the Pa_{O_2} in the normal range of 60 to 80 torr.[8] A lower Pa_{O_2} may result in increased pulmonary vascular resistance[11] and retard circulatory adaptation of the newborn;[12] a higher Pa_{O_2} may increase the incidence of retrolental fibroplasia.[1]

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Anesthesiology
47:520–522, 1977

Serum Cholinesterase Activity Following the Use of Methoxyflurane in Obstetrics

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Serum cholinesterase activity tends to be low in normal women during pregnancy and labor and in the postpartum period.[1,2] The exact mechanism for this decrease is unclear, but occasionally the levels are sufficiently reduced so as to result in prolonged paralysis following normal clinical doses of succinylcholine.[2,3] Recently, it has been suggested that the use of methoxyflurane may result in a further decrease in serum cholinesterase activity (Shnider, S. M., personal communication). One of the metabolic products of methoxyflurane, inorganic fluoride ion, is capable of inhibiting normal cholinesterase, a property utilized in the identification of the fluoride-resistant variant of serum cholinesterase.[4] Because of the continuing frequent use of methoxyflurane and succinylcholine in patients undergoing labor and delivery or cesarean section, we determined the effect of methoxyflurane administration on serum cholinesterase activity in normal parturients undergoing elective cesarean section.

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Received from the Departments of Anesthesia and Obstetrics and Gynecology, Health Sciences Centre and University of Manitoba, Winnipeg, Manitoba. Accepted for publication June 16, 1977. Presented in part at the Society of Obstetrical Anesthesia and Perinatology Meeting, Philadelphia, April 1975.

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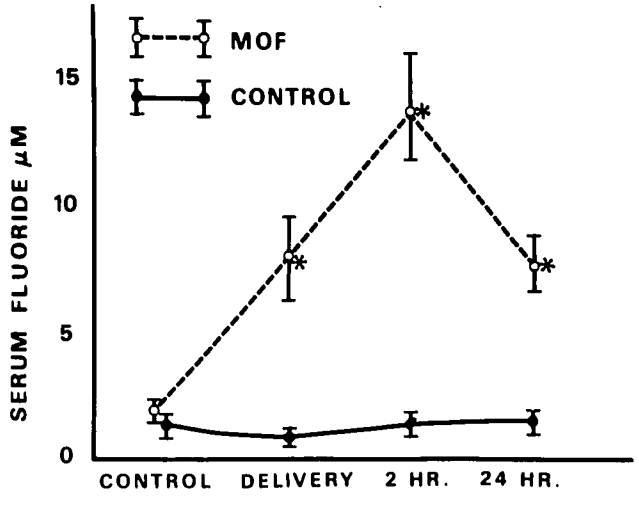

Fig. 1. Serum inorganic fluoride levels ± SE. * = significantly different from the control value for the methoxyflurane group and significantly different from the non-methoxyflurane group.

Methods

Twenty-two parturients with no evidence of hepatic or renal disease undergoing elective cesarean section were included in the study. All patients were informed of the nature of the study and consented to be included. Patients were assigned to the methoxyflurane or control groups according to the preference of the anesthetist in charge of the anesthesia.

Sixteen patients received methoxyflurane for elective cesarean section. No patient was premedicated. Anesthesia was induced with thiopental, 4 mg/kg and, after tracheal intubation with the aid of succinylcholine, 100 mg, was maintained with nitrous oxide–oxygen, 50 per cent each, with total flow rates of 8 l/min. Methoxyflurane was added to the anesthetic mixture from the time of induction until completion of the operation in concentrations ranging from 0.2 to 0.5 per cent delivered from a Pentec® vaporizer. The actual concentrations used and the total times of exposure varied considerably according to the requirements of the individual patients. Delivered concentrations did not exceed 0.5 per cent. The mean duration of exposure to methoxyflurane was 43 min, with a range of 23–75 min.

Six patients undergoing elective cesarean section were included as controls. These patients were treated the same as those in the methoxyflurane group except that anesthesia was maintained with only nitrous oxide, 70 per cent–oxygen, 30 per cent. Muscle paralysis was maintained in both the methoxyflurane and control patients with a single dose of *d*-tubocurarine, 0.25 mg/kg. Ventilation was controlled throughout using an Ohio anesthesia ventilator.

Venous blood samples for serum fluoride and cholinesterase determinations were drawn before any anesthetic was administered (control sample), at delivery, and two and 24 hours after delivery. Serum fluoride levels were determined using an ion-specific electrode.[5] Serum cholinesterase activity was determined using the method described by Kalow and Lindsay.[6]

Statistical analysis was performed using Student's t test for paired data (intragroup analyses) or for unpaired data (intergroup analyses). $P < 0.05$ was considered significant.

Results

Serum fluoride levels (fig. 1) were significantly increased at all times in the methoxyflurane group, while they were unchanged in the control group. The mean peak fluoride level occurred two hours after delivery and was 13.9 ± 2.1 μM.

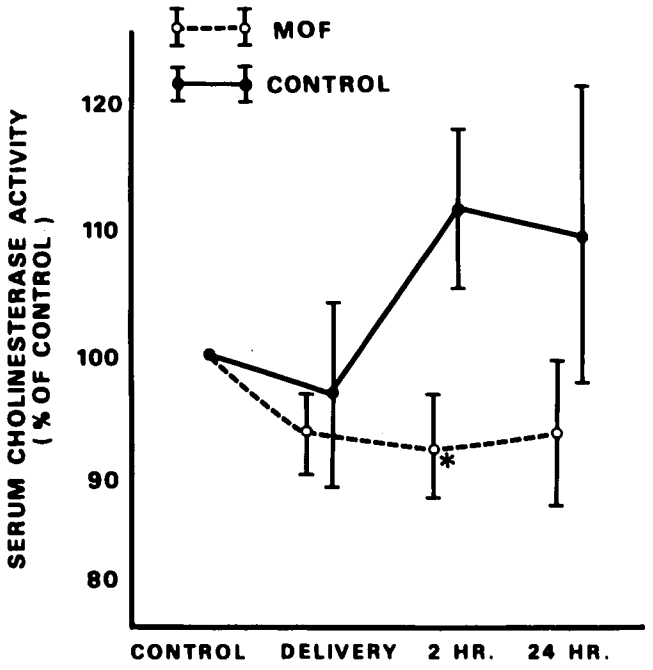

Fig. 2. Serum cholinesterase activity ± SE. * = significantly different from the value for the non-methoxyflurane group.

Serum cholinesterase activity (fig. 2) after anesthesia in the methoxyflurane group was never significantly less than control. The levels in the control group as well did not change significantly, but were quite variable, as can be seen from the large standard errors. There was a significant difference between the groups two hours after the operation only.

The grouping of the absolute serum cholinesterase values obtained before anesthesia (control samples) is shown in table 1. Both control and study patients are included since the distributions of preanesthetic cholinesterase activities were not different in the two groups. Thirteen of the 22 patients (59 per cent) had values below the lower limit of normal for our laboratory. Of these 13 patients, six had cholinesterase activities in the range of 75–99 per cent of normal; six, 50–74 per cent of normal; while one patient had less than 50 per cent of normal cholinesterase activity.

Discussion

Although there tended to be a decrease in serum cholinesterase activity following the use of methoxyflurane in obstetrical patients, the change was too small to be statistically or clinically significant. The greatest decrease seen in any one patient was 28 per cent. There did tend to be a difference between

TABLE 1. Preoperative Serum Cholinesterase Activity in 22 Patients Undergoing Elective Cesarean Section (Normal Activity = 1.07–2.38 IU)

	Serum Cholinesterase Activity (IU)			
	More than 1.07	.81–1.06	.54–.80	Less than .54
Number of patients	9	6	6	1
Percentage of patients	40.9	27.3	27.3	4.5

serum cholinesterase activities in the patients exposed to methoxyflurane and those who received only nitrous oxide for cesarean section, but the absolute magnitude of this difference was insufficient to suggest a need to avoid methoxyflurane in obstetric anesthesia. Our failure to demonstrate significant depression of serum cholinesterase activity may have resulted from the low total dose of methoxyflurane administered and the resultant low serum fluoride levels. It is possible that longer durations of administration of methoxyflurane at higher concentrations may result in serum fluoride levels sufficiently high to result in clinically significant decreases in plasma cholinesterase. Harris and Whittaker[4] have shown that a fluoride concentration of 50 μM will produce about 60 per cent inhibition of serum cholinesterase activity *in vitro*. Because of the renal dangers of high-dose methoxyflurane administration, it is undesirable to administer methoxyflurane in anything but low doses for short periods, as we used it during this study.

Our results for preoperative serum cholinesterase activity (table 1) agree with Shnider's finding of a substantial number of parturients having below-normal levels.[2] Shnider, however, found that only 10 per cent of patients had low values during late pregnancy, while we found 59.1 per cent with values below the normal range.

In conclusion, the levels of inorganic fluoride achieved with the normal clinical use of methoxyflurane in obstetrics are insufficient to depress serum cholinesterase activity to a clinically relevant extent. The variable and sometimes quite low levels of serum cholinesterase activity that may occur in healthy parturients should serve to caution anesthesiologists who use succinylcholine infusion for relaxation during obstetric anesthesia that prolonged apnea may occur with lower total doses of succinylcholine than would produce it in surgical patients.

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Anesthesiology
47:522–523, 1977

Anesthetic Death of an Experimental Animal Related to a Scavenging System Malfunction

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Received from the Department of Anesthesia, Hospital of the University of Pennsylvania, 3400 Spruce St., Philadelphia, Pennsylvania 19104. Accepted for publication June 20, 1977. Supported in part by USPHS Center for Research in Anesthesia Grant, 5-P01-GM-15430-09, and Research Training Grant, 5-T01-GM-00214-19, from the National Institute of General Medical Sciences, National Institutes of Health.

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In response to the mounting evidence that chronic exposure to trace levels of anesthetic gases may constitute a health hazard,[1–5] clinicians and researchers alike have begun to scavenge excess anesthetic circuit gases. It has been demonstrated that scavenging alone can reduce anesthetic contaminant levels in an average 4,000-cu ft operating room approximately tenfold.[6] Scavenging apparatus, however, adds complexity, hence hazards, to the ad-