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Research Article

Safety and consumption of sevoflurane versus desflurane using target controlled anesthesia in children

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KEYWORDS

Sevoflurane;
Desflurane;
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Auto control mode

Abstract *Background:* Recently a concept of target controlled inhalational anesthesia (TCA) is introduced in which the fresh gas flow and its composition are automatically delivered to the patients with the least possible flow. The aim of this study is to compare safety, consumption and cost of both sevoflurane and desflurane when delivered by target controlled anesthesia (TCA) using fully closed circuit conditions.

Patient and method: After approval of the hospital review board and obtaining parental informed consent, 60 pediatric patients aged 2–12 were selected. The patients were classified into two groups according to the anesthetic used S Group (n = 30) in which sevoflurane D Group (n = 30): in which desflurane was used. Both were delivered by auto control mode of Zeus machine. Anesthetic agent and O_2 consumption, cost and number of adjustments were assessed. Blood samples were obtained preoperatively and at 24, 48 and 72 h after the end of surgery for measuring serum creatinine, BUN, AST and ALT. Twenty-four hour urine samples were collected for 3 consecutive days to measure glucose, microprotein and creatinine for the estimation of creatinine clearance.

Results: This study revealed that sevoflurane group had a lower O_2, anesthetic consumption and cost than desflurane group. Also both groups had higher levels of serum urea and creatinine together with urinary microproteins and glucose in the first three post-operative days compared to preoperative values which indicates minor tubular insult. However there was no statistically significant difference between the two groups.

Conclusion: Sevoflurane is as safe as desflurane when delivered by auto control mode of Zeus machine with decreased anesthetic consumption and cost.

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1. Introduction

Low flow anesthesia has various advantages which include decreased consumption of medical gases and volatile anesthetics with its economic impact, reduction of anesthetic gas loss into the atmosphere with its environmental impact and finally conservation of temperature and humidity of the airway [1].

More recently a concept of target controlled inhalational anesthesia (TCA) is introduced in which the fresh gas flow and its composition are automatically delivered to the patients with the least possible flow. Theoretically target controlled anesthesia has many advantages in inhalational anesthesia practice which include decreased time to achieve a desired alveolar anesthetic gas concentration together with decreased overshoots and fluctuation of anesthetic agent. Another advantage is that the need for repeated anesthetic adjustments is markedly minimized decreasing the work of anesthetist. [2].

Modern anesthesia machines that implemented the target controlled concept has an auto control mode that deliver target controlled anesthesia with a fully closed circuit through blower-driven ventilator, an electronically-controlled gas and vapor delivery system and a servo-controlled valve system [3].

The last generations of halogenated anesthetics (desflurane and sevoflurane) have certain pharmacokinetic and pharmacodynamic properties which have been greatly magnified in minimal flow states. These anesthetic agents have low potency and low solubility in tissues, which fastens equilibration between concentrations of the alveoli and the brain. This makes these agents ideal for minimal flow and closed circuit conditions; hence, their Minimum Alveolar Concentration (MAC) in the inspiratory mixture is easily reached [4].

Despite being synthesized before the 1970s, one of the major barriers to their use is the high cost together with greater amount of agent required. This is evident in desflurane which has the highest MAC known among all anesthetic agents increasing its consumption and overall cost [4].

The side effects of accumulated volatile substances as an outcome of metabolism of sevoflurane are another aspect to be considered and may add to barriers of its use in minimal flow conditions [5].

The aim of this study is to compare safety, consumption and cost of both sevoflurane and desflurane when delivered by auto-control mode of Zeus machine that deliver target controlled anesthesia (TCA) using fully closed circuit conditions.

2. Patients and methods

After approval of the hospital review board and obtaining parental informed consent, 60 pediatric patients aged 2–12 and ASA status I–II with normal liver and kidney function scheduled for procedures longer than two hours duration in children's cancer hospital of Egypt were included in this study.

2.1. Anesthetic management

After arrival of the patients in the holding area, I.V cannula was inserted; midazolam 0.2 mg kg^{-1} and atropine 0.02 mg kg^{-1} were administered intravenously for anxiolysis. Patients then were transferred into the operating theatre and the non invasive monitoring including electrocardiogram, non-invasive blood pressure, pulse oximetry, axillary temperature and bispectral index (BIS) was used to estimate hypnosis. All patients had warming blanket to maintain a body temperature between 34 and 36 °C throughout surgery. Anesthesia was induced with propofol (2.5 mg kg^{-1}), atracurium (0.5 mg kg^{-1}), and fentanyl (2 μg kg^{-1}). After endo-tracheal intubation, the patient's lungs were mechanically ventilated with volume-controlled mode in order to maintain an end-tidal CO_2 between 30 and 36 mmHg, with O_2/air, with an inspired O_2 concentration of 50%. The anesthesia machine used (Zeus®, Draeger, Luebeck, Germany) utilizing target controlled anesthesia (TCA) through the autocontol mode.

2.2. Study settings

The patients were classified into two groups according to the anesthetic used:

S Group (n = 30)**:** in which sevoflurane was delivered by auto control mode of Zeus machine.

D Group (n = 30)**:** in which desflurane was delivered by auto control mode of Zeus machine.

In both groups, during maintenance, the administered end tidal concentration of agent used was readjusted in order to maintain the BIS value between 40 and 60 units. Adequate neuromuscular blockade was achieved using atracurium boluses at 0.15 mg kg^{-1} every 20 min.

During skin closure, anesthetic was discontinued and the patient received 100% O_2. At 25% recovery of the first response to train-of-four stimulation, neuromuscular blockade was reversed by neostigmine (4 μg kg^{-1}) and atropine (15 μg kg^{-1}).

2.4. Measured and recorded parameters

1. Anesthetic agent and O_2 consumption, cost and number of adjustments:

Sevoflurane, desflurane and O_2 consumption were obtained and recorded from the integrated Zeus delivery system and calculated as per hour consumption. Cost is calculated as per hour cost by Egyptian pound. Also the number of adjustments needed to maintain the BIS value between 40 and 60 units were recorded.

2. The laboratory variables:
   - Renal function

A. Standard renal biomarkers

Blood samples were obtained preoperatively and at 24, 48 and 72 h after the end of surgery for measuring serum creatinine and BUN. Normal values are defined by the commercial laboratory. Results are expressed in conventional units.

B. Specific renal biomarkers

Twenty-four hours urine samples were collected for 3 consecutive days to measure glucose, protein in urine as sensitive