Recovery after desflurane anaesthesia in the infant: comparison with isoflurane

A. R. WOLF, R. A. LAWSON, C. M. DRYDEN AND F. W. DAVIES

Summary
We have studied 20 infants, aged 2.5–8 weeks, undergoing general anaesthesia for pyloromyotomy with either desflurane or isoflurane. Patients were anaesthetized with equivalent 1 MAC values for age and agent. A blinded observer recorded times to breathing, swallowing, movement, extubation and side effects after discontinuation of the agent. Recovery times in the desflurane group were significantly shorter than in the isoflurane group. The times to swallowing, movement and extubation in the desflurane group were 3.89 (sd 2.4) min, 5.33 (4.95) min, 7.5 (4.53) min, respectively, and 8.82 (2.40) min, 10.73 (3.93) min, 13.45 (4.20) in the isoflurane group. In addition, postoperative apnoea was documented in the isoflurane group but not in those infants receiving desflurane. There was no laryngospasm after extubation in either group. We conclude that desflurane possesses useful characteristics for recovery conditions in the infant and may be particularly useful in the immature infant prone to apnoea and ventilatory depression. (Br. J. Anaesth. 1996; 76: 362–364)

Key words

Neonates are susceptible to ventilatory depression after general anaesthesia [1] and this results partly from the residual effects of the volatile agent [2]. Isoflurane is often used in preference to halothane in the neonate because of its more rapid recovery characteristics. However, desflurane, a relatively new short-acting volatile agent, may confer further characteristics. However, desflurane, a relatively new short-acting volatile agent, may confer further advantages with respect to quality of recovery. Desflurane has a blood:gas solubility of 0.42 [3] which should be associated with a more rapid recovery than isoflurane which has a blood:gas solubility of 1.4 [4]. Its use in paediatric anaesthesia has been limited by concerns about laryngospasm and breath-holding during inhalation induction. However, these effects are less relevant in neonates because the trachea is usually intubated on induction and the lungs ventilated during surgery. Taylor and Lerman demonstrated that these complications do not occur at extubation [5].

We therefore hypothesized that desflurane anaesthesia in infants would be associated with faster recovery than isoflurane even after a relatively short period of general anaesthesia and that there would be fewer postoperative ventilatory complications.

Patients and methods
After obtaining Ethics Committee approval and informed parental consent, we studied 20 patients undergoing pyloromyotomy. Patients were allocated randomly, using random number tables, to receive either isoflurane (even numbers) or desflurane (odd numbers) anaesthesia. No premedication was given and anaesthesia was induced with thiopentone 1.5 mg kg\(^{-1}\) and suxamethonium 1.5 mg kg\(^{-1}\) using a modified rapid sequence induction. Immediately after tracheal intubation, atracurium 0.5 mg kg\(^{-1}\) was administered and the lungs ventilated to normocapnia with 1 MAC of desflurane (9.16 % neonates, 9.42 % infants) [6] or isoflurane (1.6 % neonates, 1.87 % infants) [7] in 100 % oxygen. Heart rate, arterial pressure and rectal temperature were recorded at 5-min intervals throughout the procedure. A normal value of 80 mm Hg for systolic arterial pressure in the awake neonate was used as baseline given the variability [8] and difficulty in recording accurate non-invasive readings in the unpremedicated awake infant. End-tidal concentrations of carbon dioxide and volatile agent were monitored (Datex Capnomac Ultima). End-tidal volatile agent was maintained at 1 MAC until surgery was finished, local anaesthetic had been infiltrated and residual neuromuscular block antagonized with neostigmine 40 μg kg\(^{-1}\) and atropine 20 μg kg\(^{-1}\). The infant was then left undisturbed and normocapnia maintained with 100 % oxygen. The onset of swallowing, breathing, movement and extubation were recorded by an observer blinded to the agent used. Perioperative and immediate postoperative ventilatory complications were documented. Breath-holding was defined as coughing and straining on the tracheal tube, and significant apnoea was regarded as a period of 15 s or more occurring after extubation.
Because of the relatively small sample size, numerical data of times recorded to breathing, swallowing, movement and extubation were analysed using the Mann–Whitney U test. Nominal data were analysed using the chi-square test with Yates’ correction. \( P < 0.05 \) was considered significant.

**Results**

Both groups were comparable in age, weight and duration of surgery (table 1).

Figure 1 shows the times taken from discontinuation of the agent to breathing, swallowing, movement and extubation. The times taken to commence swallowing, movement and extubation were significantly shorter in the desflurane group (\( P < 0.01 \) for swallowing, \( P < 0.05 \) for movement and extubation).

Changes in heart rate and systolic arterial pressure are shown in figure 2. There was no statistical difference in heart rate or systolic arterial pressure between the two groups. Complications were recorded as a decrease in systolic pressure and breath-holding or apnoeic episodes. A decrease in systolic arterial pressure of more than 30 % from a normal neonatal awake value was regarded as clinically significant. Table 2 shows the number of patients in each group in which these complications occurred.

**Discussion**

We have observed that desflurane anaesthesia in the infant resulted in approximately twice the speed of recovery, in terms of breathing, swallowing, movement and extubation, compared with an equivalent MAC value of isoflurane. We have confirmed the finding [6] that 1 MAC of desflurane resulted in a decrease in systolic arterial pressure and that in 44 % of patients this was clinically significant (table 2). We have also shown that a similar decrease in systolic arterial pressure occurred with isoflurane. The difference in systolic arterial pressure during surgery between the two groups was not significant in our study. However, given the small numbers in the groups and the large variability around the mean value, the power of the test was only 0.4. In order to reject the null hypothesis (that there was no difference in systolic arterial pressure between the two groups) a total of 250 patients would be required, assuming that the size of the difference between the two treatment groups remained the same [9].

The increased number of apnoeas noted in the isoflurane group may reflect slower recovery. The prolonged apnoeic episodes (> 15 s) noted were distinct from breath-holding which we had predefined. Taylor

---

**Table 1** Patient characteristics (mean (SD or range))

<table>
<thead>
<tr>
<th></th>
<th>Desflurane group (n = 9)</th>
<th>Isoflurane group (n = 11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (weeks)</td>
<td>3.87 (2–7)</td>
<td>4.91 (2–6)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>3.64 (0.47)</td>
<td>3.53 (0.75)</td>
</tr>
<tr>
<td>Duration of surgery (min)</td>
<td>34.56 (6.50)</td>
<td>33.64 (5.18)</td>
</tr>
</tbody>
</table>

**Figure 1** Recovery times (mean (SD) minutes) after discontinuation of the volatile agents isoflurane (●) (n = 11) and desflurane (●) (n = 9). *\( P < 0.05 \), **\( P < 0.01 \).

**Figure 2** Mean (SD) measurements of heart rate (HR) and systolic arterial pressure (SAP) in the isoflurane (●) (n = 11) and desflurane (●) (n = 9) groups.

**Table 2** Number of patients in each group with a decrease in systolic arterial pressure (SAP) (percentage decrease from normal value of 80 mm Hg) and number with ventilatory complications

<table>
<thead>
<tr>
<th></th>
<th>Isoflurane (n = 11)</th>
<th>Desflurane (n = 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decrease in SAP ≥ 10 %</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Decrease in SAP ≥ 30 %</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Breath-holding</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Apnoea</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>
and Lerman have suggested that because of the speed of recovery after desflurane anaesthesia, airway complications at extubation are unlikely [5], and we are not aware of any cases documented in the paediatric literature.

The anaesthetic technique chosen did not attempt to reflect routine clinical practice for general anaesthesia for pyloromyotomy. It was used as a means of comparing the effects of isoflurane and desflurane at equivalent MAC values for a standard period of time in neonates undergoing a short surgical procedure. The technique was a model to allow us to determine the differences in recovery characteristics of these two agents. The slightly lesser dose of thiopentone than that recommended by Hatch and Sumner [10] was chosen to minimize the ventilatory depressant effects of any residual i.v. agent at the end of the procedure. In order to ensure standardization of the anaesthetic, an end-tidal concentration of 1 MAC of agent was maintained until completion of the operation. Thus there was no tailoring of MAC levels as might occur in practice and no external stimulation allowed in order to facilitate awakening. Although not studied formally, it was our clinical impression that patients in the isoflurane group were sleepier and slower to recover than those in the desflurane group. Longer term data on respiration and sedation in the postoperative period would be advantageous.

In many respects, desflurane appears to be an impractical agent. It is expensive, requires a special vaporizer, and in paediatric practice has been associated with significant ventilatory complications on inhalation [5, 6]. However, it has the desirable characteristics of rapid emergence from anaesthesia because of its low blood:gas and tissue:gas solubilities. While these properties may be of little benefit in routine paediatric anaesthesia for healthy children undergoing short procedures, they may become increasingly relevant in the ex-premature infant. These patients are at increased risk from postoperative ventilatory complications such as apnoeic spells, with an incidence correlating inversely with gestational age and weight [11, 12]. Inhalation and i.v. anaesthetic agents exacerbate this problem by depressing immature ventilatory control mechanisms. Central nervous system depressant effects may be reduced further if desflurane is used at a lower concentration than 1 MAC. This could be achieved if inhalation anaesthesia was used to produce “insensibility” in combination with a regional technique or a local anaesthetic block.

If it is agreed that there are advantages in using desflurane in this particular group of patients, cost becomes an important consideration. Taking the example of a 3-kg infant using a fresh gas flow of 1300 ml min\(^{-1}\) [13], 1 h of desflurane used at 1 MAC for an infant is estimated to cost £5.47 per hour compared with £1.91 for 1 MAC of isoflurane. This moderate increase in anaesthesia cost becomes irrelevant if the use of desflurane enables postoperative extubation and thus avoids intensive care admission.

References

1. Steward DJ. Preterm infants are more prone to complications following minor surgery than are term infants. Anesthesiology 1982; 56: 304–306.