

Acupuncture versus ondansetron in the prevention of postoperative vomiting

A study of children undergoing dental surgery

M. Somri,¹ S. J. Vaida,¹ E. Sabo,² G. Yassain,³ I. Gankin³ and L. A. Gaitini⁴

1 Senior Anaesthesiologist, 2 Research Fellow, 3 Resident in Anaesthesiology, and 4 Director, Anaesthesiology Department, Department of Anaesthesia, Bnai-Zion Medical Center, PO Box 4940, 31048 Haifa, Israel

Summary

This study compares the anti-emetic effect of acupuncture with that of ondansetron and a placebo. Ninety children undergoing dental treatment under general anaesthesia were randomly allocated to one of the three equal groups, to receive acupuncture needle insertion, intravenous ondansetron 0.15 mg.kg⁻¹ or a placebo. Parental satisfaction scores and the incidence of emetic episodes were recorded. A significant difference was found in the number of patients who vomited and the total number of the emetic episodes when comparing the two treatment groups with the placebo group ($p < 0.0001$). A significant difference was also found between the treatment groups and the placebo group with respect to parental satisfaction score ($p < 0.03$). We conclude that traditional Chinese acupuncture is a valid non-pharmacological alternative anti-emetic treatment that can be recommended as a prophylactic technique in children undergoing dental surgery under general anaesthesia.

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Correspondence to: Dr M. Somri

E-mail: somri_m@yahoo.com

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Postoperative vomiting continues to be a significant unpleasant side-effect of general anaesthesia in children, causing patient discomfort and, as a result, parental distress and dissatisfaction [1]. In addition, the occurrence of postoperative vomiting may lead to dehydration, electrolyte imbalances, delayed discharge from hospital and unscheduled hospital admissions [2].

Acupuncture has been reported to be effective as an anti-emetic therapy in adults after surgery or chemotherapy [3]. Al-Sadi *et al.* [4] found that acupuncture at the PC₆ point reduced the incidence of postoperative nausea and vomiting in hospital from 65% to 35%, and after discharge from 69% to 31%. Ondansetron is one of a group of drugs that has been developed to antagonise 5-hydroxytryptamine type 3 (5HT₃) receptors selectively. It has been demonstrated to be more effective than droperidol and metoclopramide in the prevention of nausea and vomiting after minor surgery [5]. Ondansetron in high doses (0.15 mg.kg⁻¹) is effective in preventing vomiting after surgery, particularly that occurring after discharge from the hospital [6]. The incidence of

vomiting was found to be significantly lower with ondansetron (9%) than with placebo (35%) or droperidol (32%) in children undergoing ambulatory surgery for dental restoration in a study performed by Davis *et al.* [7]. However, ondansetron may be associated with unpleasant side-effects and is costly [8].

In order to study the prophylactic effect of acupuncture at the PC₆ and CV₁₃ sites on postoperative vomiting, we designed a randomised, prospective study comparing this treatment with ondansetron and placebo in children undergoing outpatient dental procedures under general anaesthesia.

Methods

After acquiring Local Research Ethics Committee approval and written parental consent, 90 ASA Grade 1 children aged 4–12 years undergoing dental restoration under general anaesthesia were randomly assigned to one of the three equal groups to receive acupuncture, ondansetron or a placebo. Exclusion criteria included:

allergy to ondansetron; symptomatic medical illness; any anti-emetic therapy within 7 days of surgery; any infectious disease within the previous 2 weeks; local infection near an acupuncture point. Children who experienced any hypoxic ($S_{pO_2} < 95\%$) or hypercapnic ($F_{E/CO_2} > 6.0$ kPa) episodes during anaesthesia were also excluded.

Heart rate, heart sounds (precordial stethoscope), non-invasive systolic blood pressure, pulse oximetry, F_{E/CO_2} and temperature were recorded in all patients using an AS/3 monitor (Datex, Finland). The general anaesthetic technique employed was that used routinely for children in our hospital: induction with halothane and nitrous oxide in oxygen was performed in the presence of the parents; an intravenous cannula was inserted after induction; intravenous atracurium 0.5 mg.kg^{-1} was given to facilitate nasotracheal intubation; intravenous atropine 0.02 mg.kg^{-1} ; anaesthesia was maintained with halothane in 50% nitrous oxide in oxygen and fentanyl in fractional doses of 1–2 $\mu\text{g.kg}^{-1}$, the concentration of halothane being adjusted to maintain blood pressure and heart rate within 15% of baseline values. Ventilation was adjusted to keep F_{E/CO_2} in the range 4.5–5.5 kPa. Residual neuromuscular block was reversed with intravenous atropine 0.02 mg.kg^{-1} and neostigmine 0.06 mg.kg^{-1} . At the end of surgery, all children received rectal paracetamol in a dose of 25 mg.kg^{-1} up to a maximum dose of 750 mg.

Patients were assigned before induction of anaesthesia, using a random number table, to one of three groups.

Acupuncture group

A sterile, single-use, 0.22-mm-diameter acupuncture needle (Hawatto, Suzhou, China) was inserted bilaterally at point PC₆ (Nei-Guan), situated in the Pericardium Meridian and located 2 Cun proximal to the wrist, between the flexor carpi radialis and palmaris longus tendons. A Cun is a unit of traditional Chinese medicine measurement, whereby 1 Cun is the breadth of the patient's thumb and 2 Cun is equal to three times the diameter of the patient's little finger. A third needle was inserted at point CV₁₃ (Shang Wen), situated in the Conception Vessel Meridian, 1 Cun above the midpoint between the umbilicus and the xiphisternum. These two points are specifically designated in traditional Chinese medicine for the treatment of vomiting [9, 10]. The needles were inserted in a sterile fashion immediately after induction of anaesthesia and remained in place for 15 min. They were removed in the induction room before transfer to the operating theatre and the start of surgery. One anaesthetist conducted the anaesthetic while another anaesthetist, trained and licensed in traditional Chinese medicine, performed the acupuncture needling.

Ondansetron group

These patients were given intravenous ondansetron 0.15 mg.kg^{-1} , to a maximum dose of 8 mg, in normal saline 50 ml as an infusion over 20 min

Placebo group

These patients were given an intravenous infusion of normal saline 50 ml over 20 min. All patients were kept in the induction room for a period of 15–20 min and were transferred to the operating theatre without intravenous drug infusions or acupuncture needles in place.

At the end of surgery, all patients' stomachs were aspirated via an orogastric tube. The patients were given an infusion of Ringer lactate solution at a rate of $4\text{--}6 \text{ ml.kg}^{-1} \cdot \text{h}^{-1}$ from the start of surgery until successful oral fluid intake. The intravenous cannula remained in place until the child was discharged home. In both the Post Anaesthesia Care Unit and in the Day Surgery Care Unit, trained nurses assessed the number of postoperative emetic episodes. All parents were given the same definition of vomiting and emetic episodes and were told how to complete a satisfaction score report. Vomiting was defined as expulsion of any stomach contents through the mouth, and an episode of retching was defined as an attempt to vomit. An emetic episode was defined as a single vomit or retch or a number of continual vomits and/or retches [7]. Nausea, a subjective feeling of the urge to vomit, is difficult to quantify in children, so it was not assessed. The parents were contacted on the day of surgery at home and on the first day after surgery by an anaesthetist in order to determine the incidence of postoperative emetic episodes at home. Parents were asked if they were satisfied with the anti-emetic treatment (yes or no) and they were asked to quantify their level of satisfaction using a 10-point score (1 = very poor and 10 = excellent).

The children, parents, nurses and the anaesthetist performing the telephone survey were unaware of the subjects' group allocation. Duration of anaesthesia was recorded, as were the durations of stay in the Post Anaesthesia Care Unit and the Day Surgery Care Unit.

Outcome measurements

The number of patients treated in the hospital for vomiting, complications of vomiting, the incidence of overnight admissions, the number of readmission days and parental satisfaction scores were recorded. Patients from any of the three groups with two or more emetic episodes occurring in the Post Anaesthesia Care Unit or the Day Surgery Care Unit were treated with intravenous ondansetron 0.1 mg.kg^{-1} . Postoperative pain was treated by the anaesthetist in the Post Anaesthesia Care Unit with

Table 1 Demographic and other data. Values are mean (SD).

	Ondansetron (n = 30)	Acupuncture (n = 30)	Placebo (n = 30)
Age; years	6.6 (3)	7.2 (3)	7.4 (3)
Sex; Male: Female	18 : 12	14 : 16	17 : 13
Weight; kg	25.3 (8)	25.3 (8)	26.4 (9)
Duration of surgery; min	107.5 (39)	103.5 (33)	99.1 (25)
Time in Post Anaesthesia Care Unit; min	86 (30)	86.3 (32)	83 (31)
Time in Day Surgery Care Unit; min	288.5 (260)	301.7 (280)	276 (255)
Fentanyl dose given during surgery; µg	20.3 (11.2)	21.3 (10.4)	20.8 (12)
Fentanyl dose given after surgery; µg	12 (5.3)	11 (5.6)	10 (6.5)

intravenous fentanyl 1–2 µg.kg⁻¹ in fractionated doses. Pain experienced in the Day Surgery Care Unit was treated with oral paracetamol up to 15 mg.kg⁻¹. All children were discharged to the Day Surgery Care Unit when they achieved an Aldrete recovery score of 10 [11]. Patients were discharged from the hospital when they achieved a score of ≥ 9 in the Modified Postanaesthesia Discharge Scoring System [12]. The ability to tolerate oral fluids was not included in the discharge criteria. All children studied lived in the same area and returned to their homes by car.

Statistical analysis

Comparisons of the incidence of emetic episodes and the satisfaction scores between the three groups were performed by Kruskal–Wallis analysis of variance, followed by a corrected Mann–Whitney test. Comparison of the fentanyl doses between the three groups was performed using one-way analysis of variance. Associations between the number of patients who vomited and parental satisfaction of three study groups were tested using the Chi-squared test or Fisher's test, as appropriate. Two-tailed probability values < 0.05 were considered to be significant. All tests were performed using SPSS for Windows.

Results

Ninety patients were enrolled in the study. Three patients in the acupuncture group were excluded from the study, one who was given naloxone and two whose parents could not be contacted after discharge. In the ondansetron group, two patients were excluded from the study, one because it was necessary to administer dexamethasone for stridor and one whose parents could not be contacted. Five children were therefore randomly added to the study, three to the acupuncture group and two to the ondansetron group, to bring the total number of patients to 90. No patient from the placebo group was excluded.

The three groups were comparable (Table 1). There were no statistically significant differences in the time spent in the Post Anaesthesia Care Unit or the Day Surgery Care Unit between the three groups, nor in the doses of fentanyl given during or after surgery.

There was a significant difference between the acupuncture and ondansetron groups when compared with the placebo group in the number of emetic episodes occurring after discharge on the day of surgery ($p < 0.0001$) (Table 2). A significant difference was also noted in the overall proportion of patients experiencing emetic episodes in the acupuncture and ondansetron groups compared to the placebo group ($p = 0.0004$, $p = 0.001$) (Fig. 1). There was no significant difference between the treatment groups and the placebo group in the incidence of emetic episodes in the Post Anaesthesia Care Unit ($p = 0.3$), in the Day Surgery Care Unit ($p = 0.1$) and on the first day after surgery ($p = 0.2$) (Table 2). Comparing the acupuncture group with the ondansetron group in the various phases of the study (Post Anaesthesia Care Unit, Day Surgery Care Unit, on the day of surgery after discharge and on the first day after surgery), there were no statistically significant differences

Table 2 Incidence of postoperative emetic episodes. Values are number of patients [number of episodes].

	Acupuncture (n = 30)	Ondansetron (n = 30)	Placebo (n = 30)
Post Anaesthesia Care Unit	4 [5]	2 [3]	6 [8]
Treatment needed	1	1	1
Day Surgery Care Unit	3 [3]	4 [4]	8 [13]
Treatment needed	1	1	4
Admission required	1	1	1
Day of surgery after discharge	3 [3]	2 [3]	14 [19]*
First day after surgery	2 [2]	2 [2]	5 [6]
Readmission required	0	0	1

*Significantly different from acupuncture and ondansetron groups, $p < 0.0001$.

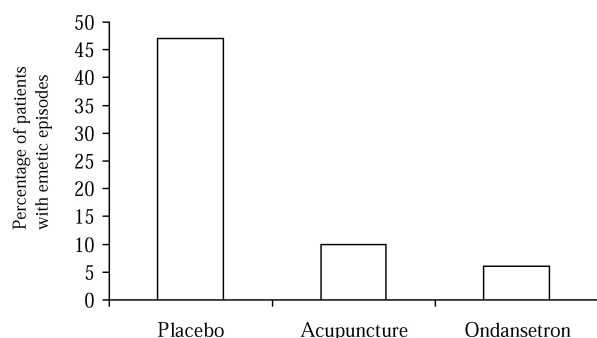


Figure 1 The overall proportion of patients suffering emetic episodes in the three study groups, combining episodes experienced in the Post Anaesthesia Care Unit, the Day Surgical Care Unit, on the day of surgery at home and on the first day after surgery.

in the incidence of emetic episodes ($p = 0.3$, $p = 0.1$, $p = 0.3$ and $p = 0.1$) or in the number of patients who suffered an emetic episode ($p = 0.6$, $p = 0.7$, $p = 0.6$, $p = 1$) (Table 2).

Higher mean satisfaction scores were reported for the acupuncture group (9.5) and in the ondansetron group (9.0) when compared to the placebo group (7.0), $p = 0.03$. No statistical difference in satisfaction was noted between the acupuncture and ondansetron groups ($p = 0.5$). A statistically significantly greater number of parents in the ondansetron and acupuncture groups expressed overall satisfaction with the anti-emetic treatment than in the placebo group ($p = 0.019$).

One patient in the acupuncture group and one in the ondansetron group required unscheduled overnight hospital admission. Two patients in the placebo group stayed in hospital overnight and one patient was readmitted to the hospital. These patients were all successfully treated with intravenous ondansetron 0.1 mg.kg^{-1} and intravenous fluid. No complications other than emesis were noted.

Discussion

Although the exact mechanism of action of this form of acupuncture treatment is yet to be determined, it does appear to be effective. A number of studies have been conducted of the effect of acupuncture and acupressure on postoperative nausea and vomiting [4, 9, 13]. Fan *et al.* [13] concluded that acupressure at the pericardium meridian PC_6 point (Nei-Guan) is effective prophylaxis for postoperative vomiting in adults undergoing minor surgery. It was also suggested that PC_6 acupressure is as effective as intravenous metoclopramide 10 mg in preventing nausea and vomiting during spinal anaesthesia

[14]. Dundee *et al.* [15, 16] reported that acupuncture or acupressure at the PC_6 point is an effective postoperative anti-emetic in women given opioid premedication before minor gynaecological surgery. The same group suggested that in order to be effective, the acupressure or the acupuncture must be given before the emetic stimuli that occur during anaesthesia or surgery [17]. In our study, acupuncture proved to be effective when administered before the start of surgery. However, some studies have failed to find a significant anti-emetic effect of acupuncture in children undergoing tonsillectomy [18,19] or strabismus surgery [20].

The effectiveness of acupuncture in preventing postoperative vomiting in our study may be related to the accurate bilateral location of the PC_6 acupuncture points, the additive effect of the use of the CV_{13} point and the timing of needle insertion. In order to obtain an accurate location for needle insertion, a Cunometer (a special measuring device commonly used in traditional Chinese medicine) was used in all cases. In the studies in which acupuncture was unsuccessful [18–20], only a unilateral PC_6 point was used and the use of a Cunometer was not reported. Nausea and vomiting are explained in traditional Chinese medicine as an upward rebellious Qi (energy) of the stomach. Both the PC_6 and the CV_{13} have the effect of subduing the rebellious energy of the stomach. The additive effect of the CV_{13} point to the PC_6 point could be another explanation for the effectiveness of acupuncture therapy in our study.

Clement-Jones [21] reported increased β endorphin, but not met-enkephalin, levels in human cerebrospinal fluid after acupuncture stimulation. Opioids have both emetic and anti-emetic effects. The emetic effect is mediated by δ receptors and the anti-emetic effects are mediated by μ receptors. β endorphin has equal affinity for both receptors, whereas enkephalins bind predominantly to δ receptors. Thus, the anti-emetic effect of acupuncture could be related to the high levels of β endorphin it appears to stimulate. Another hypothesis explaining the mechanism of PC_6 and CV_{13} acupuncture in preventing nausea and vomiting is that the PC_6 meridian point is located near the median nerve and therefore stimuli caused by needles, acupressure or electrical stimulation may release neurochemical substances that in turn desensitise the chemoreceptor trigger zone in the brain and prevent postoperative vomiting.

Ondansetron is a selective $5HT_3$ receptor antagonist shown in a number of studies to be more effective than other prophylactic anti-emetic agents in children undergoing general anaesthesia [22, 23]. Our results confirm the efficacy of ondansetron as a prophylactic therapy for postoperative vomiting when compared to placebo, particularly during the early postdischarge period.

However, ondansetron may be associated with a number of side-effects, including headache, fever, dizziness, abdominal cramps and a transient elevation in plasma aminotransferase and bilirubin levels [24]. Anaphylactic or anaphylactoid reactions have been reported after the administration of ondansetron given with chemotherapy [25]. Moreover, the routine dose of ondansetron 0.15 mg.kg^{-1} is considered to be a high dose and is an expensive treatment [25]. Splinter *et al.* [26] demonstrated that a low dose of ondansetron (0.05 mg.kg^{-1}) given with dexamethasone (0.15 mg.kg^{-1}) is more effective in decreasing the incidence of vomiting in children after strabismus surgery than ondansetron 0.15 mg.kg^{-1} alone.

A variety of factors affect the incidence and severity of postoperative nausea and vomiting: sex and age of the patient; administration of opioids during and after surgery; a history of motion sickness; the anaesthetic technique; postoperative pain; the administration of anticholinergic drugs [23,27]. These factors were controlled in our study. Our findings with respect to the interval between anaesthesia and emesis are similar to those of Woods *et al.* [28] and Shreiner *et al.* [29]. They concluded that postoperative vomiting occurs a relatively long time after surgery, usually in the Day Surgery Care Unit and at home after discharge, and rarely occurs in the immediate postoperative period. The timing of oral fluid intake may have had some influence on this. Scuderi *et al.* [30] reported that there was a significant difference in satisfaction score between patients who received prophylactic anti-emetic treatment when compared to the subjects in a control group who were only treated when necessary. As our study was in children, we were limited to determining parent satisfaction, which was significantly higher in the treatment groups than in the placebo group. The decision as to whether it is worthwhile to administer anti-emetic prophylaxis or to wait and treat the patient as required, seems, in terms of patient and parent satisfaction, to fall heavily in favour of routine prophylactic anti-emetic therapy.

References

- 1 Watcha MF, Bras PJ, Cieslak GD, Pennant JH. The dose – response relationship of ondansetron in preventing postoperative emesis in pediatric patients undergoing ambulatory surgery. *Anesthesiology* 1995; **82**: 47–52.
- 2 Gold BS, Kitz DS, Lecky JH, Neuhaus JM. Unanticipated admission to the hospital following ambulatory surgery. *Journal of the American Medical Association* 1989; **262**: 3008–10.
- 3 Anon. NIH consensus development panel on Acupuncture. *Journal of the American Medical Association* 1998; **280**: 1518–24.
- 4 Al-Sadi M, Newman B, Julious A. Acupuncture in the prevention of postoperative nausea and vomiting. *Anaesthesia* 1997; **52**: 658–61.
- 5 Alon E, Himmelseher S. Ondansetron in the treatment of postoperative vomiting: a randomized, double blind comparison with droperidol and metoclopramide. *Anesthesia and Analgesia* 1992; **75**: 561–5.
- 6 Splinter WM, Rhine EJ. Prophylactic antiemetics in children after tonsillectomy: high dose vs low dose ondansetron. *Paediatric Anaesthesia* 1997; **7**: 125–9.
- 7 Davis PJ, McGowan FX Jr, Landsman I, *et al.* Effect of antiemetic therapy on recovery and hospital discharge time. A double blind assessment of ondansetron, droperidol, and placebo in pediatric patient undergoing ambulatory surgery. *Anesthesiology* 1995; **83**: 956–60.
- 8 Tang J, Watch MF, White PF. A comparison of costs and efficacy of ondansetron and droperidol, as prophylactic antiemetic therapy for elective outpatient gynecologic procedures. *Anesthesia and Analgesia* 1996; **83**: 304–13.
- 9 Dundee JW, Fitzpatrick KT, Gale R. Is there a role for acupuncture in the treatment of postoperative nausea and vomiting? *Anesthesiology* 1987; **67**: A165.
- 10 Ross J. *Acupuncture Point Combinations: Their Point to Clinical Success*. Edinburgh: Churchill Livingstone, 1995: pp. 138.
- 11 Aldrete JA, Kroulik D. A postanesthetic recovery score. *Anesthesia and Analgesia* 1970; **49**: 924–34.
- 12 Chung F. Discharge criteria – a new trend. *Canadian Journal of Anaesthesia* 1995; **42**: 1056–8.
- 13 Fan CF, Tanhui E, Joshi S, *et al.* Acupressure treatment for prevention of postoperative nausea and vomiting. *Anesthesia and Analgesia* 1997; **84**: 821–5.
- 14 Stein DJ, Birnbach DJ, Danzer BI, *et al.* Acupressure versus intravenous metoclopramide to prevent nausea and vomiting during spinal anesthesia for cesarean section. *Anesthesia and Analgesia* 1997; **84**: 342–5.
- 15 Dundee JW, Chestnutt WN, Ghaly RG, Lyness AG. Traditional Chinese acupuncture: a potentially useful antiemetic? *British Medical Journal* 1986; **293** (6547): 583–4.
- 16 Dundee JW, Milligan KR. Acupuncture as an antiemetic. *British Medical Journal* 1988; **296**: 135.
- 17 Dundee JW, Ghaly RG, Bill KM, *et al.* Effect of the stimulation of PC6 antiemetic point on postoperative nausea and vomiting. *British Journal of Anaesthesia* 1989; **63**: 612–8.
- 18 Shenkman Z, Holzman RS, Kim C, *et al.* Acupressure – acupuncture antiemetic prophylaxis in children undergoing tonsillectomy. *Anesthesiology* 1999; **90**: 1311–16.
- 19 Yentis SM, Bissonnette B. P6 acupuncture and postoperative vomiting after tonsillectomy in children. *British Journal of Anaesthesia* 1991; **67**: 779–80.
- 20 Lewis IH, Pryn SJ, Reynolds PI, *et al.* Effect of P6 acupressure on postoperative vomiting in children undergoing outpatient strabismus correction. *British Journal of Anaesthesia* 1991; **67**: 73–8.
- 21 Clement-Jones V, McLoughlin L, Tomlin S, *et al.* Increased β -endorphin but not met-enkephalin levels in human cerebrospinal fluid after acupuncture for recurrent pain. *Lancet* 1980; **1** (8201): 946–9.

- 22 Furst SR, Rodarte A. Prophylactic antiemetic treatment with ondansetron in children undergoing tonsillectomy. *Anesthesiology* 1994; **81**: 799–803.
- 23 Ummenhofer W, Frei FJ, Urwyler A, *et al.* Effects of ondansetron in the prevention of postoperative nausea and vomiting in children. *Anesthesiology* 1994; **81**: 804–10.
- 24 Watcha MF, White PF. Postoperative nausea and vomiting. Its etiology, treatment and prevention. *Anesthesiology* 1992; **77**: 162–84.
- 25 Frigerio C, Buchwalder PA, Spertini F. Ondansetron; reasons to be restrictive. *Lancet* 1996; **347**: 1484–5.
- 26 Splinter WM, Rhine EJ. Low-dose ondansetron with dexamethasone more effectively decreases vomiting after strabismus surgery in children than does high-dose ondansetron. *Anesthesiology* 1998; **88**: 72–5.
- 27 Chhibber AK, Lustik SJ, Thakur R, *et al.* Effects of anticholinergics on postoperative vomiting, recovery and hospital stay in children undergoing tonsillectomy with or without adenoidectomy. *Anesthesiology* 1999; **90**: 697–700.
- 28 Woods AM, Berry FA, Carte BJ. Strabismus surgery and postoperative vomiting clinical observations and review of the current literature; a medical opinion. *Paediatric Anaesthesia* 1992; **2**: 223–9.
- 29 Schreiner MS, Nicolson SC, Martin T, Whitney L. Should children drink before discharge from day surgery? *Anesthesiology* 1992; **76**: 528–33.
- 30 Scuderi PE, James RL, Harris L, Mims GR. Antiemetic prophylaxis does not improve outcomes after outpatient surgery when compared to symptomatic treatment. *Anesthesiology* 1999; **90**: 360–71.