. (C, F) Radiographs revealing resolution of benign pneumoperitoneum after conservative management.

there is no abdominal peritoneal irritation or other positive signs, abdominocentesis revealed air but not liquid (or a small amount of clear liquid), after conservative treatment, abdominal free air decreased, or disappeared, and surgical pneumoperitoneum is excluded as much as possible. But if the patient has surgical signs, avoiding delay the condition of the patient, a surgical operation should be performed as soon as possible.

BPPT should be mainly differentiated from the more hollow viscus perforation.^[9,10] The physical examination of latter often shows shiny redness and swelling on the abdominal wall, decreased or disappeared bowel sounds, positive shifting dullness, and other signs of peritonitis. However, for neonatal patients, because of the weak abdominal muscles, peritoneal irritation is not necessarily typical, abdominocentesis can provide assistance for identification. In addition, attention still needs to be paid to differentiate this disease while some diseases that can cause false pneumoperitoneum X-ray results, such as subphrenic abscess, extraperitoneal gas accumulation, mediastinal emphysema, pneumatosis cystoides intestinalis, and so on. The X-ray of subphrenic abscess shows irregular gas-containing cavity under the diaphragm, among which fluid level can be seen. The extraperitoneal gas accumulation X-ray shows crescent gas

shadow with a fixed position under the diaphragm and its position changes little follow postural changes. The main differential point of mediastinal emphysema is the mediastinal emphysema which is accompanied by pneumomediastinum or subcutaneous pneumatosis. The X-ray of pneumatosis cystoides intestinalis shows free air under the diaphragm with multiple circular translucent areas around the edge of intestinal wall. Patients in this study were all excluded from these diseases by taking multiposition abdominal X-ray.

If the pneumoperitoneum patient with mild clinical symptoms, no signs of peritonitis, no fever, and increasing leukocyte count, especially whose abdominocentesis shows air but no liquid, BPPT should be considered. Conservative treatment can be given first, and close observation as following, attention should be paid to the abdominal signs of patient and dynamic reexamine abdominal X-ray. If necessary, multiple abdominocentesis can be performed for further differential diagnosis.^[11,12] If patient appeared severe abdominal distension that affects respiratory and hemodynamic, abdominocentesis can release pneumoperitoneum, this operation not only alleviates the effect on cardiopulmonary function, but also assists the judgment of positive signs of abdomen on physical examination.^[13] The

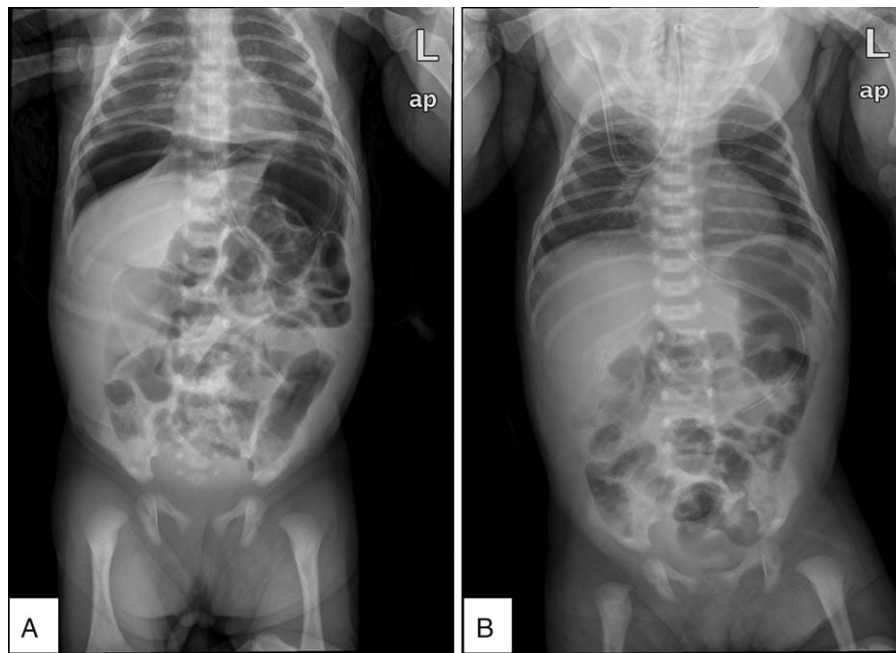


Figure 2. The patient of No. 2. (A) Radiographs revealing the free air under the diaphragm. (B) Radiographs revealing pneumoperitoneum disappeared.

patients we reported above were cured by conservative treatment except one case of laparotomy, including fasting, rehydration, infection prevention, close observation, and dynamic reexamine abdominal X-ray to exclude other organic diseases. Follow-up was conducted from 7 months to 6 years. Children were in good growth, and no similar symptoms occurred again.

5. Conclusions

In conclusion, the vast majority of clinical pneumoperitoneum are caused by organic diseases, and generally require surgery. However, due to the possible presence of BPPT. It is necessary to identify carefully when encountering with pneumoperitoneum, especially for neonatal pneumoperitoneum, comprehensive judgments combined with clinical symptoms, signs, and laboratory examinations should be made to avoid unnecessary surgical exploration.

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