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LETTER TO THE EDITOR

A novel cause of rebreathing carbon dioxide related to removed CLIC-seal on the Dräger Apollo© anesthesia machine

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Abstract
We present a case report involving two sequential, surgically uneventful, laparoscopic cholecystectomies using the same anesthesia machine (Drager Apollo©) for which the level of inspired carbon dioxide was noted to be elevated following various diagnostic interventions including replacing the sodalime, increasing fresh gas flows, and a full inspection of equipment for malfunction. Eventually it was discovered that a rubber ring seal connecting the Dragersorb CLIC system© to the sodalime canister was inadvertently removed during the initial canister exchange resulting in an apparent bypassing of the absorbent and thus an inability of the exhaled gas to contact the sodalime. To our knowledge this is the first such description of this potential cause of elevated inspired carbon dioxide and should warrant consideration when other conventional interventions have failed.

Keywords Dragersorb CLIC · Sodalime · Inspired carbon dioxide · Rebreathing

1 Introduction

We present our case of two sequential elective laparoscopic cholecystectomies during which the anesthetic management was complicated by an elevation in the fraction of inspired carbon dioxide ($FICO_2$). The same workstation was used in each case (Drager Apollo©). Following numerous interventions with the help of our biomedical engineering department it was revealed that a component connecting the Dragersorb CLIC system to the sodalime canister was inadvertently removed. Written consent was obtained from both patients in compliance with HIPAA prior to publication.

2 Case 1

Our first laparoscopic cholecystectomy involved a 62-year-old female. Following endotracheal intubation, end tidal CO_2 ($ETCO_2$) and bilateral breath sounds were confirmed and the patient was placed on volume control ventilation with sevoflurane maintenance. The surgery began uneventfully, the abdomen was insufflated and $ETCO_2$ increased secondary to insufflations thus the respiratory rate was increased to offset. No change in the capnogram waveform was noted. Over the course of the next hour the $FICO_2$ increased to 4 mmHg. The sodalime canister was observed to be moderately discolored indicating potential exhaustion. The canister was removed and shaken to redistribute the sodalime to offset the effect of channeling. No reduction in $FICO_2$ was noted and the anesthesiology technician was called to change the canister. A new canister was installed, yet the $FICO_2$ increased to >10 mmHg. FGF was increased to >10 L/min to maintain $FICO_2 < 5$ mmHg. Suspecting a faulty canister we asked for a new replacement. Again this proved ineffective and we maintained elevated FGF >10 L/min for the duration of the case. The case finished uneventfully, the patient was extubated and brought to PACU. A manual and automated workstation inspection was performed following the case. The expiratory valve leaflet was exchanged as earlier case reports purported the possible "rebreathing of carbon dioxide caused by incompetent cage and disc unidirectional valves" [1]. A full examination of the scavenging system was also performed as part of the manual workstation inspection.

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3 Case 2

The second laparoscopic cholecystectomy proceeded with a 60-year-old female. After placing the patient on positive pressure ventilation and sevoflurane maintenance, the $FICO_2$ was again elevated requiring increased FGF. The biomedical engineering department suggested changing the Dragersorb CLIC system© before replacing the machine entirely. The patient was hand-ventilated with intermittent boluses of Propofol for general anesthesia. The CLIC system was switched out and compared to a new one and noted to be missing a rubber ring seal connecting the Dragersorb CLIC system© to the sodalime canister (Fig. 1). Once in place the $FICO_2$ returned to 0 and the case finished uneventfully.

4 Discussion

It is important to note that the routine practice of replacing soda lime absorbent using the Dragesorb CLIC system is not without potential for mechanical compromise. Indeed the benefit of the Dragersorb CLIC system© is one of efficiency and safety as the whole contraption is changed at one time. The absorbent can be taken out of the circuit without causing a leak because valves seal the circuit. It was apparent that during Case 1 after the absorbent was exhausted and replaced by our anesthesia technician staff, that the rubber seal valve came off and was accidentally discarded (Fig. 2). Without an effective seal, a rising $FICO_2$ was observed since carbon dioxide essentially bypassed the absorbent. The different causes of carbon dioxide retention intraoperatively fall into four major categories: hypoventilation, increased dead space, increased carbon dioxide production and finally rebreathing. We have therefore presented a novel cause for elevated levels of $FICO_2$ under the category of rebreathing. In our discussions with Drager representatives, it was clear that this was a problem that had not been encountered before. It is thus necessary to confirm the presence of an effective seal connecting the Dragersorb CLIC system© to the sodalime canister in order to prevent the rebreathing of carbon dioxide.

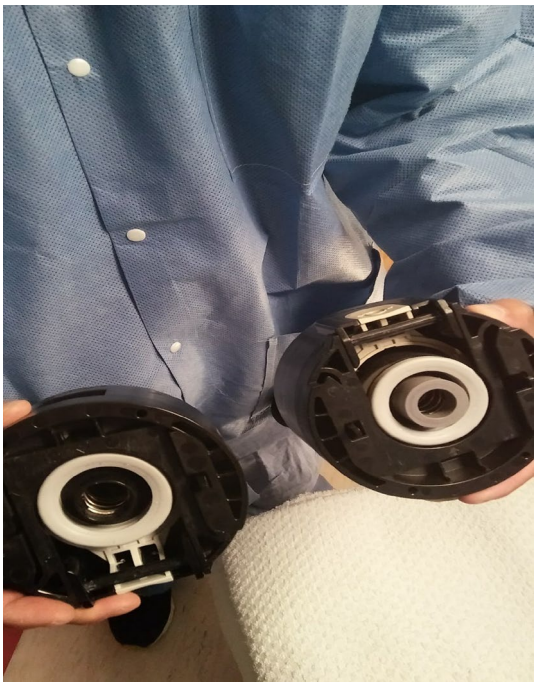

Fig. 1 Missing rubber seal on CLIC system on left as compared to intact seal on right

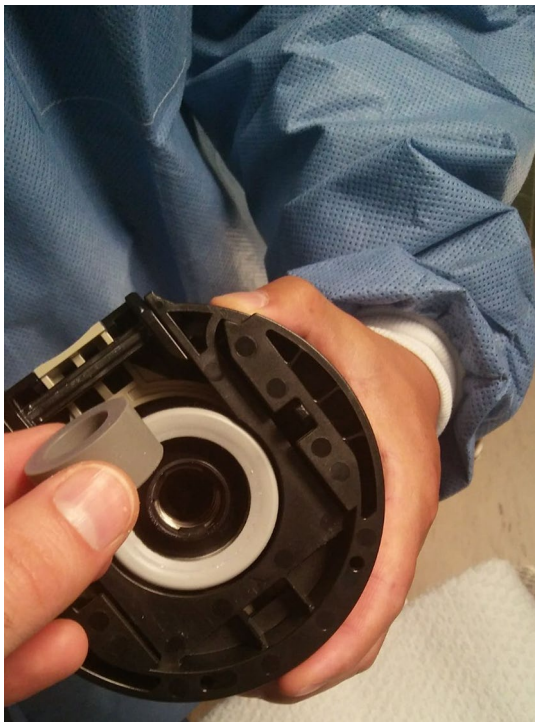

Fig. 2 Dislodged rubber seal which was inadvertently removed upon changing the soda lime canister

Author contributions BN: This author formulated this case report and was the primary resident involved in the care of patients. ZB: This author helped edit this case report and was a senior resident that assisted in the care of the patients. AR: This author was the attending anesthesiologist during the two procedures. He aided in supervision and guidance of this publication.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Reference

1. Vasudevan A, et al. Carbon dioxide rebreathing caused by deformed silicon leaflet in the expiratory unidirectional valve. J Anaesthesiol Clin Pharmacol. 2013;29(1):108–10.