

original  
papers

JAMES PALMER, MOHSEN KHALIL AND DAVID MEAGHER

## Inhalation induction with sevoflurane for electroconvulsive therapy: a case series

### AIMS AND METHOD

Until 1999, the most common drug for induction of anaesthesia for electroconvulsive therapy (ECT) in the UK was methohexital. Cessation of production left few choices of induction agent. Increased use of sevoflurane in short procedures suggests that it might be suitable as a sole agent for anaesthesia in ECT. We therefore induced

anaesthesia in five consecutive patients undergoing ECT to assess sevoflurane's potential for this use. We recorded vital signs, needle phobia, face-mask toleration, duration of induction, seizure duration and recovery variables.

### RESULTS

Anaesthesia was successfully induced in all patients without difficulty. One

patient experienced mild hypoxia following the seizure. Seizure duration ranged from 24 to 72 seconds. Recovery times to eye opening and times to 'ward' fitness were acceptable.

### CLINICAL IMPLICATIONS

Sevoflurane may be a suitable alternative for induction of anaesthesia for ECT.

The production of methohexital ceased in September 1999, ending 40 years of its use in anaesthesia for electroconvulsive therapy (ECT), first described by Friedman (1959). In December 1999, the Special Committee on Electroconvulsive Therapy of the Royal College of Psychiatrists issued guidance on the preferred induction agent for ECT (Freeman, 1999). These guidelines suggested propofol as the next best choice, but concluded by stating that methohexital remained the drug of choice. The requirements for an anaesthetic agent for ECT are difficult to realise: the drug must not only possess induction characteristics suited for repeated use, including rapid recovery to street fitness with no confusion following therapy, but also have a minimal effect on seizure duration.

Sevoflurane, a methyl-propyl ether first used in 1971 in the USA, has been increasingly available since 1997 in the UK. It is non-irritant, has a pleasant ethereal smell, and, with its low blood gas solubility of 0.6, induces anaesthesia rapidly. It also appears to have excitatory effect on the electroencephalogram (EEG) during inhalational induction (Yli-Hankala *et al*, 1999; Sato *et al*, 2002). It would appear to be a suitable agent for repeated induction of anaesthesia for short procedures, including ECT. To date there has been little study of sevoflurane in ECT. Ishikawa *et al* (2001) described a case of a pregnant woman receiving sevoflurane for maintenance of anaesthesia during her course of ECT. At the time of the series described here (1999), the use of sevoflurane for inhalational induction of ECT had not been presented. We describe an open observational study on a consecutive series of patients presenting for ECT.

### Method

After ethical committee approval, five consecutive patients (four male, one female: age range 33–52 years) were recruited; all had had between one and ten ECT treatments with propofol as the induction agent. Informed consent was obtained from all participants. We

excluded patients with a history suggestive of malignant hyperpyrexia or those with severe respiratory or cardiac disease. Patients received no premedication, but did receive all current psychiatric medication on the day of treatment. In the treatment room, all patients had monitoring applied and received pre-oxygenation through a face mask and Bain circuit.

At time zero, the anaesthetist turned the vaporiser to 8% (maximum) and an assistant cannulated a vein in the hand or arm. The time to loss of eyelash reflex and verbal contact, occurrence of adverse airway events and any purposive movements were recorded. Once the anaesthetist was satisfied with anaesthetic depth, succinylcholine was administered at a dose commensurate with the size of the patient or the same as that given during previously successful ECT therapy. The electrical stimulus was delivered bilaterally using an Ectonus 5CB-62 (Ectron Ltd, Letchworth, Herts, UK) and the duration of motor activity was recorded in an isolated foot. Sevoflurane administration was stopped when the stimulus was delivered. The patient was monitored, and ventilation assisted, until spontaneous respiration returned; the patient was placed in the recovery position and transferred to the recovery area. Time to eye opening after cessation of sevoflurane administration, times to follow simple commands, and time to street fitness were recorded. Recovery staff and patients also completed a simple questionnaire, which measured patient satisfaction and any confusion or excessive drowsiness in the recovery period.

### Results

All participants were rated as class II on the American Society of Anesthesiologists classification (Saklad, 1941), and their body mass indices ranged from 22.6 kg/m<sup>2</sup> to 30.4 kg/m<sup>2</sup>. Montgomery & Åsberg Depression Rating Scale (Montgomery & Åsberg, 1979) scores ranged from 15 to 35, and patients' current medication included zopiclone, clozapine, venlafaxine, paroxetine and



chlorpromazine. No patient had needle phobia. Skull impedance ranged from 215  $\Omega$  to 351  $\Omega$  in four patients, and was unrecorded in one. Charge delivered ranged from 235 mC to 676 mC. Face mask tolerance was good in four patients, and acceptable in one.

Duration of induction was acceptable in all patients (range 79–268 seconds) and there was no adverse event. Motor seizure duration ranged from 24 to 72 seconds. No additional drug was given to any patient either during or after the procedure. Four patients maintained acceptable oxygen saturation during the entire procedure, but one patient's saturation level fell to 94%. All patients increased their heart rate and systolic blood pressure during the ECT procedure. Recovery in all patients was rapid and uncomplicated with no post-operative nausea or vomiting. Two patients took a longer time to respond to verbal commands than the other three, but their times to street fitness were similar (range 12–21 minutes). Reasons for this are unclear. All patients completed the questionnaire. The most important finding was that four of the five patients liked the method of induction, even though two liked it less than an intravenous induction. Two of the five felt that induction was slower, and two (the patients with the fastest induction times) thought it was faster; four of the five felt that something was different, and recalled both the cannula and face mask; and three recalled the smell of the volatile. Interestingly, one patient could not say what had induced anaesthesia. Sensations of restlessness and confusion in recovery were reported by three patients and corroborated by recovery staff.

## Discussion

Methohexital, a methylated oxybarbiturate with rapid onset of action and smooth induction characteristics, has been the drug of choice for induction of anaesthesia for ECT for many years. The drug's ability in some cases to produce abnormal spike discharges in some patients with epilepsy but a normal EEG might have been influential in its selection (Harel *et al*, 1975). It is more likely, however, that its popularity was due to its recovery profile being superior to that of thiopental, although in this it does not compare with propofol (Pollard *et al*, 2003).

The introduction of propofol predictably led to a number of studies comparing propofol with methohexital, propofol with thiopental, and propofol with both methohexital and etomidate. Studies examining the potential effects of anaesthetic agents on the therapeutic effect of ECT often assume that duration of motor seizure, or cumulative seizure duration of a course of ECT, provides a main indicator of beneficial effect (Maletzky, 1978; American Psychiatric Association, 1990), although the duration of the motor seizure is not now felt to be essential (Fear *et al*, 1994). Although the current *ECT Handbook* suggests that a seizure of at least 15 seconds peripherally or 25 seconds on EEG is likely to produce a consistently beneficial effect (Scott & Lock, 1995), there is no current substantive evidence for a minimum effective seizure length. In fact, since the change in seizure

threshold (possibly due to the release of endogenous opioid anticonvulsants), particularly with unilateral ECT, over a treatment course, may be more relevant to outcome (Sackeim, 1999).

It should be noted that measurable seizure quality indices that relate to how generalised a seizure is, rather than to its length, such as mean integrated amplitude and postictal suppression (how quickly the EEG flattens after a seizure), are not affected by anaesthetic agent choice. There is also no difference in outcome (Fear *et al*, 1994; Kirkby *et al*, 1995), at least between propofol and methohexital.

In studies comparing induction agents for ECT in terms of seizure duration, etomidate appears to have the least effect both on motor and EEG seizures, followed by methohexital, thiopental and finally propofol, but the reduction in seizure duration experienced with propofol and methohexital is dose-dependent, whereas that of etomidate is not (Boey & Lai, 1990; Avramov *et al*, 1995; Kirkby *et al*, 1995; Geretsegger *et al*, 1998). The effects of different doses, concentrations and methods of application of sevoflurane on seizure duration require detailed investigation. In terms of cardiovascular stability, propofol has been shown to be most effective at blunting the haemodynamic response to ECT and etomidate the least (Boey & Lai, 1990; Avramov *et al*, 1995), but since recent work suggests an intriguing link between a vigorous cardiovascular response to ECT and an earlier antidepressant effect, this might be beneficial in some individuals (Saravanan *et al*, 2002). Etomidate, however, is associated with high rates of postoperative nausea and vomiting, and in repeated doses has a dangerous adrenocortical suppressive effect (Watt & Ledingham, 1984); its use is therefore discouraged. Thiopental has an undesirable recovery profile, and may lead to prolonged sedation and confusion, especially among the elderly, and is considered unsuitable (Freeman, 1999).

Inhalational induction of anaesthesia with sevoflurane has been shown to be acceptable for day case surgery and may be performed either by stepwise increase in concentration of inhaled anaesthetic agent or by inhalation of high concentrations from the start. Induction is slower than with the intravenous agents, but emergence is more rapid and apnoea less common; however, the increased rate of postoperative nausea and vomiting may reduce these perceived advantages in some population groups (Pollard *et al*, 2003). The effect of sevoflurane on the electrophysiology of the brain has been studied, with conflicting results. Several workers have recorded epileptiform EEG tracings accompanied in some cases by visible motor manifestations (Yli-Hankala *et al*, 1999; Sato *et al*, 2002). The ability of sevoflurane to modulate neuroexcitability was shown in one study on patients with epilepsy to be dose-dependent, manifested most at near burst suppression doses of 1.5 minimum alveolar concentration (MAC). During induction with sevoflurane inhaled concentrations of up to 4 MAC are used, and although concentrations at the effect site will be well below this – usually 1–2 MAC – inhalation of sevoflurane before ECT could affect seizure threshold and possibly duration. Comparing our results with those of

original  
papers

Calarge *et al* (2003) shows some interesting differences, particularly induction times (generally shorter in our series), seizure duration (longer in our series) and lack of nausea in our patients. This may reflect the male skew or the number of smokers in our group (males and smokers suffer less postoperative nausea and vomiting) and possibly the technique used to induce and maintain anaesthesia.

In conclusion, although recognising the small size of the study and hence the lack of evidence as to the safety of the technique for repeated use, we present additional preliminary findings on the efficacy of sevoflurane in a new area of application. The high level of acceptability of the method to patients, the rapid recovery with low numbers of adverse effects and the fact that this agent is indicated for repeated inductions for surgery suggest that sevoflurane might be a useful alternative to current intravenous induction agents, particularly if the potential exists for reducing the charge delivered if seizure duration is prolonged.

## Acknowledgements

The authors thank the members of the Departments of Anaesthesia and Psychiatry at Dumfries and Galloway Royal Infirmary and the Crichton Royal Hospital for their assistance.

## References

- AMERICAN PSYCHIATRIC ASSOCIATION TASK FORCE ON ELECTROCONVULSIVE THERAPY (1990) *The Practice of Electroconvulsive Therapy: Recommendations for Treatment, Training, and Privileging*. Washington, DC: American Psychiatric Association.
- AVRAMOV, M. N., HUSAIN, M. M. & WHITE, P. F. (1995) The comparative effects of methohexital, propofol and etomidate for electroconvulsive therapy. *Anesthesia Analgesia*, **81**, 596–602.
- BOEY, W. K. & LAI, F. O. (1990) Comparison of propofol and thiopentone as anaesthetic agents for electroconvulsive therapy. *Anaesthesia*, **45**, 623–628.
- CALARGE, G. A., CROWE, R. R., GERGIS, S. D., *et al* (2003) The comparative effects of sevoflurane and methohexital for electroconvulsive therapy. *Journal of ECT*, **19**, 221–225.
- FEAR, C. F., LITTLEJOHNS, C. S., ROUSE, E., *et al* (1994) Propofol anaesthesia in electroconvulsive therapy. Reduced seizure duration may not be relevant. *British Journal of Anaesthesia*, **163**, 506–509.
- FREEMAN, C. (1999) Anaesthesia for electroconvulsive therapy; statement from the Royal College of Psychiatrists Special Committee for electroconvulsive therapy. *Psychiatric Bulletin*, **23**, 740–741.
- FRIEDMAN, E. (1959) Methohexital anesthesia in electrocerebral therapy. Monograph supplement. *Diseases of the Nervous System*, **20**, 121–124.
- GERETSEGGER, C., ROCHOWANSKI, E., KARTNIG, C., *et al* (1998) Propofol and methohexital as anesthetic agents for electroconvulsive therapy (ECT): a comparison of seizure-quality measures and vital signs. *The Journal of ECT*, **14**, 28–35.
- HAREL, D., SHARF, B. & BENTAL, E. (1975) Methohexital as an activator in epileptic patients with normal electroencephalograms. *Israel Journal of Medical Science*, **11**, 986–990.
- ISHIKAWA, T., KAWAHARA, S., SAITO, T., *et al* (2001) Anaesthesia for electroconvulsive therapy during pregnancy – a case report. *Masui*, **50**, 991–997.
- KIRKBY, K. C., BECKETT, W. G., MATTERS, R. M., *et al* (1995) Comparison of propofol and methohexital in anaesthesia for ECT: effect on seizure duration and outcome. *Australian and New Zealand Journal of Psychiatry*, **29**, 299–303.
- MALETZKY, B. M. (1978) Seizure duration and clinical effect in electroconvulsive therapy. *Comprehensive Psychiatry*, **19**, 541–550.
- MONTGOMERY, S. A. & ÅSBERG, M. (1979) A new depression scale designed to be sensitive to change. *British Journal of Psychiatry*, **134**, 382–389.
- POLLARD, B. J., ELLIOTT, R. A. & MOORE, E. W. (2003) Anaesthetic agents in adult day case surgery. *European Journal of Anaesthesiology*, **20**, 1–9.
- SACKEIM, H. A. (1999) The anticonvulsant hypothesis of the mechanisms of action of ECT: status. *Journal of ECT*, **15**, 5–26.
- SAKLAD, M. (1941) Grading of patients for surgical procedures. *Anesthesia*, **2**, 281.
- SARAVANAN, E. S., GANGADHAR, B. N., JANAKIRAMAIAH, N., *et al* (2002) Does higher cardiovascular response to ECT predict early antidepressant effect? *Journal of Affective Disorders*, **69**, 101–108.
- SATO, K., SHAMOTO, H. & KATO, M. (2002) Effect of sevoflurane on electroencephalogram in normal brain. *Journal of Neurosurgical Anesthesiology*, **14**, 63–65.
- SCOTT, A. & LOCK, T. (1995) Monitoring seizure activity. In *The ECT Handbook. The Second Report of the Royal College of Psychiatrists Special Committee on ECT* (ed. C. P. Freeman), pp. 62–65. London: Royal College of Psychiatrists. Council Report CR39.
- WATT, I. & LEDINGHAM, I. M. (1984) Mortality amongst multiple trauma patients admitted to an intensive therapy unit. *Anaesthesia*, **39**, 973–981.
- WATTS, A. A., HERRICK, I. A., McLACHLAN, R. S., *et al* (1999) The effect of sevoflurane and isoflurane on interictal spike activity with refractory epilepsy. *Anesthesia and Analgesia*, **89**, 1275–1281.
- YLI-HANKALA, A., VAKKURI, A., SARKELA, M., *et al* (1999) Epileptiform electroencephalogram during mask induction of anaesthesia with sevoflurane. *Anesthesiology*, **91**, 1596–1603.

\*James Palmer Consultant in Anaesthesia, Department of Anaesthesia, Hope Hospital, Stott Lane, Salford, Manchester M6 8HD (e-mail: james.palmer@srht.nhs.uk), Mohsen Khalil SHO in Anaesthesia, Department of Anaesthesia, Hope Hospital, Salford, David Meagher Consultant Psychiatrist, Departments of Psychiatry and Anaesthesia, Dumfries and Galloway Royal Infirmary and Crichton Royal Hospital, Dumfries