Minimum alveolar concentration of desflurane for tracheal extubation in deeply anaesthetized, unpremedicated children

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Summary
We have studied 25 children, aged 4–9 yr, to determine the minimum alveolar concentration (MAC) of desflurane at which safe tracheal extubation can be performed in deeply anaesthetized children. The end-tidal concentration of desflurane was noted at tracheal extubation. Successful extubation was defined as one in which there was no coughing or bucking on the tracheal tube during suctioning of the pharynx, no movement or coughing within 1 min of tracheal extubation and no breath-holding or laryngospasm after extubation. Successful extubation was followed by extubation at a concentration of 0.5% less, and so on in subsequent subjects, until unsuccessful extubation occurred. After a reaction, the percentage was increased in the next patient, continuing up and down in pairs, until the required number of subjects was achieved. In 50% of children aged 4–9 yr, tracheal extubation may be accomplished without coughing or moving at an end-tidal concentration of 7.7%. The end-tidal concentration of desflurane to achieve satisfactory extubation in 95% of children was 8.5%. (Br. J. Anaesth. 1997; 78: 370–371).

Key words

Exubation of the trachea can be performed while the patient is deeply anaesthetized, or awake in a patient who has intact airway reflexes. The advantages of so called “deep extubation” are a reduction in coughing and other airway complications in situations where this is undesirable, for example during neurosurgery. Extubation during deep anaesthesia may also result in improved haemoglobin oxygen saturation compared with “awake extubation”.1

The disadvantages of “deep extubation” are continuation of suppression of the laryngeal reflexes induced by general anaesthesia. This prevents coughing and may result in contamination of the airway. Partial or total airway obstruction may not be recognized.

These disadvantages should become less significant with an agent such as desflurane. Its low blood-gas solubility coefficient results in extremely rapid emergence and it would therefore be an ideal agent for “deep extubation”.2

Patients and methods
After obtaining Ethics Committee approval and informed consent from the parents or guardians, we studied 25 children, aged 4–9 yr (mean 6.0 yr). The children were ASA I or II, undergoing ear, nose and throat surgery: 10 patients were undergoing adentosillectomy, eight tonsillectomy and seven adenoidectomy with insertion of grommets.

The children were unpremedicated. Anaesthesia was induced using an inhalation technique with halothane and nitrous oxide in oxygen. An Ayre’s T piece was used at fresh gas flows of 2.5 times the patient’s minute volume. The trachea was intubated during deep halothane anaesthesia. When the airway was secure, halothane and nitrous oxide were discontinued and anaesthesia was maintained with desflurane in oxygen. The children were allowed to breathe spontaneously. Ventilation was assisted where necessary to maintain normocapnia.

End-tidal desflurane and carbon dioxide concentrations were measured using the Datex Capnomac Ultima monitor, sampling from the tracheal tube connector. The pharynx was suctioned before extubation and the patient’s trachea extubated in the left lateral position while noting the end-tidal concentration of desflurane. There was no residual halothane or nitrous oxide at the time of extubation. A steady state concentration had been maintained for at least 10 min.

Unsatisfactory extubation was defined as one which resulted in coughing or bucking during suctioning of the pharynx, moving or coughing within 1 min of tracheal extubation, or produced laryngospasm or breath-holding. The investigator observing the response to extubation was independent from the anaesthetist responsible for controlling the end-tidal desflurane concentration. We chose a starting concentration of 12% because research on other volatile agents has shown that the optimal level for “deep extubation” is twice the MAC.3

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After successful extubation, the trachea of the next patient was extubated at 0.5% less than the previous patient. This continued in a stepwise fashion until unsuccessful extubation. The following patient’s trachea was extubated at 0.5% more than the reactor, continuing up and down in a stepwise manner until the required number of patients was achieved.

When tracheal extubation was achieved, the children were given i.v. analgesia.

The number of patients and the methodology were modelled on a previous similar study to establish the safe dose of isoflurane for “deep extubation”.3

STATISTICAL ANALYSIS

Probit analysis was used to estimate the end-tidal concentration of desflurane at which extubation was achieved satisfactorily in 50% (MACEX50) and 95% (MACEX95) of patients. These were 7.7% (95% confidence limits 6.77–8.22%) and 8.5% (8.03–14.5%), respectively.

Results

Figure 1 shows the response of each individual to tracheal extubation at varying end-tidal concentrations of desflurane.

Using the Mann–Whitney U test and the Wilcoxon rank sum W test, the ages, weights and steady state times did not influence the outcome of extubation.

Two patients developed laryngospasm at tracheal extubation; in both the trachea was extubated at end-tidal concentrations of 7.0% desflurane. One patient had undergone adenotonsillectomy and the other tonsillectomy alone. Laryngospasm resolved with application of positive pressure until the spasm settled. Oxygen saturation of both patients remained greater than 94%.

Discussion

The MACEX50 in a deeply anaesthetized patient was established for isoflurane by Neelakanta and Miller.3 This was defined as the alveolar concentration of inhalation anaesthetic at which 50% of patients undergoing tracheal extubation cough or move within 1 min of extubation or develop breath-holding or laryngospasm immediately after tracheal extubation.

“Deep extubation” is a useful technique in circumstances where coughing on the tracheal tube is undesirable. It has been suggested that “deep extubation” reduces episodes of desaturation in the emergence phase of anaesthesia.1 4 Opponents of “deep extubation” argue that while the reflexes in the airway are obtunded, aspiration of foreign material can occur. Patients are also at risk of partial or total airway obstruction. Recovery staff need to be adequately trained and understand the possible complications involved in caring for the deeply unconscious patient.

Previous data suggested that despite its irritant nature, there is no increased incidence of coughing or airway irritation during emergence from desflurane anaesthesia.2 The low blood-gas solubility coefficient of desflurane (0.42) and its low tissue–blood partition coefficient allow a more rapid decrease in the rate of elimination (F/A/FAM) compared with isoflurane and halothane. This makes it an ideal agent for “deep extubation” as it is eliminated rapidly, allowing prompt return of upper airway reflexes. Several studies have shown its rapid recovery characteristics in children and adults.5 6

In conclusion, the safe MAC value of desflurane for successful deep extubation in 50% of anaesthetized school-aged children was 7.7%. This is approximately the same value quoted for the MAC of this agent in children of 5–12 yr (established as mean 7.98 (SD 0.43)%). We have demonstrated that the safe concentration in oxygen was approximately 8.5% and therefore we would expect that safe “deep extubation” should be possible at a concentration of at least 8.0% in the presence of nitrous oxide and analgesics.

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References


Figure 1  Data for each patient’s response to tracheal extubation. Each individual is represented by a line.