Use of filters in anaesthesia: Is it warranted?

INTRODUCTION

Anaesthesia machine check is an integral part of the anaesthesiologists' daily routine. The use of filters in anaesthesia breathing circuit is recommended to reduce the risk of cross-infections and to prevent the contamination of those parts of the machine which are difficult to clean or sterilise.[1] Cases of filter obstructions have been reported, generally due to excessive secretions, blood in trauma patients or excessive water condensation.[2] This can lead to high-airway pressures and inadequate ventilation. We report a case of high efficiency particulate air (HEPA-) filter causing obstruction of anaesthesia circuit despite a normal pre anaesthesia machine check.

CASE REPORT

A 15-year-old boy, weighing 38 kg, American Society of Anaesthesiologists physical status I, was posted for tonsillectomy under general anaesthesia. Routine monitors including non-invasive blood pressure, electrocardiogram and pulseoximeter were attached.

After premedication, general anaesthesia was induced. The endotracheal tube position was confirmed by auscultation and capnography. Isoflurane 0.8-1.0% and 60% nitrous oxide in oxygen was started using circle system. Patient was put on IPPV mode on Drager Primus® anaesthesia machine with tidal volume = 300 ml, respiratory rate = 14/min, PEEP =5, P max = 25 cm of H_2O and I: E ratio 1:2.

Immediately, the ventilator alarm sounded for failure to attain tidal volume which was 100 ml only. Manual mode was selected for ventilation which confirmed tightness of the bag and reduced chest excursions with high-airway pressures. $EtCO_2$ monitor showed obtunded tracings. On auscultation, air entry was severely reduced bilaterally with no evidence of bronchospasm or any foreign sounds.

Patient was then ventilated with an AMBU® non rebreathing bag. Immediately, chest excursion was evident without any resistance in ventilation. A conclusion of apparatus malfunction was made, and anaesthesia was continued with a fresh anaesthesia machine, uneventfully. Later, on examining the malfunctioning anaesthesia machine, obstruction to ventilation was found to be the HEPA filter at the inlet of the soda lime canister of the circle system. After removal of the HEPA filter and on re-checking the machine with a test lung, there was no problem in the ventilation.

DISCUSSION

Heat and moisture exchangers (HMEs) in combination with bacterial and viral filter (heat and moisture exchanger filters [HMEFs]) are widely used during general anaesthesia. The moisture exchange component passively humidifies the inspired air, and the filter component reduces the risk of viral and bacterial cross contamination between patients.[1] Typically, filters are positioned at the expiratory port

of the breathing circuit though these devices can be interposed between the circuit and the catheter mount to provide "patient-end" filtration and effective isolation of the patient from the rest of the circuit.

To administer anaesthesia to our patient, we used the Drager Primus® anaesthesia workstation with circle absorber system. Autoclavable antimicrobial HEPA filters (654ST) were used at both the inlet and the outlet of the soda lime canister of the circle system as per recommendations of the manufacturer. These re-usable filters can be used for 24 h and may be autoclaved to a maximum of 24 times.[3]

Of the two main types of filters, mechanical filters physically stop particles while electrostatic filters attract and capture charged particles. Mechanical filters (e.g. HEPA) consist of a sheet of densely packed resin-bonded, hydrophobic glass fibres which provide high resistance to gas flow. To decrease this resistance, the sheet is pleated to maintain a large surface area in a smaller package.[1,4] Large particles (>0.3 m) are filtered by inertial impaction and interception while smaller particles are captured by Brownian diffusion.[2]

These filters may be modified to perform additional functions like conservation of heat and moisture content of inhaled respiratory and anaesthetic gases and thus function as 'HMEFs'. HMEs contribute to patient humidification, only if placed on the Y connector as they depend on to and fro air movement.[2]

Atkinson *et al.* found that bacterial filters, HMEs and HMEFs are commonly used interchangeably. When HME or HMEFs are used instead of bacterial filters, they may lead to condensation in circuits with circle absorbers and increase the risk of blockage due to ingress and absorption of water. However, this risk can be reduced by placing the filter above the level of the patient and the breathing system, so that any liquid flows away from the filter.[5]

McEwan *et al.* recommended that the routine use of filters be discouraged as efficacy of all bacterial filters is not fully established. They should not be used in the presence of active humidification, nebulised drugs, copious secretions or pulmonary oedema and should be visible to detect contamination, obstruction or disconnection.[2]

Other authors have reported near-fatal complications that have resulted as a consequence of partial or complete airway obstruction during anaesthesia when using a filter.[6-9]

In our case, a new HEPA filter at the inlet of the soda lime canister was found to be blocked, probably due to moisture, resulting in increased resistance and inability to ventilate although manufacturers guarantee low resistance till 24 h of use.

CONCLUSION

Filters are additional devices, at extra cost, at a crucial position in the breathing circuit, the Y-piece. They may be associated with problems of increased dead space, resistance to airflow and have the potential for obstruction. Hence, routine use of filters should be discontinued. In addition, every anaesthesia set up should have a self-inflating bag readily available for use if any problem with the anaesthesia circuit occurs.

This report is highlights that the increased resistance or inability to ventilate could be due to a blocked filter being used in the anaesthesia circuit, despite a completely normal pre-anaesthesia machine check.

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