

## Hypercapnia-An Enigma In The Diagnosis Of Expanding Pneumothorax During One Lung Anesthesia

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### ABSTRACT:

Pneumothorax is a potentially dangerous condition, which may arise during general anaesthesia. Intraoperative diagnosis of pneumothorax is difficult due to inadequate access to the chest. The diagnosis is one of exclusion, as the changes in vital signs are non-specific, and other causes of such changes reflecting abnormalities in hemodynamics and ventilation are more common.<sup>1</sup> We report a case of intraoperative pneumothorax in a 52 yr old female patient with paraplegia secondary to spinal tuberculosis, posted for 'Anterior Spinal Fusion'. The patient was taken up for surgery after preoperative assessment. Intubation was attempted with 35Fr left double lumen tube (DLT), but could not succeed. In view of the limited experience of the surgeon, to facilitate surgery, intubation was attempted with 28Fr left DLT and isolation confirmed clinically. Later patient was placed in right lateral decubitus position and left lung was isolated to facilitate surgery. The patient desaturated after isolation of the lung. Saturation improved promptly with oxygen supplementation to the non-dependent lung; but ETCO<sub>2</sub> and airway pressures gradually increased. This has prompted us a possibility of pneumothorax and was confirmed by detailed clinical examination and chest x-ray which showed right sided 'pneumothorax'. Pneumothorax was successfully managed with tube thoracostomy.

**Key-words:** Pneumothorax, Double lumen tube, Lung isolation, Lateral decubitus position, anterior spinal fusion.

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### INTRODUCTION:

Pneumothorax is a potentially dangerous complication, which is difficult to diagnose during the intraoperative period. Recognition of any preoperative procedure which may predispose to a pneumothorax is crucial such as difficult and traumatic intubation, central venous catheterization; supra-clavicular brachial plexus block.<sup>1,2</sup> Previous instrumentation of spine and a pre-existing pulmonary pathology may also contribute to development of pneumothorax.<sup>1,2</sup>

Positive pressure ventilation can

produce a pneumothorax, which may progress to tension pneumothorax, if not identified and intervened<sup>3</sup>. One should have a high index of suspicion and close monitoring to anticipate this relatively rare complication. If rapid deterioration ensues in the clinical status, the probability of tension pneumothorax should be reckoned and increase in FiO<sub>2</sub> (Fraction of inspired oxygen) with correction of hypoxia is critical for immediate management.

### CASE REPORT:

We present a case of 52 yr old female

patient (weight 45 kg, Ht 140cm) with paraplegia secondary to Pott's spine, posted for Anterior Spinal Fusion. She was a known case of diabetes mellitus and hypothyroidism on regular medication and taken in euglycemic and euthyroid state. The patient underwent D6-D7 laminectomy and pedicle screw fixation three months ago without any benefit. Patient was connected to a monitor and basal parameters are recorded. Preoperative values are: PR-109/min, BP-120/70mm Hg, RR-16/min and SpO<sub>2</sub> was 96-97% on room air. The systemic clinical examination was unremarkable.

The patient was premedicated with intravenous Glycopyrrolate, Ondansetron 4mg, and Fentanyl 70mcg and was preoxygenated and induced with 80mg of propofol. Intubation was facilitated with Vecuronium and lignocaine. A 35Fr left sided DLT was used for intubation, but could not succeed as the DLT size was found to be larger for that patient. So we have used a smaller size tube (28Fr DLT) available with us. Lung isolation was checked and confirmed. Following intubation, patient's parameters were within normal limits (SpO<sub>2</sub>-97%, Peak airway pressure 16-18 cm H<sub>2</sub>O and ETCO<sub>2</sub> of 36-38 mmHg) after initiating ventilation. The settings were 50% oxygen in Nitrous oxide, Sevoflurane 1%, RR-12/min, Tidal volume 270ml and I: E ratio 1:2. Later the patient was placed in right lateral decubitus position and dual lung ventilation was continued until the left lateral thoracotomy was done.

To facilitate surgery, the left lung was isolated and ventilator settings were changed accordingly. Patient desaturated rapidly after isolation, from 97% to 86%. In view of the falling saturation 100% oxygen was administered. We have probed for all the causes of hypoxia like bronchospasm, secretions, kink in the tube/circuit etc. But to our surprise we could not identify the problem. The surgeon was asked to continue with surgery while the non dependent lung was marginally inflated with oxygen insufflation from another oxygen source and

FiO<sub>2</sub> is reduced to 0.5. Although the oxygen saturation was maintained, there was an increase in peak airway pressures from 16 to 25cm H<sub>2</sub>O. EtCO<sub>2</sub> gradually increased from 38mmHg to 60mmHg and we were still in diagnostic dilemma for these unforeseen observations. The surgeon was alerted and fortunately surgery was concluded and when the patient was turned to supine position, there was tachypnea, tachycardia, shortness of breath with desaturation (SpO<sub>2</sub> 82%). Airway pressures and EtCO<sub>2</sub> further escalated. On clinical examination, movements of the chest were diminished with hyper resonant notes on percussion and decreased breath sounds on auscultation revealed breath sounds on the right side. An empirical diagnosis of pneumothorax was made and confirmed by chest x-ray. **An emergency x-ray chest showed a significant pneumothorax on the right side with ipsilateral hemi-diaphragmatic depression, intercostal widening and contralateral mediastinal shift.**

After radiological confirmation, tube thoracostomy was done with 30 Fr intercostal tube to relieve the pneumothorax. There was rapid improvement in SpO<sub>2</sub> to 97%, Airway pressures and ETCO<sub>2</sub> levels were restored to normalcy. Hypotension and tachycardia were spontaneously corrected. There was a complete expansion of the lung after tube thoracostomy on chest roentgenogram. **The chest radiographs of the patient prior to surgery and before and after insertion of an intercostal tube are shown in Figures-1,2&3.** DLT was changed to 7.0 mm ID single lumen tube for post operative ventilation. In view of coexisting morbidities, elective ventilation was believed more essential to rest the lungs. The patient was uneventfully extubated the next day.

## DISCUSSION:

Pneumothorax can occur spontaneously or following trauma, and is a common iatrogenic complication of multiple procedures. The most common procedures to cause a pneumothorax include

biopsy of thoracic structures, a central venous line, pacemaker insertion, airway instrumentation. Other causes include Cardiopulmonary resuscitation and positive-pressure ventilation in predisposed individuals. In Ying-Lun Chen series, the most common causes for pneumothorax were found to be regional blocks (40% of reported cases), airway instrumentation (19%), barotrauma (16%), placement of central venous lines (7%) and others rare reason being the improper use of mechanical ventilators.<sup>3</sup>

Pneumothorax occurring during general anesthesia is a rare event, accounting for less than 3% of anesthesia complications, according to the American Society of Anesthesiologists' closed claims database. Brachial plexus blocks and central lines comprise the majority of the cases.<sup>4</sup> Hypoxia was attributed to the general observation that it is more common when isolation is done in healthy lungs contributing to the higher VQ mismatch. In our case, we presumed the cause of desaturation is lung isolation in accordance with general hypothesis. Increase in EtCO<sub>2</sub> was attributed to inadequate ventilation and rising airway pressures due to the smaller size of DLT. There were no significant changes in hemodynamics and hence the surgery was allowed to continue.

Classically patients who are ventilated will deteriorate rapidly exhibiting hypoxia, hypotension, and tachycardia in the event of tension pneumothorax. There will be extreme difficulty in bagging or high airway pressures, EtCO<sub>2</sub> increases and subcutaneous emphysema may manifest. In unilateral pneumothorax, signs of disease lateralization like hyper resonance, decreased breath sounds, chest hyper-expansion, and chest hypomotility with adventitious sounds can occur. A traumatic tension pneumothorax may develop rather quickly, but other causes, such as iatrogenic pneumothorax may manifest insidiously as seen in this case.<sup>5</sup> Chow MY et al predicted the size of the left-sided DLT based on the width of patient's trachea measured from the

preoperative chest radiograph. The correct size of the DLT was the largest size tube inserted into the left bronchus with a small air leak detectable when the endobronchial cuff was deflated but not exceeding the recommended resting volume when inflated for lung isolation. Using this method of choosing DLT, they found that an oversized DLT was often chosen especially among their female Asian patients because of their smaller and shorter stature.<sup>6</sup> Jay B Brodsky in his study on predicting the size of DLT by tracheal width measurement stated that an inappropriately sized DLT can cause airway trauma and interfere with oxygenation and lung separation during one-lung ventilation. The tracheal width for women was significantly narrower than for men. This has probably produced airway trauma when intubation was attempted with 35Fr DLT<sup>7</sup>.

In our case, development of intraoperative pneumothorax could not be suspected because; oxygen saturations were maintained with oxygen supplementation to nondependent lung. Incidentally auscultation of the chest did not reveal any decrease in the breath sounds. Other suggestive features of the complication were elevated airway pressures and hypercapnia, both of which are possible during one lung anesthesia. These were attributed to the small size of the DLT (28Fr), but the increase was perpetuated, which should have disputed our patient monitoring. Clinical suspicion of pneumothorax did not arise, as the breath sounds were audible and oxygen saturation was maintained throughout the length of surgery which went on up to 90minutes. The only perplexing finding was insidious yet significant rise in EtCO<sub>2</sub> and airway pressures which were otherwise not expected during non pulmonary surgery.

Physical examination findings suggestive of pneumothorax like hyper resonance with percussion and decreased chest wall movement could not be elicited until the completion of surgery due to inadequate access. The differential diagnosis includes malposition or kinking of the double-lumen endotracheal tube,

pulmonary thromboembolism, acute, right heart failure secondary to marked pulmonary hypertension, “pulmonary tamponade” resultant from air trapping, circuit disconnection and allergic reaction.<sup>8</sup>

Daniel et al reported a case where the patient developed bilateral pneumo-thoraces after intubation with double lumen tube and was taken up for surgery after introducing intercostal drains on either side. Surgery was performed uneventfully and the patient was subjected to postoperative elective ventilation for 24 hours.<sup>9</sup> In Zollinger series of 26 cases of lung volume reduction surgeries, one tension pneumothorax occurred during one lung ventilation. Oxygen saturation was well maintained, but hypercapnia persisted for 48 h after surgery. It can be concluded that adequate oxygenation can be preserved during OLA, but CO<sub>2</sub> elimination is impaired. However, intraoperative hypercapnia and immediate postoperative tracheal extubation are usually well tolerated.<sup>10</sup>

Pneumothorax is very likely to be misdiagnosed during OLA, as the increase in FiO<sub>2</sub> may maintain normal SpO<sub>2</sub> despite higher [(A-a) O<sub>2</sub>]. Hypercapnia may be the only manifestation during OLA, causing a common diagnostic dilemma as it can be multi-factorial. In view of the absence of classical signs, any deviation in monitoring parameters should be critically analyzed and evaluated for early recognition and management of pneumothorax, especially during OLA.

### CONCLUSIONS:

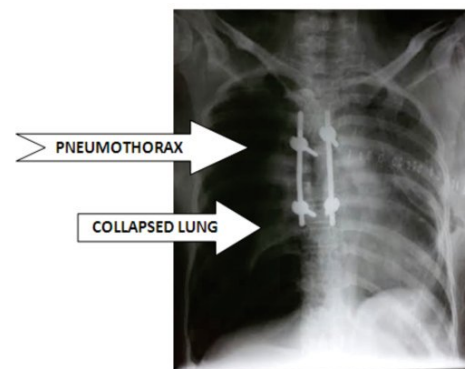
Intraoperative pneumothorax is an uncommon complication during one lung anesthesia and is likely to go unnoticed, as hypoxia is usually corrected by increasing FiO<sub>2</sub>. It should be recognized before it causes venous congestion and compression of mediastinal structures leading to adverse hemodynamic changes. Anaesthesia provider should be vigilant and watchful to suspect this condition as it may exhibit only subtle, nonspecific changes without raising

an alarm given the difficulties of proper access to the chest during thoracic spine procedures. A precordial stethoscope can be an additional potential gadget that can be used to access the inaccessible areas during surgeries.

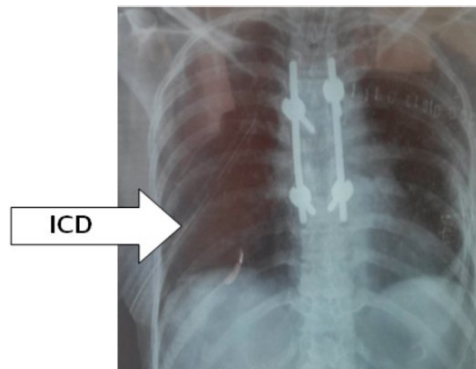
The observations in our case emphasize the need for selection of appropriate double lumen tube, based on the preoperative tracheal width measurement by chest x-ray in addition to consideration for gender and ethnic group. Higher EtCO<sub>2</sub> values in the absence of tube kink, secretions and bronchospasm should raise the possibility of intraoperative pneumothorax. Anesthetisiologist should anticipate, recognize and manage pneumothorax promptly that may develop during the intraoperative period.



**Figure 1-** Preoperative chest radiograph showing previous pedicle screw fixation. Both lung fields appear normal



**Figure2-** Immediate postoperative Chest radiograph showing pneumothorax on right side.



**Figure 3: Chest Radiograph after ICD insertion showing expansion of the lung on the right side**

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