A Comparison of Patient State Index (PSI) Changes and Remifentanil Requirements during Cardiopulmonary Bypass in Infants Undergoing General Anesthesia with or without Spinal Anesthesia.

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Background

The aim of this prospective, randomized, controlled study in infants was to evaluate the role of the Patient State Index (PSI) in determining remifentanil requirements during open heart surgery. We hypothesized that the PSI values in pediatric patients will be consistent with clinical endpoints demonstrated in adults and that this will facilitate the titration and delivery of anesthesia. We further wished to determine whether spinal anesthesia in combination with a remifentanil-based general anesthetic (SAB+REMI) resulted in a change in intra-operative remifentanil requirements and hemodynamics compared to a remifentanil (REMI) based general anesthetic without SAB (REMI) in infants and children undergoing cardiac surgery and cardiopulmonary bypass (CPB).

Methods

Following IRB and parental consent, children were randomized to SAB+REMI or REMI. Exclusion criteria included age < 3 months, pulmonary hypertension, CHF, and contraindication to spinal anesthesia. Following inhalation induction with sevoflurane and maintenance of anesthesia with remifentanil and isoflurane 0.3%, patients assigned to the SAB+REMI group received spinal anesthesia with tetracaine (0.5-2.0 mg/kg) and morphine (7 mcg/kg). In both the SAB+REMI and REMI groups, remifentanil was administered using a target plasma concentration infusion (TCI) and adjusted according to hemodynamic criteria using the software program Rugloop®. Isoflurane 0.3% and the remifentanil infusion were continued during CPB. Pump flow during CPB was maintained at approximately 2.5 L/m2. Prior to induction, EEG data was obtained after placement of 10 gold cup electrodes and acquired with a modified PSA4000 (Physiometrix Inc.). The EEG data was processed off-line to provide a PSI value. Endpoints considered between groups were PSI at baseline, during loss of responsiveness, and on CPB. In addition, the duration of CPB, mean arterial blood pressure on CPB (MAP), and remifentanil requirements during CPB were also noted. Differences were significant by Student's t-test if $p<0.05$.

Results

15 subjects aged 1-4 yrs of age (mean 2.4) were enrolled. The PSI at baseline, loss of responsiveness, and during CPB were 97, 61, and 57 respectively and were similar in the two groups. The mean duration of CPB in both groups was 76 (SD 37) min. The MAP was 45 mmHg and similar in both groups. Remifentanil requirements were significantly less during CPB in the SAB+REMI group, mean target remifentanil concentration was 3.9 ng/ml in the REMI group versus 1.8 ng/ml in the SAB+REMI group ($p<0.05$).

Discussion

The PSI values in this group of children were consistent with adult PSI values for awake baseline and loss of responsiveness. The decrease in PSI between loss of responsiveness and that during CPB is consistent with use of an anesthetic with a low isoflurane concentration. The PSI may be helpful in measuring sedation during pediatric cardiac anesthesia, particularly when fast-tracking is a consideration. We found that the addition of intrathecal morphine and tetracaine to a remifentanil-based general anesthetic resulted in significantly reduced remifentanil anesthetic requirements while the mean arterial pressure during CPB was not different. The use of a TCI for control of remifentanil anesthesia was not technically difficult and is a useful method for delivering remifentanil.