The laryngeal mask airway (LMA) is a new type of airway which does not require neuromuscular block or laryngoscopy for placement, thus attenuating the associated pressor response [1]. Its insertion causes a minimal increase in intratracheal pressure compared with tracheal intubation [2]. Compared with the tracheal tube, it is tolerated well during light anaesthesia [3] and may avoid trauma to the vocal cords caused by tracheal intubation [4]. Hence it has been used for day-case surgery [5, 6]. The LMA has been shown to cover both the laryngeal inlet and the oesophagus, thus forming a potential direct communication between the two [7]. The positive pressure required for mechanical ventilation of the lungs may result in gastric insufflation, increased intra-gastric pressure and may promote regurgitation and aspiration: 25% of patients may regurgitate when the LMA is used for spontaneous ventilation [8] and there are reports of aspiration associated with the use of the LMA [9-11]. It has been used for mechanical ventilation of the lungs [12, 13], although it is well known that it does not protect the laryngeal inlet from regurgitated gastric contents. It is not known if the use of mechanical ventilation increases the incidence of aspiration when the LMA is used.

The aim of this study was to investigate the incidence of aspiration under general anaesthesia when a LMA is used for mechanical ventilation of the lungs and compare it with the use of the LMA for spontaneous ventilation.

SUMMARY
In order to assess if the use of the laryngeal mask airway is associated with an increased risk of gastric regurgitation during mechanical ventilation, we studied 50 patients allocated randomly to undergo anaesthesia with either artificial ventilation with isoflurane and nitrous oxide in oxygen and atracurium (group A) or spontaneous ventilation with isoflurane and nitrous oxide in oxygen (group B). In both groups a laryngeal mask airway was used. Regurgitation was assessed by the patient ingesting a methylene blue capsule 10 min before induction of anaesthesia and examining the oropharynx by direct laryngoscopy at the end of surgery. In one patient in each group, there was staining of the oropharynx with blue dye at the end of surgery. In the patient in group A, dye was present in the trachea and bronchi. (Br. J. Anaesth. 1994; 72: 447-450)

KEY WORDS
LMA was then placed and secured. Manual ventilation of the lungs was not performed in any patient before insertion of the LMA. Anaesthesia was maintained with 1–3 % isoflurane and 60 % nitrous oxide in oxygen. Mechanical ventilation of the lungs was carried out throughout the duration of operation for patients in group A. Ventilation was adjusted to maintain an end-tidal carbon dioxide partial pressure of approximately 5.3 kPa. All patients were anaesthetized by the authors, both experienced in the use of the LMA. Patients in group B were allowed to breathe spontaneously throughout surgery and no attempt was made to control end-tidal carbon dioxide partial pressure. Airway pressure generated during ventilation was recorded and if it was increased more than 25 cm H₂O the patient was excluded from the study. At the end of surgery, the LMA was removed and direct laryngoscopy repeated to ascertain the presence of dye in the pharynx. The presence of methylene blue in the pharynx was taken to indicate regurgitation and its presence in the larynx as aspiration.

Data were analysed by Student’s t test and Fisher’s exact probability test, as appropriate. P < 0.05 was considered significant.

RESULTS

There were no statistically significant differences in age and weight between the two groups. The male to female ratio was similar in the two groups. There was no difference in the dose of propofol and fentanyl in the two groups (table I). The LMA was placed in a single attempt in all patients and there was no coughing on insertion in any patient.

The type of surgical operation is shown in table II. The position of the patients on the operating table during operation is shown in table III. The LMA was placed successfully in all patients with a good seal in 49 patients. One patient required an inflation pressure of 17 cm H₂O for mechanical ventilation of the lungs and a small leak was noticed but it did not interfere with ventilation. This patient did not regurgitate. Maximum airway pressure recorded in the positive pressure ventilation group was 23 cm H₂O.

Methylene blue dye was seen in the pharynx of two patients, one in each group. The patient in the mechanical ventilation group was a 37-yr-old female undergoing diagnostic laparoscopy as a day-case patient. She was placed on the operating table in the lithotomy position with a 15° head-down tilt. Pneumoperitoneum to a maximum pressure of 20 cm H₂O was produced. Towards the end of surgery (20 min after induction of anaesthesia) blue dye appeared in the LMA tube. The operation finished before the patient’s trachea could be intubated. The patient was maintained in the head-down position and the LMA removed when it was found to have most of its inner surface covered with blue dye. Direct laryngoscopy revealed extensive staining of the pharynx, larynx and visible tracheal lumen. A suction catheter was passed down into the trachea and main bronchi and a few millilitres of dye was aspirated. The patient maintained an SpO₂ of 98 % throughout surgery and in the recovery room. She recovered normally from anaesthesia and experienced no difficulty in breathing after operation. Her postoperative chest x-ray was unremarkable and she was allowed home about 8 h later with instruction to contact the hospital staff should she experience any difficulty breathing.

A 57-yr-old male in the spontaneous ventilation group undergoing varicose vein surgery regurgi-
RISK OF ASPIRATION WITH THE LMA

tated. He was supine for the duration of operation which lasted 90 min. His anaesthetic was uneventful with no coughing or hiccups. Laryngoscopy at the end of operation revealed blue staining of the inner surface of the LMA and pharynx, but no dye was seen in the larynx.

**DISCUSSION**

The incidence of silent regurgitation during general anaesthesia varies between 9 and 20% [14, 18, 19] and the reported incidence of aspiration varies from 0.01 to 0.8% [20–23].

In the awake resting human, the upper and lower oesophageal sphincters act as barriers. Induction of general anaesthesia and muscle paralysis decreases upper oesophageal sphincter pressure from approximately 51 to 8 cm H$_2$O [24] and lower oesophageal sphincter pressure from approximately 35 to 29 cm H$_2$O [25]. If the airway pressure required to manually ventilate the lungs exceeds 30 cm H$_2$O it could possibly open both the lower and upper oesophageal sphincters and cause gastric insufflation. Therefore, an airway pressure of 25 cm H$_2$O was chosen as a cut-off point and patients requiring larger airway pressures for manual ventilation of the lungs were excluded from the study. However, we did not need to exclude any patients in our study as the maximum airway pressure recorded was 23 cm H$_2$O. Atracurium 0.6 mg kg$^{-1}$ does not affect lower oesophageal pressure [26] and therefore this drug was chosen to maximize thoracic wall compliance during mechanical ventilation of the lungs in group A.

In patients undergoing elective surgery, a head-down position does not affect regurgitation [19]. Illing, Duncan and Yip reported that gastro-oesophageal reflux may occur in up to 12.5% of awake and 15.9% of anaesthetized patients. They found no correlation between gastro-oesophageal reflux and obesity, Trendelenburg position, increase in intra-abdominal pressure or reflux gastro-oesophagitis. They postulated that the risk of regurgitation is perhaps more of a function of how anaesthesia is conducted than of the characteristics of individual patients [18].

The LMA has been used for intraocular [27, 28], ENT [29, 30] and laparoscopic surgery [5], although doubts about the use of the LMA for laparoscopy have been expressed [31]. Regurgitation and aspiration have been associated with the use of the LMA for both spontaneous ventilation and mechanical ventilation of the lungs [8–11, 32, 33]. The reported incidence of regurgitation associated with the use of the LMA varies from 0.08 to 23% [8, 33].

In our study the frequency of regurgitation was 4%, which is smaller than that reported by Barker and colleagues (23%) [8], although we used the same method of detecting regurgitation, a similar anaesthetic technique and studied similar types of patients. However, we used isoflurane instead of halothane, but we are not convinced that this accounts for such a different result.

One of our patients aspirated and she had widespread methylene blue dye in her lungs, possibly because of the positive pressure required for mechanical ventilation of the lungs. Warner, Warner and Weber reviewed the records of 215488 general anaesthetics and reported that patients with clinically apparent aspiration who did not develop symptoms within 2 h of aspiration were unlikely to have respiratory complications. However, if mechanical ventilation of the lungs is required for more than 24 h it is associated with 50% mortality [21]. Hence patients who do aspirate should be observed for at least 2 h after operation.

Although we found no significant difference in this study in the incidence of regurgitation between spontaneously breathing patients and those undergoing artificial ventilation, the overall incidence of regurgitation into the pharynx was 4%, which may be regarded as undesirable in modern anaesthetic practice. Furthermore, in the patients undergoing ventilation, the dye was dispersed into the trachea and bronchus, suggesting that artificial ventilation with an LMA may encourage the risk of pulmonary aspiration.

**REFERENCES**


