Case Report

Ultra-modified rapid sequence induction with transnasal humidified rapid insufflation ventilatory exchange: Challenging convention

Address for correspondence:
Dr. Ketan Sakharam Kulkarni, Near Janata High-School Mahadeonagar, Islampur, Sangli - 415 409, Maharashtra, India.
E-mail: ketan29.5@gmail.com

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Ketan Sakharam Kulkarni, Nandini Dave, Shriyam Saran[1], Madhu Garasia, Sandesh Parelkar[2]

Department of Anesthesiology, Seth GS Medical College and KEM Hospital, [1]Freelance Anaesthesiologist, Islampur, Dist-Sangli, [2]Department of Paediatric Surgery, Seth GS Medical College and KEM Hospital, Parel, Mumbai, Maharashtra, India

ABSTRACT

During positive pressure ventilation, gastric inflation and subsequent pulmonary aspiration can occur. Rapid sequence induction (RSI) technique is an age-old formula to prevent this. We adopted a novel approach of RSI for patients with high risk of aspiration and evaluated it further in patients undergoing laparoscopic surgeries. We believe that, in patients with risk of gastric insufflation and pulmonary aspiration, transnasal humidified rapid-insufflation ventilatory exchange can be useful in facilitating pre- and apnoeic oxygenation till tracheal isolation is achieved.

Key words: Apnoeic oxygenation, gastric insufflation, lower oesophageal sphincter, transnasal humidified rapid-insufflation ventilatory exchange, ultra-modified rapid sequence induction

INTRODUCTION

Generally, it is agreed that inflation of air into the stomach is one of the main causes of regurgitation.[1] Patients with particular pathological conditions (e.g., intestinal obstruction, inadequate starvation, gastroparesis and tracheo-oesophageal fistula) are prone to the risk of aspiration. Rapid sequence induction (RSI) technique is an age-old formula to prevent this threatening complication. Components of classic RSI are pre-oxygenation, cricoid pressure and the avoidance of mask ventilation before securing the airway with endotracheal tube.[2] However, pre-oxygenation with tight-fitting face mask is not ideally possible in paediatric patients. The inability to pre-oxygenate, increased oxygen demand and reduced functional residual capacity are the main causative factors leading to rapid desaturation during apnoea in children.[3] The 'modified RSI or the controlled RSI' utilises pressure-limited mask ventilation after induction of anaesthesia to circumvent this problem.[4] However, with limited inspiratory pressure, lung ventilation might be inadequate leading to desaturation; moreover, the chances of gastric insufflation remain. Effective and safe use of cricoid pressure requires training and experience. Furthermore, it is contraindicated in patients with suspected cricotracheal injury, active vomiting or unstable cervical spine injuries.[5] The role of cricoid pressure during RSI in children is now controversial. Incorrectly and inappropriately applied cricoid pressure can make laryngoscopy and endotracheal intubation difficult and cause more harm than good.[6] A technique which can allow pre-oxygenation with 100% FiO_2 and maintain saturation without opening lower oesophageal sphincter (LOS) till tracheal isolation is achieved with intubation would be ideal. Introduction of transnasal humidified rapid-insufflation ventilatory exchange (THRIVE) technique offers a possibility to achieve these goals. We report the use of THRIVE technique with Airvo™ and Optiflow™ (Fisher and Paykel Healthcare Limited, Panmure, Auckland, New Zealand), a commercial transnasal humidified

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oxygen delivery system. We named this technique ultra-modified RSI (UMRSI) and implemented it in paediatric patients posing high aspiration risk. Further evaluation of this technique was done in patients undergoing laparoscopic surgeries. Consent was obtained from all the patients' parents for employing this technique and also for publication of this case series.

CASE REPORTS

Case 1

A 2-day old neonate, weighing 2356 g, a diagnosed case of tracheo-oesophageal fistula, was scheduled for thoracotomy and fistula closure. On preoperative examination, there was mild respiratory distress (respiratory rate 45/min), SpO_2 92% on room air and heart rate 150/min. Appropriate monitoring was instituted in operating room. Injection fentanyl 5 mcg was administered intravenous (IV). A flow of 8 l/min at FiO_2 of 100% was then started with Optiflow™ nasal cannula. An oropharyngeal catheter was placed and transduced to measure the positive pharyngeal pressures (PPP) created by THRIVE. SpO_2 improved to 100% immediately. Injection propofol 2 mg/kg and injection rocuronium 1 mg/kg were given IV. The airway was kept open with application of jaw thrust. Patient was successfully intubated in the first attempt using 3.0 mm ID uncuffed endotracheal tube (ETT). The apnoeic time was 120 s during which there was no desaturation [Table 1]. We did not use face mask ventilation. Once the fistula was isolated with appropriately placed tube (ETT tip beyond the fistula but above the carina, confirmed with auscultation), volume control mechanical ventilation was commenced. An epigastric stethoscope was placed to detect any gastric insufflation created by THRIVE. Pharyngeal pressures were measured continuously and were <2 mmHg. During pre- and apnoeic oxygenation, no gurgling sounds were auscultated over the epigastrium, indicating the absence of gastric insufflation.

Case 2

A 3-year-old, 10 kg male child, with intestinal obstruction, was scheduled for laparoscopic division of Ladd's band. On examination, patient had massive abdominal distension. Multiple air–fluid levels were seen on X-ray abdomen. After instituting monitoring of heart rate and SpO_2, injection fentanyl 10 mcg was given IV, and high flow nasal oxygenation was started [Table 1]. An epigastric stethoscope was placed to detect gastric insufflation. After IV administration of propofol and injection rocuronium, trachea was intubated with 5 mm ID ETT. The nasogastric tube was in place and we transduced it and measured gastric pressure continuously. No pressure changes were recorded during oxygen insufflation. After insertion of laparoscope, surgeons also confirmed the absence of any visible gastric bulge.

Cases 3–7

We studied a series of patients undergoing elective laparoscopic surgeries [Table 1]. The Optiflow nasal cannula was used (without conventional mask ventilation) with set oxygen flow rate as appropriate for age after premedication with injection fentanyl 2 mcg/kg. LOGIQ™ e R7 ultrasound machine (GE Medical Systems, Milwaukee, WI, USA) equipped with a wide-band linear array transducer with a frequency of 4.2–13.0 MHz (Model 12 L-RS) was used to visualise gastric antrum and to detect any gastric insufflation with UMRSI technique. In all the patients, successful tracheal intubation was possible without any desaturation. Gastric insufflation was neither seen with ultrasound [Figure 1] nor on direct visualisation of stomach by surgeons during laparoscopy.

DISCUSSION

Gastric inflation can occur during positive pressure ventilation, especially when the peak inspiratory pressure exceeds LOS pressure.[1] We used Optiflow™ nasal cannula for pre-oxygenation and apnoeic

Table 1: Patient characteristics and oxygenation details

Case	Age	Sex	Weight (kg)	Diagnosis	Optiflow cannula type	Flow rate (l/min)	Pre-oxygenation time (s)	Apneic oxygenation time (s)
1	2 days	Female	2.3	TEF	OPT 314	8	96	120
2	3 years	Male	10	Intestinal obstruction	OPT 316	15	126	98
3	10 years	Male	22	Appendicitis	OPT 318	25	204	137
4	6 months	Male	6	Undescended testis	OPT 314	8	180	148
5	11 years	Female	24	Cholecystitis	OPT 318	25	120	150
6	5 years	Male	15	Right inguinal hernia	OPT 316	20	148	223
7	8 years	Female	19	Intrahepatic hydatid cyst	OPT 318	25	98	108

TEF – Tracheo-oesophageal fistula

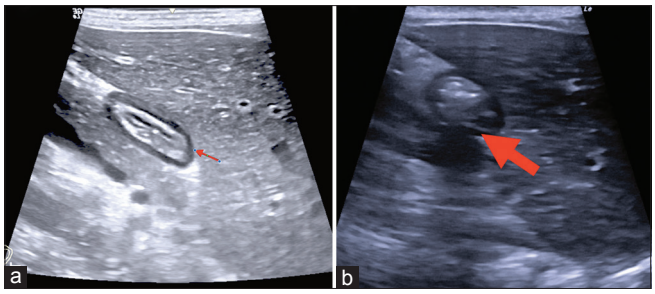

Figure 1: Ultrasonographic view of antrum (a) without gastric insufflation (small arrow) (b) with gastric insufflation. Note the comet-tail artefact (large arrow)

oxygenation without exceeding LOS pressure till tracheal isolation was achieved. After administration of injection fentanyl, 100% oxygen with age-appropriate flow rate was started through Optiflow™ nasal cannula. The time between application of nasal cannula till the administration of muscle relaxant was assumed to be pre-oxygenation time. Time following administration of relaxant till the appearance of first trace of capnograph was apnoeic time. Jaw thrust was used to maintain airway patency throughout this period.

THRIVE technique maintains oxygenation by gaseous exchange through flow-dependent dead space flushing.[7] Recently, THRIVE technique has proved its effectiveness in delaying hypoxia during apnoea after induction of anaesthesia in children with healthy lungs.[8] In healthy adult volunteers, positive pressures generated in the airways at 60 L/min flow are <3 cm of water.[9] PPP generated in paediatric airways after administration of anaesthetic drugs is still a question. We monitored pharyngeal and gastric pressure continuously using TruWave® Pressure Transducer (Edwards Lifesciences, Irvine, CA, USA) in conjunction with the Infinity® Omega-S monitor (Dräger, Lübeck, Germany).

In Case 1, pharyngeal pressures were <2 mmHg. In Case 2, gastric pressures did not change during the whole process of intubation indicating no gastric inflation.

A microphone,[1] stethoscope,[10-12] and ultrasonography of the antrum[13] have been used to detect gastric insufflation. Entry of air into the stomach produces acoustic shadows, comet-tail artefacts or increase in the antral area on ultrasonography.[13] The absence of an acoustic shadow phenomenon and/or a comet-tail artefact into the antrum throughout the intubation procedure ruled out entry of air into the stomach in our patients. The absence of gastric insufflation was further confirmed by laparoscopic visualisation by surgeons.

There are some limitations to the application of our technique. Unlike airway pressure monitors, there are no commercially available pressure transducers which can measure pharyngeal/gastric pressures. Accuracy of this technique needs to be validated. We did not measure the end-tidal/transcutaneous carbon dioxide before endotracheal intubation when the THRIVE was instituted. Retained carbon dioxide during intubation attempt, which is a known complication of THRIVE, can lead to arrhythmias.

CONCLUSION

We believe that, in patients with increased risk of aspiration, use of THRIVE to perform UMRSI is a promising technique to prevent gastric inflation and subsequent regurgitation. However, it is advisable to do controlled trials and further research to test the efficacy before making it a standard of care.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the legal guardian has given his consent for images and other clinical information to be reported in the journal. The guardian understands that names and initials will not be published and due efforts will be made to conceal patient identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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