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Postoperative Apnea in a Full-term Infant

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General anesthesia for elective surgical procedures in young former preterm infants appears to be associated with a high incidence of respiratory complications.[1] Precautions to detect and treat apnea are recommended for these children up to 60 weeks post-conceptual age,[2–6] especially if there is prior history of apnea.

We report a case of a full-term infant who had two prolonged apnea spells in the postoperative period, and discuss the anesthetic care and postoperative course. This is the first reported instance of post-anesthetic apnea in an otherwise healthy full-term infant.

REPORT OF A CASE

A 3.2-kg female infant, twin A of identical twin gestation at 39 weeks was brought to the Operating Room at age 21 days, 42 weeks post-conception, for excision of the left of bilateral congenital cataracts. The right eye was to be operated on the following day. Her 3.1-kg twin was also scheduled for the same procedure. Neither baby had other congenital anomalies, except for bilateral congenital cataract. She was brought to the operating room unpremedicated, where anesthesia was induced *via* a mask using nitrous oxide, oxygen, and halothane. When obtunded, an iv was started and atropine 0.1 mg given iv. Anesthesia was deepened until oral tracheal intubation could be performed without use of a muscle relaxant. Anesthesia was maintained with nitrous oxide/oxygen and halothane by non-rebreathing circuit. The intraoperative course of 110 min was benign. When she was awake, the pharynx was suctioned and the trachea extubated. All extremities moved actively; there was a vigorous cry. Respiratory rate was regular with normal depth. She was transported to recovery room with spontaneous ventilation, crying loudly. In the recovery room, while breathing 40% oxygen, respiration was reported as regular in 26–32 breaths/minute range with regular pulse rate 130–150 bpm.

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One hour later, while awaiting transport, she became cyanotic. Stimulation and jaw thrust with blow-by oxygen restored ventilation after 15–20 s. There was no bradycardia. Although subsequent breathing pattern was normal, her recovery stay was extended, pediatric consultation obtained, and apnea monitor ordered. The next day, while in the opthalmology clinic, she again became apneic for 20–30 s. Stimulation rapidly restored ventilation. Evaluation of apnea during the next 72 h, including electroencephalogram and sleep study with oxygen saturation monitoring, failed to detect any abnormalities. A pediatric cardiologist noted a murmur, and echocardiogram revealed a potentially patent ductus arteriosus, felt to be within normal limits for age. Six days later, she was anesthetized for surgery on the right eye, except atracurium 2 mg was used to facilitate tracheal intubation. Under halothane and nitrous oxide anesthesia, the intraoperative course was again unremarkable. At the conclusion of surgery, muscle relaxant was reversed with neostigmine and atropine iv. When awake and moving all extremities actively, her trachea was extubated. Immediately, crying was noted. Initially, the respiratory rate was regular, but shortly after arrival in recovery room, periodic breathing was noted. There were no apneic spells, but pauses of 5–10 s were interspersed between regular breathing. Recovery room stay was extended to 4 h, at which time there was no further evidence of periodic breathing. Subsequent apnea observation over 72 h was negative. The parents were counselled about the implication of these events. The pediatric consultant did not think that home monitoring was indicated. The twin sister had both cataracts removed without evidence of apnea or periodic breathing.

Discussion

Several factors limit reporting this case as one of a normal, full-term infant with apnea in the postoperative period. First, this baby was a product of twin gestation, known to be associated with sudden infant death syndrome (SIDS),[7,8] although other risk factors (family history of SIDS, prematurity, low birth weight, young mother, black race, seizures, sepsis) are absent. The immaturity of the respiratory center, postulated to cause periodic breathing in preterm infants in the post-anesthetic period, is also implicated as a cause of SIDS.[5,6,9–11] Steward[1] reported high incidence of apnea in the postoperative period in preterm infants, and noted that all were anesthetized with halothane. He attributed the apnea to the effect of even very low concentration of residual halothane, which Knill *et al.* showed to be depressant to the chemoreceptors in adults.[12] Steward[13] specifically attempts to dissociate the post-anesthetic state from the etiology of SIDS, but does not address the recent postoperative state.

The second unusual aspect of this case is the existence of a congenital defect (congenital cataracts). Virtually all reports of perioperative apnea[1–4,6] and studies of SIDS[5,7–11] note an increased incidence of associated congenital defects. Congenital cataract is not reported to be associated with perioperative apnea or SIDS.

The opportunity to reanesthetize the child offered the chance to eliminate high-dose halothane as the cause of the first episode. But low doses of volatile anesthetics combined with atracurium was followed by periodic breathing after the second procedure, lasting longer than residual halothane could be expected to last. Kurth *et al.* reported late apnea (>12 h) in preterm infants with the etiology being either endorphin, diminished responsiveness to carbon dioxide, or pharyngeal obstruction of the airway.[6] Keens *et al.*[14] has established easy fatigue of respiratory muscles in newborns. This is based on high content of oxidative muscles in the diaphragm.[14] Periodic breathing with SIDS has been proposed to be caused by immature respiratory control.[15,16] Welborn *et al.*[5] reports periodic breathing as a normal occurrence in 30–95% of preterm infants, but absent in term infants in the post-anesthetic period.

We were struck by the low risk of apnea that many authors afford the term infant in the postoperative period.[2–4,6] This case does not perfectly fit either apnea, SIDS, or even an idiopathic postoperative event. But the reproducible postoperative instability of respiratory control in a term infant certainly merits consideration. Whether this should impact on day surgery plans for newborns, newborn twins, or infants with congenital lesions of the eye requires prospective analysis. Further study might also delineate whether an association of residual volatile anesthesia accentuates existing immature respiratory control.

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Patient-controlled Analgesia: A Comparison of Intravenous *Versus* Subcutaneous Hydromorphone

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Patient controlled analgesia (PCA) allows patients to self-administer small doses of analgesic medications as necessary to control postoperative pain. This technique has the advantage of allowing for interpatient variability in analgesic requirements, while minimizing the delay between the perception of pain and its relief.[1] In addition, anxiety may be decreased by providing patients with immediate access to pain-relieving medication and a measure of control over their medical care.[2] The efficacy of the technique has been well-established for the commonly used opioid analgesics, morphine, and meperidine.[3–13] Hydromorphone hydrochloride (Dilaudid®) is a narcotic analgesic that is approximately six to seven times more potent than morphine.[14] It has a pharmacokinetic (*e.g.*, elimination half-life of 2–4 h) and pharmacodynamic profile (*e.g.*, duration of analgesia of 3–6 h), which would suggest that it could be a useful alternative to morphine and meperidine by the PCA route of administration.[14–17]

A potential disadvantage of conventional PCA therapy is the requirement for intravenous (iv) access, thus limiting its use in patients with difficult iv access, as well as for patients undergoing operations on an ambulatory (outpatient) basis. The subcutaneous (SQ) administration of narcotic analgesics, either by bolus injection or continuous infusion, can produce effective pain relief after surgery.[15–18] If safe and effective, SQ-PCA may offer the advantages of PCA therapy to a wider spectrum of patients. The objective of this study was to compare the efficacy of SQ-PCA to conventional iv-PCA for providing postoperative pain relief.

MATERIALS AND METHODS

Thirty ASA physical status I–III patients, who were scheduled for elective abdominal or extremity surgery, participated in the study after giving their informed consent. The study protocol was approved by the Committee for the Protection of Human Subjects at Stanford University. Patients were randomly assigned to receive either iv or SQ-PCA, and were instructed in the use of the Abbott Lifecare® PCA infuser prior to their surgical procedure. All patients received general anesthesia; however, the anesthetic and analgesic drugs administered were at the discretion of the attending anesthesiologists.

When the patient began to complain of pain in the Post-Anesthesia Care Unit (PACU), hydromorphone, 0.2 mg iv, was administered every 5 min by the PACU nurse until the patient was no longer experiencing dis-

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TABLE 1. Demographic Data for the Two Study Groups

	iv	SQ
Number (N)	15	15
Age (years)*	52 ± 15	44 ± 15
Weight (kg)*	73 ± 14	73 ± 18
Gender (F/M)	9/6	9/6
Hydromorphone loading dose (mg)*	0.52 ± 0.62	0.56 ± 0.36

* Mean values ± SD.