

dual antiarrhythmic effects. In addition to their beta-adrenergic blockade there is a quinidine-like or local anesthetic-like action on the myocardium, which tends to increase the refractory period and decrease excitability. The latter property probably accounts for its effectiveness in the treatment of drug-induced arrhythmias, most notably digitalis, although Warner² recently has compiled a review of its increasing usage in the management of arrhythmias during anesthesia.

This report would add another drug to the growing list of arrhythmia-producers amenable to reversal by beta-adrenergic blockers. However, physicians should become thoroughly acquainted with the adverse effects as well as the contraindications of this group of drugs before attempting their use. It is recommended that well-accepted conventional forms

of therapy be administered before resorting to the beta-adrenergic blockers.

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Malignant Hyperthermia during Anesthesia

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Several reports describe the clinical signs, the prescribed treatment and the prognosis associated with malignant hyperthermia during anesthesia.¹⁻⁴ Wilson recently reviewed 40 cases. These were otherwise-healthy patients with a mean age of 21.7 years; the mortality was 73 per cent.⁵

We have treated a case of malignant hyperthermia which we present for several reasons: the signs of the syndrome were typical; there was a favorable response despite the severity of the disorder; the importance of early and vigorous treatment is demonstrated; the patient had been anesthetized twice before with no undesirable results.

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CASE REPORT

On March 12, 1962, at the age of three months, the patient had her first operation for repair of a cleft lip. Premedication consisted of morphine, 0.2 mg, and scopolamine, 0.075 mg. Following oxygenation, 16 mg succinylcholine intramuscularly, and conscious intubation, anesthesia was maintained with nitrous oxide, ether and oxygen by means of an Ayer's T Tube. Procaine with epinephrine was used locally. Operation, anesthesia and postoperative course were uneventful.

On June 3, 1963, at the age of 18 months, the patient had her second anesthesia and plastic surgical procedure on the lip. Premedication was morphine, 0.5 mg, scopolamine, 0.1 mg, and secobarbital, 15 mg. Induction and intubation were accomplished with a cyclopropane-ether sequence. Succinylcholine was not used. Anesthesia was maintained with nitrous oxide and oxygen with an Ayer's T Tube.

On September 6, 1968, at the age of 5 years and 9 months, the patient was admitted for further correction of a cleft lip and nose deformity.

She was noted to have slow mentation, poor concentration, and poor fine-motor functions, scoring at the 3-year-old level on psychologic tests. Family history revealed no deaths associated with anesthesia. There had been no previous uncontrollable fever and no temperature above 104 F. Respiration, pulse rate and blood pressure were normal. Hemoglobin was 14.0 gm/100 ml. The leukocyte count was 9,100 with a normal differential.

On the basis of body weight of 18.6 kg, the patient received atropine, 0.2 mg, meperidine, 40 mg, and secobarbital, 40 mg, all intramuscularly. The pulse rate on arrival in the operating room was 160/min and the oral temperature was 98.6 F.

Anesthesia was started at 1:05 PM with nitrous oxide, oxygen and halothane. At 1:10 PM intubation was attempted, but the jaw was tight. Succinylcholine, 20 mg, was given intravenously. This was followed by unusually forceful and coarse fasciculations and continued lack of relaxation, even several minutes after administration. The pulse rate fell to 60 beats/min, and atropine sulphate, 0.2 mg, was given intravenously; the pulse rose to 160/min. Intubation was accomplished with mild difficulty at 1:15 PM and the operation started at 1:20 PM. Anesthesia was maintained with nitrous oxide, halothane and oxygen by a nonbreathing technique. At 1:25 PM, 20 minutes after the beginning of anesthesia, the blood was noted to be dark; at this time the hand was clenched and the muscles were rigid. The skin was noted to be hot to the touch. The pulse, which had continued at 160/min, was now above 180/min.

Anesthesia was discontinued and the patient was given 100 per cent oxygen by intermittent positive-pressure ventilation. The operative procedure was quickly terminated. The first rectal temperature recorded was at least 109 F, the top reading of the scale of the Telethermometer that was used.

The patient was packed in ice and alcohol was splashed over the ice and the patient. Air current from two fans was directed at the patient. A precordial heart beat was audible, but peripheral pulsations were barely palpable. The muscles were tense and the extremities were markedly vasoconstricted. Chlorpromazine, 3.0 mg, was given intravenously in divided doses and sodium bicarbonate, 223 mEq, was given intravenously during the first 20 minutes after institution of therapy. The patient was vigorously hyperventilated with oxygen, and lung compliance seemed decreased. Though the lung fields did not sound wet, typical pink, frothy fluid of pulmonary edema was found in the endotracheal tube and aspirated. The pulse rate was approximately 200/min and blood pressure was not measurable. Cedilanid, 0.2 mg, was given intramuscularly in two doses. Prostigmine, 0.4 ml of 1/2,000 solution in two doses and Decadron, 8 mg, were also given, intrave-

nously. The pulse rate fell to 160/min, blood pressure was 60-70 mm Hg, and color and general circulatory status improved notably.

At 1:40 PM, 15 minutes after resuscitative efforts began, the temperature was 102 F, and after an hour it had dropped to 98.4 F. At this point, mump-like swellings of the parotid glands were noted, which subsided during the next several hours. The ice was removed and the temperature continued to drift to 95.5 F. The patient was allowed to warm spontaneously, and there was no difficulty maintaining the temperature below 100 F with alcohol sponges and fans. Venous blood drawn at 2:50 PM, one hour and 25 minutes after resuscitation began, showed P_{CO_2} 25, pH 7.76, and a base excess of +12, indicating metabolic and respiratory alkalosis. At 3:15 PM, one hour and 50 minutes after anesthesia was discontinued, calcium was 7.5 mEq/l, CO_2 content 89% v/v, chlorides 90 mEq/l, potassium 3.7 mEq/l. At 3:30 PM, two hours and 5 minutes after resuscitation began, an arterial blood sample showed P_{CO_2} 32, pH 7.58, and base excess +6.

Approximately four hours after anesthesia was discontinued, while the patient was breathing spontaneously, respiratory acidosis developed, with a P_{CO_2} of 99 mm Hg. Respiratory assistance was reinstated, followed by controlled breathing, with monitoring of blood gases. Spontaneous respiratory activity returned gradually, while blood pressure and pulse rate remained stable. The temperature was easily kept below 100 F with alcohol sponging; metabolic acidosis did not recur. The lungs were congested and there was a moderate increase in physiologic deadspace, which resolved at 24 hours. The SGOT was 11,720, the SGPT 6,680, and the LADH 4,700. Blood cultures were sterile.

After three days the patient was released to the general pediatric floor; to the mother and the attending physician she appeared no different mentally and emotionally than before the experience. Two weeks postanesthesia there was still some spasm in the gastrocnemius muscles, making walking awkward and uncomfortable.

DISCUSSION

A number of signs that appeared in this patient are characteristic of the syndrome of malignant hyperthermia and should be re-emphasized. The patient did not relax as well as might have been expected after five minutes of halothane anesthesia, and endotracheal intubation was difficult because the jaw was tight. Intravenous succinylcholine caused coarse and forceful fasciculations, which were not followed by relaxation. There was a decrease in chest compliance and also cyanosis in the absence of known lung disease, bronchospasm or

other airway or ventilatory problems. The temperature rose from 100 F to 109 F within 30 minutes: such a dramatic rise is seldom seen in association with any other disease entity. After recovery, the patient continued to have spasm of the gastrocnemius muscles; this has been noted previously in patients who have recovered.⁶

The patient also had transient swelling in the parotid area, which may have been a process similar to that noted by Hall *et al.* in the lower jaws of two boars which were litter mates⁷ and by Attas, who reported transient edema of the salivary glands after induction of anesthesia in seven patients.⁸

The syndrome has been reported in sibling pigs⁷ and in members of a human family,⁹ which suggests a congenital physiologic defect. The present patient, however, had had two previous uneventful anesthetics. It would seem, therefore, that the syndrome might be acquired or congenital but dormant during early infancy or until a specific set of circumstances develops. Based on observations to date, the occurrence of the syndrome remains unpredictable.

Several aspects of this case should be emphasized. The anesthesiologist should be aware that the development of malignant hyperthermia is a distinct possibility when faced with an unsatisfactory induction of anesthesia and inadequate muscle relaxation. Muscle rigidity rather than relaxation following succinylcholine helps confirm this impression. High temperatures cause a rapid build-up of metabolites with development of severe metabolic acidosis. While blood gas determinations should guide management, institution of therapy should not await these data. As noted, the prompt administration of 12 mEq/kg sodium bicarbonate (223 mEq) proved not to be a

gross overdose, and many have been an important factor in saving our patient. In addition, 100 per cent oxygen must be given to support increased oxygen utilization. Hyperventilation is necessary to eliminate increased amounts of carbon dioxide.

Metabolic factors and/or the very rapid pulse rate may place an undue burden on the heart, as was manifested for a period in our patient. Digitalization was indicated. But it is interesting that the circulatory status in this patient improved most markedly after the heart rate slowed following the use of prostigmine.

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