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The safety, efficacy and recovery characteristics of desflurane versus propofol for anaesthesia in an older day surgery population

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Abstract

Desflurane is one of a new generation of volatile anaesthetic agents with a low blood gas solubility coefficient of 0.42 (cf. Isoflurane 1.40 and nitrous oxide 0.46) and the potential for rapid recovery and minimal post-operative hangover. This could have advantages for day surgery particularly in an older day surgical population. This study compared the maintenance of anaesthesia with desflurane or propofol in a randomised, comparative, controlled and open labelled trial. A variety of tests of or indices of recovery were studied including psychometric testing and the recovery from similar depths of anaesthesia as assessed by the coherent frequency analysis of auditory evoked potentials in the electroencephalogram (EEG). © 1997 Elsevier Science B.V.

Keywords: Desflurane; Propofol; Older day surgery population

1. Introduction

The Royal College of Surgeons of England defines day surgery as the admission of a patient on a planned non-resident basis for an operation or investigation who nonetheless requires facilities for recovery. It has advantages including a high patient throughput with a resulting reduction in costs and waiting times as well as offering convenience and a low morbidity for the patient. However preoperative preparation must be good, minor sequelae still occur and there is resistance to its use due to fears of an increase in community workload or medicolegal complications. One of the keys to successful day surgery is good quality anaesthetic recovery to facilitate the patient returning home. However the ideal anaesthetic technique has not been established and this study hopes to examine the differences in recovery between two different techniques of anaesthetic maintenance in the older day surgical population.

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2. Methods

The study was approved by the Local Research and Ethics Committee and all the patients gave written informed consent. Forty patients aged 50 years or older, male and female, ASA status I-III, undergoing elective day case surgical procedures were entered into the study. The study was randomised, comparative, controlled and open labelled.

Patients were excluded from the trial if they had a history of clinically significant cardiovascular, respiratory, hepatic or renal disease. Patients with a history of alcohol or drug abuse or of allergy to any of the drugs used in the trial were also excluded. Other exclusions included any patients having received general anaesthesia within the past 7 days and participation in another study within the proceeding month.

Patients were randomly allocated into two groups and received either desflurane or propofol for anaesthetic maintenance. Blood was taken prior to induction

Table 1
Patient characteristics

	Desflurane				Propofol			
	n	Mean	S.D.	Range	*n*	Mean	S.D.	Range
Male								
Age (years)	13	56.7	3.9	51–63	12	62.2	7.5	50–71
Weight (kg)	13	74.7	8.5	65–94	12	75.8	15.4	54–114
Height (cm)	13	172	4.8	165–179	12	173	10.1	152–190
Female								
Age (years)	7	55.6	4.3	50–63	8	56.5	4.1	50–60
Weight (kg)	7	65.7	10.4	51–79	8	69.7	10.1	58–86
Height (cm)	7	165	8.1	158–180	8	167	9.3	148–178

of anaesthesia and in the postoperative period to examine serum Creatinine, bilirubin, Alanine-amino transferase (ALT), Alkaline phosphatase (ALP) and Aspartate-amino transferase (AST).

2.1. Anaesthesia

All patients were unpremedicated and taken into the operating theatre where routine monitors were positioned. Heart rate, arterial blood pressure and pulse oximetry were recorded at 2 min intervals until the incision, at 1 min intervals for 5 min after incision and every 5 min thereafter. The inspired oxygen and end-tidal carbon dioxide, nitrous oxide and desflurane concentrations where appropriate were continuously measured with a Datex® monitor calibrated for the study and the values were recorded at the same time as the haemodynamic variables. The desflurane was administered by an Ohmeda TEC 6™ vaporiser and a propofol infusion was delivered with a Graseby 3100® pump. All doses of anaesthetic administered were noted.

Induction of anaesthesia commenced with intravenous (i.v.) alfentanil 7–15 mg/kg given over 1–2 min followed by propofol 1.5–2.5 mg/kg until the loss of verbal contact and loss of eyelash reflex. The airway was maintained with a laryngeal mask airway (LMA) and maintenance of anaesthesia was provided by either desflurane or propofol infusion (6–15 mg/kg per h) together with an oxygen/nitrous oxide mixture achieving an inspired oxygen concentration of between 30–50%. The concentrations of propofol or desflurane were adjusted to the patients needs as clinically indicated with the object of maintaining the heart rate and blood pressure within 20% of the baseline values. Light anaesthesia demonstrated by an increasing respiratory rate, pupillary dilatation, lacrimation or movement were treated with further boluses of alfentanil 5 mg/kg. Clinically significant bradycardia was treated with atropine 0.3–0.6 mg as required.

Anaesthesia was terminated at the application of the dressings and following this the immediate recovery criteria were then monitored.

2.2. Recovery testing

The anaesthesia emergence observations consisted of time to opening eyes, obeying commands and the ability to vocalise birth date. Visual analogue scores measuring pain, sore throat, nausea, dizziness, drowsiness and headache were noted preoperatively and then 30 and 90 min after achieving a Steward's score of 6. At the same time intervals psychological tests including simple reaction times, grooved peg board and word retention tests, logical reasoning, speed of comprehension, visual acuity and contrast sensitivity were also performed. Finally the coherent frequency analysis of the auditory evoked potentials in the EEG was carried out preoperatively, 5 min after surgical incision and 1 h after awakening.

Any adverse events during the anaesthetic or in recovery were noted. Pain and nausea were treated in the recovery room with a combination of oral or rectal diclofenac 50–lOO mg, codydramol 2 tablets and metoclopramide lO mg i.v. Patients were followed up for 14–21 days after surgery to assess the occurrence of any problems or adverse events.

Table 2
Surgical procedures

Surgical Procedure	No. of Patients	
	Desflurane	Propofol
Varicose veins ligation and strip	8	6
Inguinal hernia repair	10	11
Arthroscopy of knee	1	1
Minor orthopaedics	1	2

Table 3
Duration of anaesthesia

	Desflurane				Propofol			
	n	Mean	S.D.	Range	*n*	Mean	S.D.	Range
Duration (min)	20	42.0	18.0	12.0–73.0	20	41.6	17.9	17.0–86.0
End-tidal cone (%):								
Mean during surgery	20	3.31	0.56	2.32–4.20	—	—	—	—
Peak during surgery	20	4.14	0.79	2.70–5.70	—	—	—	—
End of surgery	20	2.75	0.72	1.60–4.20	—	—	—	—
Infusion rate (mg/kg per h)								
Mean during surgery	—	—	—	—	20	8.29	2.56	4.38–13.9
Peak during surgery	—	—	—	—	20	9.51	2.19	6.00–15.0
End of surgery	—	—	—	—	20	6.810	2.96	2.901–12.0
Total amount (mg)	—	—	—	—	20	392	168	150–850

Table 4
Number (%) of patients given additional medication for blood pressure/heart rate control

Additional medication during anaesthesia	Reason	No. of patients (%)	
		Desflurane	Propofol
Haemoccel + atropine	Hypotension	1 (5%)	—
Atropine	Bradycardia	4 (20%)	1(5%)
Glycopyrrolate	Bradycardia	1 (5%)	—
Ephedrine	Hypotension	—	1(5%)

Table 5
Number (%) of patients needing additional medication for light anaesthesia/intra-operative pain

Additional medication during anaesthesia	Reason	No. of patients (%)	
		Desflurane	Propofol
Alfentanil	Intra-operative pain	17 (85%)	14 (70%)
Bupivicaine	Intra-operative pain	1 (5%)	2 (15%)
Propofol	Light anaesthesia	—	2 (10%)[a]

[a] Those patients also received alfentanil for intra-operative pain.

2.3. Statistics

Treatment groups were compared with respect to the efficacy variables using the Students *t*-test. If the assumption of normality was seriously broken, corresponding non parametric tests were used (Wilcoxon rank sum tests).

3. Results

Tables 1 and 2 show that the two treatment groups were similar with regard to patient characteristics, diagnosis and surgical procedures.

Table 3 indicates that the mean value of duration of anaesthesia was 42 min for both treatment groups. The mean end-tidal concentration of desflurane during surgery was 3.3% and the mean propofol infusion rate during surgery was 8.3 mg/kg per h.

Tables 4 and 5 record that the desflurane group six patients (30%) received additional medication for heart rate/blood pressure control compared to two patients in the propofol group. In addition, 18 patients (90%) in the desflurane group and 17 patients (85%) in the propofol group received additional medication for intra-operative analgesia/light anaesthesia during surgery.

3.1. Haemodynamic response

At baseline, and in the induction, surgery and recovery periods the mean values of heart rate and blood pressure were similar for the two treatment groups. The

Table 6
Times to eye-opening, 'squeeze my fingers', 'date of birth' and fit for discharge from recovery room (minutes from the end of anaesthesia)

	Desflurane				Propofol				*P*-value
	n	Mean	S.D.	Range	*n*	Mean	S.D.	Range	
Eye-opening	20	6.7	4.8	2–24	20	8.7	4.2	2–16	0.052
Squeeze my fingers	20	7.3	4.6	2–24	20	9.7	4.6	2–19	—
Date of birth	20	8.5	5.0	3–26	20	10.8	4.9	3–19	—
Fit for discharge	20	92.7	106.7	7–295	20	111.9	121.8	8–382	0.16

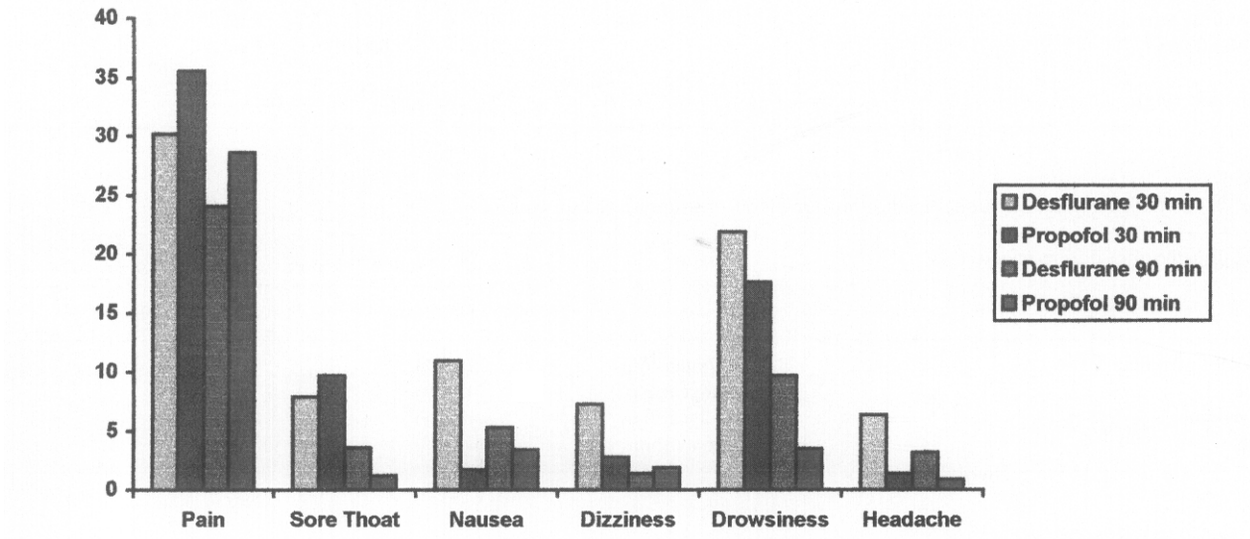

Fig. 1. Visual analogue scores in mm from 0–100 mm scale (pain, sore throat, nausea, dizziness, drowsiness and headache).

mean values at baseline, and the mean maximum and minimum values during surgery, of heart rate and blood pressure were:

	Desflurane-baseline/min/max	Propofol-baseline/min/max
Heart rate (bpm)	77/52/84	73/59/85
Systolic BP (mmHg)	147/97/154	142/92/150
Diastolic (mmHg)	87/58/92	83/55/89

In the desflurane group eight patients (40%) had adverse events during surgery. Seventy percent of these effects were haemodynamic problems including hypotension and bradycardia. Two of the patients had hypoxaemia for 1–2 min and one patient had laryngospasm. In the propofol group four patients (20%) had adverse haemodynamic events including two separate episodes of both hypotension and bradycardia.

3.2. Emergence variables

No statistically significant difference between the treatment groups was recorded for the primary efficacy variable 'time to eye opening' ($P = 0.052$) nor for the secondary efficacy variable 'time judged fit for discharge from the recovery room' ($P = 0.16$). The mean values (min) for the emergence variables were:

Time to:	Desflurane	Propofol	*P*-value
Eye-opening	7 min	9 min	0.052
'Squeeze my fingers'	7 min	10 min	—
'Date of birth'	9 min	11 min	—
Fit for discharge from the recovery room	93 min	112 min	0.16

See Table 6.

Table 7
Recovery tests (simple reaction time, grooved pegboard)

	30 min Before anaesthesia	30 min After Stewards score 6	90 min After Stewards score 6
Mean simple reaction time (1/1000th s)			
Desflurane	250	274	254
Propofol	258	288	259
Mean grooved peg board time (s)			
Desflurane	77	90	75
Propofol	73	92	76

3.3. Psychometric tests

The following psychometric tests were performed during the study: Visual Analogue Score (for pain, sore throat, nausea, dizziness, drowsiness and headache); Recovery tests (simple reaction time, coherent frequency values of the auditory evoked potentials, grooved pegboard); and Psychological tests (word retention, logical reasoning, speed of comprehension, visual acuity and contrast sensitivity). Apart from a higher median score in the VAS assessment of drowsiness in the desflurane group 30 min after a Stewards score of 6 (16.5 vs 3.5), the values in the psychometric tests were similar for the two treatment groups (see Fig. 1 Tables 7 and 8). The results shown in Fig. 2 demonstrate that both groups of patients were subject to similar reduction and subsequent return of the coherent frequency measured auditory evoked responses during anaesthesia and recovery.

3.4. Pain and PONV

In the desflurane group six patients, of whom one received post-operative opioids before the event, and one patient in the propofol group experienced nausea and/or vomiting after surgery. Two patients in the desflurane group (10%) and one patient (5%) in the propofol group needed opioids during recovery (see Tables 9 and 10).

3.5. Biochemistry results

No significant changes in the laboratory values were observed after surgery.

During the follow up from the end of surgery to 21 days post surgery 15 adverse events were reported for eight patients in the desflurane group, two-thirds of these were for post-operative nausea or vomiting. One of the patients stayed in hospital overnight due to nausea and an episode of syncope. In the propofol group two adverse events were reported for two patients. One of the events was thrombophlebitis suffered after propofol administration and the other event was nausea in the recovery room. No patients reported intra-operative recall in either group.

4. Discussion

Inhalational induction of anaesthesia with either desflurane or a combination of desflurane and nitrous oxide (N_2O) is rapid with typical induction times of 142 s with N_2O and 188 s without N_2O (Rapp et al. [1]. However several reports have found a high incidence of excitatory phenomena and airway complications including laryngospasm, breath-holding and coughing [2]. Observers have then smoothed the induction of desflurane anaesthesia with opioids to obtund the airway reflexes and even the addition of carbon dioxide may help [3]. In this study it was observed that the smooth, rapid induction characteristics of propofol made it the induction agent of choice for both anaesthetic groups. Pain on injection of propofol was common [4,5] and increased if injected into a small, distal vein [6]. This problem may be largely overcome if lignocaine (2 ml of 1% plain solution) is added to the propofol before injection [7].

The intraoperative haemodynamic stability was relatively stable for both groups despite the initial concern for an increase in hypotension in an older patient population. The four episodes of bradycardia noted in the desflurane group were all successfully treated with atropine or glycopyrrolate and no evidence of the sympathomimetic stimulation with associated tachycardias from rapid changes in anaesthetic depth reported in desflurane was noted [8,9].

Both anaesthetic agents provided rapid control of the depth of anaesthesia. Rampil et al. reported an MAC of 4.0% in younger (age 18–30 years) and 2.8% in older patients (age 31–65 years) for desflurane in 60% N_2O in oxygen [10–12]. In this study the mean end-tidal concentration of desflurane during surgery was 3.3% with the depth of anaesthesia being judged on clinical signs such as changes in the haemodynamic variables and evidence of light anaesthesia (lacrimation, sweating, pupillary signs). In addition this study provided an

Table 8
Psychological tests

	30 min Before anaesthesia	30 min After Stewards score 6	90 min After Stewards score 6
Word retention-words recognised (mean)			
Desflurane	22.0	15.6	20.7
Propofol	21.3	14.0	20.1
Logical reasoning-mean % correct out of total			
Desflurane	37.7	37.5	39.4
Propofol	34.9	43.6	48.0
Speed of comprehension-mean numbers completed			
Desflurane	67.4	65.2	70.5
Propofol	62.9	59.2	70.8
Visual acuity quotient (mean)			
Desflurane	88.5	83.1	84.6
Propofol	85.7	88.0	86.0
Contrast sensitivity (mean)			
Desflurane	1.71	1.67	1.71
Propofol	1.58	1.61	1.59

assessment of the depth of anaesthesia using the coherent frequency analysis of the auditory evoked potentials. In the EEG the auditory evoked potentials are obtained by recording the electrical activity from the brain after auditory click stimulation via headphones over a range of frequencies between 5–50 Hz. After signal averaging and then applying a Fourier analysis a value called the 'coherent frequency' is derived. The coherent frequency is typically about 40 Hz in the awake patient and decreases with increased depth of anaesthesia [13]. This allowed the confirmation of equal depths of anaesthesia in both groups thus allowing anaesthetic recovery to be studied from equal points of coherent frequency.

Both treatment groups produced similar scores of cognitive function as assessed by the recovery tests (simple reaction time, coherent frequency values of the auditory evoked potentials, grooved pegboard) and the psychological tests (word retention, logical reasoning, speed of comprehension, visual acuity and contrast sensitivity). Again analysis of the Visual Analogue Score for pain, sore throat, nausea, dizziness, drowsiness and headache were all similar apart from a higher median score in the VAS assessment of drowsiness in the desflurane group 30 min after a Stewards score of 6 (16.5 vs 3.5). Previous work has also supported these findings [14] showing no difference in cognitive function after 60 min with either agent. However some workers suggested a delayed recovery of cognitive function with propofol [15].

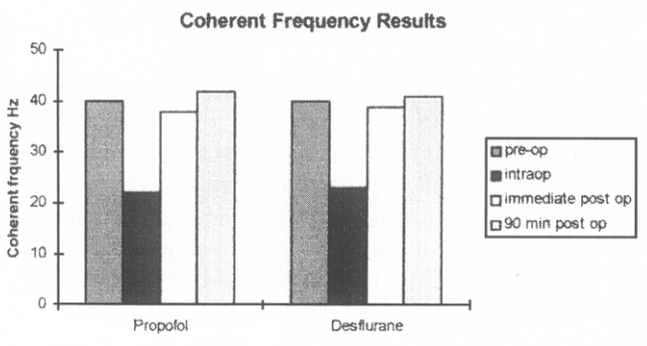

Fig. 2. The coherent frequency results of the study.

Thus in contrast to work by several authors showing a more rapid emergence with desflurane anaesthesia compared to propofol anaesthesia, rapid recovery in patients receiving desflurane was not a feature of our study [16]. Even differences reported by Apfelbaum et al. of 18 min for emergence from propofol anaesthesia versus 10 min from desflurane anaesthesia may be of doubtful clinical significance [17]. Indeed many papers support the conclusion that desflurane and propofol have similar emergence times [18]. Many factors such as intraoperative opioid administration are known to prolong emergence times [19].

The analgesic requirements were similar for both groups but the incidence of nausea and/or vomiting was higher in the desflurane group. This finding was present despite the use of nitrous oxide [20,21] and it remains unclear whether the large variations in PONV were the result of an inherent propofol antiemetic effect or whether it was due to the absence of volatile anaesthetic

Table 9
Number of patients suffering from nausea and/or vomiting

	Desflurane	Propofol
Nausea and/or vomiting	6 (30%)[a]	1 (5%)

[a] One of these patients had received opioids prior to this reported episode.

Table 10
Number of patients who needed post-operative opioids

	Desflurane	Propofol
Opioids	2 (10%)	1 (5%)

agents [22–24]. Many other factors such as age, gender, type of surgery and the use of narcotic analgesia are known to affect the degree of PONV [25].

In conclusion, both techniques provided a safe, effective anaesthetic with a rapid recovery profile as assessed by simple recovery tests and by selective, quantitative psychometric tests. The major questions for the choice of an anaesthetic technique for modern day surgery revolve around the ease of use for the anaesthetist, the cost of the technique and the quality of the recovery for the patient. Although authors have quoted potential cost savings from the use of desflurane in low flow circle systems [26] the rapid turnover in day surgery operating theatres may not allow enough time for these low flows to be achieved. There is no doubt that although desflurane may be potentially expensive compared to other agents such as isoflurane or enflurane it is cheaper than using propofol [27]. Desflurane has other advantages over other volatile anaesthetic agents in that it has a low rate of metabolism with a potentially lower incidence of hepatic complications, a low rate of fluoride production and safe, easy use in circle systems. It's low blood gas solubility coefficient of 0.42 allows rapid changes in anaesthetic depth without the need for nitrous oxide- an agent capable of producing PONV and atmospheric pollution. Propofol has its own drawbacks including the cost issue, fears of awareness in paralysed patients, the potential for epileptiform activity, accumulation and a high incidence of movement during surgery [25]. In summary therefore the basic question is a quality issue. PONV may be used as a quality indicator of anaesthetic care and due account for substantial day surgery overnight admissions [28]. All anaesthetists will have to address these issues and consider how much they and their anaesthetic departments will be prepared to pay for subjectively higher quality anaesthesia. At present there is no easy solution.

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