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## Rectal Methohexital Causing Apnea in Two Patients with Meningomyeloceles

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Induction of anesthesia with rectal methohexital is a common practice in pediatric anesthesia. We present two children with meningomyeloceles in whom apnea developed following the administration of rectal methohexital.

### CASE REPORTS

*Case 1.* A 3-yr-old, 10-kg child with a midthoracic meningomyelocele was scheduled for bilateral ureteral reimplants. Her medical history was remarkable for impaired respiratory function requiring chronic oxygen therapy ( $pH$  7.43, oxygen tension [ $P_{O_2}$ ] 89 mmHg, carbon dioxide tension [ $P_{CO_2}$ ] 37 mmHg, total carbon dioxide 27 mM, and hemoglobin oxygen saturation 96%, while breathing 1 l/min oxygen per nasal cannula). The hematocrit was 35%. A "sleep study" (including continuous pulse oximetry) done prior to a tonsillectomy–adenoidectomy demonstrated only "trivial changes in breathing pattern, which may be consistent with an obstructive airway". A ventriculoperitoneal shunt was in place and was clinically assessed as functioning by her neurosurgeon. She was receiving phenytoin for a seizure disorder and had not had a seizure in the month preceding surgery.

Rectal methohexital had been used in three previous anesthetics (at a dosage range of 25–30 mg/kg) without incident. This technique was chosen again at her mother's request to ease separation of the child

from her mother. A 27-mg/kg dose of 10% methohexital was given rectally. Two minutes after administration the child lost consciousness in her mother's arms. The child was then placed supine on a stretcher and was observed to be apneic, with ensuing cyanosis. Her lungs were quickly ventilated without difficulty *via* a mask, and her trachea was intubated 1 min later. There were no physical signs of seizure activity, and the child's muscle tone was flaccid with no evidence of any respiratory effort. Cardiovascular status was stable as assessed by ECG and blood pressure monitoring, and the child underwent surgery without incident.

*Case 2.* A 10-yr-old, 18-kg child with a low thoracic meningomyelocele was scheduled for heel-cord lengthening. The child showed marked developmental delay, making communication difficult. A clinically functioning ventriculoperitoneal shunt was in place, and the child was receiving phenytoin for a generalized seizure disorder. She had not had a seizure in the preceding month. Her medical history was otherwise unremarkable.

The patient had received rectal methohexital on a previous anesthetic without incident. On this occasion, at the mother's insistence, the child received 10% methohexital rectally for a total dose of 28 mg/kg. Within 3 or 4 min the child was noted to be apneic. Positive pressure ventilation of her lungs *via* a mask was followed by tracheal intubation over the next few minutes. There were no physical signs of a seizure, and she remained apneic. The child's blood pressure and ECG were stable, and she underwent surgery without complications. Her postoperative condition was unchanged from that existing prior to the rectal methohexital administration.

### DISCUSSION

Rectal methohexital is commonly used to induce anesthesia and ease the separation of young children from their parents and can be particularly useful in patients with a meningomyelocele. These patients may have some degree of mental retardation, making communication difficult, and in addition, the anxiety of repeated hospitalizations, limited intravenous access, and extreme "needle phobia," despite paresthetic lower limbs, make inhalational or intravenous induction techniques less desirable.

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The dose of methohexital in these two cases was within the dose range of 25–30 mg/kg that is usually recommended.<sup>1</sup> Previous studies using similar doses have not reported apnea.<sup>2,3,‡</sup>

Based on our experience, it was unusual that both of the children described in our report lost consciousness within 2 or 3 min after administration of the rectal methohexital, especially since both children were receiving phenytoin. Our experience has been similar to Griswold and Liu,<sup>‡</sup> who showed that 25–30 mg/kg rectal methohexital often failed to induce unconsciousness in unpremedicated children taking phenytoin or phenobarbital. In many such children, a second dose of methohexital may be needed to achieve unconsciousness.

Rockoff and Goudsouzian described two children with evidence of psychomotor seizures after induction with rectal methohexital.<sup>4</sup> Both patients described in his report had temporal or psychomotor epileptic disorders and showed gross physical evidence of tonic, clonic seizure activity. In our report neither child had temporal or psychomotor epileptic disorders, and there were no physical signs of seizure activity. Rectal methohexital has not been described to induce seizure activity in children with generalized seizure disorders. We believe it unlikely, therefore, that the episodes of apnea described are secondary to seizure activity or a postictal state.

Interestingly, both children had received a similar dose of rectal methohexital on a previous anesthetic without incident. Absorption of rectally administered drugs is unpredictable,<sup>5</sup> and it is possible that higher serum concentrations of methohexital were achieved in the two circumstances described than in the previous anesthetics. Unfortunately, methohexital plasma concentrations were not measured for the two cases presented here. However, although several studies have shown marked variability in the plasma concentrations of methohexital following rectal administration,<sup>3,6</sup> apnea was not noted in any of the patients studied.

Drugs deposited in the rectum are absorbed directly into the systemic circulation and/or portal circulation, as both venous plexuses are present in variable proportions. However, the length of the rectal catheter, and therefore the site of rectal deposit, has been shown to bear little relationship to peak serum concentrations obtained with this induction technique.<sup>6</sup> We therefore believe it unlikely that the two apneic episodes in our case reports resulted from increased systemic absorption related to the length of catheter used. In addition, the dose of rectal methohexital to be given was recalculated, and the concentration

of the methohexital solution was reviewed in both cases and found not to be in error.

Children with a meningocele have by definition a type II Arnold-Chiari malformation (ACM).<sup>7</sup> This defect involves both an anatomic and a physiologic lesion that can result in several respiratory problems.<sup>8</sup> Anatomically, there is caudal displacement of the cerebellar tonsils through the foramen magnum and caudal displacement of the medulla oblongata, pons, and upper cervical cord. Hydrocephalus secondary to the anatomic obstruction can, if uncontrolled, lead to pressure on the important respiratory centers and result in apnea.<sup>9</sup> Traction of the vagus nerve(s) can result in vocal cord paralysis and obstructive apnea.<sup>10</sup> In the current case reports, neither patient had symptoms of increased intracranial pressure or vagal instability, and the ventriculoperitoneal shunts were clinically assessed to be functioning by the attending neurosurgeons.

Histologic studies have shown dysplastic development of cranial nuclei in the brainstem in ACM.<sup>11</sup> Davidson-Ward *et al.* have shown that in patients with a meningocele who have had apneic episodes there is a marked change in carbon dioxide and oxygen ventilation response curves.<sup>12</sup> Responses to increased carbon dioxide and decreased oxygen tensions are depressed significantly with the greater loss occurring in hypoxic drive. The loss of the hypoxic response is pronounced not only because it involves central respiratory centers, but also because carotid body chemoreceptors function abnormally. Lack of afferents to and dysplasia of the ninth cranial nerve nuclei can make carotid body receptors less effective.<sup>13</sup>

*Post mortem* studies in meningocele patients have shown evidence of recent and old brainstem infarcts.<sup>14</sup> These infarcts may be the result of the tortuous blood supply in ACM, which may be stretched and severed by anatomic changes in the posterior fossa as the child grows. It is conceivable that these infarcts result in a deterioration of brainstem function. Apnea might then occur with an anesthetic induction, despite previous uneventful inductions using the same technique.

Rectal methohexital should always be regarded as an agent to induce anesthesia rather than as a premedication. Children should never be left unattended after administration of rectal methohexital. Constant vigilance by personnel familiar with the effects of rectal methohexital and capable of providing cardiopulmonary resuscitation is imperative, regardless of the clinical setting.

As a result of our experience, we recommend that pulse oximetry be used throughout the induction whenever possible, and at the very least, that resuscitative equipment be readily accessible whenever rectal methohexital is used.

In summary, apnea following rectal methohexital is reported for the first time. We believe that the two patients described may be part of a unique subset calling for con-

‡ Griswold JD, Liu LMP: Rectal methohexital in children undergoing computerized tomography and magnetic resonance imaging scans (abstract). ANESTHESIOLOGY 67:A494, 1987

siderable caution when using rectal methohexital. As demonstrated by our two patients, previous safe use is not always indicative of future responses.

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## Transesophageal Indirect Atrial Pacing for Drug-resistant Sinus Bradycardia

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Hemodynamically deleterious bradycardia consequent to intrinsic or drug-related sinus node dysfunction is not uncommon in patients under general anesthesia. While bradycardia can be associated with hypotension that could impair vital organ perfusion in patients with cardiac disease, it can also predispose to life-threatening tachyarrhythmias in patients with the sick-sinus syndrome<sup>1</sup> or congenital or acquired QT-interval prolongation.<sup>2</sup> Further, bradycardia may not respond to chronotropic drug treatment, or the treatment may lead to worse arrhythmias. If either or both of these occur, it may not be possible

to continue with anesthesia and surgery, or temporary cardiac pacing may need to be instituted. Available routes for emergency pacing include transvenous,<sup>3</sup> transcutaneous,<sup>4</sup> and transesophageal indirect atrial pacing (TAP).<sup>5</sup>

Transvenous atrial or ventricular pacing can be difficult to establish in patients undergoing surgery, particularly when access is limited by the surgical field or patient's position. Also, fluoroscopy may be required to correctly position electrodes (particularly with atrial or atrioventricular (AV) sequential leads). Though less invasive, transcutaneous indirect ventricular pacing may not provide reliable capture in some patients (*e.g.*, those with obesity or pulmonary emphysema) and does not preserve atrial transport function. The latter can contribute importantly to cardiac output in patients with intact AV conduction and who are not in atrial fibrillation, but who have myocardial functional impairment.<sup>6,7</sup> TAP, in contrast, preserves atrial transport function, is relatively non-invasive and easy to establish in patients under general anesthesia, and has been suggested as alternative management to drugs for hemodynamically disadvantageous bradycardia in anesthetized patients.<sup>8</sup> In addition, we have recently determined TAP thresholds in 100 anesthetized adult surgical patients, 38 of whom showed hemodynamic

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