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Influence of head and neck position on cuff position and oropharyngeal sealing pressure with the laryngeal mask airway in children

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We studied how head and neck position affect the cuff position and oropharyngeal sealing pressures of the laryngeal mask airways (LMAs) in children. We studied 39 non-paralyzed healthy children aged 1.5–8.0 yr, weighing 10.3–27.0 kg, managed with size 2 or 2.5 LMAs during elective surgery. Head and neck movements did not adversely affect airway patency in 97% of patients. One child developed apparent airway obstruction with head and neck flexion, which was relieved in the neutral position. Oropharyngeal sealing pressure was significantly greater during neck flexion compared with the neutral position ($P<0.02$). Fibreoptic examination revealed that the epiglottis covered a larger area of the LMA aperture during neck flexion, compared with the neutral position ($P<0.02$).

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The laryngeal mask airway (LMA[†]) is used for paediatric surgery with different head and neck positions, such as extension of the neck for adenotonsillectomy,[1] and rotation of the head for myryngotomy.[2] Studies of children with their head and neck in neutral position, assessing the position of the LMA fibreoptic[3–5] or radiological[6] examination, found that well functioning LMAs were not necessarily ideally anatomically, placed. Fibreoptic examination of the LMA position showed that the epiglottis occupied a larger area within the LMA aperture in children than in adults.[4 5] These observations suggest that head and neck movement could distort the oropharyngeal space, and affect anatomical position and function of the LMA more in children than in adults.

[†] LMA is the property of Intavent Limited.

A study of adult patients[7] showed little influence of head and neck position on cuff position and oropharyngeal leak pressure of the LMA, but no studies have been done in children.

We measured how head and neck movement changed the cuff position and oropharyngeal sealing pressure of the LMA in children patients.

Methods and results

After obtaining Ethics Committee approval and informed consent from the parents, we studied ASA physical status I paediatric patients who were managed with size 2 or 2.5 LMAs during elective urological surgery.

Anaesthesia was induced via a facemask with 5% sevoflurane and nitrous oxide in 65% oxygen. After obtaining sufficient depth of anaesthesia, LMAs were inserted by well-trained anaesthesiologists using the technique recommended by the manufacturer without the use of neuromuscular blocking agents. The size of LMA was chosen according to the manufacturer's guideline (size 2 for 10–20 kg, and size 2.5 for 20–30 kg). The intra-cuff pressure was adjusted to 60 cmH_2O using an ergonomic pressure gauge (Hi-Lo™ Hand Pressure Gauge, Mallinckrodt Medical, Germany). General anaesthesia was maintained with oxygen, 65% nitrous oxide, and sevoflurane. Patients breathed spontaneously through the LMA for the duration of surgery. In all patients regional anaesthesia (caudal block or epidural block) was performed.

At the end of surgery, the intra-cuff pressure of the LMA was adjusted to 60 cmH_2O again with the head and neck in the neutral position. Anaesthesia was maintained with sevoflurane 2%, nitrous oxide 65%, and oxygen. The head and neck position was then changed successively to the following positions; neutral, maximal flexion, maximal extension (about 45°, each) and about 90° rotation to the left and right. In each position, after 30–60 s of a stable period, oropharyngeal sealing pressures and fibreoptic images were recorded. To assess sealing pressure, the expiratory valve of the circle breathing system was closed and fresh gas flow adjusted to 3 litre min^{-1}. Pressure in the breathing circuit increased until airway pressure reached equilibrium. The airway pressure was measured with an aneroid manometer attached to the breathing circuit and recorded as oropharyngeal sealing pressure.[8] During these measurements the position of the head and neck was hidden from the observer. After this the expiratory valve was re-opened and a fibreoptic scope was passed to a position just proximal to the mask aperture bars and the view was recorded on videotape. A second anaesthetist, not aware of the position of the head and neck, scored the views on videotape as follows; 1: the view through aperture bars completely covered with anterior epiglottis, but LMA function adequate; 2: anterior epiglottis covering more than 2/3 of the view in diameter; 3: anterior epiglottis covering more than 1/3, but less than 2/3 of the view in diameter; and 4: anterior epiglottis covering less than 1/3 of the view in diameter.

A factorial analysis of variance was used to assess the differences in the oropharyngeal leak pressure among groups. Post-hoc testing of multiple comparisons was performed with Scheffé's procedure. The fibreoptic scores were analysed using the Kruskal–Wallis rank test for comparison among groups and the Mann–Whitney *U* test for the comparison between neutral position and other groups. $P<0.05$ was accepted as statistically significant.

Thirty-nine patients, ages from 1.5 to 8.0 yr (mean 4.0 yr) and weighing between 10.3 and 27.0 kg (mean 15.7 kg) were enrolled in this study. Thirty-one size 2 LMAs, and eight size 2.5 LMAs were used.

The movement of the head and neck did not adversely affect the airway patency in 38 of the 39 patients and these patients could breathe spontaneously in all head and neck positions. One 3-yr-old child weighing 14 kg, managed with a size 2 LMA developed airway obstruction during neck flexion, which was relieved in the neutral position. The results are summarized in Table 1.

Table 1 Oropharyngeal sealing pressure and fibreoptic score in the five head and neck positions. *$P<0.05$ *vs* neutral position

Head and neck positions	Sealing pressure (cm H_2O) (mean (SD))	Fibreoptic score (4/3/2/1)
Neutral	20.3 (7.4)	10/20/7/2
Flexion	26.8 (10.3)*	4/17/11/6*
Extension	19.1 (7.2)	12/20/5/2
Ation (right)	22.7 (7.0)	21/11/5/2
Rotation (left)	22.6 (7.5)	20/14/4/1

Comment

In agreement with previous reports,[3–6] we also found that the epiglottis occupied a considerable area of the aperture of the LMA, and that airway patency was well maintained in most patients with any head and neck position, during breathing.

The fibreoptic score proposed by Brimacombe[9] has been used for the assessment of LMA positioning in many studies, mainly with adult patients. However, this score did not seem suitable for the assessment of LMA positioning in paediatric patients. As the epiglottis occupied a considerable area in the LMA aperture in the majority of children, such fibreoptic findings would be classified into the same score if this method were used. We used an alternative scoring system to express the extent that the epiglottis occupied the LMA aperture.

In the current study, the fibreoptic score was less during neck flexion than in the neutral position, with the epiglottis filling more of the aperture view. Neck flexion could increase the posterior deflection of the epiglottis. Sealing pressure with neck flexion was greater than in the neutral position in agreement with previous studies of adults.[7] Neck flexion could reduce the longitudinal tension in the anterior pharyngeal muscles, allowing them to settle down onto the mask to form a better seal.

One child developed an apparent airway obstruction with neck flexion, which could be relieved in the neutral position. Together with the fact that the epiglottis fills the aperture of the LMA more in this position, head flexion may possibly jeopardize LMA function, but further study of this is needed.

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Waste gas exposure to sevoflurane and nitrous oxide during anaesthesia using the oesophageal–tracheal Combitube small adult™

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Exposure to sevoflurane (SEV) and nitrous oxide during ventilation using a Combitube (37Fr) small adult (SA) was compared with waste gas exposure using conventional endotracheal tubes. Trace concentrations of SEV and nitrous oxide were assessed using a direct reading spectrometer during 40 gynaecological laparoscopic procedures under general anaesthesia. Measurements were made at the patients' mouth and in the anaesthetists' breathing zone. Mean (SD) concentrations of SEV and nitrous oxide measured at the patients' mouth were comparable in the Combitube SA (SEV 0.6 (0.2) p.p.m.; nitrous oxide 9.7 (8.5) p.p.m.) and endotracheal tube group (SEV 1.2 (0.8) p.p.m.; nitrous oxide 17.2 (10.6) p.p.m.). These values caused comparable contamination of the anaesthetists' breathing zone (SEV 0.6 (0.2) p.p.m. and nitrous oxide 4.3 (3.7) p.p.m. for the Combitube SA group, compared with SEV 0.5 (0.2) p.p.m. and nitrous oxide 4.1 (1.8) p.p.m. for the endotracheal tube group). We conclude that the use of the Combitube SA during positive pressure ventilation is not necessarily associated with increased waste gas exposure, especially when air conditioning and scavenging devices are available.

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Because the health consequences of environmental exposure to anaesthetic vapour[1] are controversial, US and European health authorities recommend limits ranging between 2 and 75 p.p.m. for volatile anaesthetic exposure and between 25 and 100 p.p.m. for nitrous oxide to minimize health hazards.[2] The European community has yet to establish exposure limits for sevoflurane (SEV), but the likely level is expected to be similar to that of isoflurane or enflurane ranging between 10 and 20 p.p.m.

During general anaesthesia, more contamination occurs when unsealed airway devices and/or high concentrations of inhalational anaesthetics are used.[2–5] In particular the laryngeal mask airway (LMA) or the oesophageal–tracheal Combitube™ (ETC) could increase contamination when