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# Pneumatic colon injury following high pressure blow gun dust cleaner spray to the perineum

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ABSTRACT

*INTRODUCTION:* A pneumatic tool or air tool such as blow gun dust cleaner is a tool driven by compressed air and spraying of the perineum can insufflate the colon due to its high pressure and high flow rate.
*PRESENTATION OF CASE:* We present a case of 4 year old boy who developed sudden onset of tense abdominal distention and developed peritonitis. Patient's family initially denied a history of trauma. Radiologic examination showed pneumoperitoneum and colon dilatation. Exploratory laparotomy revealed a tension pneumoperitoneum, bloody ascitic fluid, multiple site of ecchymosis and serosal tear of the colon and a minute perforation of transverse colon. Postoperative reinvestigation revealed that the patient's perineum was sprayed, using blow gun dust cleaner.
*DISCUSSION:* Air from pneumatic tools produces column of air at pressure of 3.5–8.8 kg/cm$^2$ and pressure greater than the resting anal pressure of 0.109 kg/cm$^2$ force air to enter the colon when the perineum is sprayed. Different degree of colon injury results when airflow is greater than 1.46 L/m, and/or intraluminal pressure greater than 0.109 kg/cm$^2$. In most children, initial anxiety to tell the truth result in difficulty to obtain good history.
*CONCLUSION:* Spraying of the perianal with excessive pneumatic force of greater than the resting anal pressure and high air flow rate causes multiple site colon injury and tension pneumoperitoneum due to colon perforation. Parent should be caution in children playing with high pressure pneumatic tool, and the importance of history is emphases for early correct diagnosis.


## 1. Introduction

A pneumatic tool such as blow gun dust cleaner (BGDC) is a tool driven by a gas, usually compressed air supplied through an air compressor. It is popular and readily available in the do it yourself market and common in small family industrial and manufacturing settings in Taiwan. The first case of pneumatic rupture of the colon was reported by Stone [1]. Industrial accident and perineal blasting with compressed air had been commonly reported in adult and results in colon injury either with or without perforation. We present a case of 4 year old boy with tension pneumoperitoneum and transverse colon perforation associated with multiple site non-perforated colon injury secondary to spraying of the perineum using high pressure BGDC.

## 2. Case report

A 4 year old healthy boy developed sudden onset of tense abdominal distention. Few hours later, he developed on and off low grade fever (37.7–38.5 °C), episode of bloody stool, non-bilious vomiting, abdominal tenderness and poor activity. Patient was brought to a nearby hospital. Initial physical examination showed a distended tense abdomen with hypoactive bowel sound, generalized direct and indirect tenderness. Supine chest X-ray and upright abdomen film showed presence of pneumoperitoneum and colon dilatation (Fig. 1). Accompanying parent initially denied any history of trauma. He was referred to our Hospital for further management. On arrival, he complaint of severe abdominal pain, and his vital signs were *T* 37.7 °C, PR 143/min, RR 24/min, BP 103/57 mmHg. Physical examination was the same as previous. Perianal area did not showed any sign of trauma. His laboratory workup showed a hemoglobin 12/dL, hematocrit 34.9%, white blood cell count 7.2 × 103/μL, platelet count 297 × 103/μL and CRP 240 mg/L. Amylase and lipase was 30 UL and 22 U/L, respectively. Emergent exploratory laparotomy was done. On opening the abdomen, significant foul smelling air whistled out of the abdominal cavity. Bloody ascitic fluid of about 100 cc was found. The

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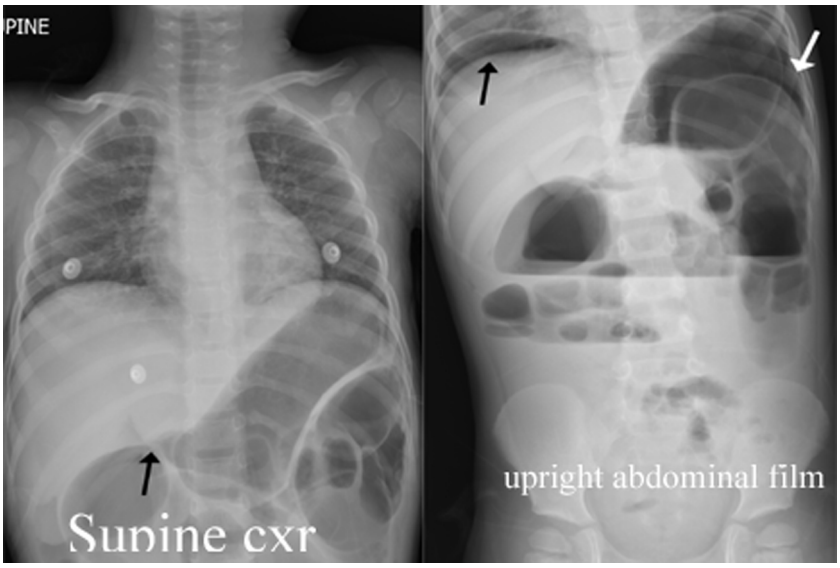


**Fig. 1.** Supine chest X-ray and upright abdominal film showed the presence of pneumoperitoneum with distention of the colon (black and white arrow).

small bowel and colon was distended with air with multiple areas of serosal tear and subserosal hemorrhage of the entire colon. A perforation hole, about 0.1–0.2 cm in size, partially covered with omentum was noted on the antimesenteric side of mid transverse colon. The diaphragm, liver, spleen, and pancreas were normal. A loop transverse colostomy was done at the site of perforation. With the assumption of trauma related injury, further investigation for history of trauma was done. His older brother confessed the patient perineum was deliberately spray using a jet type BGDC with air pressure of about 8.2 kg/cm$^2$ (116.6 psi/6031 mmHg) based on the air compressor gauge pressure (Fig. 2A). Patient was discharge in stable condition few days later. On the 3rd postoperative month, barium contrast examination of the colon was normal, and colostomy was closed subsequently.

## 3. Discussion

The phenomenon of pneumatic insufflations colon injury is similar to hydrostatic injury sustained during a high-speed fall from personal water craft such as jet skis, seadoos, and wave-runners in which either the high-powered jet of water strikes the perineum or the perineum strikes the water forcing column of water into the colon [2,3].

External pneumatic insufflation of the colon through the anus depends on the air pressure, air flow velocity, anal resting pressure and the distance between the source and anus [4,5]. Under normal condition, normal resting anal pressure can prevent the insufflation of the colon from a direct external source with low air pressure. Duthie and Wattes study showed that the mean anal pressure in normal adult subject was $0.87 \pm 0.005$ kg/cm$^2$ ($12.4 \pm 0.711$ psi/$640 \pm 50$ mmHg) with a range 0.06–0.109 kg/cm$^2$ (0.85–1.55 psi/44–80 mmHg) and following pudendal block, anal pressure decreased with mean of $0.07 \pm 0.006$ kg/cm$^2$ ($1.04 \pm 0.08$ psi/$54 \pm 4.4$ mmHg) and range of 0.05–0.11 kg/cm$^2$ (0.73–1.55 psi/38–80 mmHg) [6]. Andrew have postulated that air at 3.5–8.8 kg/cm$^2$ (50–125 psi/2585–6464 mmHg) forms a column which acts like a solid body, forcing to open the anal sphincter [7]. BGDC at 8.2 kg/cm$^2$ (116.6 psi/6031 mmHg) pressure, as in our case, can produce an air thrust of tenfold greater than the resting anal pressure and overcome the anal sphincter pressure, resulting in sudden inflation of the colon. The outcome of spray was retrospectively examined in our case and found to cause significant compression deformity of the skin when air is sprayed at short distance (Fig. 2B). The bowel wall is elastic, distensible and tolerates certain amount pressure. The mucosa is the most elastic and the serosa and the muscularis, the least. The intraluminal pressure required to result in colon perfora-

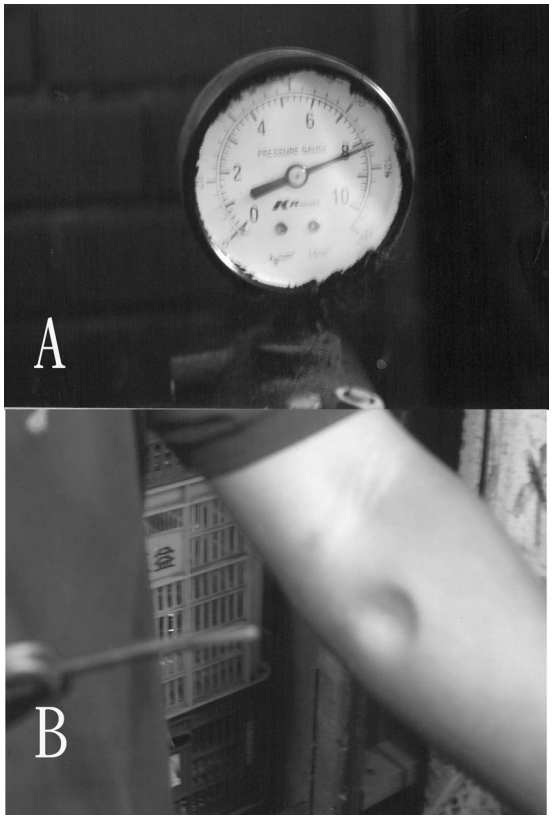


**Fig. 2.** (A) Pressure gauge of air compressor showed the air pressure of 8.2 kg/sq cm (116.6 psi, 6031 mmHg) and (B) showed compression deformity of the skin during actual spraying of the forearm at a short distance, using blow gun dust cleaner.

tion has been estimated through colonoscopic studies and was found to be greater than 0.109 kg/cm$^2$ (1.547 psi/80 mmHg) [8]. However, in previous experimental studies showed that the air pressure that leads to colon perforation was one to four folds higher. Shiels et al. found that the hydrostatic pressure to cause perforation in pig bowel is 0.16 kg/cm$^2$ (2.32 psi/120 mmHg) [9]. In cadaveric diverticula containing sigmoid colon, the mean ± SEM pressure causing serosal tear was 0.27 ± 0.02 kg/cm$^2$ (3.9 ± 0.29 psi/202 ± 15 mmHg), and mucosal rupture was 0.307 ± 0.019 kg/cm$^2$ (4.37 ± 0.271 psi/226 ± 14 mmHg) following colonoscopic insufflations [10]. Burt's experimental work also showed that a pressure of 0.27 kg/cm$^2$ (3.99 psi/201.69 mmHg) is required to rupture the serosa and the muscularis of intestinal wall, and a pressure of 0.29 kg/cm$^2$ (4.07 psi/210.48 mmHg) will cause a through-and-through rupture [11] while, Rosenberg and Smiddy found that the bursting pressure of normal bowel was found to be 0.415 kg/cm$^2$ (5.9 psi/305 mmHg) [4].

Flow represents the quantity of compressed air that passes through a section over a unit of time and varies depending on the diameter of the hose and air pressure. The air flow of gun cleaner is estimated to be 141 L/min (5 cfm), which is 100 fold greater that the safe level airflow of 1.46 L/m (at 80 mmHg intraluminal pressure) during colonoscopic examination [8] and hydrostatic pressure or air flow pressure of 0.16 kg/cm$^2$ (2.32 psi/120 mmHg) during barium [12], saline [13], and air reduction [14] of intussusception, which protects patients from colonic barotrauma.

During gradual insufflation of colon or in large bowel obstruction distal to the caecum, the caecum is the segment most prone to distention injury which is explain by the Law of Laplace [15]. The caecum has the largest diameter and requires the least amount of pressure to distend [16]. An important corollary to Laplace's theorem is that the degree of angulations (sharpness of cylinder curvature) is more important in determining wall tension than its internal volume [10]. The anatomy of the distal colon with the firm lateral support of the rectum makes the first part of the colon to be struck by a column of pressure from external source and the bending of the sigmoid [17] pose the recto sigmoid to rupture in pressure related colon barotraumas. In Luning et al. review of 30,366 endoscopic colonic procedures, 74% of perforation (26/35) occurred in the sigmoid colon which is related to anatomical bending of sigmoid causing a closed loop obstruction while other report ascribed it to as mechanical in nature [18]. During rapid air distention, inability to produce a total obstruction by the bending of sigmoid and high pressure allows the flow of air proximally to the next anatomical bending such as splenic flexure and hepatic flexure and ileocaecal valve resulting in a stepwise closed loop obstruction, resulting in other site of the bowel to be injure and perforate. Comparison of different section of the colon shows that the rectum supports the greatest pressure and the sigmoid, transverse colon, caecum in decreasing strength. Single site perforation are common during colonoscopic examination, however, the speeds of pressure builds up following high pressure insufflation with high flow rate results in multiple site colon injury. In Brown and Dwindle reviewed of 32 cases of pneumatic colon perforation, 91% (29/32) had single perforations, 6 (2/32) had three perforations and 3% (1/32) had two perforations [19]. The pathologic lesions following pneumatic insufflation depends on the resultant intraluminal pressure and includes serosal hemorrhage, lacerations of the serosa and muscular coat with bulging of the mucous membrane, or complete rupture of the bowel through the serosa, muscular coat, and mucous membrane as in our case.

Management of pneumatic colon injury include rectal tube decompression, intraoperative decompression of bowel in the presence of distended bowel, resection of severely injured segment of colon and repair of perforation with proximal diverting colostomy or enterostomy, when the integrity of the bowel is in doubt [19]. Careful observation following surgery is often necessary since full-thickness perforation of the colon may have delayed presentation. Closure of ostomy can be perform as early as 2–3 weeks of following creation without significance increase in complications compared to late closure [20] and depends on whether patient had recovered from his initial injuries, which is assess with barium enema or sigmoidoscopic examination.

In conclusion, patient with tension pneumoperitoneum associated with multiple site colon injury and perforation, the importance of history is emphasized and parent should be caution in children playing with pneumatic tool to avoid barotrauma.

## Conflicts of interest

All authors state no conflicts of interest.

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## Author contribution

Edgar Sy: final drafting and manuscript preparation, analysing data collection.

Yin-I Chiu: drafting of manuscript, collection of data from the family.

Yan-Shen Shan: analysing the manuscript content.

Roger L. Ong: manuscript designing, family interview and data collection.

## Consent

Oral informed consent was obtained from the patient family for publication of this case report and family provided the picture of blow gun dust cleaner, pressure gauze and effect on the skin.

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