CASE REPORT

See-saw pattern in ventilator graphic: Is there any story behind?

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ABSTRACT

The importance of ventilator graphics cannot be over emphasized that provide the useful information about airway, ventilation, compliance and lung mechanics. Some bizarre forms of graphics are usually overlooked in view of artifacts, but sometimes these tracings may in fact predict some relevant information.

Key words: Diagnosis, mechanics, ventilator graphics

INTRODUCTION

Monitors are important compliments to every physician, especially, anaesthesiologist. Usually, the patterns of different tracings and/or values of the monitors depict the pathophysiological responses of surgical or anaesthesiological stimuli and assist in the patient's management. In this regard, tracing the utility of ventilators is worth mentioning. The importance of ventilator graphics cannot be over emphasised, as they provide useful information about airway, ventilation, compliance, and lung mechanics.[1-5] Some bizarre forms of graphics are usually overlooked as artefacts, but sometimes these tracings may in fact predict some relevant information.

Here, we have described a unique pattern of pressure-time and flow-time curves of an operating room ventilator that shares clinically relevant information.

CASE REPORT

Case 1

An otherwise healthy young male patient weighing 60 kg was presented for olfactory groove meningioma surgery. The patient was induced and maintained with balanced general anaesthesia. After 5 hours of smooth intra-operative course, we suddenly noticed wide fluctuations in peak airway pressure (9-16 cm of water). Delivered tidal volume was also showing varying values ranging from 140-350 ml, despite the set tidal volume of 600 ml. However, there was no change in end tidal carbon-di-oxide ($ETCO_2$) waveform or in haemodynamics. At this point, considering the inadequate muscle paralysis and being a neurosurgical procedure, we repeated the muscle relaxant to ensure complete immobility of the patient. In addition, we also searched for the other possible causes such as valve malfunction, secretion in the endotracheal tube, possible kinking of endotracheal tube etc. However, the fluctuation in tidal volume and pressure persisted, and the pressure-time and flow-time curves showed a small zig-zag or see-saw pattern [Figure 1]. After eliminating all these causes, we started searching for the leak in the circuit as well as in the soda lime canister, and surprisingly, we found water [Figure 2] in the outflow tube of the circuit, and the column of water was moving with each ventilatory cycle. We immediately removed water from the circuit, and subsequently the curves as well as the other ventilatory mechanics returned to normal. Rest of the intra-operative course was uneventful.

Case 2

An otherwise healthy young male patient weighing 62 kg was taken for an urgent craniotomy and excision for left parieto-occipital space occupying lesion. Due to deteriorating consciousness, he was in an emergency room and shifted to OR. Anaesthesia was induced with fentanyl 100 μg and propofol 80 mg. Maintenance of anaesthesia was done with oxygen, isoflurane, fentanyl, and vecuronium. Intra operatively, we observed see-

Access this article online	
Quick Response Code:	Website: www.nigeriamedj.com
	DOI: 10.4103/0300-1652.137232

saw pattern in the pressure-time and flow-time curves [Figure 2] with continuous change of airway pressure as well. Several measures were taken to correct the condition and eliminate the other possible causes. A thorough search revealed water inside the circuit tubing. After removal of water (around 50 ml), ventilator mechanics reverted to normal and the further intra-operative course was uneventful.

DISCUSSION

The importance of ventilator graphics is well described in the literature.[1-4] We can see various patterns in pressure-volume loop, which are the characteristic features of different airway conditions including obstructive, restrictive lung diseases, intra-operative kinking etc.[1-4] Importantly, some of these patterns in intra-operative period are usually accompanied by changes in airway pressures as well. Notably, intra-operative sudden changes in peak airway pressure may occur due to multiple causes including inadequate depth of anaesthesia, recovery from muscle relaxant, kinking of endotracheal tube, tube blockage with secretions/mucus, bronchospasm, pulmonary embolism, pneumothorax and valve dysfunction. A thorough check-up to eliminate these conditions are of paramount importance [Table 1].

In the above cases, the peak airway pressure and the delivered tidal volume were changing continuously and the probable reason for such intra-operative finding is the onset of spontaneous respiration. We did repeat the muscle relaxant, but only the removal of water from the anaesthesia circuit could solve this puzzle. In this regard, water in the anaesthesia circuit is a common entity. Condensation of water usually occurs due to the humidified anaesthetic gases, soda lime, and losses from the patient's airway that can lead to clogging of water in the circuit tubing. In addition, factors like the prolonged duration of surgery, difference in the patient core body and ambient temperature, and the fluid status of the patient can further affect the loss and vaporisation from the patient airway and result in water condensation. In our case, the water was not only collected in the tubing but it partially obstructed the pathway. The water column was moving with each ventilator cycle and its to and fro movement inside was reflecting as changing airway pressure, tidal volume and see-saw pattern in the pressure-time and flow-time curves. The see-saw pattern in flow-volume loop has also been studied and found to be well correlated with secretions in endotracheal tubes.[2,4] These are suggested as the non-invasive methods to detect secretions in endotracheal tube in patients on ventilators. Importantly, the absence of see-saw pattern in flow-volume loop after suctioning suggested the absence of secretions. In addition, clinical examination was found to be less accurate than that of curves in predicting the secretions in endotracheal tube.[4] On contrary, our findings suggest that see-saw pattern in flow-time and pressure-time curves point towards water in the external ventilator tubing and signify the substantial amount of water present. However, it is a matter of further research related to volume of water and appearance of these types of graphics.

Table 1: Significance of different ventilatory mechanics

Fluctuation airway pressures	Rule out Breathing efforts Valves malfunctions Partial obstruction of ETT Bronchospasm Pulmonary embolism ETT secretions / mucus
See-saw pattern pressure-time and flow-time curves	Rule out Water in the circuit

Figure 1: See saw pattern in ventilatory graphics

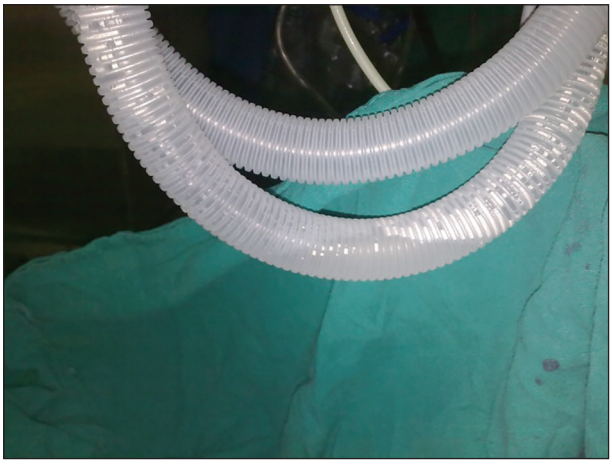

Figure 2: Water in the ventilator circuit

We noted that certain parameters were consistently present in both the cases and removal of water ameliorated the condition that includes:

1. See-saw pattern in the pressure-time and flow-time curves,
2. Regular fluctuation in airway pressure,
3. Fluctuating tidal volume
4. No changes in $ETCO_2$ waveform and haemodynamics.

Therefore, we suggest that findings of these parameters would certainly alert the peri-operative physicians to look for water clogging in the ventilatory circuit. This will not just help prevent overzealous use of anaesthetics, but may reduce the chances of clogging related serious intraoperative as well as intensive care unit consequences.

In conclusion, bizarre forms of ventilatory graphs may have some important information behind them and one should always try to find out the exact cause for this. In this regard, findings of see-saw pattern of pressure and flow curves may assist to eliminate water clogging in the ventilatory circuit.

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How to cite this article: Sokhal N, Goyal K, Chowdhury T, Rath GP. See-saw pattern in ventilator graphic: Is there any story behind?. Niger Med J 2014;55:359-61.

Source of Support: Nil, **Conflict of Interest:** None declared.