

# Deep sedation with propofol by pediatric intensive care physician during magnetic resonance imaging procedures: a prospective experience.

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## Citation

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## Abstract

**Purpose:** This study evaluated the safety and efficacy of a propofol based protocol for deep sedation in spontaneously breathing children undergoing magnetic resonance imaging (MRI) procedures under the direction of the intensive care pediatrician. **Methods:** Propofol sedation was prospectively studied in 36 MRI procedures. Sedation was induced with 3 mg/kg of propofol infused over 6 minutes and maintained with infusion of propofol between 1 and 10 mg/kg/h rate. **Results:** All procedures were completed without any adverse event. The average time for sedation was 30 minutes. The average maintenance rate was 4.99 mg/kg/h. The average total dose of propofol was 5.3 mg/kg. All patients were in normal ward after MRI procedure. No side effects were observed in recovery period and all patients were discharged in less than two hours. **Conclusion:** Propofol infusion for sedation in children undergoing MRI procedures can be considered safe and acceptable under the direction of intensive care pediatrician.

## INTRODUCTION

Magnetic resonance imaging (MRI) is now considered as the imaging method of choice for the diagnosis of a wide number of congenital and acquired pediatric diseases. This examination requires patients to stay still for a variable length of time of up to an hour in a closed, claustrophobic and noisy environment; hence the need for sedation in children is very common to ensure that images are of diagnostic quality. The demand for sedation and anesthetic procedures in general hospitals often exceeds the availability of trained anesthesia personnel which means a delay of imaging procedures especially in children (1). On the other hand, magnetic and radio-frequency interactions between the imager and anesthetic equipment may result in image degradation and interference with anesthetic monitoring devices. For these reasons sedative intravenous regimens monitored by pediatricians are often required in infants and children (2-18). Propofol (2,6 diisopropylphenol) is an ultra-short acting non-opioid non-barbiturate sedative hypnotic agent that has favorable properties for use by non-anesthesiologists to facilitate diagnostic or therapeutic procedures in infants and children (19). These properties include; onset of almost instantaneous action; sustained

sedation when administered as continuous infusion; the highest metabolic clearance of any intravenous hypnotic agent, allowing a rapid recovery; and low incidence of nausea and vomiting with no anesthetic hangover (2,20). The main obstacle for using propofol in children younger than 16 years of age is the propofol infusion syndrome after prolonged sedation (21). Therefore, propofol is currently not registered for sedation in children but long term sedation must be separated from short term sedation lasting for 20 min to 3-4 hour (6). Large case series have shown that propofol can be given to children as short-term sedation with efficacy, safety and rapid recovery (11-18). There is no antidote for propofol (22). A decrease in blood pressure and heart rate, and apnea or hypoventilation which can result in arterial oxygen desaturation are common adverse effects of intravenous propofol. These adverse effects are usually mild and transient (5,23). These complications of over-sedation can be quickly minimized by stopping the infusion, but occasionally respiratory and/or hemodynamic support may be necessary (2). On the other hand, children are considered at higher risk of the cardiorespiratory side effects of this drug. For these reasons propofol should be used by personnel trained in advanced cardiopulmonary resuscitation

techniques (24,25), such as intensive care pediatricians. With this study we intend to evaluate the safety and efficacy of our protocol for deep sedation with propofol in spontaneously breathing children between six months and fourteen years undergoing magnetic resonance imaging procedures titrated by an intensive care pediatrician of our unit.

## **MATERIAL AND METHODS**

All children between 6 months and 14 years undergoing MR imaging who were referred for deep sedation in the pediatric intensive care unit of the Hospital General de Ciudad Real (Spain) were prospectively included in this study during an 18-month period (October 2006 to march 2008). Children with ASA physical status > III, egg or soy allergy or intubated patients were excluded.

A preoperative assessment was performed on all children and written informed consent was obtained from parents. During this evaluation a medical history was taken and a physical examination was performed. Additional data recorded included age, gender, weight and indication for MRI. The children fasted from solids for 6 h and from clear liquids for 3 h prior to sedation on the day of the procedure. If the child did not meet strict fasting criteria or presented with symptoms or history consistent with upper respiratory tract infection, the procedure was rescheduled. Before sedation, an intravenous access was established and intravenous hydration was started if needed. The complete sedation procedure took place in the MRI room where oxygen, suction, and pediatric resuscitation equipment were available. At least one parent was with the child during the induction of sedation. The induction consisted of two doses of Propofol injected with a syringe pump (Alaris GH Cardinal Health Inc) over 3 minutes each one. The first dose was 2 mg/kg and the second 1 mg/kg with a total induction dose of 3 mg/kg over 6 minutes. After the induction, a continuous infusion via a syringe pump was started at a rate chosen by the pediatrician of between 1, 5 or 10 mg/kg/h to maintain deep sedation. Our goal was to achieve a level > 5 on the Ramsay scale (26). Titration of dose was based on pulse rate, respiratory rate and movement. If there were movements or heart or respiratory rates increased, maintenance rate was increased and if they decreased the infusion rate was also reduced. When the heart and respiratory rates were stable we would try to decrease the maintenance rate to infuse the minimum dose possible. Propofol infusion was discontinued at the end of the

procedure. We used a syringe pump with sufficient extension tubing to avoid interaction with the imager. When children were unconscious their head and neck were placed carefully to keep the airway clear. Oxygen was administered routinely during procedures by nasal cannula at a rate of 2 l/min in all children. All patients were continuously monitored with electrocardiogram and arterial oxygen saturation (SpO<sub>2</sub>). Data were obtained with an MR imaging compatible monitor (Datex-Omheda S/5<sup>TM</sup> MRI monitor). Respiratory rate, chest excursion and peripheral perfusion were monitored visually. Physiological parameters and Ramsay Sedation Score were recorded every five minutes. Adverse effects such as respiratory depression, defined as the need for assisted ventilation (bag mask-valve or endotracheal intubation), airway repositioning maneuvers or hypoxemia (oxygen saturation < 93%) or hemodynamic instability defined as the presence of bradycardia (HR < 60), inadequate capillary perfusion or weak peripheral pulses were carefully noted. Induction time, MRI procedure duration, propofol infusion rates, and time of propofol infusion were also recorded. Sedation was considered successful when the patient tolerated MRI procedure without spontaneous movements or any adverse events that could stop MRI sequences. After finishing the procedure, the patients were moved to the pediatric area. If there were no adverse events during sedation and children were able to awake easily and having adequate oxygenation without supplemental oxygen, then they were transferred to the normal ward until complete return to baseline. The rest of patients should be moved to pediatric intensive care unit. Any episode of post-sedation nausea and vomiting or any other side effect until discharge was recorded. Patients were considered ready for discharge when they had stable vital signs, were oriented and showed no side effects. Independent nursing staff not associated with the study took the decision for patient discharge to home. Data on patient characteristics, initial propofol dose, duration of MRI scanning, infusion rate of propofol, total dose of propofol, pulse rate and respiratory rate were summarized as mean +/- SD. The average propofol infusion rate during maintenance in mg/kg/h was calculated on the basis of the maintenance dose and the duration time of the procedure.

## **RESULTS**

A total of 41 patients between 6 months and 15 years were referred to pediatric intensive care unit for deep sedation during MRI procedures. Three patients lost the intravenous line before propofol induction dose had been completed and

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these children were excluded, although the MRI procedure could be finished successfully without infusion of more doses of propofol or other sedative agent. One patient had egg allergy and other two did not need sedation during the study. Finally 35 patients underwent 36 MRI studies. The mean age was  $4.4 \pm 3.8$  years (range 6 months-13.4 years). The mean weight was  $18.6 \pm 13.7$  kg (range 6.3 – 53 kg). There were 22 boys and 13 girls. Most were healthy; thirty two (91.4%) were classified as ASA class I or II, and three (8.6%) as ASA III. The MRI studies performed are listed in Table I. Original diagnoses are listed in table II.

**Figure 1**

Table I: List of MRI studies performed

MRI	Number of studies
Cerebral without contrast	28
Cerebral with contrast	2
Abdominal	3
Medullar	3
Hypophysis	1
Cholangio MR	1
Soft tissue	2

-Cerebral, abdominal and hypophysis studies were performed at same time on one patient  
 -Cerebral and medullar studies were performed at same time on two patients.

**Figure 2**

Table II: List of original diagnoses

Original diagnoses	number
Epilepsy	9
Developmental delay	7
Cerebral malformation	2
Acute encephalopathy	4
Cryptorchidism	1
Abdominal mass	1
Headache	1
Cushing syndrome	1
Soft tissue tumors	2
Hypoacusis	2
Pancreatitis	1
Medullar lesion	2
Cerebral palsy	2
Cerebral infarct	1

The mean duration of procedure was  $30.3 \pm 13.6$  minutes (range 15-70 minutes). The mean dose of propofol was  $5.31 \pm 2.2$  mg/kg. The median infusion rate after induction was  $4.99 \pm 3.4$  mg/kg/h. The maintenance rate was started at 1 mg/kg/h, 5 mg/kg/h and 10 mg/kg/h in 6, 17 and 13 cases, respectively. The initial infusion rate was modified once during procedure in 17 cases, and in all cases infusion rate was decreased. Titration was performed in thirteen procedures where the initial rate was 5 mg/kg/h and in four who had 10 mg/kg/h as initial rate. Deep sedation with Ramsay score of 6 was reached in all cases. Propofol infusion resulted in a decrease in heart rate and respiratory rate in all children. There was no respiratory depression or oxygen desaturation in any child. All MRI procedures could be finished successfully. In one case the MRI sequence was stopped when the propofol loaded in syringe pump was finished. The child moved but he did not recover consciousness and the procedure could be completed satisfactory after restarting propofol infusion at the previous rate, 10 mg/kg/h. All the patients could be transferred to the ward after the end of the propofol Infusion. All patients started oral feeding in first hour after MRI and all outpatients

were ready to discharge in the following hour. None of the patients experienced any episode of postoperative nausea and vomiting or any other side effect up to discharge.

## **DISCUSSION**

Over the past decade, propofol based sedation has been used increasingly for procedures outside the operating room setting (11-18). However there are few studies that evaluate the use of propofol as the sole agent to provide deep sedation in pediatric patients during MRI procedures (2-7). Some of these studies have compared sedation with propofol and other sedative agents, such as pentobarbital, chloral hydrate, opioids and midazolam (2-4). Other authors have reported the use of propofol plus other sedative agents (7-11). In most of these studies propofol is given by an anesthetist (2,3,6-11). The shortage of anesthesiologist is the most common barrier to the development of pediatric sedation (3,4). Hasan et al reported the use of propofol by pediatric intensivist in the MRI room without any mayor adverse events (5). In this study we describe the experience of our pediatric intensive care unit with a protocol for intravenous administration of propofol for deep sedation during MRI procedures. Possible adverse effects of propofol include respiratory depression and apnea, and most of them take place during the induction phase. Frequency of apnea following induction with propofol in other studies has been reported to be between 0-15% (2,4,6-8,27,28). In our study no apnea events were observed during induction. The induction dose of propofol in our study was similar to those previously reported in non-premedicated children who underwent MRI procedures (2,5-7). Whereas the time for administration of induction dose of propofol was said to range between 30-60 seconds (4,7,8), in our study it was infused over six minutes. We did not have to modify the preset dose in any case and all children were ready for the procedure after the six minutes of induction. In other studies, induction time and induction dose varies between patients and in most cases they were higher (3,4,8,10) than we used. This could be because our sedation procedure took place in the MRI room and at least one parent accompanied the child providing an environment that reduced child anxiety. It is known that the need for sedation is influenced by the level of anxiety (9). The absence of respiratory events during induction could be explained by our slower induction rate. Other sedation techniques for MRI procedures have shown a higher incidence of movements and interruptions of the examination. The movement rates during MRI scan for sedation with chloral hydrate or pentobarbital can be as high

as 22.5% and 12.2%, respectively (3) and the failure rates for complete scan without additional rescue agent was 11.7% and 10.4% (3). Movements and failure rates of sedation with propofol for MRI procedures were 0.9-3.2 % and 0-1.8% respectively (2,3). Using a mean maintenance dose of 4.99 mg/kg/h we could maintain deep sedation during procedures and all scans could be finished successfully. We only observed movements in one patient (2.7%) because propofol infusion was stopped during the refilling of the syringe when procedure was longer than expected. It is known that continuity of the infusion is crucial to avoid mid-scan wake-ups and movements. Most authors did not report the mean maintenance dose employed in their studies, but most of them started the maintenance with a dose of 6 mg/kg/h and they varied between 6 and 15 mg/kg/h so mean maintenance dose may be higher than we observed (2-4,7,8,10). Only Hasan reported a lower maintenance infusion rate of propofol, 1-2 mg/kg/h (5). The median total dose of propofol (5.3 mg/kg) employed in our case was similar to Hasan et al (4.3mg/kg) (5), Bloomfield (4.7mg/kg) (2) and Pershad (7.6 mg/kg) (4) but in this last study the median time of MRI examinations was two times longer than in our report. The highest total dose of propofol for sedation during MRI (9 mg/kg) has been reported by Gutmann et al., who also used midazolam as induction (8). No adverse effects during sedation were encountered and as in other published series no problems related to systemic tolerability were observed (2-11). One case of acute pancreatitis induced by a single dose of propofol has been reported (29) but we used it for sedation during a cholangio magnetic resonance procedure for recurrent pancreatitis without any complications. Propofol has shorter recovery times than other sedative agents traditionally used for sedation during MRI scan (2-4). We did not record recovery time but in previous studies it ranged between 5 and 17 min depending on the definition of recovery time (2,4,7). In our study all patients were transferred to a normal ward after the procedure. It is known that propofol is an anti-emetic with no anesthetic hangover (20) so, as in other series (2-7) no patient had vomiting or nausea and all children were able to start and tolerate oral feeding in the first hour after the procedure.

## **CONCLUSION**

This prospective observational report describes a protocol for using propofol for deep sedation in children undergoing MRI procedures and it confirms that propofol can be used safely and effectively by intensive care pediatricians in the

MRI room. The main difference with other protocols was the induction phase. Our protocol offers a predictable induction and it suggests that if induction dose is infused slowly (over six minutes in our case), the incidence of apnea can be reduced. As expected, sedation with propofol offered an easy titration, low failure rate and a rapid recovery without gastrointestinal adverse effects.

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## **References**

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