ARTICLE

Use of Intravenous Methohexital as a Sedative in Pediatric Emergency Departments

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Objective: To evaluate the effectiveness and safety of intravenous methohexital as a sedative in children undergoing emergency computed tomographic scans.

Design: Case series.

Setting: An urban pediatric emergency department at a level I trauma center.

Participants: Patients receiving intravenous methohexital for sedation to undergo emergency computed tomographic scans.

Methods: Descriptive data were generated, including demographics, doses administered, times of sedation, outcomes, and complications.

Results: Data are reported from a total of 55 patients. The doses administered ranged from 0.5 mg/kg to 2.0 mg/kg (mean ± SD, 1 ± 0.5 mg/kg). Onset of sedation was rapid (mean ± SD, 1 ± 0.4 minutes), sedation was brief (mean ± SD, 12 ± 5 minutes), and the mean ± SD length of the drug's effects was 14 ± 6 minutes. Sedation was effective in most cases, and only a few patients had complications.

Conclusion: Intravenous methohexital is a short-acting and effective sedative for use in pediatric emergency departments to obtain computed tomographic scans.

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COMPUTED tomographic (CT) scans are frequently performed on an emergent basis in pediatric emergency departments (PEDs). Infants and young children often require sedation for CT scans to be completed successfully. The duration of CT scans may vary from 5 to 30 minutes, depending on the type of scan and the need for additional imaging. Different classes of medications have been used to achieve sedation in children for this purpose. These include chloral hydrate (both orally and rectally), barbiturates such as pentobarbital, benzodiazepines such as midazolam, and narcotics like meperidine (alone or in combination with promethazine) and chlorpromazine.[1-9] Most of these medications have long induction and recovery times that extend patients' length of stay in the emergency department.

Methohexital is an ultrashort-acting barbiturate, producing few cumulative adverse effects and a more rapid recovery than other barbiturates.[10-13] Because of its quick onset, predictable physiological effects, minimal complication rate, and short duration of action, methohexital may be an attractive option for sedation in children. Rapid induction and speed of recovery make it ideal in situations where a brief effect is desired, such as CT scans. Although in our institution intravenous (IV) methohexital has been used as a sedative to obtain CT scans, data in the literature remain sparse about its use in PEDs.

The objective of this study was to evaluate the effectiveness and safety of IV methohexital in achieving sedation in pediatric patients undergoing emergency CT scans, and to document our experience with the use of methohexital in our PED.

RESULTS

There were a total of 55 patients, 35 in phase 1 and 20 in phase 2. Twenty-two sedations were performed in phase 2 because 2 patients required additional scans. There was no statistical difference between patients in phase 1 compared with those in phase 2 in regard to age, weight, race, scan type, total dose given, and dose in mg/kg ($P > .05$ for all), although there were more boys in phase 2 (85% vs 43%, $P = .002$).

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PATIENTS AND METHODS

We conducted this study in 2 phases. In phase 1, we retrospectively reviewed medical records of patients in whom IV methohexital had been used to achieve sedation to obtain CT scans. In phase 2, we prospectively studied the use of IV methohexital to achieve sedation for the same procedure.

PHASE 1

After approval from our institutional review board, we reviewed medical records of 653 children younger than 6 years who came to our PED between January 1990 and February 1998 and required CT scans. Of those, 35 patients were identified in whom IV methohexital was used to achieve sedation. From these records, we collected data on demographics, type of CT scan done, dose of methohexital given, and complications.

PHASE 2

Between March 1998 and September 1998, all patients who came to our PED requiring emergency CT scans and falling into the age group that might require sedation were invited to participate in the study. Inclusion criteria were patients meeting the American Society of Anesthesiologists class 1 or 2 criteria, parental consent, and the need for sedation to undergo the CT scan. Exclusion criteria were abnormalities of the airway or the cardiorespiratory system, a history of hypersensitivity to barbiturates, and patients who received any sedatives or hypnotics within 6 hours of the CT scan. All patients had existing IV lines for reasons other than the purpose of the study.

The institutional review board approved the research protocol, study design, and consent forms. We followed guidelines published by the American Academy of Pediatrics for monitoring patients during and after sedation for diagnostic and therapeutic procedures.[14] Sedation flow sheets were created documenting patients' demographics, type of scan, and presedation vital signs (including heart rate, respiratory rate, blood pressure, and pulse oximetry).

While the patient was on the CT scan table, 1% methohexital sodium solution was administered through a standard IV catheter followed by a 3-mL saline flush. At the principal investigator's discretion, doses were titrated to achieve sedation, marked by an adequate state of motionlessness that allowed the start and completion of the scan. The initial dose was 0.5 mg/kg, titrated up using increments of 0.5 mg/kg to a maximal dose of 2.0 mg/kg. No additional sedatives were used.

Documentation of the dose of methohexital and times of administration, onset of sedation (marked by motionlessness without stimulation), start of scan, end of scan, end of sedation (marked by patients either starting to move or cry, simultaneously or on stimulation), and return to a presedation state (marked by return of vital signs and mental status) were all reported on the sedation flow sheets.

Subjects were monitored continuously throughout the procedure by the principal investigator and an accompanying nurse. Documentation of vital signs included heart rate; respiratory rate and pulse oximetry were done at 1- to 2-minute intervals throughout the procedure. Presedation and postsedation blood pressure was included in the documented vital signs. Complications and interventions were also documented. In case of sedation failure, IV ketamine was used to achieve conscious sedation to obtain the CT scans. The criterion for discontinuation of monitoring was a return to a presedation level of consciousness.

STATISTICAL ANALYSIS

The primary end points were the percentage of patients who remained motionless throughout their CT scans, as a measure of effectiveness of the medication, and percentage of patients experiencing complications, as a measure of drug safety.

Descriptive statistics were generated, including percentage distributions, means, and SDs where appropriate. Data from phases 1 and 2 were examined separately and then compared for differences between the 2 groups using the χ^2 test, *t* test, and Kruskal-Wallis test where appropriate. Analysis was performed using Stata 6.0 (Stata Corp, College Station, Tex) and SAS 6.12 (SAS Institute Inc, Cary, NC) statistical software.

In phase 1, the mean ± SD patient age was 28 ± 24 months, and 43% were boys. The mean ± SD weight was 16 ± 13 kg. Of the CT scans performed, 80% were for the head, 9% were for the abdomen, and 11% were both head and abdominal. The mean ± SD dose of methohexital given was 1 ± 0.4 mg/kg, and the mean ± SD total dose was 20 ± 18 mg/kg. There were no data on dose titration in phase 1 patients. All 35 patients remained motionless for the CT scans to be completed. No complications were reported, and no interventions were needed.

In phase 2, the mean ± SD patient age was 26 ± 17 months, and 85% were boys. The mean ± SD weight was 12 ± 4 kg, and 91% of the CT scans performed were for the head. The mean ± SD dose of methohexital given was 1 ± 0.5 mg/kg, and the mean ± SD total dose was 14 ± 7.5 mg/kg.

For patients in phase 2, where prospective design allowed more data collection, the mean onset of sedation was 1 minute, and the mean adequate sedation time was 12 minutes. Although the mean scan time was 9 minutes, the mean total procedure time was 15 minutes, as demonstrated in the **Table**.

Only 2 patients (<1%) failed to be sedated, whereas the remaining 20 patients remained motionless for the CT scans to be completed. Three patients (<1%) had a transient drop in their pulse oximetry that ranged from 93% to 94% on room air, and were counted as complications. Those patients required only a chin lift maneuver to bring their pulse oximetry to a value higher than 95%, and remained stable throughout the procedure. No other complications were observed.

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COMMENT

Methohexital use as an induction agent has been well documented in the anesthesia literature. Its use in children for induction of anesthesia has been demonstrated via the rectal, intramuscular, and IV routes.[15-18] The pharmacokinetics of methohexital have been studied in humans, particularly in children.[19,20]

Methohexital has been used in adult emergency departments and has been found to produce rapid and brief sedation, especially for orthopedic procedures. Lerman et al[21] studied 76 adult patients in a prospective observational study where IV methohexital had been used for a variety of procedures, and concluded that it caused clinically insignificant changes in hemodynamics and oxygenation. Although respiratory depression did occur, if significant it was brief and easily managed. Zink et al[22] reported a consecutive case series of 102 patients (including 10 patients younger than 10 years) who received IV methohexital for various procedures. The authors concluded that methohexital is safe and effective in selected emergency department patients.

Despite the popularity of methohexital in adult emergency departments, its use in PEDs is rare. In a recent survey to all members of the emergency medicine section of the American Academy of Pediatrics by Conners et al,[23] less than 1% of respondents used methohexital (unmentioned route of administration) to sedate uncooperative stable children for posttraumatic head CT scans. Most of those respondents were board certified in pediatrics and pediatric emergency medicine.

The use of methohexital via the rectal and intramuscular routes in children undergoing imaging procedures has been documented in 3 published studies. Manuli and Davies[24] demonstrated its effectiveness via the rectal route compared with oral chloral hydrate in a series of 190 patients undergoing CT scans and magnetic resonance imaging, and no cardiorespiratory complications or allergic reactions occurred. Varner et al[25] demonstrated methohexital use via the intramuscular route, comparing 3.5% to 5% solution in achieving sedation for CT scans in a series of 50 pediatric patients, and concluded that intramuscular methohexital is safe, effective, and short acting. The use of rectal methohexital as a sedative for CT scans of stable PED patients has been documented in a recent study by Pomeranz et al.[26]

In our case series, we looked at IV methohexital in doses of 0.5 mg/kg to 2.0 mg/kg to achieve sedation in pediatric patients for obtaining emergency CT scans during their stay in the PED. Our primary measure was its effectiveness in keeping patients motionless to obtain CT scans; most of the scans were completed, signifying adequate sedation. The other measure was safety, and only 3 of our patients had a small drop in their oxygen saturation, which was transient and easily handled by the chin lift maneuver with no supplemental oxygen.

In phase 2 of our study, we achieved rapid and brief sedation. The mean onset of sedation after administering the drug was 1 minute; therefore, we recommend that methohexital be given while the patient is on the CT scan table and the radiology technician is ready to start the scan. The shortest adequate sedation was 5 minutes, which is usually long enough to complete a noncontrast head CT scan, whereas the longest adequate sedation was 21 minutes, enough time to complete most abdominal CT scans. This rapid induction and recovery help to expedite the process of discharging patients from the PED.

Times of Sedations in Phase 2 of the Study*

	Range	Mean ± SD
Onset of sedation (time between administration of dose and onset of sedation)	1-2	1 ± 0.4
Adequate sedation time (time between onset of sedation and end of sedation)	5-21	12 ± 5
Total effect of the drug (time between onset of sedation and return to presedation state)	5-26	14 ± 6
Scan time (time between start and end of scan)	4-24	9 ± 5
Total procedure time (time between dose administration and return to presedation state)	7-27	15 ± 6

*Data are presented in minutes (n = 22).

To our knowledge, our case series is exclusive in documenting the use and effectiveness of IV methohexital in sedating children for CT scans during their stay in the PED; however, it is limited by the number of sedations performed. We documented a drop in oxygen saturation in only 3 of 55 patients. Although this complication was transient and easily managed, our study had too few patients to have detected rarer adverse effects of IV methohexital.

In summary, we conclude that IV methohexital produces rapid and effective sedation, and we recommend its use as a sedative in PEDs for brief, nonpainful procedures such as CT scans. We recommend further studies using IV methohexital with larger numbers of patients for monitoring rare adverse effects. Studies comparing IV methohexital with other sedatives in the PED are also recommended.

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