

Comparison the Incidence of Emergence Agitation between Sevoflurane and Desflurane after Pediatric Ambulatory Urologic Surgery

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Objective: To compare the incidence and severity of emergence agitation, recovery profile, and adverse events between desflurane and sevoflurane anesthesia in unpremedicated pediatric ambulatory urologic surgery patients.

Material and Method: The study was conducted among 136 healthy children, aged six months to nine years, and randomized to two groups, sevoflurane and desflurane, during maintenance anesthesia with laryngeal mask airway. Recovery profile and perioperative adverse events were recorded. The emergence agitation (EA) was assessed using a 4-point scale by an anesthetist nurse in the recovery room who was blinded to the treatment.

Results: The incidences of EA between sevoflurane/desflurane were not significantly different at 36.8%/41.2%, $p = 0.73$, and neither was the median (IQR) of severity (2 (1, 3)/2 (1, 3), $p = 0.4$). The awakening time in the desflurane group was 6.4 ± 4.0 minutes, faster than in the sevoflurane group of 10.6 ± 7.6 minutes ($p < 0.001$). The number of children having intraoperative respiratory events was significantly higher in the desflurane group (17), compared to the sevoflurane group (7) ($p = 0.043$).

Conclusion: The occurrence of EA and adverse events between sevoflurane and desflurane were not different, except that the overall of intraoperative respiratory events was higher in desflurane group.

Keywords: Emergence agitation, Sevoflurane, Desflurane, Pediatric ambulatory surgery

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The suitable anesthetic agents for pediatric ambulatory anesthesia should provide fast recovery, low incidence of emergence agitation (EA) and early discharge time. Sevoflurane provides faster recovery than propofol and isoflurane^(1,2) and is now likely to be the anesthetic agent of choice for ambulatory surgery in children. However, known reports revealed a high incidence of emergence delirium (20 to 50%) in sevoflurane anesthesia compared to halothane and isoflurane⁽³⁻⁶⁾. Desflurane is quite a novel volatile agent but less used than sevoflurane because of the pungent smell and higher airway irritation associated with desflurane. Nonetheless, desflurane is reported to provide faster recovery^(3,7) and a shorter length of stay in the post-anesthetic care unit (PACU)⁽⁸⁾ with no difference in the incidence of respiratory events, except coughing, compared to sevoflurane^(9,10).

Previous studies in children in ambulatory surgery by Welborn et al⁽³⁾ and inpatients surgery by Valley et al⁽⁹⁾ reported a higher incidence of emergence agitation (EA) in children given desflurane than sevoflurane assessed using a 4-point scale (55% vs. 10% and 46% vs. 21%, respectively). Demirbilek et al⁽⁷⁾, however, reported a similar incidence of severe EA between sevoflurane (13%) and desflurane (13%) in tonsillectomy or adenoidectomy inpatient surgery.

To date, comparative studies between sevoflurane and desflurane in pediatric ambulatory surgery in terms of EA profile are scarce⁽³⁾. Therefore, the present study aims to compare the incidence and severity of EA, recovery profile and adverse events between desflurane and sevoflurane anesthesia in unpremedicated pediatric ambulatory urologic surgery.

Material and Method

The study was approved by the institutional review board. Children, aged six months to nine years, with American Society of Anesthesiologists (ASA) physical status I or II, scheduled for elective ambulatory

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urologic surgery, at Songklanagarind Hospital between May 2010 and August 2012 were selected for this study. The children were randomized by a computer-block randomization to receive either sevoflurane or desflurane for maintenance anesthesia.

Exclusion criteria included emergency procedures, medical contraindication to placement of a caudal block, mental retardation, delayed development, attention-deficit/hyperactivity disorder, psychiatric illness, and a history of paradoxical excitation with sedatives. The children did not receive any premedication and midazolam was not given intraoperatively. Parents were allowed to be present during induction.

The children's behavior was assessed at the time of separation from parents by using a 4-point separation scale, 1 = excellent (separates easily), 2 = good (not clinging, whimpers, calms with reassurance), 3 = fair (not clinging, cries, will not calm or quiet), and 4 = poor (crying, clinging to parent)⁽¹¹⁾.

A 4-point induction scale was used to assess acceptance of the anesthetic mask, 1 = excellent (unafraid, co-operates, accepts mask readily), 2 = good (slight fear of mask, easily calmed), 3 = fair (moderate fear, not calmed with reassurance), and 4 = poor (terrified, crying, agitated)⁽¹²⁾.

The separate scale and induction scale of 2 or less were considered satisfactory, and the remains were unsatisfactory.

All children received a mask induction with either incremental sevoflurane 2 to 8% or single breath sevoflurane 8% in a 70% nitrous oxide and 30% oxygen mixture with 10 liters per minute (LPM) fresh gas flow. After induction, the ventilation was controlled by laryngeal mask airway (LMA), and the children were assigned to randomly receive either sevoflurane or desflurane by adjusting the end-tidal concentration to deliver a minimum alveolar anesthetic concentration (MAC) of 1. The nitrous oxide in oxygen concentration was reduced to 66% and the total gas flow rate was reduced to 3 LPM. Penile block, ilioinguinal nerve block or caudal block was performed at the discretion of the attending anesthesiologist based on routine practice and type of operation. The anesthesiologists in charge were not blinded to the treatment allocation.

Intraoperative analgesics were not given unless the child's heart rate increased to more than 20% of the baseline after incision was started or if a regional nerve block could not be obtained. Fentanyl 0.5 to 1 mcg/kg intravenously was given to supplement analgesia throughout the operation. After the surgical

wound was closed, the anesthetic was discontinued. Nitrous oxide was then discontinued and the oxygen flow rate was increased to 10 LMP. The LMA was removed when the child opened their eyes and their airway reflex recovered. Awakening time was defined as the time from discontinuing anesthetic to removal of LMA. Duration of surgery and duration of anesthesia were also recorded.

At PACU the EA score was assessed by three experienced nurses, blinded to the treatment group, using a 4-point scale, 1 = awake and calm, cooperative, 2 = crying, requires consoling, 3 = irritable/restless, screaming, inconsolable, and 4 = combative, disoriented, thrashing⁽¹³⁾. The EA score of 3 or 4 were classified as agitated. The onset time of EA was recorded after the child arrived at the PACU. Parents were reunited with their children in the PACU after an initial admission and stabilization phase. Pain scores (0 to 10) were assessed by the same PACU nurse using the FLACC scale⁽¹⁴⁾ for children under the age of 5 years and the Numeric Rating Scale⁽¹⁵⁾ or the Wong-Baker FACES Pain Rating Scale⁽¹⁶⁾ for children aged five to nine years who could and could not vocalize their pain score, respectively.

If the child had an agitation score ≥ 3 or pain score ≥ 4 , fentanyl 0.5 mcg/kg was administered intravenously every 10 to 15 minutes for treatment of EA or for rescue analgesia. The maximum agitation score and maximum pain score were recorded. Duration of PACU stay was defined as the time from arrival in the PACU until discharge home or to the ward. Intraoperative respiratory adverse events and PACU adverse events were recorded. Intention to treat for group assignment was performed in the data analysis if the data collection was completed.

Statistical analysis

The primary outcome was the incidence of EA, defined as having an agitation score ≥ 3 . The required sample size was based on an incidence of sevoflurane induced EA of 52% reported by Bortone et al⁽⁴⁾. It was deemed that 62 subjects per treatment arm would have at least an 80% power to detect a 50% reduction in the incidence of EA in the desflurane group. Secondary outcomes were the severity, time to onset and duration of EA, and recovery profile including awakening time, length of stay in PACU, pain score, and fentanyl requirement.

Data were reported as mean \pm SD, median (interquartile range; IQR) or frequency (percent). The incidence and severity of EA including categorical data

such as gender, ASA physical status, separation score, induction score, type of operation, choice of anesthesia, intraoperative, and PACU adverse events were compared using the Chi-square test or Fisher's exact test as appropriate. The other secondary outcomes including other continuous data such as age, weight, duration of surgery and duration of anesthesia were analyzed by Student's t-test or non-parametric rank sum test as appropriate. A p-value <0.05 was considered to be statistically significant.

Results

The overall incidence of EA in the present study was 39% (53/136). One hundred forty two children were randomized from 158 eligible children. Four children from the sevoflurane group were excluded,

two because they did not receive the intervention and two due to protocol violations. Two children from the desflurane group were excluded, one due to incomplete data collection and one due to protocol violation. Sixty-eight children per group were included in the study.

Table 1 shows a comparison of demographic data between the two groups. The body weight of children given sevoflurane was significantly higher than children given desflurane (17.2 kg vs. 15.2 kg, $p = 0.02$), otherwise, there were no significant differences between the two groups for gender, age, ASA, previous surgery, separate score, induction score, type of surgery, choice of anesthesia, duration of surgery, and duration of anesthesia.

Table 2 shows a comparison of awakening time and EA profile at PACU between the two groups.

Table 1. Comparison of demographic data in pediatric ambulatory urologic surgery between the sevoflurane and desflurane groups

Variable	Treatment group		p-value
	Sevoflurane (n = 68)	Desflurane (n = 68)	
Gender (male/female)	57/11	62/6	0.30
Age (year) \pm SD	4.7 \pm 2.1	4.1 \pm 2.1	0.13
Weight (kg) \pm SD	17.2 \pm 4.8	15.2 \pm 5.2	0.02*
ASA physical status I/II	30/38	34/34	0.61
Previous surgery	30 (44.1%)	25 (36.8%)	0.49
Separation score ⁺	1 (1, 4)	1 (1, 3)	0.82
Separation score \leq 2	45 (66.2%)	44 (64.7%)	1.00
Induction score ⁺	1 (1, 4)	1.5 (1, 4)	0.51
Induction score \leq 2	45 (66.2%)	44 (64.7%)	1.00

ASA = American Society of Anesthesiologists

* Statistical significance, p-value <0.05

⁺ Values as median (interquartile range; IQR)

Table 2. Comparison of awakening time and emergence agitation profiles during the PACU period between the sevoflurane and desflurane groups

Variable	Treatment group		p-value
	Sevoflurane (n = 68)	Desflurane (n = 68)	
Awakening time (min) ⁺	10.6 \pm 7.6	6.4 \pm 4.0	<0.001*
EA score			0.14
1	30 (44.1%)	20 (29.4%)	
2	13 (19.1%)	20 (29.4%)	
3	15 (22.1%)	22 (32.4%)	
4	10 (14.7%)	6 (8.8%)	
EA \geq 3 (agitate)	25 (36.8%)	28 (41.2%)	0.73

EA = emergence agitation; PACU = post anesthetic care unit

* Statistical significance, p-value <0.05

⁺ Values as mean \pm SD

Awakening time was faster for children in the desflurane group (6.4 vs. 10.6 minutes, $p < 0.001$). The incidence of EA between sevoflurane/desflurane was not significantly different at 36.8%/41.2% ($p = 0.73$) nor was the median (IQR) of severity of EA (2 (1, 3)/2 (1, 3), $p = 0.4$). Other variables of sevoflurane/desflurane had no statistical significance: the times of onset were $2.5 \pm 4.5/3.1 \pm 7.5$ minutes, durations of EA were $4.3 \pm 6.8/5.5 \pm 6.7$ minutes, and the lengths of stay in PACU were $88.9 \pm 51.5/93.2 \pm 62.0$ minutes.

Intraoperative fentanyl requirement was not different in sevoflurane/desflurane of 0.6 ± 0.7 mcg/kg/ 0.4 ± 0.6 mcg/kg, as well as median pain score of 3 (0, 8)/5 (0.8, 9). There were no differences in the number of children receiving fentanyl at PACU of 38/42, and the number of children receiving oral acetaminophen at PACU of 20/19 ($p = 1.0$) with significantly higher doses of acetaminophen 218 ± 55.3 mg/ 179 ± 50.7 mg ($p = 0.026$).

The intraoperative adverse events of sevoflurane/desflurane were not significantly different except the overall of respiratory events (7 children/17 children, $p = 0.043$): cough of 7.4%/14.7%, laryngospasm of 1.5%/8.9%, desaturation of 2.9%/11.8%, and bradycardia of 1.5%/4.4%. While the PACU adverse events were also not significantly different: nausea or vomiting of 20.6%/23.5%, bronchospasm of 1.5%/0%, upper airway obstruction of 1.5%/1.5%, unplanned admission related to surgery of 1.5%/4.4%, and unplanned admission related to anesthesia of 2.9%/2.9%. One child from the sevoflurane group had desaturation from pulmonary aspiration that resolved within two days. No other child had any serious complications.

Discussion

The incidences and severities of EA between children given desflurane and sevoflurane were not different, in the range of other previous studies of 13 to 55%^(3,7-9,17-19). The incidence of EA for both sevoflurane and desflurane appears to depend on the cut point used. In the present study, the authors used a different measurement scale but a similar cut point as Locatelli BG et al with EA score 3 or more⁽¹⁸⁾.

The intraoperative respiratory events of sevoflurane/desflurane were similar, contrast with the study by Lerman et al⁽²⁰⁾. The limitation of the study was due to the EA score having less validity and reliability than Pediatric Anesthesia Emergence Delirium (PAED) scale⁽²¹⁾.

In conclusion, the EA between sevoflurane and desflurane were not different. Desflurane is less suitable than sevoflurane due to its higher incidence of respiratory adverse events.

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Potential conflicts of interest

None.

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เปรียบเทียบอุบัติการณ์ของภาวะกระวนกระวายหลังฟื้นจากยาคมสลบซีโวฟลูเรนและเดสฟลูเรนในเด็กที่มาผ่าตัดระบบทางเดินปัสสาวะแบบผู้ป่วยนอก

มลิวัลย์ ออฟูวงศ์, ศิริกาญจน์ ศิริพฤกษ์พงศ์, จำรัส ณ กรองดี, เรวดี หนูคง, ชารีฟา ละกะเต็บ

วัตถุประสงค์: เพื่อเปรียบเทียบอุบัติการณ์และความรุนแรงของภาวะกระวนกระวาย ภาวะฟื้นตัว และภาวะแทรกซ้อน ระหว่างยาคมสลบเดสฟลูเรนและซีโวฟลูเรน ในเด็กผ่าตัดระบบทางเดินปัสสาวะแบบไปกลับผู้ไม่ได้รับยามาก่อน

วัสดุและวิธีการ: การศึกษากระทำในเด็กสุขภาพดี 136 ราย อายุระหว่าง 6 เดือน ถึง 9 ปี สุ่มเป็นสองกลุ่ม ได้แก่ กลุ่มซีโวฟลูเรน และกลุ่มเดสฟลูเรน ระหว่างคำจูนการระงับความรู้สึกด้วยช่องอากาศหน้ากากกล่องเสียง บันทึกระยะเวลาฟื้นตัวและผลไม่พึงประสงค์ ภาวะกระวนกระวายโดยแบ่งเป็น 4 ระดับ ประเมินโดยวิสัญญีพยาบาล ณ ห้องพักฟื้น ผู้ไม่ทราบการรักษา

ผลการศึกษา: อุบัติการณ์ของภาวะกระวนกระวายระหว่างยาคมสลบซีโวฟลูเรนและเดสฟลูเรนไม่แตกต่างทางสถิติ (ร้อยละ 36.8 และร้อยละ 41.2, p เท่ากับ 0.73) รวมถึงค่าเฉลี่ยของระดับความรุนแรงก็ไม่แตกต่างกัน (2 (1, 3) และ 2 (1, 3), p เท่ากับ 0.4) ระยะเวลาฟื้นตัวในกลุ่มเดสฟลูเรนเร็วกว่ากลุ่มซีโวฟลูเรนอย่างมีนัยสำคัญทางสถิติ (6.4 ± 4.0 นาที และ 10.6 ± 7.6 นาที, p น้อยกว่า 0.001) จำนวนของเด็กที่มีภาวะแทรกซ้อนทางระบบทางเดินหายใจในกลุ่มเดสฟลูเรนสูงกว่ากลุ่มซีโวฟลูเรนอย่างมีนัยสำคัญทางสถิติ (17 ราย และ 7 ราย, p เท่ากับ 0.043)

สรุป: ภาวะการเกิดกระวนกระวายและผลอันไม่พึงประสงค์ระหว่างซีโวฟลูเรนและเดสฟลูเรนไม่แตกต่างกัน ยกเว้นผลอันไม่พึงประสงค์โดยรวมของระบบทางเดินหายใจของกลุ่มเดสฟลูเรนสูงกว่า
