Intramuscular Dexmedetomidine: An Effective Route of Sedation Preserves Background Activity for Pediatric Electroencephalograms

Keira P. Mason, MD[1], Nina Lubisch, APRN[2], Fay Robinson, MPH[3], Rudolph Roskos, MD[2], and Mark A. Epstein, MD[2,4]

Objectives To describe the efficacy and outcome of dexmedetomidine (Dex) via the intramuscular (IM) route for sedation for electroencephalography (EEG).

Study design Quality assurance data and EEG studies were reviewed for consecutive patients who received IM Dex for EEGs between August 2007 and September 2009. Sleep spindles, delta waves, and beta activity were evaluated to determine the deepest stage of sleep achieved.

Results One hundred seven consecutive children (age 0.2-17 years) between August 2007 and September 2009 received IM Dex (range 1.0-4.5 mcg/kg). The average time to achieve sedation was 15.5 minutes (range 3.0-55.0) with an average of 54.5 minutes to meet discharge criteria following EEG studies, which averaged 34.2 ± 22.6 minutes. The deepest stage of sleep recorded for each child was: awake (n = 1), stage N2 (n = 51), and stage N3 (n = 55). Excessive beta activity was seen in only 1 patient. Epileptiform activity was noted in 11 patients. Hemodynamic fluctuations in heart rate and blood pressure were noted, none of which required pharmacologic intervention. All EEGs were successfully completed.

Conclusion We describe Stage 3 sleep and preserved background activity in response to Dex. We present the IM route as a new method, which preserves background EEG activity to provide safe and effective sedation for EEG studies. *(J Pediatr 2012;161:927-32)*.

Some infants, children, and developmentally compromised patients are unable to remain sufficiently motionless in order to acquire electroencephalograms (EEGs). Historically, chloral hydrate via the oral route has been administered to elicit sedation and facilitate the acquisition of these studies.[1] Dexmedetomidine (Dex) (Precedex; Hospira, Lake Forest, Illinois) is a highly selective α-2 adrenoceptor agonist, which, when given by the intravenous (IV) route, has been shown to mimic natural sleep.[2] With a shorter half-life and lack of observable effect on respiratory centers, Dex could offer advantages over chloral hydrate for EEG sedation.[3] Dex was approved by the Food and Drug Administration in 2008 as a sedative via the IV route for adults in settings outside of the intensive care unit.[4] Although still not labeled for pediatric usage, its application for pediatric sedation has been described.[5,6] Dex via the IV route has been described for pediatric sedation for EEG imaging. It has been shown to produce EEGs, which mimic stage 2 of physiologic sleep without altering EEG peak frequency and amplitude.[2,7]

Although the intramuscular (IM) route of administration has been described in adults for anxiolysis, this route has not been described for children.[8,9] The IM route may offer advantages to the IV route of delivery in those patients who display aggressive behavior toward IV insertion and in outpatients who do not require IV catheterization for the exam itself. Furthermore, the IM route has not been described for EEG sedation in this population. The IM route, if effective, could represent an alternate to oral chloral hydrate and, in some situations, may provide an option for the patient who is not an appropriate candidate for chloral hydrate.

Methods

At Chris Evert Children's Hospital, IM Dex is administered to achieve sedation for EEG studies in children. In order to maintain compliance with the institutional requirements, quality assurance (QA) data are collected at the time of each sedation, on all patients. Institutional review board approval was obtained for review of all consecutive QA data from August 2007-September 2009, for patients who received IM Dex sedation for EEGs. Written, informed consent had been obtained for sedation. The need for a separate informed consent form for this retrospective review was waived by the institutional review board. Sedation-related demographics and QA data are collected on every patient. Patient demographics, physiologic vital signs (noninvasive

EEG	Electroencephalography or electroencephalogram
Dex	Dexmedetomidine
IM	Intramuscular
IV	Intravenous
MAP	Mean arterial blood pressure
QA	Quality assurance
RSS	Ramsay Sedation Score

From the [1]Department of Anesthesiology, Boston Children's Hospital, Boston, MA; [2]Department of Pediatrics, Chris Evert Children's Hospital, Fort Lauderdale, FL; [3]DM-Stat, Inc, Malden, MA; and [4]Department of Neurology, Miami Children's Hospital, Miami, FL

The authors declare no conflicts of interest.

 10.1016/j.jpeds.2012.05.011

Table I. Exclusions to receiving IM Dex sedation

Prolonged QT syndrome
Retts syndrome
Wolff Parkinson White syndrome
Current use of Digoxin
Hypertension
Intracranial hypertension
Marfan's syndrome
Intracranial bleed, stroke
Uncontrolled gastroesophageal reflux or vomiting
Bone marrow suppression
Platelets <60 000/mL
Sickle cell crisis
Coagulation disturbance

blood pressure, heart rate, pulse oximetry), and sedation outcomes are collected coincident with the sedation and subsequently entered into a database by a single administrator (N.L.).

At Chris Evert Children's Hospital, IM Dex sedation was supervised by a pediatrician (R.R.) and administered by one provider, pediatric nurse practitioner (N.L.) with Pediatric Advanced Life Support and Basic Life Support credentials. All patients who receive Dex must not have institutionally established contraindications (Table I). The Sedation Policies and Guidelines follow the recommendations of the Joint Commission on Accreditation of Healthcare Organization and the American Academy of Pediatrics.[10] All sedation is administered following institutionally approved protocols. The standard protocol for sedated EEGs was IM administration of Dex. Exceptions would include those who have an IV catheter in place; these patients would receive IV Dex. An initial bolus of undiluted Dex (200 mcg/mL) is administered in the deltoid at a dosage of 1.0-4.5 mcg/kg, chosen at the provider's discretion, based on the child's initial presentation: children who present extremely anxious, inconsolable, aggressive, and noncompliant tend to receive ≥2.5 mcg/kg initially. Those who are relatively compliant and calm usually receive ≤2.5 mcg/kg. The Dex is administered with the intended goal to achieve a Ramsay Sedation Score (RSS) 4, a value generally accepted as an adequate sedation depth to achieve motionless conditions.[2] A repeat, reduced dose is administered if the first dose fails to achieve a RSS 4 after a minimum observation period of 10 minutes. Physiologic monitoring is consistent with American Academy of Pediatric guidelines.[10] Noninvasive blood pressure (systolic, diastolic, and mean arterial blood pressure [MAP]), heart rate, and pulse oximetry are monitored continuously and documented at 5 minute intervals from time at which the initial dosage is administered until discharge criteria are met in the recovery room. Discharge from the recovery room includes the achievement of a minimum RSS 2 and Aldrete Score 8 (Table II; available at www.jpeds.com).

Outcomes

Analysis of our sample is descriptive in nature. Effectiveness measures and demographics of primary interest are presented for our group. Effectiveness measures include successful completion of EEG study, total dosage (mcg), time to achieve adequate sedation (minutes), total duration of sedation (minutes), and time to recovery (minutes). Physiological responses of interest include hypertension, hypotension, bradycardia, and respiratory compromise.

Time to achieve adequate sedation is defined as the time (minutes) interval between the initial IM dose and the achievement of RSS 4. Total duration of sedation is defined as the time span (minutes) between achieving RSS 4 to meeting hospital discharge criteria. Time to recovery refers to the duration of time elapsed from arrival to recovery room and meeting discharge criteria. The occurrence of hypertension or hypotension was examined in 2 ways, by a 20% deviation from either baseline MAP or from expected age-adjusted awake normal values.[11] Bradycardia was defined as a deviation of greater than 20% from baseline heart rate.

EEG Analysis

EEG recordings during Dex sedation were recorded per established guidelines using XLTEK digital electroencephalographs (Excel-Tech, Ltd, Toronto, Canada) using standard 10-20 electrode placement system.[12]

All EEGs were visually evaluated by a board-certified child neurologist (M.E.). The background activity was analyzed for frequency content and amplitude. Specifically, the presence or lack of excessive beta (defined as sustained >13 Hz activity exceeding 25 uV) that traditionally obscures sedated sleep EEGs was noted. Further characteristics of spindle symmetry and synchrony and vertex wave distribution were identified. Stage differentiation was noted and EEG epochs were classified into stages according to Grigg-Damberger et al.[13] Stage N2 was characterized by sleep spindles ranging from 11-16 Hz (most commonly 12-14 Hz) and K during an epoch. Stage N3 (slow-wave sleep) was characterized by the presence of a minimum of 20% delta waves ranging from 0.5-2 Hz and having a peak-to-peak amplitude >75 during an epoch.

Statistical Analysis

Descriptive statistics were generated on all patients in the study sample, including means and standard deviations for continuous variables and relative frequencies for categorical variables. All statistics were generated using SAS v. 9.2 (SAS Institute Inc, Cary, North Carolina).

Results

The total number of EEG studies performed during the study period was 984; 107 consecutive children (83 male, 24 female) received IM Dex for EEG studies and the majority of the remainder received unsedated sleep-deprived EEGs. The rate of sedated EEGs with IM Dex during the study period was 10.9%. Mean age was 3.5 years (±2.6; range 0.2-17.0 years). The most common diagnoses were encephalopathy (32%), developmental delay (32%), and seizures