Research Article

Sedation in children undergoing magnetic resonance imaging comparative study between dexmedetomidine and ketamine

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Abstract  Aim and background: In this study we compared between sedative effect of dexmedetomidine and ketamine as regards their sedative, hemodynamic, respiratory effects and complication when given as infusions in children undergoing magnetic resonance imaging (MRI).

Methods: One hundred and ten children of both sex aged 3–7 years were randomly distributed into two groups. The first group (n = 55) received dexmedetomidine (D) 1 μg/kg as a loading dose followed by continuous infusion 0.5–0.75 μg/kg/h and the second group (n = 55) received ketamine (K) 1 mg/kg as a loading dose followed by continuous infusion 10–15 μg/kg/min. Inadequate sedation was defined as difficulty in completing the procedure because of movement of the child during MRI. The children who were inadequately sedated were given a single dose of propofol 0.5 mg/kg in both groups intravenously (iv) as rescue doses. Mean arterial pressure (MAP), heart rate (HR), peripheral oxygen saturation (SpO 2) and respiratory rate (RR) were monitored during this study.

Results: Inadequate sedation was observed in 6 children from (D) group and 4 children from (K) group during MRI examination. Onset of sedation was significantly shorter in (K) group, but the discharge time was longer in this group. MAP and HR decreased significantly from baseline during sedation in group (D). Nausea, vomiting, and dysphoria were observed in 3 children of group (K).

Conclusion: Dexmedetomidine provided adequate sedation in most of the children without hemodynamic or respiratory embarrassment, in comparison with ketamine which provided adequate sedation but with delayed discharge time and more side effects.

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1. Introduction

Sedation of children for imaging procedures is often challenging. While not painful, these procedures require patient immobility for as long as one to three hours. MRI examination is very sensitive to motion artifacts. If any movement occurs
during the imaging process for one sequence, the entire sequence must be repeated [1]. Children may be frightened by being in the magnetic resonance imaging (MRI) tunnel or duct and the loud noise generated during the imaging process. Thus sedation is required for children aged between 4 and 7 years. Children may not remain immobile for long enough to allow a sequence to be completed [2].

Consequently, a deep level of sedation is required during MRI. Deep sedation is defined as “a medically induced state of central nervous system depression in which the patient is essentially unconscious, and so does not respond to verbal command”. The potential complications of deep sedation include hypoventilation, apnea, airway obstruction, aspiration, hypotension, bradycardia, and increased intracranial pressure [3].

If any complications occur during an MRI examination, the nature of the set-up precludes easy access to the patient. Also, limited access to the patient may pose a safety risk during MRI examination [2,3]. There has been debate over the appropriate drugs and dosage regimens for MRI sedation in children.

Dexmedetomidine is a potent highly selective α2-adrenoreceptor agonist with a distribution half-life of approximately 8 min and a terminal half-life of 3.5 h [4]. Dexmedetomidine, as a sedative agent, can provide easily controllable analgesia and sedation without respiratory depression and has been widely used in the intensive care unit (ICU) for sedation and postoperative analgesia [5].

Ketamine is an N-Methyl-D-Aspartate (NMDA) receptor antagonist used clinically as an anesthetic, sedative, and analgesic in pediatric patients.

In this preliminary study, the aim was to improve sedation and develop a regimen based on dexmedetomidine, and to evaluate the sedative, hemodynamic, respiratory effects and incidence of complication of dexmedetomidine compared with ketamine in children undergoing MRI examination in Ain Shams University hospitals from January 2014 to August 2015.

2. Methods

After departmental approval and written parents consent, 110 ASA (American Society of Anesthesiologists) I–II children aged 3–7 years undergoing MRI were included in this randomized prospective study from January 2014 to August 2015. Patients with heart, lung or neurological disease, central nervous system or extremity trauma, or contraindication or allergy to any of the drugs studied were excluded. Randomization was done using a computer-generated random number list in 1:1 ratio. The randomization list was concealed until the time of randomization. Allocation of patients to either group was done by a clinician not involved in the study and the randomization codes were kept concealed until after data collection and analysis were completed. All children were allowed to take clear liquids up to 2 h before sedation but food (including milk) intake was withheld for at least 8 h in children older than 3 years. To facilitate intravenous (i.v.) cannulation, EMLA cream was applied on the dorsum of both hands 1 h before transfer to the preparation room. Presedation behavior was assessed on a four-point scale (1 = calm, cooperative; 2 = anxious but reassurable; 3 = anxious and not reassurable; 4 = crying or resisting). Categories 1 and 2 were classed as stressed and categories 3 and 4 as distressed. Baseline values were recorded upon arrival in the preparation room. A 22G (gauge/size) or 24G venous cannula was inserted in the dorsum of the hand. Children were randomized using a computer generated random numbers table into groups: D and F; 55 patients each. Solutions of dexmedetomidine (Precedex, Abbott laboratories, Lake Forest, IL60045, USA), 1 ml at a concentration of 100 μg/ml, were diluted with 49 ml normal saline to a concentration of 2 μg/ml, and ketamine (Ketamine 50, Sigma-Tec Pharmaceuticals Industries, Egypt-SAE), 1 ml at a concentration of 50 mg/ml, was diluted with 49 ml normal saline to a concentration of 1 mg/ml. A loading dose (dexmedetomidine 1 μg/kg was given over 10 min or ketamine 1 mg/kg with glycopyrrolate 5 μg/kg) was given intravenously followed by continuous infusion (dexmedetomidine 0.5–0.75 μg/kg/h or ketamine 10–15 μg/kg/min). The sedation level of the children was measured every 10 min using the Ramsay sedation scale by evaluating response to sound, verbal commands or tactile stimulation. The Ramsay scale (Table 1) assigns a score of 1–6 based on the clinical assessment of the level of sedation (1 = anxious, agitated, restless; 2 = awake, but cooperative, tranquil, orientated; 3 = responds to verbal commands only). Scores 4–6 apply to sleeping patients and are graded according to the response to loud noise or a glabellar tap (4 = brisk response; 5 = sluggish response; 6 = no response). The children were taken into the MRI room after a Ramsay score of 6 and hemodynamic and respiratory stability were achieved. If a Ramsay score of 6 was not achieved after 25 ± 5 min of study drug infusion or inadequate sedation occurred during MRI examination, a single rescue dose of propofol 0.5 mg/kg i.v. was administered to the patients in both groups. Inadequate sedation was defined as difficulty in completing the procedure because of movement during MRI examination.

Mean arterial pressure (MAP), heart rate (HR), peripheral oxygen saturation (SpO2) and respiratory rate (RR) were monitored continuously and recorded at 5-min intervals during the study period. Spontaneous respiration was maintained in all children, and oxygen via a facemask was given as 8 L/min to maintain SpO2 above 95%.

The quality of the MRI examination was evaluated using a three point scale (1 = no motion; 2 = minor movement; 3 = major movement necessitating another scan). At the end of the MRI, drug infusion was discontinued and the children were transferred to the recovery room. The onset of sedation time was defined as the time from starting drug infusion to achieving a Ramsay score of 6. Recovery time was the time between discontinuation of drug infusion and reaching a Ramsay score of 2. Discharge time was the time between discontinuation of drug infusion and discharge of the child from hospital.