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Dexmedetomidine is effective for sedation for outpatient electroencephalography

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Key points

Dexmedetomidine is an excellent choice for sedation for EEG because it does not have anticonvulsant properties like all of the other available sedatives. Dexmedetomidine is well tolerated by children, including those with autism, undergoing EEG testing and abnormal electrical activity can be seen in patients that are receiving it during testing. Children two years and younger require higher doses to complete the EEG studies, but there are no increased adverse events.

Abstract

Background

Ideally an electroencephalogram (EEG) should be obtained when the patient is in their baseline, non-sedated state. However, this can be challenging in children, especially those with autism. We reviewed our experience utilizing dexmedetomidine for sedation for EEG, in particular, younger children and those with autism.

Methods

A retrospective cohort study was performed on all patients that received dexmedetomidine for sedation for EEG during a two year period. Clinical data including demographics, vital signs, drug doses and adverse events was collected. Statistical analysis was performed using paired student T and Fisher exact tests and p value < 0.05 was considered significant

Results

41 patients received dexmedetomidine for sedation for EEG over a 2 year period. The average age of the patients was 59±34 months, 88% were male and 15% had abnormal EEGs. The average loading dose was 0.95± 0.21 mcg/kg and infusion rate was 0.64±0.16 mcg/kg/hr. There was a decrease in heart rate, mean blood pressure and respiratory rate during the sedation compared to their baseline vitals ($p= 0.007$). Children 2 years and less required higher doses (2.45 vs 2.01 mcg/kg/hr, $p = 0.04$) and took longer to reach level 4 sedation (19.7 vs. 12.9 minutes, $p = 0.05$). Children with autism were older than those without autism (100 vs 34 months, $P=0.04$), but did not require increased doses to perform EEG testing. There were no adverse events.

Conclusions

Dexmedetomidine provides reliable and effective sedation for EEG testing in children of all ages and those with autism. Children two years and younger require higher doses and take longer to reach a level appropriate for EEG testing and this should be kept in mind when sedating these children.

Keywords: Dexmedetomidine, sedation, EEG

Introduction

Electroencephalography is commonly used to assess patients with clinical seizures and patients with unclassified episodes. Children with developmental disorders, like autism, may be at risk for subclinical seizure disorders. Ideally an electroencephalogram (EEG) should be obtained when the patient is in their baseline, non-sedated state. However, this can be challenging in children, especially in younger children and those with autism. For many years chloral hydrate was used as the agent of choice for sedation for EEGs at our hospital and other children's hospital. However, chloral hydrate is not available in the United States anymore. Benzodiazepines and barbiturates have traditionally been avoided due to their anticonvulsant properties and concern that it may interfere with the interpretation of the EEG. We previously utilized propofol because of its reliable sedation profile for outpatient procedures. However, our neurologists became concerned about the CNS depression they were seeing on the EEGs. Recently, it has been suggested that dexmedetomidine may be useful for sedation for EEG because it does not have antiepileptic properties.[1] We present our experience utilizing dexmedetomidine for sedation for EEG, focusing on younger children and those with autism.

Methods

Prior to the study, approval was obtained from the institutional review board at Miller Children's Hospital. A policy was put into place for the use of intravenous dexmedetomidine for EEG testing in 2010. The guidelines developed by pharmacy and the pediatric sedation service based on a literature review at that time were as follows: Initial bolus dose of 0.25- 1 mcg/kg over ten minutes and may repeat 0.5 mcg/kg over 5 minutes every 5 minutes a needed. A maintenance infusion of 0.6mcg/kg/hr with a range of 0.2 to 1 mcg/kg/hr was recommended. All patients were sedated in the neurodiagnostics center by the pediatric sedation team that included a pediatric intensivist, a trained sedation RN and a child life specialist. All patients were transported to and recovered in the pediatric post anesthesia care unit.

A retrospective cohort study was performed on all patients that received intravenous dexmedetomidine for sedation for EEG during a two-year period. Patients were identified through a pharmacy database and then the charts were reviewed to confirm that they did receive dexmedetomidine for EEG testing. The following information was collected: age, sex, weight, diagnosis, indication for EEG, heart rate, mean blood pressure (BP), respiratory rate, oxygen saturation before, during and after sedation, Richmond Agitation-Sedation Scale scores,[2] initial dose, infusion rate and total dose of dexmedetomidine infusions, duration of sedation, length of stay, adverse events and results of EEG recordings. Statistical analysis was performed using a paired student T and Fisher exact test and p value < 0.05 was considered significant.

Results

A total of 52 patients were identified from the database. However, review of the charts indicated that six patients did not require sedation, three were sick and did not have the procedure, one had inadequate documentation and one did not have an EEG. Therefore, 41 patients received dexmedetomidine for sedation for EEG over a 2-year period.

The average age of the patients was 59±34 months, 88% were male and 15% had abnormal EEGs. The average loading dose was 0.95± 0.21 mcg/kg and infusion rate was 0.64±0.16 mcg/kg/hr. Patients received a total of 2.1±0.7 mcg/kg/hr during their EEG (table 1). 39% of the patients required an additional bolus to reach the desired level of sedation to begin the testing and one patient required three boluses. All patients reached a level 4 sedation score. Four patients were described as waking up during the procedure and had to be given an additional bolus at that time. All patients received only dexmedetomidine with the exception of one patient who was induced with propofol for an MRI, but then main-

tained on a dexmedetomidine infusion for the MRI and EEG that followed.

There was a decrease in heart rate, mean blood pressure and respiratory rate during the sedation compared to their baseline vitals ($p = 0.007$). No change in oxygen saturation was seen. 14% of the patients received oxygen during the procedure. The average duration of the sedation was 58±14 minutes, recovery room stay 76±27 minutes and hospital LOS was 228±35 minutes.

The predominate findings on the EEGs was 4-6 Hz theta slowing with some posteriorly prominent delta waves and sleep spindles. All of the patients achieved stage two sleep, but slow wave sleep (stage 3 and 4) was rare. Focal and generalized epileptiform discharges were seen in six patients. Abnormalities included: frequent high amplitude spikes that were occasionally general and multifocal, prolonged runs of multiphasic spike and slow wave discharges at a frequency of 1-1.5 cycles per second and frequent high amplitude slow waves were occasional sharp wave activity.

Subgroup analysis did not show any difference in the change in vital signs caused by dexmedetomidine when younger children (2 years or less) where compared to older. There was a difference in the dose needed per kilogram standardized to the time to complete the study. Younger children needed more dexmedetomidine (2.45 mcg/kg/hr vs 2.01 mcg/kg/hr, $p = 0.04$) and also took a longer time to reach level 4 sedation (19.7 vs. 12.9 minutes, $p = 0.05$). See table 2.

Children with autism were older than those without autism (100 vs 34 months, P=0.04). There was no difference in the change in vital signs caused by dexmedetomidine when compared to children that did not have autism. There was no difference in the time to reach level 4 or the duration of sedation needed to complete the study. There was a trend towards receiving less dexmedetomidine to complete the study when patients with autism were compared to those without (1.8mcg/kg/hr vs 2.3 mcg/kg/hr, P=0.07). See table 3.

Discussion

Our primary finding in this small study is that dexmedetomidine can be used safely and effectively for sedation for EEG testing when administered by a pediatric sedation service. With the discontinuation of chloral hydrate, our non-anethesiology service has been increasingly called upon to treat these patients. This has allowed our anesthesiologists to focus on patients in need of their expertise. Although there was a predictable decrease in heart rate, mean blood pressure and respiratory rate, there were no adverse events. No patient required bag mask ventilation, airway adjuncts, or any intervention for the decrease in heart rate or blood pressure. In fact, most patients did not even require supplemental oxygen during the procedure. It appeared that oxygen was administered as a standard procedure by some of the sedating physicians rather than due to any decrease in the oxygen saturation as measured by the pulse oximeter. Although normal saline was available to treat potential hypotension, none of the intensivists felt it was warranted for the completion of the studies.

Our bias going into the study was that children with autism were more difficult to sedate and required higher doses of dexmedetomidine to complete the procedure. Based on our data, this is not true. At times it was certainly challenging to initiate the sedation process. We worked closely with their families, our child life specialists and were able to place peripheral IVs without the use of any oral sedation. Utilizing distractions from family members, movies, and electronic devices allowed us to administer the loading dose over 10 minutes without the children becoming overly agitated. There were times that the bolus dose had to be repeated, but not any more frequent than with other children. Some of the patients with severe autism did not allow continuous monitoring until they feel asleep and so close observation and visualization was critical during this phase.

Parameter		Baseline	Sedated	P value
Patients	41			
Age (months)	59±54			
Sex-male	36 (88)			
Abnormal EEG	6 (15)			
Dex load (mcg/kg)	0.95±0.21			
Dex infusion rate (mcg/kg/hr)	0.64±0.16			
Dex total (mcg/kg/hr)	2.1±0.7			
Time to level 4 (min)	14.7±6.5			
Duration of sedation (min)	59.1±13.2			
Repeat Bolus	16 (39)			
Hospital LOS (min)	228±35			
Heart Rate (BPM)		103±16	85±13.5	<0.001
Mean BP (mmHg)		75±13	64±7.7	< 0.001
Respiratory rate (BPM)		22±4.7	19.8±3	0.007

Table 1. Patient characteristics. Dex=Dexmedetomidine, data presented as average ± standard deviation or number (percentage)

Parameter	2 yo and under	Greater than 2 yo	P Value
Patients	10	31	
Dex Total (mcg/k/hr)	2.45±0.5	2.01±0.7	0.04
Repeat Bolus	6	10	0.14
Duration to level 4	19.7±8.7	12.9±4.8	0.05
Duration of sedation	61.2±15	59.5±12	0.7
HR change (BPM)	-18.8±7.7 (17)	-18.6±12.9 (19)	0.7
Mean BP change (mmHg)	-7.6±8.5 (10)	-11.3±10 (14)	0.3

Table 2. Subgroup analysis of patient parameters. Dex=Dexmedetomidine, data presented as average ±standard deviation or total number. Durations are expressed in minutes. HR and Mean BP are overall change or (%) and p value calculated on percent change from baseline.

Parameter	Autism	No Autism	P Value
Patients	13	28	
Age (months)	100±66	34±14	0.004
Dex Total (mcg/k/hr)	1.8±0.7	2.3±0.7	0.07
Repeat bolus	5	11	1
Duration to level 4	13.2±5.8	15.7±6.6	0.2
Duration of sedation	61.7±13.4	58±13	0.4
HR change (BPM)	-15.6±10(17)	-19±11 (18)	0.7
Mean BP change (mmHg)	-7.4±8 (10)	-11±11 (14)	0.2

Table 3. Subgroup analysys for autism and non-autism. Dex=Dexmedetomidine, data presented as average ±standard deviation or total number. Durations are expressed in minutes. HR and Mean BP are overall change or (%) and p value calculated on percent change from baseline

There was a period that we utilized propofol for sedation for EEGs for patients that could not be done with choral hydrate. It was certainly easier to rapidly achieve level 4 sedation, but most of the EEGs were very depressed despite trying to titrate down the propofol during the exam. Because of propofol's anti-epileptiform drug properties, we became concerned that it may be suppressing some of the epileptiform discharges during the study. Others have also described this.[3-4] At this same time, there was one description of utilizing dexmedetomidine for telemetry patients that were being sedated for various procedures.[1] Based on that, we developed a policy for EEG sedation that could be administered by our pediatric sedation service staffed by pediatric intensivists. Besides our study, there is limited data on dexmedetomidine regarding the information obtained on the EEG, optimal dosing and specific patient populations; such as younger patients and those with autism.[5-6] We examined children less than 2 years of age because this age group has not been looked at in other studies on dexmedetomidine for EEG testing. Most infants at our institution were bundled and done without sedation and so there was only one patient less than a year of age. However, we believe patients near two years of age are

becoming an increasingly larger group of candidates for dexmedetomidine because of the concerns for autism at that age and the lack of availability of chloral hydrate. It should not be surprising that younger children required more medication and took a longer time to reach a desired level of sedation. This phenomenon has been recognized in pediatric intensive care units for years. It is reassuring to see that the larger doses were tolerated without any adverse events or any increase in time spent in the recovery room. We continue to utilize an initial bolus of 1 mcg/kg over 10 minutes, but have increased our standard basal rates to 1 mcg/kg/hr in this group. We also plan to see if we can complete the studies with patients in both level 3 and 4 rather than only level 4 sedation score.

Although we had a fairly high percentage of normal stage 2 sleep EEGs (85%), we did have EEGs that demonstrated sharp waves and epileptiform activity. Compared to the EEGs that were obtained while we were using propofol sedation, there was a much more normal sleep background with dexmedetomidine, as others have described.[7] It has been estimated that about 30% of patients with autism have epilepsy and the overall rate of 15% was not that far off from what would be expected.[8-12]

One practical downside to using dexmedetomidine is the amount of time required to complete the study. When pre-procedure IV insertion and complete recovery are factored in, the patients spent an average of almost 4 hours at the hospital. However, it was clear that in the patients with autism, the examine could not have been performed without some type of sedation. Several patients had already failed to complete testing without sedation. Since we were unable to obtain slow wave (stage 3 and 4) sleep, we could not confirm or exclude the diagnosis of electrical status epilepticus (ESES) during slow wave sleep. This diagnosis has been described in patients with autism and so we are now attempting to sedate patients with this concern only during the hook up period. [13] They will then remain on telemetry for about 8 hours in an outpatient setting in order to try and capture normal slow wave sleep.

Conclusion

Dexmedetomidine provides reliable and effective sedation for EEG testing in children. Children two years and younger require higher doses and take longer to reach a level of sedation desired for testing. It appears to be well tolerated in patients with autism and achieves excellent results without any increase in dosage requirement. Given the number of patients with autism and epilepsy, more EEG testing is going to be needed and dexmedetomidine appears to be an excellent choice for this challenging group.

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