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Low-dose sufentanil as a supplement to halothane/N₂O anaesthesia in infants and children

Sufentanil as a supplement to halothane/N₂O anaesthesia was evaluated in 32 unpremedicated infants and children age 6 months to 9 yr undergoing elective orthopaedic surgery. Patients were randomly assigned in a double-blind manner to receive one of four intravenous supplements: placebo, sufentanil 0.5, 1.0 or 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$. Systolic arterial pressure (SAP), heart rate (HR) and end-tidal halothane concentration were recorded before and after induction, supplement administration, tracheal intubation, incision and every 15 min during the procedure. Venous catecholamine samples were obtained before and after incision. A pain score was assigned to the patients in the postanaesthesia care unit (PACU). Sufentanil at all three doses prevented increases in SAP and HR with intubation and incision, provided superior pain relief in the PACU and did not prolong wake-up time. Sufentanil 1.0 and 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$ allowed for a reduction in the halothane requirements. Sufentanil 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$ was associated with lower catecholamine levels than in the placebo group following incision. Sufentanil supplementation at 1.0 and 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$ was associated with bradycardia and/or hypotension during induction and an increased incidence of vomiting during the first 24 hours postoperatively. One patient in the sufentanil 1.0 $\mu\text{g} \cdot \text{kg}^{-1}$ group whose surgical time was less than 45 min exhibited respiratory depression in the PACU requiring narcotic reversal. In conclusion, sufentanil 0.5 $\mu\text{g} \cdot \text{kg}^{-1}$ improved immediate postoperative pain relief and is acceptable as a supplement during halothane anaesthesia in infants and children. The associated side effects of larger doses of sufentanil (1.0 and 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$) make their use as a supplement to halothane anaesthesia unacceptable.

Key words

ANAESTHESIA: paediatric; ANAESTHETICS: sufentanil;
ANALGESICS, NARCOTIC: sufentanil.

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Sufentanil in high doses (5–20 $\mu\text{g} \cdot \text{kg}^{-1}$) has been shown to be safe and effective in infants and children undergoing cardiac surgery.¹ However, the use of low-dose (0.5–1.5 $\mu\text{g} \cdot \text{kg}^{-1}$) sufentanil in infants and children has not been studied. The purpose of this double-blind study was to evaluate the use of low-dose sufentanil as a supplement to halothane/N₂O anaesthesia in children undergoing orthopaedic procedures.

Methods

The subjects were infants and children six months to nine years of age undergoing elective orthopaedic surgical procedures with anticipated duration of one to two hours. The study was approved by the Institutional Review Board and written informed consent obtained. Patients were randomly assigned in a double-blind manner to receive one of four supplements (placebo, sufentanil 0.5 $\mu\text{g} \cdot \text{kg}^{-1}$, 1.0 $\mu\text{g} \cdot \text{kg}^{-1}$, or 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$) to be used as part of a halothane/N₂O anaesthetic.

Anaesthesia was performed by one of the investigators who was blinded as to the supplement the patient received. A syringe was prepared by a second investigator and contained either 3 ml of normal saline or 3 ml of a solution containing the correct quantity of sufentanil. The syringe was labeled "study drug" and was given to the anaesthetist providing the anaesthesia. Members of the surgical team, other operating room personnel and the postanaesthesia care unit (PACU) nurses were also blinded as to the supplement received.

All patients were fasted and no patient received a premedication. Upon arrival in the operating room a precordial stethoscope, electrocardiogram (Datascop, Paramus, NJ) and an automated blood pressure device (Dinamap, Critikon, Tampa, FL) were attached to the patient and control values of heart rate and systolic, mean and diastolic blood pressure were recorded. Patient temperature was maintained between 35 and 38°C. Tourniquets on the lower extremities were utilized in 17 patients. Bradycardia was defined as a 40 per cent decrease from the control heart rate (HR) and hypotension defined as a 40 per cent decrease from the control systolic arterial pressure (SAP).

Anaesthesia was induced with halothane/N₂O in 40 per

cent oxygen. Following induction, two intravenous lines were secured: one for fluid and drug administration and one for obtaining venous blood samples. End-tidal halothane concentration was measured by a Beckman LB-2 infrared gas analyzer (Beckman Instruments, Inc., Fullerton, CA) that was calibrated prior to each study with a known concentration of halothane in 60 per cent nitrous oxide. A circle system was used with gas being sampled at the proximal end of the endotracheal tube. End-tidal halothane was maintained at 1.4 per cent for at least three minutes prior to the rapid intravenous administration of the supplement: placebo (3 ml normal saline), sufentanil 0.5, 1.0 or 1.5 $\mu\text{g}\cdot\text{kg}^{-1}$. The last 20 patients had the supplement administered intravenously over 60 to 120 seconds. Three minutes following the supplement administration the patient's trachea was intubated. Three minutes following tracheal intubation the halothane was decreased to maintain the end-tidal halothane at 1.2 per cent until five minutes following skin incision. At that point and until the conclusion of the surgical procedure the end-tidal halothane was adjusted to keep the patient's HR and SAP between 80 and 100 per cent of the control level. Nitrous oxide 60 per cent in oxygen was continued as part of the anaesthetic maintenance. Atropine 0.01 $\text{mg}\cdot\text{kg}^{-1}$ was administered intravenously if bradycardia occurred and was accompanied by a decrease in SAP.

Transcutaneous carbon dioxide tension (Novamatrix Medical Systems, Inc., Wallingford, CT) was maintained between 35 and 45 mmHg with assisted manual ventilation. Spontaneous ventilation was allowed when the transcutaneous CO_2 could be maintained below 45 mmHg. Respiratory depression at the end of the surgical procedure was defined as inability to achieve spontaneous ventilation. Tracheal extubation was performed when the patient demonstrated adequate ventilation, presence of protective airway reflexes and purposeful movements.

SAP, HR and end-tidal halothane concentrations were obtained at the following times: in the operating room prior to induction of anaesthesia (control values); prior to and 3 min after supplement administration; prior to and 3 min after tracheal intubation; prior to and 3 min after skin incision; every 15 min following tracheal intubation; at the time of tracheal extubation; and upon arrival in the PACU.

Venous blood samples for catecholamine levels were obtained just prior to and 5 min following skin incision. Plasma epinephrine and norepinephrine analysis was performed by a radioenzymatic assay technique (Endocrine Sciences, Tarzana, CA).

All patients were cared for by the same two PACU nurses who were blinded to the supplement the patient received. A pain score (Table I) was assigned to the patient upon admission to the PACU, 15 min following

TABLE I Pain scoring system

1	Comfortable – denies pain, lying quietly.
2	Mild pain – fussy, verbalizes pain then rests quietly, infants able to be pacified with comfort measures.
3	Moderate pain – constantly verbalizes pain, whining, unable to pacify, does not rest.
4	Severe pain – hysterical, guarding, elevated vital signs, constant crying.

admission and upon discharge from the PACU. Morphine 0.1 $\text{mg}\cdot\text{kg}^{-1}$ IV was administered if the pain score was three or four. Narcotic requirements in PACU, side effects including vomiting and respiratory depression, and the time from the discontinuation of the inhalation agent until the patient responded to verbal commands (wake-up time) were also noted.

The patients were visited by one of the anaesthetist investigators on the first postoperative day to determine if any side effects occurred and to evaluate the overall recovery from anaesthesia.

Statistical analyses were carried out using the SPSS software package and intergroup differences were tested by one-way analysis of variance.² The Tukey multiple range test was used as a *post hoc* multiple comparison technique after the analysis of variance. The dependent variables were SAP, HR, end-tidal halothane concentration, age, weight, surgery duration, time to achieve spontaneous ventilation, wake-up time, time in PACU, and total dose of morphine required during the first 24 hrs. SAP and HR changes within groups at supplement administration, intubation and incision were compared with a Student's *t* test using a Bonferroni correction. The number of patients requiring narcotics in the PACU were tested by Chi-square with the Yates correction. The incidence of side effects between groups was tested by the Fisher exact test. Changes in catecholamines within groups at incision were tested with the Wilcoxon signed-rank test using a Bonferroni correction. Catecholamine and pain score intergroup differences were tested by the Kruskal-Wallis one-way analysis of variance. A *p* value ≤ 0.05 was considered significant. Values are presented as means $\pm$ standard deviation (SD).

Results

Thirty-two patients were studied, eight in each study group. Mean ages, weight, admission SAP and HR, and duration of operation for the four groups are shown in Table II. There were no statistically significant intergroup differences, though the patients in the placebo group tended to be younger.

The pre-supplement SAP and HR were significantly less than control values in the placebo, sufentanil 0.5 and 1.5 $\mu\text{g}\cdot\text{kg}^{-1}$ groups (Table III). There were no differ-

TABLE II Patient data (mean $\pm$ SD)

Study group	n	Age (mos)	Weight (kg)	Surgery duration (min)	Admission	
					SAP*	HR†
Placebo	8	37 $\pm$ 32	12.7 $\pm$ 7.1	108 $\pm$ 37	91 $\pm$ 12	122 $\pm$ 25
Sufentanil 0.5 $\mu\text{g} \cdot \text{kg}^{-1}$	8	75 $\pm$ 19	18.6 $\pm$ 6.4	108 $\pm$ 45	96 $\pm$ 8	106 $\pm$ 21
Sufentanil 1.0 $\mu\text{g} \cdot \text{kg}^{-1}$	8	73 $\pm$ 42	19.6 $\pm$ 7.2	97 $\pm$ 61	103 $\pm$ 7	95 $\pm$ 14
Sufentanil 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$	8	72 $\pm$ 33	18.5 $\pm$ 7.6	92 $\pm$ 25	101 $\pm$ 19	106 $\pm$ 15

*SAP = systolic arterial pressure, mmHg.

†HR = heart rate, beats $\cdot \text{min}^{-1}$.

ences between groups in control or pre-supplement SAP and HR.

Significant decreases in SAP and HR occurred with sufentanil administration in the 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$ group and a significant decrease in HR occurred in the 1.0 $\mu\text{g} \cdot \text{kg}^{-1}$ group. The decrease occurred within 60 sec of sufentanil injection in each instance and promptly responded to intravenous atropine 0.01 $\text{mg} \cdot \text{kg}^{-1}$. The bradycardia (HR 60 per cent of control value) and hypotension (SAP 60 per cent of control value) occurred in all the patients in the

1.5 $\mu\text{g} \cdot \text{kg}^{-1}$ group and 63 per cent of the patients in the 1.0 $\mu\text{g} \cdot \text{kg}^{-1}$ group (Table IV). Intergroup comparisons revealed a significantly lower heart rate following sufentanil injection in the 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$ group than in the placebo group (Table III).

HR increased significantly following intubation only in the placebo group. There were no significant intergroup differences in SAP or HR just prior to or following intubation (Table III).

A significant increase in SAP and HR occurred with

TABLE III Haemodynamic data (mean $\pm$ SD)

	Systolic arterial pressure, mmHg				Heart rate, beats $\cdot \text{min}^{-1}$			
	Sufentanil ($\mu\text{g} \cdot \text{kg}^{-1}$)				Sufentanil ($\mu\text{g} \cdot \text{kg}^{-1}$)			
	Placebo	0.5	1.0	1.5	Placebo	0.5	1.0	1.5
Control	109 $\pm$ 19*	107 $\pm$ 15*	96 $\pm$ 21	114 $\pm$ 12*	115 $\pm$ 28*	110 $\pm$ 18*	112 $\pm$ 14	117 $\pm$ 18*
Pre-supplement	84 $\pm$ 10	87 $\pm$ 19	90 $\pm$ 18	89 $\pm$ 28	101 $\pm$ 19	94 $\pm$ 25	103 $\pm$ 24	88 $\pm$ 13
Post-supplement	79 $\pm$ 10	74 $\pm$ 18	62 $\pm$ 17	58 $\pm$ 10†	94 $\pm$ 23	86 $\pm$ 24	70 $\pm$ 27†	62 $\pm$ 8†
Mean % change	-6 $\pm$ 10	-10 $\pm$ 35	-24 $\pm$ 18	-29 $\pm$ 11	-7 $\pm$ 12	-3 $\pm$ 42	-33 $\pm$ 21	-29 $\pm$ 6
Pre-intubation	79 $\pm$ 10	79 $\pm$ 14	87 $\pm$ 25	83 $\pm$ 51	94 $\pm$ 23	93 $\pm$ 23	100 $\pm$ 25	113 $\pm$ 32
Post-intubation	87 $\pm$ 13	74 $\pm$ 12	92 $\pm$ 22	75 $\pm$ 30	106 $\pm$ 24†	96 $\pm$ 22	107 $\pm$ 20	116 $\pm$ 29
Mean % change	11 $\pm$ 13	-5 $\pm$ 20	7 $\pm$ 9	-1 $\pm$ 7	14 $\pm$ 14	3 $\pm$ 8	9 $\pm$ 12	4 $\pm$ 9
Pre-incision	78 $\pm$ 13	84 $\pm$ 17	88 $\pm$ 21	81 $\pm$ 8	103 $\pm$ 20	124 $\pm$ 22	109 $\pm$ 13	124 $\pm$ 13
Post-incision	94 $\pm$ 15†	94 $\pm$ 15	90 $\pm$ 17	81 $\pm$ 8	126 $\pm$ 18†	125 $\pm$ 18	107 $\pm$ 13	123 $\pm$ 12
Mean % change	21 $\pm$ 18	13 $\pm$ 16	4 $\pm$ 13	0 $\pm$ 5	25 $\pm$ 14	2 $\pm$ 7	-2 $\pm$ 3	-1 $\pm$ 2
Post-intubation								
30 min	97 $\pm$ 20	97 $\pm$ 14	90 $\pm$ 16	81 $\pm$ 12	119 $\pm$ 19	124 $\pm$ 17	106 $\pm$ 15	123 $\pm$ 13
60 min	95 $\pm$ 15	98 $\pm$ 15	91 $\pm$ 19	94 $\pm$ 13	119 $\pm$ 24	125 $\pm$ 18	106 $\pm$ 17	121 $\pm$ 7
90 min	97 $\pm$ 13	100 $\pm$ 13	102 $\pm$ 23	95 $\pm$ 18	128 $\pm$ 28	123 $\pm$ 14	125 $\pm$ 7	120 $\pm$ 8
120 min	93 $\pm$ 14	106 $\pm$ 8	91 $\pm$ 22	87 $\pm$ 13	116 $\pm$ 29	125 $\pm$ 14	124 $\pm$ 13	120 $\pm$ 19
Extubation	102 $\pm$ 13	112 $\pm$ 11	103 $\pm$ 11	102 $\pm$ 17	133 $\pm$ 38	145 $\pm$ 25	137 $\pm$ 14	138 $\pm$ 22
Arrival in PACU	96 $\pm$ 9	97 $\pm$ 14	104 $\pm$ 9	103 $\pm$ 16	144 $\pm$ 19	141 $\pm$ 19	130 $\pm$ 24	147 $\pm$ 14

*Control values significantly different from pre-supplement values by Student's *t* test with Bonferroni correction ($p < 0.05$).†Pre- and post-values significantly different by Student's *t* test with Bonferroni correction ($p < 0.05$).

FIGURE 4 End-tidal halothane requirements at 15 min intervals following intubation. * Significantly different from placebo by one-way analysis of variance with Tukey multiple range test ($p < 0.05$). #Significantly different from placebo and sufentanil $0.5 \mu\text{g} \cdot \text{kg}^{-1}$ by one-way analysis of variance with Tukey multiple range test ($p < 0.05$).

skin incision in the placebo group. There were no significant intergroup differences in SAP or HR just prior to or following skin incision (Table III).

There were no significant intergroup differences in SAP or HR at 30, 60, 90, and 120 min following intubation, at extubation or upon arrival in the PACU.

End-tidal halothane concentration at supplement administration, tracheal intubation and incision was not

TABLE IV Number of patients experiencing side effects and complications ($n = 8$ in each group)

	Placebo	Sufentanil ($\mu\text{g} \cdot \text{kg}^{-1}$)		
		0.5	1.0	1.5
Bradycardia*	0	3	5	8
Hypotension†	2	4	5	8
Chest wall rigidity	0	0	0	1
Respiratory depression	0	0	3	0
Nausea/vomiting in PACU	0	2	2	2
Nausea/vomiting first 24 hrs*	2	4	6	7

*Significant difference between placebo and the sufentanil 1.0 and $1.5 \mu\text{g} \cdot \text{kg}^{-1}$ groups by Fisher exact test ($p < 0.05$).

†Significant difference between placebo and the sufentanil $1.5 \mu\text{g} \cdot \text{kg}^{-1}$ group by Fisher exact test ($p < 0.05$).

significantly different between groups (Table V). By 15 min following intubation the sufentanil $1.5 \mu\text{g} \cdot \text{kg}^{-1}$ group required less halothane than the placebo group (Figure). By 45 min following intubation the sufentanil 1.0 and $1.5 \mu\text{g} \cdot \text{kg}^{-1}$ groups were requiring less halothane than either the placebo or sufentanil $0.5 \mu\text{g} \cdot \text{kg}^{-1}$ groups. The sufentanil $0.5 \mu\text{g} \cdot \text{kg}^{-1}$ group had similar halothane requirements as the placebo group throughout the procedure.

Intergroup differences in epinephrine and norepinephrine levels are presented in Table VI. There were no intragroup differences in pre- or post-incision norepinephrine and epinephrine levels.

The time from induction until spontaneous ventilation was achieved was 38 ± 23 , 66 ± 27 , 68 ± 18 , and 83 ± 32 min for the placebo, 0.5, 1.0, and $1.5 \mu\text{g} \cdot \text{kg}^{-1}$ groups, respectively. This time was significantly less in the placebo group compared to the sufentanil $1.5 \mu\text{g} \cdot \text{kg}^{-1}$ group. Two patients in the sufentanil $1.0 \mu\text{g} \cdot \text{kg}^{-1}$ group were unable to be extubated in the operating room due to absence of protective reflexes or purposeful movements. One patient in the sufentanil $1.0 \mu\text{g} \cdot \text{kg}^{-1}$ group was unable to be extubated in the operating room and required narcotic reversal in the PACU. In each of these three cases the surgical procedure time was less than 60 min with a mean surgical time of 40 ± 19 min. The mean surgical time of those patients who were extubated in the operating room was significantly longer, 107 ± 39 min.

There was no difference between groups in pain scores upon admission to the PACU (Table VII). Within 15 min the placebo group had a significantly higher pain score than the sufentanil groups. Seventy-five per cent of the patients in the placebo group required narcotics in the PACU. Only 21 per cent of the patients in the sufentanil groups required additional narcotics. This difference is statistically significant. Upon discharge from the PACU there was no difference in pain scores between the groups. The amount of morphine required during the first 24 hrs postoperatively was not different between groups. The wake-up time, the time from discontinuation of the inhalation agents until patient responsiveness, was similar in all four groups. Time spent in the PACU was not different between groups.

The most common side-effect was the bradycardia and

TABLE V End-tidal halothane concentrations (%) during induction, intubation and incision

	Placebo	Sufentanil ($\mu\text{g} \cdot \text{kg}^{-1}$)		
		0.5	1.0	1.5
Supplement administration	1.41 ± 0.14	1.39 ± 0.12	1.49 ± 0.15	1.46 ± 0.04
Intubation	1.46 ± 0.13	1.39 ± 0.05	1.47 ± 0.14	1.53 ± 0.13
Incision	1.24 ± 0.06	1.21 ± 0.04	1.13 ± 0.16	1.15 ± 0.04

TABLE VI Catecholamine data (mean $\pm$ SD)

	Placebo	Sufentanil ($\mu\text{g} \cdot \text{kg}^{-1}$)		
		0.5	1.0	1.5
Epinephrine ($\text{pg} \cdot \text{ml}^{-1}$)				
pre-incision	71 $\pm$ 85	55 $\pm$ 75	68 $\pm$ 86	41 $\pm$ 23
post-incision	141 $\pm$ 107	91 $\pm$ 133	50 $\pm$ 60*	34 $\pm$ 18*
Norepinephrine ($\text{pg} \cdot \text{ml}^{-1}$)				
pre-incision	466 $\pm$ 160	306 $\pm$ 220	441 $\pm$ 198	252 $\pm$ 159*
post-incision	564 $\pm$ 106	441 $\pm$ 365	423 $\pm$ 180	305 $\pm$ 139*

*Significantly different from placebo by Kruskal-Wallis one-way analysis of variance ($p < 0.05$).

TABLE VII Post-anaesthesia care unit (PACU) data

	Placebo	Sufentanil ($\mu\text{g} \cdot \text{kg}^{-1}$)		
		0.5	1.0	1.5
Pain score, median (range)				
admission to PACU	1 (1-3)	1 (1-3)	1 (1-4)	1 (1-3)
15 min later*	3 (1-4)	1 (1-2)	1 (1-4)	1 (1-3)
discharge from PACU	1 (1-2)	1 (1-2)	1 (1-2)	2 (1-3)
Number of patients requiring narcotics in PACU†	6/8 75%	2/8 25%	1/8 12%	2/8 25%
Wake-up time (min)	23 $\pm$ 20	35 $\pm$ 10	40 $\pm$ 12	19 $\pm$ 7
Time in PACU (min)	59 $\pm$ 16	63 $\pm$ 20	67 $\pm$ 20	52 $\pm$ 9
Total dose of morphine (mg) required during first 24 hrs	5.7 $\pm$ 3.4	5.0 $\pm$ 3.5	5.3 $\pm$ 4.4	7.0 $\pm$ 5.0

*Placebo group pain score significantly greater than any of the sufentanil groups pain scores – Kruskal-Wallis one-way analysis of variance ($p < 0.05$).

†Significantly more patients in the placebo group required narcotics in the PACU than in any of the sufentanil groups – Chi-square ($p < 0.05$).

hypotension described above (Table IV). Chest wall rigidity occurred in one patient in the 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$ group. There was no significant difference in the incidence of vomiting in the PACU between groups. However, during the first 24 hrs postoperatively significantly more patients in the 1.0 and 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$ groups experienced vomiting than the patients in the placebo group.

Discussion

Patients in the placebo group tended to be younger than the patients in the sufentanil groups, though the difference in ages was not statistically significant. Therefore, it is possible that some of the patients may not have received equipotent anaesthetic concentrations. However, the halothane requirements for a three-year-old and a six-year-old are similar.³ For this reason we feel the age difference did not significantly affect the outcome of the study.

An end-tidal halothane concentration of 1.4 per cent was chosen for baseline anaesthesia during induction and intubation because in our experience nonparalyzed children can be intubated at this level of anaesthesia without

precipitating reflex coughing or movement. An increase in heart rate occurred with intubation in the placebo group but was prevented in the sufentanil groups. Similarly, a haemodynamic stress response occurred with incision in the placebo group but was not present in the sufentanil groups. In no group was there a significant increase in catecholamines with incision, although the catecholamine levels post-incision were higher in the placebo group compared to the sufentanil 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$ group. Whether the elimination of the sympathetic stress response in children during anesthesia is of clinical benefit remains unclear at this time.

The dose-related bradycardia and hypotension seen in the narcotic groups is more pronounced than previously reported following sufentanil administration.¹ This was most likely due to the fact that the patients were not pretreated with atropine. However, we suspect that the bradycardic effect of sufentanil potentiates the bradycardic effect of halothane. While administering the sufentanil over a longer period of time (1–2 min) seems to lessen the bradycardia it does not prevent its occurrence. With

subsequent clinical use of sufentanil we have found that concurrent administration of pancuronium or premedication with atropine will prevent the bradycardia. This is in agreement with previous adult studies.^{5,6}

The most obvious advantage of sufentanil supplementation was the consistently low pain scores achieved in the PACU along with less need for further narcotic administration in the PACU. However, sufentanil supplementation did not change the admission or discharge pain scores nor did it affect the first 24 hr postoperative narcotic requirement. Sufentanil at the higher doses (1.0 and 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$) did decrease the maintenance halothane requirements. The decreased halothane requirement did not alter the wake-up or recovery room times. Therefore, the clinical significance of lower halothane requirements is unclear. It is possible that the halothane requirement would have been lower, particularly in the sufentanil 1.0 and 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$ groups, had atropine not been used during induction.

Disadvantages of sufentanil 1.0 and 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$ supplementation included: (1) an increased incidence of gastrointestinal upset postoperatively, (2) respiratory depression, (3) inability to extubate the patient in the operating room if the surgical procedure was shorter than 1 hr, and (4) cardiovascular instability during induction.

In conclusion, sufentanil 0.5 $\mu\text{g} \cdot \text{kg}^{-1}$ improved immediate postoperative pain relief and is acceptable as a supplement during halothane anaesthesia in infants and children. The associated side effects of larger doses of sufentanil (1.0 and 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$) make their use as a supplement to halothane anaesthesia unacceptable. Doses less than 0.5 $\mu\text{g} \cdot \text{kg}^{-1}$ might be useful in surgery of less than one hour duration and deserve further investigation.

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Résumé

Le sufentanil a été évalué comme supplément lors de l'anesthésie à l'halothane/proxyde d'azote chez 32 enfants et nouveau-nés non-prémédiqués âgés de six mois à neuf ans devant subir une chirurgie électorale orthopédique. A double-insu et de façon randomisée les patients devaient recevoir l'un des quatre suppléments intraveineux suivants: placebo, sufentanil 0.5, 1.0 ou 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$. La pression artérielle systolique (SAP), la fréquence cardiaque (HR) et la concentration d'halothane en fin d'expiration ont été enregistrées avant et après l'induction et l'administration du supplément, l'intubation trachéale, l'incision et à toutes les 15 minutes pendant la procédure. Les échantillons veineux pour mesurer les catécholamines ont été obtenus avant et après l'incision. Une échelle de douleur a été conçue pour les patients à l'unité des soins postanesthésiques (PACU). Le sufentanil aux trois doses a empêché l'augmentation de la pression artérielle systolique et de la fréquence cardiaque lors de l'intubation et de l'incision, il a aussi amené un plus grand soulagement de la douleur en postop sans prolonger le temps du réveil. Le sufentanil 1.0 et 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$ a permis une réduction de la concentration d'halothane requise. Le sufentanil 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$ était associé à des taux de catécholamines plus bas comparativement au groupe placebo après l'incision. L'ajout de sufentanil à 1.0 et 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$ était associé à une bradycardie et/ou hypotension durant l'induction et une augmentation de l'incidence de vomissement durant les premiers 24 heures en période postopératoire. Un patient du groupe sufentanil 1.0 $\mu\text{g} \cdot \text{kg}^{-1}$ pour qui le temps de chirurgie était moindre que 45 minutes a démontré une dépression respiratoire en période postopératoire. En conclusion le sufentanil 0.5 $\mu\text{g} \cdot \text{kg}^{-1}$ amène un plus grand soulagement de la douleur en période postopératoire et serait un supplément acceptable durant l'anesthésie à l'halothane chez les enfants et les nourrissons. Les effets secondaires associés aux plus fortes doses de sufentanil (1.0 et 1.5 $\mu\text{g} \cdot \text{kg}^{-1}$) rendent leur utilisation inacceptable comme supplément de l'anesthésie à l'halothane.