

Laryngeal mask airway and incidence of gastro-oesophageal reflux in paralysed patients undergoing ventilation for elective orthopaedic surgery

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Summary

We have studied the incidence of gastro-oesophageal reflux associated with the laryngeal mask airway (LMA) in 82 paralysed patients undergoing ventilation for elective orthopaedic surgery. Anaesthesia was managed by skilled LMA users. A pH-sensitive probe was passed nasally into the oesophagus before induction and recordings made during five phases of anaesthesia. Anaesthesia was induced with propofol and fentanyl and maintained with 0.5-1.5% isoflurane and nitrous oxide in oxygen. Neuromuscular block was produced with vecuronium and the train-of-four count maintained at ≤ 1 . Towards the end of surgery, neuromuscular function was allowed to recover spontaneously. All LMAs were inserted at the first attempt and ventilation was successful in all patients. There were no adverse airway events. Mean oesophageal pH values during each phase of anaesthesia were: before insertion 5.88 (sd 0.77), placement 5.85 (0.74), maintenance 5.89 (0.73), emergence 5.71 (0.78) and removal 5.82 (0.75). There were no reflux events (pH < 4.0) during any phase of anaesthesia. We conclude that the incidence of gastro-oesophageal reflux is low in paralysed patients undergoing ventilation for elective orthopaedic surgery when antagonism of neuromuscular block is avoided. The validity of these findings for unskilled LMA users is unknown. (*Br. J. Anaesth.* 1998; **81**: 537-539).

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The laryngeal mask airway (LMA) has gained widespread popularity as a general purpose airway and has some advantages over the tracheal tube and face mask.¹ A limiting factor with the use of the LMA is the lack of airway protection from regurgitated gastric contents,² and some practitioners consider that the presence of the device in the pharynx could promote regurgitation.³ Published data have provided conflicting results, with a reported incidence of gastro-oesophageal reflux of 0-80%.⁴⁻¹⁰ In this study, we have determined the incidence of gastro-oesophageal reflux associated with the LMA in paralysed patients undergoing ventilation for elective orthopaedic surgery.

Patients and methods

After obtaining approval from the Hospital Ethics Committee and written informed consent, we studied 82 consecutive adult patients, ASA I-III, undergoing elective orthopaedic surgery at the University School of Medicine LIU Campus Bio-Medico, Rome, Italy. Patients were excluded if they were < 18 yr, required surgery in non-supine positions, had a body mass index (BMI) > 35 kg m⁻², were at risk of aspiration (previous upper gastrointestinal tract surgery, known or symptomatic hiatus hernia, oesophageal reflux, peptic ulceration or not fasted) or were considered otherwise unsuitable for an LMA. Patients receiving antacid therapy or drugs affecting gastrointestinal motility were excluded. All investigators were experienced with the LMA (> 200 uses and first-time failure rate < 5%).

Premedication comprised midazolam 0.04 mg kg⁻¹ i.v., approximately 30 min before induction. A monocrySTALLINE antimony pH electrode (Zinetecs Medical Inc, Salt Lake City, UT, USA) was placed in the stomach via the nose before induction of anaesthesia. Intra-gastric position was confirmed by the presence of a low pH. The electrode (2 mm) was then positioned in the lower oesophagus by withdrawing it slowly until a higher pH was obtained (pH 5-6). A flexilog 1011 pH data logger system/monitor (Oakfield Instruments Ltd, Oxford, UK) recorded pH every 6 s and displayed the information continuously on a visible liquid crystal display screen. Before and after each use, the electrode was adjusted in buffer solution at pH 4 and pH 7, 37°C. Any decrease in pH to < 4.0 was deemed to indicate gastro-oesophageal reflux.^{8,10} Data from the data logger were downloaded to a computer for further analysis.

Standard monitoring was applied, including an ECG, pulse oximeter, capnograph and non-invasive arterial pressure monitor. A TOF guard accelerometer (Biometer Int., Odense, Denmark) was used to quantify neuromuscular block. Patients were preoxygenated for 2 min, and then fentanyl 5 µg kg⁻¹ i.v. was given followed 1 min later by propofol 3 mg kg⁻¹ i.v. over 30 s. Patients' lungs were ventilated by face

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mask for 30 s with 100% oxygen. The LMA was inserted using the standard technique¹¹ when the eyelash reflex was lost, the jaw was relaxed and the patient apnoeic. Additional bolus doses of propofol 0.5 mg kg⁻¹ i.v. were given as required until an adequate level of anaesthesia was achieved for placement of the LMA. Anaesthesia was maintained with 0.5–1.5% isoflurane and 67% nitrous oxide in oxygen.

A size 4 LMA was used for small adults (<60 kg) and a size 5 for large adults (≥60 kg). The LMA cuff was inflated with air until an effective seal was formed or up to the maximum recommended volume (30 ml, size 4; 40 ml, size 5). Adequate ventilation was judged by chest wall movement, capnography and an airway sealing pressure¹² ≥10 cm H₂O during manually assisted ventilation. If adequate ventilation was not possible, the LMA was removed and a different size inserted. After insertion of the LMA, the position of the probe was verified to ensure that it had not migrated distally. A rolled gauze swab was inserted as a bite block and the LMA fixed in place in the midline using adhesive tape with the tube following its natural caudal curve. When adequate ventilation was established, patients were given vecuronium 0.1 mg kg⁻¹ and neuromuscular block was maintained using increments of 0.03 mg kg⁻¹ if the train-of-four count was >1. Patients underwent positive pressure ventilation (Ohmeda 210 Excel, Ohmeda Inc., Madison, USA) with tidal volumes of 8 ml kg⁻¹; peak airway pressure was <20 cm H₂O. Ventilatory frequency was adjusted to maintain $P_{E'}\text{CO}_2$ in the normal range (4.3–4.7 kPa). Epigastric stethoscopy was performed for 1 min during maintenance of anaesthesia to detect any air entering the stomach. Towards the end of surgery, neuromuscular function was allowed to recover spontaneously and anaesthesia was discontinued when the train-of-four ratio was >0.7. Patients underwent manually assisted ventilation until spontaneous breathing resumed. The LMA was removed when the patient was able to open their mouth to command.

Failed positive pressure ventilation was defined as SaO_2 <95% with an $F\text{I}_{\text{O}_2}$ of 0.33 or $P_{E'}\text{CO}_2$ >4.7 kPa. Any adverse airway events, such as a change in patient position, coughing, hiccups, gagging or bucking were noted and timed. All pH data were analysed independently by two investigators. Gastro-oesophageal reflux was observed and analysed during five consecutive phases of anaesthesia: (1) pre-insertion phase (placement of probe to commencement of insertion of the LMA); (2) placement phase (insertion of the LMA to establishment of an effective airway); (3) maintenance phase (effective airway to discontinuation of anaesthesia); (4) emergence phase (discontinuation of anaesthesia until removal of the device); and (5) removal phase (removal of device until removal of pH probe).

Results

Mean age, height, weight, body mass index and duration of surgery were 42 (range 21–81) yr, 165 (SD 9, range 148–181) cm, 70 (13, 43–105) kg, 25.7 (4.4, 19–35) kg m⁻² and 50 (20, 22–184) min, respectively. All LMAs were inserted at the first attempt and ventilation was successful in all patients. There were no adverse airway events in any patient and gastric insufflation was not detected. Mean preoperative

gastric pH was 2.5 (SD 0.32). Mean oesophageal pH values during each phase of anaesthesia were: before insertion 5.88 (SD 0.77, range 4.1–6.8), placement 5.85 (0.74, 4.3–6.8), maintenance 5.89 (0.73, 4.2–6.5), emergence 5.71 (0.78, 4.0–6.8) and removal 5.82 (0.75, 4.1–6.6). There were no reflux events during any phase of anaesthesia.

Discussion

Our data suggest that the incidence of gastro-oesophageal reflux is low in paralysed patients undergoing ventilation for elective orthopaedic surgery. Assuming a binomial distribution for the number of regurgitations, the upper limit for the probability when no cases have been observed in 82 patients is 0.046.¹³ Therefore, we can state with 95% confidence that the true rate of gastro-oesophageal reflux is <4.6%.

Valentine, Stakes and Bellamy, who studied 10 paralysed patients undergoing ventilation with an oesophageal pH probe, reported gastro-oesophageal reflux in 40% of patients, increasing to 80% during antagonism of neuromuscular block.⁹ This was attributed to possible gastric insufflation. A recent study by Bapat and Verghese of 100 paralysed patients undergoing ventilation for gynaecological laparoscopy reported no hypopharyngeal reflux events when managed by experienced LMA users, even in patients at risk of regurgitation.¹⁰ One reason for the lower incidence of reflux may have been that pH was measured in the hypopharynx; thus reflux events in the upper oesophagus may have been undetected. The differences may also be related to the definition of reflux: Valentine, Stakes and Bellamy considered a discrete pH change of 1 or more units, or an absolute decrease to less than 5, to be indicative of reflux, whereas Bapat and Verghese selected an absolute decrease below 4. However, it has also been suggested that the high incidence of reflux in the study of Valentine, Stakes and Bellamy may have been caused by inadequate depth of anaesthesia, premature antagonism of neuromuscular block and inexperience with the LMA.¹⁴ It has been shown that most episodes of gastro-oesophageal reflux during anaesthesia are related to the conduct of anaesthesia and occur during coughing or bucking.^{15, 16} There is both a short-¹⁷ and long-term¹⁸ learning curve with the LMA. In our study, all anaesthetists were experienced and skilled in the use of the LMA, and there were no episodes of coughing or bucking. It is not known if avoidance of antagonism of neuromuscular block contributed to the low incidence of gastro-oesophageal reflux in our series. Although Valentine, Stakes and Bellamy reported a high incidence of reflux events during antagonism, Bapat and Verghese reported no reflux events at that time.

In summary, our data suggests that the incidence of gastro-oesophageal reflux is low in paralysed patients undergoing ventilation for elective orthopaedic surgery when antagonism of neuromuscular block is avoided. The validity of these findings for unskilled LMA users is unknown.

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