Prolonged Apnea in an Infant Following the Use of Succinylcholine

Joa-Allen Horne, M.D.,* Thomas D. Watson, III, M.D.,† A. H. Giesecke, Jr., M.D.,† P. Prithvi Raj, M.B., B.S.,§ E. Warner Ahlgren, M.D.¶

This is a case report of a 7-week-old male infant who had prolonged apnea secondary to abnormal pseudocholinesterase of the genotype; one "silent" gene and one atypical gene. This is believed to be the youngest patient with postanesthetic apnea to be reported with this defect. The laboratory investigation of his serum and the sera of his parents and both sets of grandparents is presented in detail.

Report of a Case

A 7-week-old, first-born, Caucasian male infant was diagnosed as having pyloric stenosis. Pertinent admission laboratory results were: hemoglobin 12.4 g/100 ml, hematocrit 35.1 per cent, Na+ 147 mEq/l, K+ 4.8 mEq/l, CO₂ 28 mEq/l, Cl- 90 mEq/l, BUN 21 mg/100 ml. The results of urinalysis were within normal limits, including a specific gravity of 1.010. The patient received intravenously a polyionic, balanced salt solution the night before operation.

The infant was brought to the operating room at approximately 7:30 AM after receiving atropine 0.1 mg, im, as the only preoperative medication. The stomach was lavaged with warm saline solution until clear, after which an inhalation induction with N₂O, 5 l/min, O₂, 5 l/min, and halothane, 2 per cent, was achieved without difficulty. For endotracheal intubation a mixture of succinylcholine, 10 mg, and atropine, 0.1 mg (total volume 0.75 ml), was given at approximately 8:00 AM. The first attempted intravenous injection infiltrated, so that the infant received approximately 0.2–0.3 ml of the mixture subcutaneously, after which he became atonic. The remainder was then given intravenously. Maintenance of anesthesia was obtained with halothane, 0.5–1 per cent, and N₂O–O₂ (50 per cent mixture).

Ten minutes after the injection of succinylcholine, the infant still had made no spontaneous ventilatory efforts, and therefore manual control of ventilation was continued. It was noted also that the infant’s extremities were completely flaccid. Generalized flaccidity and apnea continued after discontinuance of all anesthetic gases.

The occurrence of an abnormal reaction to succinylcholine was entertained. Laboratory tests disclosed: Na+ 138 mEq/l; Cl- 95 mEq/l; K+ 3.6 mEq/l; CO₂ 30 mEq/l. Calcium was 9.6 mg/100 ml. A phase II or dual block, i.e., “fade and facilitation” was evident when neuromuscular transmission was tested with a Block-Aid Monitor (Burroughs-Wellscome). The screening test AC-HOLEST (which quantitates plasma pseudocholinesterase) indicated an absence of plasma pseudocholinesterase. A serum specimen was sent to the toxicology laboratory at an adjacent hospital for determination of plasma pseudocholinesterase activity. This was markedly decreased in the patient, being 0.07 change in pH/hour (normal range 0.11–1.63). The report was available approximately three hours after induction of anesthesia and confirmed the diagnosis of a phase II block secondary to markedly decreased plasma pseudocholinesterase.

About 3½ hours after the injection of succinylcholine, mechanical ventilation was discontinued. The nasotracheal tube was left in place for 24 hours. Because of slight hypoaxia (by blood-gas determination), an F₁O₂ of 0.6 was maintained with mist. The trachea was extubated the next day, but owing to copious secretions the nasotracheal tube was replaced for tracheal toilet for an additional 48 hours.

On the day of operation serum samples were obtained from each of the four grandparents as well as the parents. These were later evaluated quantitatively and qualitatively for pseudocholinesterase by determination of the succinylcholine number, dibucaine number, and pseudocholinesterase level. From these data, the genetic pattern of the patient’s pseudocholinesterase was derived (fig. 1). The genotype was one atypical pseudocholinesterase gene and one “silent” gene.

Method of Measuring Serum Cholinesterase Activity

Serum cholinesterase activities were measured by hydrolysis of benzoylcholine in 0.067 M phosphate buffer at pH 7.4 and 26 C according to the method of Kalow and Lindsay. Dibucaine numbers were determined by the method of Kalow and Genest.

* Assistant Professor of Anesthesiology.
† Anesthesiology Resident.
‡ Professor and Vice-Chairman of Anesthesiology.
§ Director of Anesthesiology, Veterans Administration Hospital.
¶ Associate Professor and Director of Anesthesiology, Children’s Medical Center.

Received from the Department of Anesthesiology, Children’s Medical Center and The University of Texas Southwestern Medical School, Dallas, Texas 75235. Accepted for publication March 20, 1973.
ATYPICAL PLASMA CHOLINESTERASE GENE

SILENT GENE

NORMAL GENE

Male
Female

The genotype of the M family.

Table 1 gives the results of the family study. Serum cholinesterase activities are expressed as μmol of benzoylcholine hydrolyzed per min per ml of serum. Dibucaine and succinylcholine numbers refer to percentage inhibition of benzoylcholine hydrolysis in the presence of the inhibitor.

On the basis of the inhibition studies, the patient's cholinesterase is of the genotype E₁⁺⁻ E₁⁻⁻. This is an interesting and rare variety. About a dozen individuals with a homozygous abnormal enzyme containing two silent genes, E₁⁻⁻ E₁⁻⁻, were reported by Kattanis et al. in 1967. Only scattered reports of heterozygotes with one silent gene and the other either fluoride-resistant (Whittaker, 1967; Simpson, 1967; Becker, 1972) or dibucaine-resistant (Dietz et al., 1965) have appeared in the literature. This case report adds one more patient to the list of rare mixed heterozygotes who have one silent gene and a dibucaine-resistant gene. The silent gene was inherited from the paternal side and the atypical gene was inherited from the maternal side of the family. The other members of the family with E₁⁺⁻ E₁⁻⁻ or E₁⁻⁻ E₁⁻⁻ may show either abnormal or normal responses to succinylcholine. It was interesting to find that the maternal grandmother had received an infusion of thiopental, N₂O–O₂ and succinylcholine in 1955 for removal of a renal stone. At the end of the procedure there had been a 45-minute delay after discontinuation of the succinylcholine infusion before her trachea could be extubated.

Table 1. Plasma Cholinesterase Activity in the M Family

<table>
<thead>
<tr>
<th></th>
<th>Quantitative Estimation (Units)</th>
<th>Qualitative Estimation</th>
<th>Succinylcholine Inhibition Number</th>
<th>Dibucaine Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal values (mean)</td>
<td>90</td>
<td>75</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>(Raj, et al.)†</td>
<td></td>
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</tr>
<tr>
<td>Family member</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paternal grandfather</td>
<td>80</td>
<td>76</td>
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<td></td>
</tr>
<tr>
<td>Paternal grandmother</td>
<td>120</td>
<td>78</td>
<td>85</td>
<td></td>
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<tr>
<td>Maternal grandfather</td>
<td>175</td>
<td>77</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>Maternal grandmother</td>
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<td>55</td>
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<td></td>
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<tr>
<td>Mother</td>
<td>115</td>
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</tr>
<tr>
<td>Patient</td>
<td>27</td>
<td>15</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

† Personal communications.

μmol benzoylcholine hydrolyzed per ml of serum per hour at pH 7.4 and 26°C.
The E$^*_1$ E$^*_2$ genotype plasma cholinesterase that she possesses may well have been the cause of her postoperative problem.

REFERENCES


Increased Respiratory Resistance after Ultrasonic Humidification of Anesthesia Gas

CHARLES L. WALTEmATH, M.D.,* PETER H. ERBGUTH, M.D.,† WALTER A. SUNDERLAND, M.D.‡

Humidification of anesthetic gases has been advocated to prevent drying of secretions and alterations of cells lining airways. Cheney and Butler found increased respiratory resistance in patients when they received ultrasonic humidification with half-physiologic saline solution via a tracheal tube¹ and in patients with airway disease breathing mist from a face tent.² Patients without airway disease who breathed ultrasonic mists of water, half-physiologic saline solution, or saline solution from a face tent did not have increased resistance.

We noticed that humidification of anesthesia gases with ultrasonic mist caused a prolonged expiratory phase in normal patients as well as those with chronic bronchitis. This study quantitates the effects of ultrasonic humidification of anesthetic gases on total respiratory resistance in a group of healthy patients and in a group of asymptomatic patients with increased resistance.

* Assistant Professor.
† Senior Instructor.
‡ Assistant Professor of Pediatrics and Resident I, Anesthesia.

Received from the Department of Anesthesiology, University of Oregon Medical School, Portland, Oregon 97201. Accepted for publication March 22, 1973. Supported by Grant no. 714, Medical Research Foundation of Oregon.

METHODS

Subjects of the studies were 24 adult surgical patients who needed general endotracheal anesthesia. Patients who had histories of pulmonary disease were excluded. Anticholinergic drugs were not given for premedication. Anesthesia was induced with thiopental and maintained with nitrous oxide-oxygen and narcotics. Complete muscle paralysis was obtained with d-tubocurarine (0.4 mg/pound) and the trachea was intubated with a cuffed tube. Control studies were done after surgical stimulation had begun to include any possible bronchodilator effects from increased catecholamine release.

Compliance and resistance for the total respiratory system were derived from flow, volume, and transthoracic pressure measurements obtained during thoracic inflation and subsequent passive exhalation by a method described previously.³

Control measurements were made at 3-minute intervals while the patients were being ventilated with dry gas from the anesthesia machine. After five control measurements had been made, the inspired gas mixture was humidified using an ultrasonic nebulizer (Monaghan, 670). This unit was set to deliver 1.5 ml/min of mist into the inspiratory gas flow.