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Pneumomediastinum and ECG changes during laparoscopic Nissen fundoplication in a child; Case report

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ABSTRACT

INTRODUCTION: Laparoscopic surgeries are becoming more popular in many surgical procedures particularly in pediatric age group. The physical responses and hemodynamic changes that occur during laparoscopic surgery differ between adults and pediatrics.

CASE PRESENTATION: We report a sudden hemodynamic instability and abrupt ECG changes associated with pneumomediastinum (PM) during laparoscopic Nissen fundoplication surgery in a 19 months old boy who had gastro-esophageal reflux disease. Procedure was converted to open surgery and all parameters were spontaneously returned back to normal values. The patient was successfully extubated then transferred to intensive care unit (ICU) for close monitoring. He had uneventful post-operative course where PM has been completely resolved in the repeated chest x-ray.

DISCUSSION: Pneumomediastinum (PM) occurs when air escape into the mediastinum. This air might reach the pericardium causing hemodynamic and electrophysiological changes. It is one of the reported complications that might occur during laparoscopic surgery, however isolated PM usually resolve spontaneously without any intervention. Etiology and possible contributing factors were discussed.

CONCLUSION: Pneumoperitonium leads to different hemodynamic changes during laparoscopic surgery in pediatric population compared to adults. Decreasing the insufflation pressure and patient's re-positioning might make continuing laparoscopy safe. However, surgeon must be willing to convert to open surgery to prevent any further complications.

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1. Introduction

Laparoscopic procedures are gaining popularity in the field of pediatric surgery. As laparoscopic surgeries have the advantage of less post-operative pain, wound complications, hospital stay and scarring, it is widely used nowadays. Laparoscopic surgeries require special considerations when it comes to anesthesia care. Physiological changes as a consequence of Carbon dioxide (CO₂) insufflation and the increase in the intra-abdominal pressure (IAP) is challenging. Moreover, hypoxia, hypercarbia, acidosis, pneumothorax, pneumomediastinum, subcutaneous emphysema and CO₂ embolism have been reported as complications related to laparoscopy [1].

Pneumomediastinum (PM) during laparoscopy has been reported in 2% of adult patients without any significant changes in

their cardiac function [2]. In children, this phenomenon was barely described and sparsely reported [3].

Herein, we report a case of a sudden hemodynamic instability, ECG changes (ST elevation) and PM during laparoscopic Nissen fundoplication surgery in a 19 months old boy who had gastroesophageal reflux disease.

2. Case report

A 19 months old boy with current weight of 4 kg, known hypoxic ischemic encephalopathy, global developmental delay, failure to thrive, infantile spasm and seizure disorder. A Full term boy, product of caesarean section, had meconium aspiration and poor Apgar score, which required prolonged intubation and mechanical ventilation for 2 months in neonatal intensive care unit (NICU). He presented to paediatric surgery clinic with history of frequent vomiting. There was no history of aspiration or recurrent chest infection. The upper GI series and milk nuclear scan study have shown severe reflux. He showed no improvement on anti-reflux medication, thereby laparoscopic fundoplication and gastrostomy tube insertion was offered.

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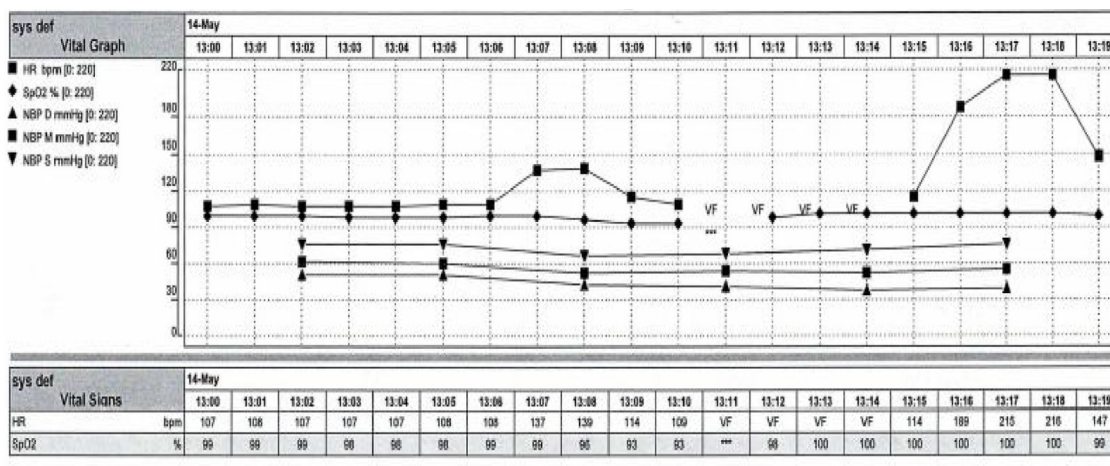


Fig. 1. Anaesthesia records showed hemodynamic changes during procedure. (VF) ventricular fibrillation was not traced in the ECG monitor, which was connected during procedure.

Under privilege of general anesthesia, procedure was started with a trans umbilical incision. A 5 mm camera port was introduced and CO₂ was insufflated. Gas pressure of 10 mmHg and flow of 4 L/min. Total of four 5 mm ports were placed. The procedure started by retracting the left lobe of the liver then opening the gastro-hepatic ligament exposing the abdominal esophagus and hiatus. Dissection of the peritoneal reflection around the lower esophagus was done. Retro esophageal window was created and both cruras were identified.

Within 60 min from induction and 35 min from gas insufflation, a sudden abrupt ECG changes in terms of S-T segment elevation had happened. Heart rate (HR) increased from 108 to 215 BPM, airway pressure (PIP) from 16 to 21 cmH₂O. FiO₂ increased from 59 to 75 up to 96% with drop in oxygen saturation from 99% to 93%. End tidal CO₂ (Et CO₂) and blood pressure (BP) remained stable throughout the procedure (Fig. 1). Gas insufflation was stopped and abdomen was deflated. Intra-operative portable chest x-ray showed questionable isolated pneumomediastinum (PM) with distinct heart border but no pneumothorax or surgical emphysema (Fig. 2). Arterial blood gas and electrolytes were normal.

Shortly after, all parameters were spontaneously returned back to normal values except for sinus tachycardia that lasted for 40 min. HR then came back to baseline of 109 BPM with no more ECG changes afterwards.

Procedure was converted to open surgery and completed with no second event. The total time of surgery was 205 min including laparoscopy, open surgery and the time needed in stabilising the patient. The patient was successfully extubated and kept on nasal cannula of 2 L/min then transferred to intensive care unit (ICU) for close monitoring. Repeated chest x-ray was normal (Fig. 3). He had uneventful post-operative course and stayed in hospital for nine days then discharged without any major sequelae.

3. Discussion

The physical responses and hemodynamic changes that occur during laparoscopic surgery differ between adults and pediatrics. Therefore, it is recommended that the IAP should be limited to 5–10 mm Hg in neonates, about 10–12 mm Hg in infants, and less than 15 mm Hg in older children [4,5]. Gas flow rates of 2–3 L/min are sufficient in infants compared to 4–6 L/min and pressure of 10–20 mm Hg, which is usually used in adult patients to maintain the distention of the abdomen [4,5].

During laparoscopic esophageal surgery in particular, dissection of the phreno-esophageal ligament exposes the plane of medi-

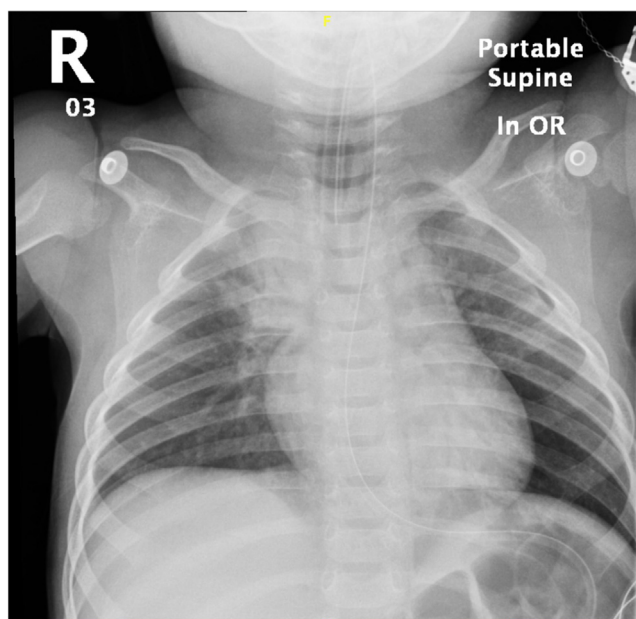


Fig. 2. Intra-operative portable chest x-ray showed questionable pneumomediastinum with distinct heart border but no pneumothorax or subcutaneous emphysema.

astinum and the subcutaneous tissue of the neck [6]. As the intra-abdominal pressure increases, insufflated gas can cross the diaphragm through esophageal hiatus causing pneumothorax or pneumomediastinum (PM). In our reported case, while performing dissection near the hiatus, hemodynamic and ECG changes had appeared. In which we do believe that gas has reached the mediastinum and the pericardium through the diaphragm by that time. The intraoperative S-T segment elevation might be explained by pneumopericardium (PPC) and/or PM. The etiology of PPC is not clear. However, the presence of air in the pericardium can affect the electrophysiological behavior of the cardiac muscle leading to changes and abnormal ECG results. ST depression or elevation and inversion of T wave changes do suggest PPC [7]. Most PPC resolves spontaneously but when associated with tension pneumothorax or cardiac tamponed intervention might be required [7].

As the gas insufflation increases, the peritoneum stretches and vagal tone increases thus lead to bradycardia and asystole [8]. Also, it increases the level of CO₂ in blood causing hypercarbia and acidosis, which by itself can cause arrhythmias and myocardial

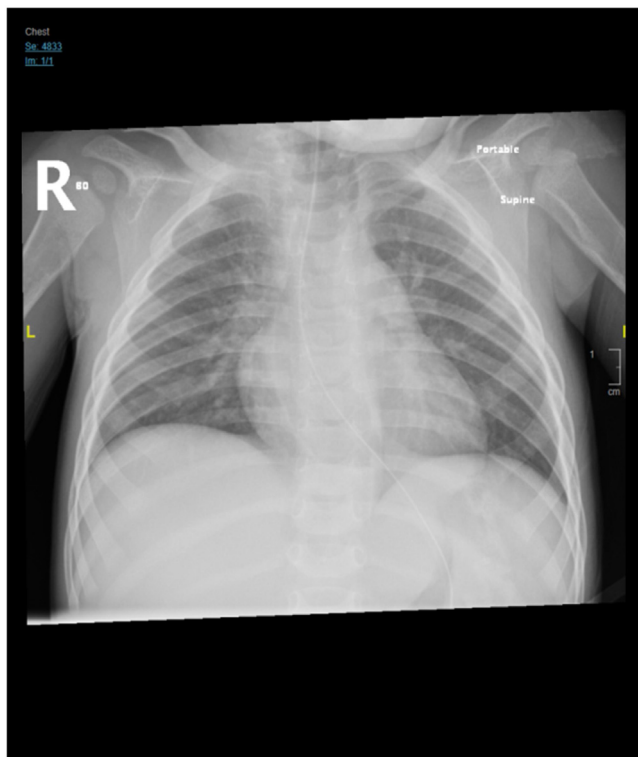


Fig. 3. Chest x-ray. Normal post-operative chest x-ray.

depression secondary to the ischemic effect of impaired oxygen affinity to hemoglobin molecules [9]. Studies on healthy subjects showed that such cardiac changes are more prominent in the first five minutes of the abdominal insufflation due to aortic compression and neuroendocrine effects [10,11]. Patient's records showed ventricular fibrillation (VF) but it was not traced in the ECG monitor during procedure. Apparently it was an inaccurate tracing as patient did not require any resuscitation or cardiac support (Fig. 1).

We could not rule out PM nor PPC depending on intra-operative chest x-ray. For technical facts, not all patients who develop PM during surgery had abnormal x-ray. This is mainly due to the insensitivity of the supine, single view chest x-ray portable film in diagnosing PM. It is found that high-resolution chest CT scan is more accurate in diagnosing PM but it is not a practical choice during surgery. However, routine chest x-ray can be utilized to monitor the resolution and tissue absorption of PM [6,12]. Despite the high solubility of CO₂ in blood, many studies had observed that extra abdominal gas could persist from 1 to 4 days after surgery till complete resolution, it is believed this might be due to the avascular nature of the areolar tissue of the mediastinum [6,13–15]. In our patient, the initial portable chest x-ray was suspicious for PM and the repeated x-ray in post-operative day 2 did not show any concern compared to the intra-operative one.

Mei-Chi Lin from Taiwan has reported similar case about a low birth weight premature infant who had cardiovascular collapse during laparoscopic Nissen fundoplication surgery [3]. The author believes that PM is due to the escape of gas through diaphragm during CO₂ insufflation after the dissection of the esophageal hiatus. After 15 min of CO₂ insufflation, Heart rate and Et CO₂ dropped, blood pressure was not recordable. The ECG showed ST elevation, widen QRS and premature atrial contraction. Intra-operative chest x-ray showed no pneumothorax but distinct heart border concerning PM. Patient required ephedrine IV bolus and dopamine infusion for resuscitation. The procedure was converted to open and lasted 240 min.

In adult literature, PM had been reported in some laparoscopic procedures such as cholecystectomy, hysterectomy and herniorrhaphy [13–16]. Other studies looked at the incidence and significance of PM after laparoscopic surgery related to esophagus and found that two thirds of their patients had developed PM that spontaneously resolved the next day. None showed any respiratory compromise during surgery nor showed signs of esophageal perforation [6]. The true incidence of PM during laparoscopic surgeries had been not reported and the reason behind this either the diagnosis of PM was overlooked or not recognized in patients who were asymptomatic [2]. The most common cause of PM is an increase in the alveolar pressure leading to rupture and leakage of air into the thoracic and/or mediastinal cavity. Other causes could be traumatic injury, esophageal perforation and barotrauma secondary to mechanical ventilation application [13–16,17]. In abdominal laparoscopic surgeries, it is more often to see pneumothorax and/or subcutaneous emphysema along with PM rather than isolated PM. When it is isolated, it is believed to be due to the passage of air into the mediastinum through either the hiatus or a defect in the diaphragm [14,17]. Some studies have found independent risk factors that increase the possibility of having PM such as long operative time (more than 200 min) and Et CO₂ of 50 mmHg or greater. Number of ports (six ports or more), age (over 65 years) and type of laparoscopic procedure i.e (gynecology, hernia repair, cholecystectomy, Nissen fundoplication) were not that significant in predicting PM risk [2]. One study has correlated the association between PM and Nissen fundoplication to the prolonged duration of surgery rather than to extensive diaphragmatic dissection [2].

In conclusion, laparoscopic surgeries are finding more applications in the pediatric population all around the world. With few modifications in the anesthetic care, laparoscopic surgeries are becoming safer. Pneumoperitonium during laparoscopic surgery leads to different hemodynamic changes in pediatric population compared to adults. Pneumomediastinum is a complication that might occur during laparoscopic surgery in particular esophageal surgery. Isolated PM can resolve spontaneously. Decreasing the inflation pressure and patient re-positioning might make continuing laparoscopy safe. However, when hemodynamic changes occur, the surgeon must be willing to convert the procedure to open surgery.

This work has been reported in line with the SCARE 2018 criteria [18].

Declaration of Competing Interest

All authors have nothing to disclose.

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Ethical approval

There is no ethical approval obtained as it is a case report

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

All authors have contributed in the each step for writing this paper, participating in the whole process to retrieve medical information, review of the literature, and writing of each paragraph included.

Registration of research studies

Not applicable.

Guarantor

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