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Research Article

Does pressure support ventilation improve the postoperative outcome of adeno-tonsillectomy patients? A prospective randomized trial

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Abstract *Background:* Spontaneous ventilation (SV) is used for adeno/tonsillectomy in children. However, inhalational anesthetics produce dose dependent decrease in minute ventilation. We tested the impact of PSV on awakening time, and length of PACU stay.

Methods: 34 patients were randomized into two groups; PS ventilation group and SV group. Premedication and induction were similar in both groups. Patients in PS group were ventilated with P_{insp} set to deliver 8 ml/kg V_T, keeping $ETCO_2$ between 35 and 45 mmHg. Any episodes of hypoventilation were recorded and corrected by manual support of ventilation.

Upon completion of surgery, time-to-extubate was recorded. Length of PACU stay, agitation and CHEOPS scores, PONV and desaturation episodes were also recorded. Results are presented as mean (SD), median (interquartile range), or number of patients as appropriate. A P value < 0.05 was considered significant.

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Results: Extubation time (min) [mean (SD)] was longer in SV group than PS group [*7.8* (*2.1*) vs. *5.5(1.4), P < 0.001*]. In the SV group 9 patients had episodes of hypoventilation that necessitated manual assist of ventilation. Pain scores were higher in SV group than PS group. Duration of stay in PACU [mean (SD)] in minutes was longer in SV group than PS group [*44.3*(*7.4*) vs. *39.4*(*5.7*), *P = 0.02*]. All but one patient in the PS group needed postoperative rescue meperidine analgesia. The mean (SD) time needed for rescue meperidine analgesia was *27.1(8.9*) in PS group and *21.8(9.4*) in SV group (*P = 0.04)*.

Conclusion: PSV carries the advantages of overcoming the effects of narcotics and inhaled anesthetics on spontaneously ventilated adeno-tonsillectomy patients. They suffer less pain and spend less time in the PACU.

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1. Introduction

Adenotonsillectomy in children is a very common surgical procedure, needing dedicated and expert anesthetic attention. Whereas a lot of clinical studies on important aspects of anesthetic handling may be identified in recent years, there will be still controversies which may not be fully solved [1]. The core principles of anesthesia for adenotonsillectomy are to maintain a sufficient depth of anesthesia to allow the introduction of a mouth gag, and prevent reflex-induced hypertensive responses, tachycardia, and hypertension. During the procedure, intermittent positive-pressure ventilation or spontaneous ventilation can be used; at the end, a careful inspection for bleeding should be performed [2].

With sevoflurane, tidal volume and the slopes of the CO_2 response curves decrease and $PaCO_2$ increases with increasing depth of anesthesia. A compensatory increase in respiratory frequency does not prevent a decrease in minute volume with increasing depth of anesthesia [3,4].

Pressure support (PS) ventilation is a form of partial ventilatory support in which each spontaneous breath is assisted to an extent that depends on the level of pressure applied during inspiration. PS ventilation improves gas exchange in anesthetized patients whether their airway is intubated or managed by laryngeal mask airway (LMA) [5–7]. To date, PSV was not studied as an anesthetic mode of ventilation in the adeno/tonsillectomy patient population. PSV carries the advantages of overcoming the effects of narcotics and inhaled anesthetics on ventilation [5].

1.1. Aim of the work

In the following randomized study, we tested the hypothesis that PSV as an anesthetic mode of ventilation for patients undergoing adeno/tonsillectomy results in a shorter awakening time and length of PACU stay.

1.2. Methods

After approval of the Institutional Ethical Committee and parents'/guardian informed consent, 51 patients with American Society of Anesthesiologists (ASA) physical status I–II, who were scheduled to undergo an adeno/tonsillectomy under general anesthesia, were enrolled in this study, from December 2010 till November 2011. Children with cognitive or developmental disorders were excluded from the study. Six children met our exclusion criteria and parents of 11 patients refused participation. Thirty-four patients were randomized, by a computer-generated schedule, into 2 groups: Pressure Support ventilation (PS) group ($n = 17$) and Spontaneous Ventilation (SV) group ($n = 17$). No patient was excluded from the study.

Patients were premedicated with midazolam 20 min before admission to OR (0.5 mg/kg PO with an upper limit of 20 mg) for preoperative anxiolysis. Standard monitors; electrocardiography (ECG), non-invasive blood pressure (NIBP), end-tidal capnography ($ETCO_2$), and peripheral oxygen saturation (SPO_2) were used for all patients. General anesthesia was induced by the inhalation of sevoflurane (6–8%) and if needed, succinylcholine (0.6 mg/kg IV) was administered to facilitate tracheal intubation [8,9]. Anesthesia was maintained with sevoflurane in 2 L oxygen: air mixture of 1:1. Inspired sevoflurane was adjusted to maintain an expired MAC in the range of 1.5–2 to prevent intraoperative movement. Dexamethasone 0.15 mg/kg intravenously was given to patients for post-operative nausea and vomiting (PONV) prophylaxis. Fentanyl 1 mcg/kg IV and intravenous infusion of paracetamol 15 mg/kg were administered after endotracheal intubation for both groups. If heart rate (HR) and/or mean blood pressure (MBP) increased more than 20% for 2 min, additional bolus dose of fentanyl 0.5 mcg/kg i.v. every 5 min was administered with an upper limit of 3 mcg/kg.

After the induction of anesthesia patients were assigned to either PS ventilation group, or SV group. Dräger Primus® (Drägerwerk AG & Co., KGaA, Lübeck, Germany) was used for the ventilation in both groups. Patients in PS group were ventilated with PSV mode; inspiratory pressure (P_{insp}) was set to deliver near normal tidal volume ($V_T = 8$ ml/kg) [6] with a backup respiratory rate of 10 breaths per minute targeting to keep the $ETCO_2$ in the physiological range; 35–45 mmHg. Any episodes of hypoventilation; $ETCO_2 > 55$ mm Hg and/or hypoxia; $SPO_2 < 92\%$, were recorded and corrected by manual support of ventilation.

Upon completing the surgical procedure, defined by the release of the mouth gag, careful inspection and laryngoscopy was undertaken to ensure no blood clots were present. The administration of sevoflurane was stopped, and manual ventilation was then performed with 100% oxygen at 6 L/min. Extubation was performed when the patients' gag reflex was regained and they showed facial grimaces or purposeful-appearing motor movements. Time to extubation was recorded as the time from the release of the mouth gag till the time at which trachea was extubated. The time span from the start of mask ventilation until the extubation time was recorded as the duration of anesthesia, whereas the time span between

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