CARDIAC ARRHYTHMIAS DURING OUTPATIENT DENTAL ANAESTHESIA: COMPARISON OF HALOTHANE WITH ENFLURANE

D. G. WILLATTS, A. R. HARRISON, J. F. GROOM AND A. CROWTHER

SUMMARY

In 75 young female patients undergoing extraction of 3rd molar teeth during halothane or enflurane anaesthesia, the electrocardiogram was recorded on magnetic tape and analysed subsequently for arrhythmias, using a high-speed analyser. Enflurane induced a much lower frequency of arrhythmia during surgery than halothane, but there was otherwise little difference between the two drugs in the quality of anaesthesia or recovery. Many arrhythmias occurred before exposure of the patient to enflurane or halothane; the significance of this is discussed.

Cardiac arrhythmia, during general anaesthesia for dental surgery, has been reported frequently (Kaufman, 1965, 1966; Miller et al., 1970; Ryder, 1970) and is particularly common when halothane is included as part of the anaesthetic technique (Rollason and Dundas, 1970; Alexander, 1971; Alexander and Murtagh, 1979).

The frequency of arrhythmia is increased by premedication with atropine (Thurlow, 1972), the injection of adrenaline (Katz and Bigger, 1970) and hypercarbia (Black et al., 1959); arrhythmia is decreased by pretreatment with beta-adrenergic blocking drugs (Rollason and Hall, 1973; Whithead, Whitmarsh and Horton, 1980) or when intermittent positive pressure ventilation (Thomas, Thomas and Thurlow, 1976), infiltration with local anaesthetic agents (Plowman, Thomas and Thurlow, 1974), or non-depolarizing neuromuscular blocking drugs (Wong et al., 1971) are used.

The use of enflurane during dental anaesthesia has been reported to decrease the occurrence of arrhythmia when compared with halothane (Strunin, Strunin and Phipps, 1977; Wright, 1980; Ryder and Wright, 1981) and this decrease has been attributed to a lesser degree of myocardial sensitization to catecholamines (Reisner and Lippmann, 1975; Johnston, Eger and Wilson, 1976). Previous studies have included patients of both sexes and widely varying ages, and have not always distinguished between arrhythmias occurring during the induction of anaesthesia, intubation of the trachea, surgery and recovery. The present investigation was designed to determine the nature, frequency and timing of arrhythmias during enflurane and halothane anaesthesia in healthy young women undergoing 3rd molar extraction.

PATIENTS AND METHODS

Seventy-five female patients attending the Outpatient Department of St Thomas' Hospital for extraction of 3rd molar teeth under general anaesthesia were included in the study and their consent obtained. Their ages ranged from 16 to 32 yr (mean 22.3 yr) and all were classified as A.S.A. group 1. No premedication was given and the patients were anaesthetized in the supine position. They were divided by random allocation into group A (halothane anaesthesia) and group B (enflurane anaesthesia).

The ECG was recorded with a Medilog 4.24 24 h tape recorder using two pre-gelled electrodes positioned to give an effective V6 lead pattern. Recording was commenced in the anaesthetic room before the induction of anaesthesia, and continued throughout the period of anaesthesia and for at least the first 15 min of the recovery period.

Arterial pressure was measured at frequent intervals with a von Recklinghausen oscillotonometer and heart rate assessed by palpation of a radial artery.

Anaesthesia was induced with sufficient thiopen-
tone to abolish the eyelash reflex, followed by suxamethonium 1 mg kg\(^{-1}\) to facilitate the introduction of a cuffed nasotracheal tube lubricated with water-based jelly. The throat was packed with damp ribbon gauze. The patient breathed spontaneously, from a circle system with soda-lime absorption, using a fresh gas flow of oxygen 2 litre min\(^{-1}\) and nitrous oxide 4 litre min\(^{-1}\). The volatile agent was delivered by a calibrated Fluotec Mark II or Enflurane vaporizer (Cyprane Ltd), commencing at an inspired concentration of 2 MAC, with subsequent adjustments according to clinical requirements, and continuing throughout surgery until extubation of the trachea.

Extubation was performed with the patient in the left lateral position. Recovery time, from extubation of the trachea to ejection of the oral airway, was measured. The occurrence of nausea and vomiting after operation, and of pain of sufficient severity to require treatment with oral analgesics, was noted.

The completed ECG tape recordings were analysed using a Pathfinder High Speed ECG Analyser (Reynolds Medical Ltd); an arrhythmia was said to be present if one or more electrical complexes originated at a site other than the sino-atrial node, thus excluding sinus tachycardia and bradycardia.

The significance of results was evaluated by using the Chi-square test, with Yates' correction, and Student's \(t\) test, as appropriate.

**RESULTS**

Of the 75 patients included in the study, 38 received halothane (group A) and 37 enflurane (group B). The two groups were similar in respect of age, weight and number of teeth extracted (table I).

The number of patients in each group who developed arrhythmias, and the time of their occurrence is shown in table II. Thirteen patients (34.2%) in the halothane group, and one (2.7%) in the enflurane group exhibited an arrhythmia during surgery — a significant difference \((\chi^2 = 10.3, P<0.01)\) between the two groups. Both groups showed a high frequency of arrhythmias during intubation, and a low frequency before and during induction and during recovery; there were no significant differences between the groups at these times.

An analysis of the different types of arrhythmia seen at each phase of the anaesthetic is given in table III. All the arrhythmias occurring during surgery were ventricular in origin, bigeminal rhythm being particularly common in those patients who received halothane. Atrial ectopic beats were, with one exception, seen only during intubation in both groups; during this period, they accounted for almost half of the arrhythmias observed.

None of the arrhythmias produced adverse clinical effects, or required treatment.

In group A the mean duration of administration of halothane was 27.3 ± 11.84 (SD) min and the mean recovery time 11.1 ± 3.92 min, compared with a mean duration of administration of enflurane of 23.7 ± 9.52 min, and a mean recovery time of 9.3 ± 4.04 min for the patients in group B. These differences were not significant.

Following operation, 30 patients (79%) in the

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of patients</th>
<th>Volatile agent</th>
<th>Mean age (yr ± SD)</th>
<th>Mean body wt. (kg ± SD)</th>
<th>No. teeth extracted (mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>38</td>
<td>Halothane</td>
<td>22.2 ± 3.52</td>
<td>59.9 ± 8.93</td>
<td>3.6 ± 0.67</td>
</tr>
<tr>
<td>B</td>
<td>37</td>
<td>Enflurane</td>
<td>22.4 ± 3.31</td>
<td>61.6 ± 9.23</td>
<td>3.3 ± 0.96</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>Volatile agent</th>
<th>Before induction</th>
<th>Induction</th>
<th>Intubation and packing</th>
<th>Surgery</th>
<th>Extubation</th>
<th>Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Halothane</td>
<td>3 (7.9%)</td>
<td>1 (2.6%)</td>
<td>11 (28.9%)</td>
<td>13 (34.2%)</td>
<td>2 (5.3%)</td>
<td>2 (5.3%)</td>
</tr>
<tr>
<td>B</td>
<td>Enflurane</td>
<td>2 (5.4%)</td>
<td>0 (0%)</td>
<td>10 (27.0%)</td>
<td>1 (2.7%)</td>
<td>1 (2.7%)</td>
<td>1 (2.7%)</td>
</tr>
</tbody>
</table>
Table III. Number of patients exhibiting different types of arrhythmia, the time of their occurrence and mean arterial pressure. A = halothane anaesthesia, B = enflurane anaesthesia

<table>
<thead>
<tr>
<th>Type of arrhythmia</th>
<th>Before induction</th>
<th>Induction</th>
<th>Intubation and packing</th>
<th>Surgery</th>
<th>Extubation</th>
<th>Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Atrial ectopics</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Unifocal ventricular ectopics</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Multifocal ventricular ectopics</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ventricular bigeminy</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Nodal rhythm</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Average arterial pressures (mm Hg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic</td>
<td>126</td>
<td>117</td>
<td>125</td>
<td>127</td>
<td>150</td>
<td>160</td>
</tr>
<tr>
<td>Diastolic</td>
<td>76</td>
<td>80</td>
<td>83</td>
<td>83</td>
<td>100</td>
<td>115</td>
</tr>
</tbody>
</table>

halothane group complained of pain and seven (18%) suffered from nausea and vomiting, compared with 27 (73%) and eight (21%) in the enflurane group. The differences between the two groups were not significant. All the patients were fit to leave hospital the same day.

DISCUSSION

Our results confirm those of previous studies in that enflurane produced significantly fewer arrhythmias during oral surgery than halothane. The frequency of arrhythmia in both the halothane and the enflurane groups was similar to that noted by other workers, and was not apparently influenced by the fact that all our patients were young women.

The frequency of surgically-induced arrhythmia during enflurane anaesthesia, in both this and other studies, is lower than that which may be observed during oral surgery under local anaesthesia alone, when it can be as high as 26.2% (Williams et al., 1963). Enflurane may thus be exerting an anti-arrhythmic effect.

It is thought that the tendency for enflurane to produce fewer arrhythmias than halothane is the result, at least in part, of the fact that, unlike halothane, the former agent does not increase ventricular conduction time, although both agents pro-long A-V conduction time (Atlee and Rusy, 1977); halothane thus produces conditions which predispose to re-entry of excitation. The mechanism of the possible anti-arrhythmic effect of enflurane is unclear.

Twenty-one (28%) of our patients developed arrhythmias during intubation (which was performed before introduction of the volatile agent), a frequency within the range of 0-90% quoted by Katz and Bigger (1970). Our finding of a high proportion of atrial ectopic beats during intubation appears to have been noted in only one other study (Alexander, 1971). De Vault, Greifenstein and Harris (1960) found that prior injection of phentolamine 5mg prevented both the hypertension and arrhythmia associated with intubation, although Katz (1965) considered that the abolition of arrhythmia was secondary to the prevention of hypertension and that pretreatment with beta-adrenergic blocking drugs was equally effective.

Clinically, there was little apparent difference between enflurane and halothane, either during the conduct of the anaesthetic or in the period after operation. This impression is reinforced by the similarity in immediate recovery times and the frequencies of postoperative pain, and nausea and vomiting, between the two groups of patients.
We found that magnetic tape recording of the ECG with subsequent high-speed analysis (a technique recently described in detail by Barker and Briscoe (1981)), was an accurate, simple and convenient method of detecting and studying arrhythmia during anaesthesia. An additional monitoring system would be required for immediate visual display of the ECG.

Our results show a marked variation in the frequency of arrhythmias at different stages of the anaesthetic; many were detected before the patients were exposed to enflurane or halothane. Thus to quote an overall frequency of abnormal rhythms for the entire duration of the anaesthetic would be potentially misleading. We suggest that, in this type of study, it is necessary to relate the occurrence of arrhythmias to the events of the procedure, if valid comparisons are to be made.

REFERENCES
De Vault, M., Greifenstein, F. E., and Harris, I. C., jr (1960). Circulatory responses to endotracheal intubation in light general anesthesia; the effect of atropine and phentolamine. Anesthesiology, 21, 360.


ACKNOWLEDGEMENTS
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TROUBLES DU RYTHME CARDIAQUE AU COURS DE L’ANESTHESIE AMBULATOIRE EN CHIRURGIE DENTAIRE: COMPARAISON DE L’HALOTHANE ET DE L’ENFLURANE

RESUME
Nous avons enregistré sur bande magnétique et analysé secondairement à l’aide d’un analyseur à grande vitesse l’électrocardiogramme de 75 jeunes femmes subissant l’extraction de la troisième molaire sous anesthésie à l’halothane ou à l’enflurane, à la recherche d’arythmies. L’enflurane induisait une fréquence bien moindre d’arythmies au cours de l’acte chirurgical que l’halothane, mais il n’y avait par ailleurs que peu de différences entre les deux agents pour ce qui est de la qualité de l’anesthésie ou du réveil. De nombreuses arythmies survenaient avant l’exposition de la patiente à l’enflurane ou à l’halothane; nous discutons la signification de ce fait.
HERZRHYTHMUSTÖRUNGEN WÄHREND AMBULANTER ZAHNÄRZTLICHER NARKOSE—
EIN VERGLEICH ZWISCHEN HALOTHAN UND ENFLURANE

ZUSAMMENFASSUNG


ARRitmias cardíacas durante la anestesia dental de pacientes externos:
Comparación del halotano con el enflurano

SUMARIO

En 75 pacientes mujeres jóvenes sometidas a una extracción de la 3ra molar bajo anestesia con halotano a enflurano, se registró el electrocardiograma en cinta magnética, el que fue después analizado respecto de arritmias, al usar un analizador de alta velocidad. El enflurano indujo una frecuencia mucho más baja en las arritmias durante la cirugía que la del halotano, pero de otro modo, hubo poca diferencia entre las dos substancias en lo que se refiere a la calidad de la anestesia o de la recuperación. Muchas arritmias ocurrieron antes de la exposición de la paciente al enflurano o al halotano; se discute del significado de ello.