Loss Of Fresh Gas Flow Due To Malposition Of Vaporizer: An Oft Repeated Anaesthetic Misadventure

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Abstract

We report a case of complete loss of fresh gas supply at anesthesia machine outlet due to malposition of vaporizer on to the manifold where it was lifted off and tilted up on one side. We also re-emphasize on the importance of strictly adhering to the recommendations for pre-use checks in the Anesthesia machine checklist, and by the manufacturers; and also for an effective collaboration amongst the operating room personnel.

INTRODUCTION

Equipment malfunction contributes to morbidity and mortality in anaesthesia. About one fourth of equipment problems are related to human error.1,2 An integral component of anesthesia machine is vaporizer, which if not used as per specifications leads to a variety of anesthetic complications. We highlight a case where improper use of the vaporizer led to failure to ventilate intraoperatively.

CASE REPORT

A 40 year old male patient, ASA Grade I, was posted for acromian decompression. The surgery was planned under general anaesthesia. The Blease Sirius Spacelabs anesthesia workstation (Blease Medical Equipment Limited, Washington, USA) passed the daily electronic system check and the circle breathing circuit was also manually checked using thumb occlusion test before the case. The BleaseDatum L Series halothane and sevoflurane vaporizers already mounted on the machine were each checked by performing leak pressure test .Standard monitors were attached and baseline parameters recorded. After premedication and preoxygenation, the patient was induced with 5mg/kg of thiopentone and 0.1mg/kg vecuronium; mask ventilation with 2.0% sevoflurane and N2O and O2 was performed. The patient was intubated, bilateral air entry checked; and switched over to volume controlled ventilation. The vital parameters remained stable. After intubation, it was decided to shift the patient on isoflurane. The technician replaced the already mounted upstream halothane vaporizer with the isoflurane vaporizer. The dial concentration was set at 2.0% aiming to maintain MAC 1.0. Soon after, there was a low minute volume alarm and the bellows were collapsing. Immediately cuff leak, disconnections, loosening of CO2 canister, and sticking of unidirectional valves were checked. But there was none. The patient was taken on bag and the flows increased but the patient could not be ventilated even with the adjustable pressure limiting valve fully closed; which was free of obstruction. The patient could only be ventilated by activating the oxygen flush; even this was shortlived as enough pressure could not be generated and the bag quickly emptied once the O2 flush was released. So the patient was taken on auxiliary common gas outlet but of no avail; the bag remained empty and could be filled only with the oxygen flush. There was no gas flow at the outlet despite the bobbins floating in the flowmeter. Meanwhile a good check was kept on the patient's vital parameters that remained stable, probably because of those desperate intermittent oxygen flushes and was taken on manual resuscitator. As the cause of failure to ventilate could not be located, the remaining case was conducted on a changed anesthesia machine maintaining anesthesia with isoflurane, intermittent intravenous boluses of fentanyl and vecuronium. The patient was successfully reversed; conscious and oriented. The previous anesthesia machine was inspected and nothing was found functionally wrong except that the isoflurane vaporizer was slightly (<10degree) tilted to one side, lifted up on the right and the locking lever was not in place, the concentration control dial could be turned on clockwise and when the test lung was attached, it barely inflated.

Figure 1

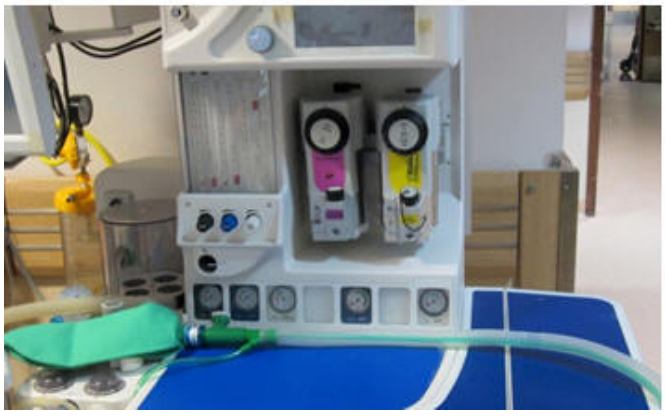
Mal-positioned Isoflurane vaporizer on to the vaporizer manifold (1-unlocked locking lever, 2-Non-aligned interlock pins)

Figure 2

Concentration controlled dial open in Malpositioned vaporizer (1-Non-aligned interlock pins, 2-Open concentration controlled dial, 3- unlocked locking lever)

Figure 3

Although bobbins floating yet the reservoir bag collapsed, vaporizer in unlocked position



Once it was repositioned and locked on the manifold, the test lung inflated. On retrospective analysis; failure to ventilate happened soon after the halothane vaporizer was replaced with the isoflurane vaporizer. On simulating the problem later, an audible quiet hiss, and a detectable odour was present at a close range from the vaporizer. There was no gas leak when no vaporizer were mounted on to the back bar and the vaporizer functioned well when used on another machine; thereby eliminating any error with in the vaporizer itself.

DISCUSSION

A number of machine factors and related human - machine interactions are exposed during equipment related crisis. With the rotameter bobbins floating; various causes of loss of gas flow at the outlet are

• fault in the vaporizer manifold block.3,4

• fault with in the vaporizer itself.5

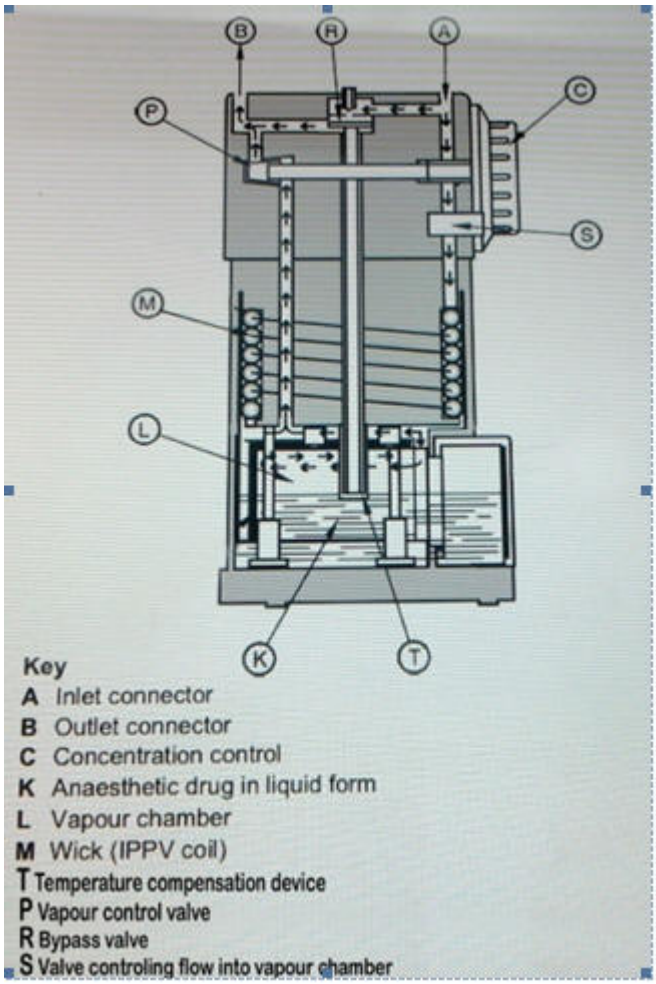
• fault in the locking of the vaporizer on to the manifold either due to overlapping of the vaporizer interlock mechanism on to the backbar,6 loss rr defect in O rings.7,8

• inadequate positioning of the vaporizer on the manifold .9

The Selectatec vaporizer mounting system consists of a pair of port valves for positioning of each vaporizer.10The BleaseDatum cage mount vaporizer is fitted with standard 23mm tapers; male (inlet) on the left and female (outlet) on the right. There are two M6 threaded studs at the rear of the vaporizer; thus securing it on to the backbar. It incorporates interlock pins to prevent use of two vaporizers simultaneously. The vaporizer should be so mounted against the back bar that the manifold ports align with vaporizer ports; and the gas connection ports are aligned correctly. Once the vaporizer is correctly seated, lock the vaporizer into position by pushing down and turning the locking lever fully clockwise to the locked position. The weight of the vaporizer and O-ring around each port valve creates a seal between the mounting system and the vaporizer. A concentration control C regulates the gas flow through the vapour control valve P; the bypass valve R and vapour chamber to produce the required concentration. When the control is set to zero the bypass remains open, however the vapour chamber is completely isolated from the patient gas flow. When the control is set to the desired concentration; valve S opens allowing flow into the vapour chamber.11

Figure 4

Internal functioning of Blease Datum Vaporizer



There are a few reported cases of anaesthetic vapor leakage from unlocked vaporizers. There was awareness and recall in two, 12, 13 while in one there was desaturation and hypercapnia.9 In our case and the case reported by Kim and Kim, 9 the concentration dial could be opened even when the vaporizer was not properly seated on the manifold; thereby not leading to an early recognition of the cause of the problem.

Leaks are relatively common, often due to malposition of vaporizer on back bar, loss of gaskets, or fault in internal seals of the manifold. 10 Even after a proper preuse check; vaporizer if slightly tilted from its mount a leak may occur.14 Leaks from junction between vaporizer and selectatec block raises a risk of hypoventilation, rebreathing , desaturation and awareness. 10

A leak from vaporizer or its mount should be suspected if

• vaporizer requires filling frequently,

• detectable odour,

• decreased fresh gas flow once vaporizer turned on 10 as what happened in our case. It was probably a large leak resulting in no fresh gas flow at the outlet, leading to a quick attention towards the mishappenning.

Our mistakes:

• changed vaporizer during a case.

• didn't check that vaporizer is not locked on to the manifold before switching it ON.

• didn't do a preuse check after changing the vaporizer, as recommended in the anaesthesia machine preuse checklist.15

A low pressure circuit leak test should be performed daily; and each time the vaporizer is changed. 10, 15 If a check valve is present upstream a negative leak pressure test is advised which is performed by attaching a suction bulb at the outlet. Also for the self test to determine if an internal vaporizer leak is present; the leak test is repeated with each vaporizer sequentially while it's concentration control dial is in on position.15 This case highlights that human error and misuse of equipment is one of the causes of preventable anaesthetic misadventure. According to Cooper et al. human error was involved in 82% while, equipment failure in 14% of preventable incidents.16 Factors frequently associated are inadequate communication among personnel, haste or lack of precaution; and distraction,17 laziness, pride and boredom too 18 are responsible. Contributing factors to most of these errors are last minute changes because of change in schedule, breathing system, ventilator, or type of anaesthesia leading to a man- machine interaction failure.1

Had we been communicated by the technician that the isoflurane vaporizer was not locked on the manifold; the event could have been averted. Since we could turn on the concentration control dial; a false impression of the correct seating of the vaporizer was created. Ancillary personnel make an important contribution to the anesthesiologist liability. Misuse of equipment by technicians, engineers, nurses contribute to patient injury.19

Certain steps elaborated by McIntyre to prevent any misadventure-

• proper pre- anesthetic check of the equipment,

• an understanding of the principles of the equipment functions,

• how it is assembled correctly through an effective

collaboration with technicians, nurses and manufacturers;

• routine servicing and calibration of the equipment. 20

Standard operating protocols should be developed and adhered to that provide individuals with information to perform a job properly; minimize miscommunication; and facilitate consistency in quality and integrity of product or end result.

CONCLUSION

Equipment sometimes fails to function properly and people err inspite of all the precautions. We were alerted of strictly following manufacturer's instructions and preuse checklist protocols as to know our equipment in entirety. Nevertheless, such incidents also provide with the insight into the lapses and lacunae in the level of training, organization and delivery of task by the staff.

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