Original Article

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Using nasal cannula for sevoflurane deep sedation in emergency dental treatment

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Background: Emergency room doctors run into difficulties in treating injured pediatric patients because usually they fell into panic after trauma. In these situation, deep sedation with sevoflurane is fully recommendable method. The conventional way can interrupt common dental treatment procedure.
Methods: In the present study, nasal cannula was used for sevoflurane deep sedation in 11 dental emergency treatment. Age ranged from 0 to 3 years old (average of 1.8 years).
Results: Treatment duration was from 10 to 35 minutes (average of 16.7 minutes). Average duration of sedation was 25.5 minutes ranging from 15 to 45 minutes.
Conclusions: It has advantages to use nasal cannula for sevoflurane deep sedation rather than conventional intubation; saves time and secures good operation field.

Key Words: Emergency dental treatment; Nasal cannula; Sevoflurane

INTRODUCTION

Several recent studies have shown that frequent emergency room (ER) visits among children are due to dental trauma [1,2]. Majewski et al, [2] documented 39% of children came to ER due to dental causes and more than one-half of the patients were 5 years old or younger. Perez et al. [3] indicated most injuries occurred at oral soft tissue and anterior teeth.

Oftentimes, emergency room doctors encounter difficulty in treating these patients. Pediatric patients are difficult to communicate and uncooperative upon command. Especially, a panic causing injury aggravates these confusing state. Therefore, proper anesthesia technique is crucial to render successful emergency dental treatment. Oral sedative drug such as chloral hydrate has been widely used in pediatric emergency treatment, but cannot be the best choice because of its slow onset of action.

Deep sedation with open airway rather than general anesthesia is recommended in this case. General anesthesia takes long induction time, can cause sore throat due to laryngeal edema, and delays recovery of consciousness. Sury et al, [4] reported the success of sevoflurane deep sedation via nasal cannula in infants undergoing MRI. We modified the nasal cannula for easier applying to children and conducted 11 emergency cases who had dental emergency treatment under sevoflurane deep sedation insufflated via a nasal cannula. In the present study, the authors present our useful experience.

METHOD

1. Subject

The study was conducted by retrospective study. The

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present survey was consisted of eleven uncooperative patients who came to pediatric emergency room because of trauma and have received treatment under sevoflurane sedation from January 2012 to September 2013. Data was collected through individual dental and anesthetic records.

2. Sedation method

As soon as we transferred the uncooperative patients to the dental chair, we administered 8 vol% inspired sevoflurane gas with 4.0 L/min of oxygen and 4.0 L/min of nitrous oxide to the patients using a full facial mask. After achieving loss of consciousness, we placed nasal cannula (HUDSON RCI: Teleflex, NC, USA) incorporated with capnography line into patients' nostril. Then, we delivered sevoflurane anesthetic gas to the patients through the nasal cannula. We adjusted sevoflurane vaporizer setting and delivered 100% oxygen at gas flow of 2 L/min to the patients.

For monitoring and sevoflurane administration, anesthesia machine (Aestiva/5; Datex Ohmeda, WI, USA) was used. We monitored electrocardiogram, oxygen saturation, noninvasive blood pressure, end-tidal carbon dioxide concentration ($ETCO_2$) and end-tidal sevoflurane concentration (ETS). We adjusted inspired sevoflurane gas concentration to maintain ETS in the range of 1 to 1.5 vol% as much as possible. After the treatment, sevoflurane was discontinued and 8 L/min of 100% oxygen gas was maintained until the patients recovered their consciousness. Then patients were transferred to a recovery room and complications were observed.

Age, gender, treatment type, duration of sedation, duration of treatment, $ETCO_2$, ETS, recovery time, and post treatment complications was recorded.

RESULTS

1. Patient distribution

Table 1 shows patients' gender, age, premedical history, treatment type, duration of treatment and duration of sedation. 10 were boys and 1 was a girl. Most of the treatment was extraction and suture case. The rate of the traumatic injury among boys was higher than that of a girl. Age ranged from 0 to 3 years old with average of 1.8 years. Average duration of treatment was 16.7 minutes ranging from 10 to 35 minutes. Average duration of sedation was 25.5 minutes ranging from 15 to 45 minutes.

2. Analyzing result

Deep sedation was done successfully. Average heart rate (HR), blood (systolic/diastolic) pressure, respiratory rate, oxygen saturation, $ETCO_2$, ETS were 99 rate/min, 97/49 mmHg, 28 rate/min, 99 %, 25 mmHg and 2.2 vol% (Table 2).

The patients regained their consciousness within 5 min

Table 1. Patient information

Gender	Age (Year)	PMH	Treatment Type	Duration of Treatment (min)	Duration of Sedation (min)
F	2	NS	Suture	10	15
M	3	NS	Suture	10	15
M	3	NS	Suture	25	30
M	3	NS	Suture	10	15
M	2	NS	Suture, Exraction	35	45
M	2	NS	Extraction	20	35
M	1	NS	Suture	20	35
M	2	NS	Suture	15	20
M	1	NS	Suture, Exraction	14	25
M	0	NS	Suture	15	25
M	1	NS	Suture	10	20

NS: Non specific

Table 2. Results of monitoring data

	Mean	Maximum	Minimum
Duration of treatment (min)	16.7	35	10
Duration of sedation (min)	25.5	45	15
Heart Rate (rate/min)	99.0	123	71
Systolic Blood Pressure (mmHg)	96.8	120	78
Diastolic Blood Pressure (mmHg)	49.0	66	35
Respiratory rate (rate/min)	28.3	48	17
SpO_2 (%)	99.3	100	94
$ETCO_2$ (mmHg)	25.2	51	7
End-tidal sevoflurane concentration (vol%)	2.2	4	0.8

after discontinuation of sevoflurane. There were no complications after transferring to the recovery room.

DISCUSSION

Pediatric patient visiting ER because of dental trauma needs immediate treatment. To achieve successful dental treatment for uncooperative patient, anesthesia is very important. General anesthesia has been widely used for pediatric dental trauma treatment. However, general anesthesia is not suitable for emergency treatment for several reasons. First and foremost, general anesthesia requires long induction time, which makes it difficult in emergency cases. According to Kim et al, [5], average induction time for general anesthesia was 32 minutes. Second, essential endotracheal intubation causes many complications such as additional trauma and sore throat due to laryngeal edema or arytenoid dislocation [3]. Another major problem is delayed recovery of consciousness [3]. Lastly, application of ventilator could cause ventilation-perfusion mismatch that may lead to hypoxemia. For these reasons, oral sedative drug such as chloral hydrate has been suggested as an alternative. But it also has its own shortcomings; it takes long onset of action and recovery time.

Deep sedation using sevoflurane as a sedative has been done in several dental procedures. Sevoflurane is a predictable anesthetic medication, which is also fast on its onset and recovery. It has rapid adjustment of anesthetic depth and high safety profile regarding cardiovascular system [6]. Several cases were completed with deep sedation using sevoflurane inhalation via nasal hood or nasal cannula for short-term dental treatment [7]. Kim et al. [6,7] reported cases of sevoflurane inhaled deep sedation using nasal hood and nasal cannula. Ji et al, [8] reported 14 cases dental treatment under sevoflurane sedation, but of 14 cases, only 3 were emergency dental treatment. This report analyzed dental and anesthetic records of 11 patients who had emergency dental treatment under sevoflurane sedation, by far the largest study. Previous report used nasal hood for brief dental procedures [6]. Nasal hood has good sealing effect and ability to provide large amount of oxygen without resistance. However, nasal hood itself can be an obstacle to dental procedure because most of the traumatic injury mainly affect upper anterior portion of mouth where nasal hood is placed. To overcome this, nasal cannula was used in this study. For optimal use, couple of factors needs to be considered. When nasal cannula is placed too deeply into the nares, the cannula itself can act as an obstruction to the patient. Diameter of nasal cannula also needs to be considered. If it fits too tightly into the nares, it disturbs patient's spontaneous breathing. On the contrary to this, if it fits too loosely into the nares, the supply of oxygen / sevoflurane becomes inefficient. Therefore it is very important to choose the right-sized cannula with enough gap to minimize obstruction and without disturbing oxygen / sevoflurane supply. Since sevoflurane inhalation sedation via nasal cannula was first reported by Sury et al, [4] for MRI scan, only the sedative effect has been widely accepted. When the procedure causes pain, analgesic effect of sevoflurane

is additional benefit to keep patients sedated. Previously, propofol and remifentanil intravenous injection was used for sedation and analgesia. But intravenous injection is a difficult and invasive procedure to the uncooperative patient, and it can induce pain and fear. In this study, patients did not show movements or awakening during painful procedure such as extraction and injection. We additionally used papoose board not for restraint but for fall prevention. After induction of deep sedation, no physical restraint was needed. Sevoflurane has been reported to cause nausea and vomiting during recovery [9], but no significant adverse effects were observed in this study. In deep sedation procedure with open airway, monitoring is important [5]. Especially, medication such as sevoflurane affects respiratory depression more than cardiovascular system. In respiratory monitoring, capnography shows the most sensitive monitor for ventilation. During the sedation, $ETCO_2$ and ETS showed continuous fluctuation. Moreover, the two elements were in inverse proportion to each other. When there was no problem on nasal breathing, $ETCO_2$ and ETS shows to the nearest 40 mmHg and 1 vol% respectively. But when patients showed difficulty in breathing or dominantly breathed through their mouth, $ETCO_2$ fell and ETS rose. It is because the nasal cannula we used has back-to-back air supply and detector. In other words, air detector dominantly detected not patient's expired gas but supply gas when the patients' nasal breathing decreases. In this case, while the value of ETS was high, actual patient's insufflated concentration of sevoflurane decreased. Decreased insufflated concentration of sevoflurane made patient easily arousable. Therefore, it is important to maintain $ETCO_2$ within normal range during the sevoflurane sedation. ETS at this time reflects actual patient's end- tidal concentration of sevoflurane. In this study, delivered sevoflurane concentration was 3-4 vol% for deep sedation but average ETS was 2.2 vol%, but actual patient's end-tidal concentration of sevoflurane which is lower than 2.2 vol% by concentration effect and so depth of sedation level is lower than 1 MAC [10]. Difference between supplied concentration of sevoflurane and ETS was found. It's because fluctuation of ETS and dilution effects. Sevoflurane gas might dilute by atmosphere and passing through anatomical dead space because it's not closed breathing circuit. From these cases, emergency sevoflurane sedation to uncooperative pediatric patient was successful. Especially for pediatric patient, the airway of the children is relative to the rear than adults. For this reason, children are often caused airway obstruction than adults. However, proper monitoring (capnography, gas analyzer) is important for safe and effective sedation. If proper cases were selected, sevoflurane sedation would bring a satisfying result to dentist, patient and parents.

REFERENCES

1. Fleming P, Gregg T, Saunders I. Analysis of an emergency dental service provided at a children's hospital. International Journal of Paediatric Dentistry 1991; 1: 25-30.
2. Majewski RF, Snyder CW, Bernat JE. Dental emergencies presenting to a children's hospital. ASDC J Dent Child 1988; 55: 339-42.
3. Perez R, Berkowitz R, McIlveen L, Forrester D. Dental trauma in children: A survey. Endod Dent Traumatol 1991; 7: 212-3.
4. Sury MR, Harker H, Thomas ML. Sevoflurane sedation in infants undergoing mri: A preliminary report. Pediatric Anesthesia 2005; 15: 16-22.
5. SO Kim. A survey of general anesthesia, sevoflurane sedation and intravenous sedation in chungnam dental clinic for the disabled. Journal of The Korean Academy of Pediatric Dentistry 2013; 40: 28-39.
6. SO Kim, YJ Kim, HK Hyun, YS Koo, TJ Shin. Deep sedation with sevoflurane inhalation via a nasal hood for brief dental procedures in pediatric patients. Pediatric emergency care 2013; 29: 926-8.
7. SO Kim, YJ Kim, YS Koo, TJ Shin. Deep sedation with sevoflurane insufflated via a nasal cannula in uncooperative child undergoing the repair of dental injury. The American journal of emergency medicine 2013; 31: 894. e1-.e3.
8. SE Ji, JS Kim, JB Kim, SO Kim. Sevoflurane sedation using a nasal cannula in pediatric patients. Journal of The

Korean Academy of Pediatric Dentistry 2013; 40: 194-9.
9. Green SM, Roback MG, Krauss B, Emergency Department Ketamine Meta-analysis Study G. Anticholinergics and ketamine sedation in children: A secondary analysis of atropine versus glycopyrrolate. Acad Emerg Med 2010; 17: 157-62.
10. Katoh T, Ikeda K. Minimum alveolar concentration of sevoflurane in children. British journal of anaesthesia 1992; 68: 139-41.