ENFLURANE IN OUTPATIENT PAEDIATRIC DENTAL ANAESTHESIA

A comparison with halothane

R. H. A. HOYAL, C. PRYS-ROBERTS AND P. J. SIMPSON

SUMMARY

Enflurane and halothane were compared as volatile supplements to nitrous oxide anaesthesia for 80 children presenting for outpatient dental extractions. Induction and maintenance of anaesthesia were comparable and satisfactory with both agents, but recovery of consciousness was significantly quicker following enflurane anaesthesia. Full recovery from either enflurane or halothane was of similar duration.

For many years halothane has been the volatile agent which has been used most frequently for outpatient dental anaesthesia. Certain physical properties of enflurane, notably its low solubility in blood and tissues and its low level of biotransformation (Chase et al., 1971; Cohen, 1971), have made the agent a potentially attractive alternative to halothane as a supplement to nitrous oxide in outpatient anaesthesia (Steward, 1977; Davidson, 1978). Since no previous comparison of enflurane and halothane in outpatient dental anaesthesia had been described, we compared these agents as volatile supplements to nitrous oxide and oxygen in children presenting for dental extractions at the Bristol Dental Hospital.

METHODS

Eighty children aged between 5 and 12 yr, requiring extraction of two to six teeth (in order to standardize both the quality and duration of anaesthesia) were allocated randomly to one of two equal groups, one receiving enflurane and the other halothane. Children giving a history of epilepsy or renal disease were excluded. None of the children received premedication. Induction was undertaken in the supine position with a nasal mask, using a continuous flow Bain circuit and active scavenging to avoid pollution in the theatre. Nitrous oxide 8 litre min⁻¹ and oxygen 3 litre min⁻¹ were administered for 45 s and the concentrations were then adjusted to 6 litre min⁻¹ and 2 litre min⁻¹ respectively and equipotent concentrations, based on the published MAC values of enflurane (Gion and Saidman, 1971) or halothane, were added, the concentration of either agent being increased at intervals of four breaths. The consultant administering the anaesthesia was not aware as to whether he was administering halothane or enflurane, the control of the relevant vaporizer being adjusted by one of the authors (R. H. A. H.). The concentration of enflurane was increased in steps of 1 vol % to a maximum of 5 vol % and that of halothane in 0.5-vol % steps to a maximum of 2.5 vol %. These maximum concentrations were maintained until induction was considered complete as judged by adequate jaw relaxation. At this point surgery began and the maintenance concentrations of enflurane or halothane were decreased to 2.0 and 1.0 vol % respectively. Administration of the volatile agent and nitrous oxide was discontinued following removal of the oral prop at the end of surgery and oxygen 100 vol % was administered for about 30 s. Enflurane was vaporized using an Enfluratec (Cyprane Ltd, Keighley) and halothane using a Fluotec Mark III (Cyprane Ltd) mounted in a “Selecatace” quick-release mount. Both vaporizers were calibrated by interferometry (Riken Type 17).

Induction time was defined as the time from the introduction of the volatile agent to the time when eyeball movement had ceased and the patient’s jaw was relaxed sufficiently to permit the insertion of a V-pack (Vickery and Burton, 1977). The time to the loss of eyelash reflex was noted also, as was the frequency of complications such as hiccup, breath-holding and stridor during the induction period. The recovery times were recorded by a small group of experienced recovery nurses, who were not told which agent had been used, and were measured from...
the time at which surgery was completed and oxygen 100 vol % introduced to the following stages of recovery: the return of the eyelash reflex, the return of swallowing, the ability to respond to commands, the ability to stand with the eyes closed without swaying and the ability to walk a straight line. These last two criteria were considered to represent full recovery. All measurements were made to the nearest 6 s.

Statistical evaluation of the results was based on unpaired Student’s t tests. A questionnaire asking about the child’s activities after returning home was given to each accompanying parent or guardian. This enquired about the frequency of headache, dizziness, nausea, vomiting, muscle pains and bad dreams. The delays in returning to a normal appetite and to normal activity were noted. Statistical evaluation of these data was based on the $\chi^2$ test.

**RESULTS**

Both agents were accepted readily by the children and in the majority induction was smooth and free from complications. The mean time to loss of eyelash reflex was 2.1 min (SD 0.9) for enflurane and 2.0 min (SD 1.3) for halothane. Mean induction times were 4.2 min (SD 1.4) for enflurane and 4.1 min (SD 1.7) for halothane. These differences were not statistically significant. In the group receiving enflurane, induction was complicated by hiccup in five patients, breath-holding in two patients and stridor in one patient, whereas in the group receiving halothane, induction was complicated by breath-holding in only two patients.

Maintenance of anaesthesia after insertion of the V-pack was uncomplicated in all children and there was no significant difference between the mean

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**Fig. 1.** Cumulative frequencies of early recovery times following enflurane (○-○) and halothane (O- -O) in two groups of 40 children.

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**TABLE I. Immediate post-anaesthetic complications. Differences between enflurane and halothane groups were not statistically significant by $\chi^2$ test**

<table>
<thead>
<tr>
<th></th>
<th>Enflurane</th>
<th>Halothane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crying</td>
<td>21</td>
<td>18</td>
</tr>
<tr>
<td>Vomiting</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Slight hypertonia</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

**TABLE II. Late post-anaesthetic complications. Results of first 32 returned questionnaires in each group. Differences between enflurane and halothane groups were not statistically significant by $\chi^2$ test**

<table>
<thead>
<tr>
<th></th>
<th>Enflurane</th>
<th>Halothane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Dizziness</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Nausea</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Vomiting</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Muscle pains</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Bad dreams</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Same day</th>
<th>Next day</th>
<th>Later</th>
<th>Same day</th>
<th>Next day</th>
<th>Later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return of normal</td>
<td>20</td>
<td>11</td>
<td>1</td>
<td>26</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>appetite</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return of normal</td>
<td>20</td>
<td>11</td>
<td>1</td>
<td>20</td>
<td>9</td>
<td>3</td>
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<tr>
<td>activity</td>
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</tbody>
</table>
duration of surgery in the enflurane (4.4 min, SD 2.6) or halothane (3.5 min, SD 3.0) groups nor between the total anaesthetic times for the enflurane (8.6 min, SD 2.9) or halothane (7.5 min, SD 3.4) groups. During the early recovery period, the group which received enflurane had a shorter mean recovery time (fig. 1) than the halothane group, as measured by the return of the eyelash reflex and the return of swallowing. In each case the differences were statistically significant ($P<0.01$). The ability to respond to command occurred earlier with enflurane and this difference was statistically significant ($P<0.05$).

The late recovery times, as measured by the ability to stand without swaying with the eyes closed, were shorter following enflurane anaesthesia (19 min, SD 7) compared with the halothane group (22 min, SD 7), but this difference was not statistically significant. The ability to walk in a straight line was not significantly shorter in the enflurane group (24 min, SD 8) compared with the halothane group (27 min, SD 8). The immediate post-anaesthetic complications are listed in table I. Examination of the first 32 completed questionnaires returned from each group (table II) showed only minor differences between the groups with regard to late post-anaesthetic complications and the return to a normal appetite and activity.

DISCUSSION
Under the conditions of this study there was little to choose between enflurane and halothane, since both agents provided equally satisfactory induction of anaesthesia and the quality of surgical anaesthesia was similar with the two agents. Enflurane was accepted readily by the children, and apart from occasional bouts of hiccups, which did not seriously interrupt the induction sequence, the induction of anaesthesia was smooth and uncomplicated. Despite the lower solubility of enflurane in blood, the times to loss of consciousness and to full surgical anaesthesia were similar to those for halothane. The early recovery from enflurane anaesthesia was significantly faster than that in the group who received halothane, but this advantage was not supported by a comparable difference in the late recovery times. Thus both groups of children were ready to leave the recovery area after about 25 min.

It is difficult to make direct comparisons between our results and those of Steward (1977) or Davidson (1978). Steward induced anaesthesia with i.v. thiopentone, and there was no attempt to use specific equipotent anaesthetic concentrations of the anaesthetic agents in Davidson's study. Some of the patients in the study by Govaerts and Sanders (1975) and that of Davidson received medication. In contrast to these studies, we could not demonstrate a significantly shorter full recovery time and this may simply reflect the need for longer periods of anaesthetic administration to differentiate between the differences in the physical characteristics of the two agents.

We conclude, therefore, that enflurane can be considered as an acceptable but expensive alternative to halothane in outpatient paediatric dental practice.

ACKNOWLEDGEMENTS
We wish to thank the anaesthetic nursing staff of the Bristol Dental Hospital for their co-operation in the conduct of this study and also the surgical dental staff whose patients we studied.

REFERENCES

L'ENFLURANE POUR L'ANESTHESIE PEDIATRIQUE DENTAIRE SUR DES PATIENTS DE CONSULTATION EXTERNE

Comparaison avec l'halothane

RESUME
On a comparé l'enflurane et l'halothane en tant que suppléments volatils pour l'anesthésie au protoxyde d'azote sur 80 enfants se présentant en tant que patients de consultation externe pour des extractions dentaires. L'induction et le maintien de l'anesthésie ont été comparables et satisfaisants avec ces deux agents, mais la reprise de conscience a été sensiblement plus rapide après l'anesthésie à l'enflurane. La récupération complète, qu'il s'agisse de l'enflurane ou de l'halothane, a été d'une durée similaire.
ENFLURAN FÜR ZAHNNAKROSE BEI
AMBULANT BEHANDELTEK KINDERN

Ein Vergleich mit Halothan

ZUSAMMENFASSUNG

ENFLURANO EN LA ANESTESIA DENTAL
PEDIATRICA DE PACIENTES EXTERNOS

Una comparación con halotano

SUMARIO
Se llevó a cabo la comparación del enflurano con el halotano como suplementos volátiles al óxido nitroso para la anestesia de 80 niños que se sometían a extracciones dentales como pacientes externos. La inducción y la mantención de la anestesia fueron comparables y satisfactorias con ambos agentes, pero la recuperación del sentido fue mucho más rápido con la anestesia por enflurano. La recuperación total con el enflurano o el halotano tuvo una duración similar.