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ARAŞTIRMA / RESEARCH

Effects of dexmedetomidine on the use of laryngeal mask airway and the cobra perilaryngeal airway in children

Deksmedetomidinin çocuklarda laringeal maske airway ve kobra perilarengeal airway kullanımına etkileri

Zehra Hatipoğlu[1], Beyza Tekin[2], Mediha Türktan[1], Ersel Güleç[1], Dilek Özcengiz[1]

[1]Cukurova University, Faculty of Medicine, Department of Anesthesiology and Reanimation, Adana, Turkey.
[2]Antalya Ataturk State Hospital, Department of Anesthesiology and Reanimation, Antalya, Turkey.

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Abstract

Purpose: The aim of this study was to evaluate the effects of dexmedetomidine on the use of laryngeal mask airway and the cobra perilaryngeal airway in children.

Materials and Methods: The medical records of 112 children who received sevoflurane alone and sevoflurane plus dexmedetomidine (loading dose 1 μg/kg + infusion 0.5 μg/kg/h) during elective inguinal region surgery with LMA or CobraPLA were retrospectively reviewed: Group LMA, Group CobraPLA, Group Dex+LMA and Group Dex+CobraPLA. Patients' demographic data, hemodynamic parameters, the number of trials and time to achieve an effective airway, the end-tidal sevoflurane (ETSevo) concentration, plateau pressure (P plateau), peak inspiratory pressure (PIP), end-tidal carbondioxide (ETCO2) values, and complications were noted.

Results: Demographic and anesthetic data, hemodynamic parameters, and complications were similar between the groups. The number of attempts, the time for insertions, P plateau, and PIP were statistically higher in the LMA group compared to other groups. ETSevo concentrations were lower in the Dex+CobraPLA group compared to LMA and CobraPLA group. The ETCO2 measurements were higher in the CobraPLA and Dex+CobraPLA groups compared to other groups.

Conclusion: Dexmedetomidine reduced airway pressures and ETSevo concentrations without side effects in the children with SADs.

Keywords: Dexmedetomidine, pediatric

Öz

Amaç: Bu çalışmanın amacı çocuklarda deksmedetomidinin laringeal maske hava yolu ve kobra perilarengeal hava yolu kullanımına etkilerini değerlendirmektir.

Gereç ve Yöntem: LMA veya CobraPLA ile elektif inguinal bölge cerrahisi sırasında tek başına sevofluran ve sevofluran + deksmedetomidin (yükleme dozu 1 μg/kg + infüzyon 0.5 μg/kg/sa) alan 112 çocuğun tıbbi kayıtları retrospektif olarak incelendi: Grup LMA, Grup CobraPLA, Grup Dex + LMA ve Grup Dex + CobraPLA. Hastaların demografik verileri, hemodinamik parametreleri, etkin bir havayolu elde etmek için deneme sayısı ve zamanı, end-tidal sevofluran (ETSevo) konsantrasyonu, plato basıncı (P plato), pik inspirasyon basıncı (PIP), end-tidal karbondioksit (ETCO2) değerleri ve komplikasyonlar kaydedildi.

Bulgular: Demografik ve anestezik veriler, hemodinamik parametreler ve komplikasyonlar gruplar arasında benzerdi. Deneme sayısı, yerleştirme zamanı, P plato ve PIP sayısı, LMA grubunda diğer gruplara göre istatistiksel olarak daha yüksekti. ETSevo konsantrasyonları Dex + CobraPLA grubunda LMA ve CobraPLA gruplarına göre daha düşüktü. ETCO2 ölçümleri CobraPLA ve Dex + CobraPLA gruplarında diğer gruplara göre daha yüksekti.

Sonuç: Bu çalışmada, supraglottik havayolu cihazları kullanılan çocuklarda deksmedetomidinin havayolu basınçlarını ve ETSevo konsantrasyonlarını yan etki olmaksızın azalttığı saptanmıştır.

Anahtar kelimeler: Deksmedetomidin, pediatri

INTRODUCTION

Several studies have shown that supraglottic airway devices (SADs) including the Cobra perilaryngeal airway (CobraPLA) and the laryngeal mask airway (LMA) can be safely used during clinical practice[1,2]. Although they are used in many areas for airway management, these devices are often preferred for minor surgery in children[3].

Yazışma Adresi/Address for Correspondence: Dr. Zehra Hatipoglu, Cukurova University, Faculty of Medicine, Department of Anesthesiology and Reanimation, Adana, Turkey. E-mail: hatipogluzehra@gmail.com
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SADs can be easily applied in the operations involving the inguinal region in children without the use of muscle relaxants. In this situation, sevoflurane is the most commonly preferred inhalation agent in children since it causes less airway irritation and facilitates the rapid onset and offset of anesthesia[4]. Nevertheless, practitioners may encounter some adverse reactions (such as coughing and laryngospasm) if adequate anesthesia depth is not achieved during the use of SADs[5]. High concentrations of sevoflurane are required when the drug is used on its own and may lead to unsatisfactory SADs insertion. Therefore, short-acting opioids such as fentanyl, remifentanil or dexmedetomidine may be combined with sevoflurane.

Dexmedetomidine has a highly selective α_2-adrenoreceptor agonistic activity with sedative and analgesic effects. Previous studies have shown that the use of dexmedetomidine attenuates airways and hemodynamic responses during intubation and extubation, and reduces the volatile anesthetics requirement[6,7]. A recent published study reported that dexmedetomidine is effective in decreasing airway reactivity during airway manipulation[8]. To our knowledge, there are limited studies in the literature using dexmedetomidine for SADs insertion in children[5,9]. We aimed to evaluate the efficacy of dexmedetomidine on airway manipulation and airway-related pressures during use of SADs in children undergoing inguinal region surgery.

MATERIALS AND METHODS

After our institutional ethics committee approved this retrospective cohort study (45/2009), the medical records of 112 children receiving anesthesia with sevoflurane for inguinal region surgery between June 2008 and May 2009, with or without dexmedetomidine, were reviewed. Children under the care of the American Society of Anesthesiologists (ASA) I-II, aged 6 months to 14 years old and scheduled for elective inguinal region surgery (hypospadias surgery, orchiopexy, inguinal hernia, cystoscopy, hydrocelectomy, circumcision, or rectal biopsy) were included in the current study.

We identified children who received sevoflurane alone (n = 57) and sevoflurane plus intravenous (iv) dexmedetomidine (n = 55) during elective inguinal region surgery with LMA or CobraPLA use. In patients who used sevoflurane alone, 28 patients had LMA and 29 patients had Cobra PLA. In patients who used sevoflurane plus dexmedetomidine, 28 patients had LMA and 27 patients Cobra PLA. According to the above data, 112 patients were evaluated under 4 subheadings: the LMA group (n = 28): sevoflurane and LMA insertion; the CobraPLA group (n = 29): sevoflurane and CobraPLA insertion; the Dex+LMA group (n = 28): sevoflurane plus dexmedetomidine infusion and LMA insertion; the Dex+CobraPLA group (n = 27): sevoflurane plus dexmedetomidine infusion and CobraPLA insertion.

None of the patients used any premedication. Anesthesia induction was provided with 6-8 % sevoflurane in a (50-50 %) oxygen/nitrous oxide mixture in all patients. Anesthesia was continued with sevoflurane 1-2 % in the LMA and CobraPLA groups, and sevoflurane 1-2 % plus dexmedetomidine infusion was used in the Dex+LMA and Dex+CobraPLA groups. Dexmedetomidine was administered using a loading dosage of 1 μg/ kg for 10 minutes; with a following infusion dose of 0.5 μg/kg/h. These dosages of dexmedetomidine have been reported as safe and effective in the literature [10].In our clinical practice, the LMA and CobraPLA sizes are determined according to the manufacturer's recommendations[11,12].

Insertion of SADs was attempted when the eyelash reflex was lost and conditions were favorable (as indicated by jaw mobility and absence of movement). All of the insertions of SADs were performed by senior anesthesia assistants. An unsuccessful attempt was defined as an inability to obtain an end-tidal carbon dioxide ($ETCO_2$) waveform and chest movement, and the occurrence of high airway pressures. In the case of two unsuccessful attempts, we inserted an endotracheal tube to the patients. The insertion time to achieve an effective airway was measured using a stopwatch on the patient monitoring equipment, and was defined as the time between the first chest movement and the full insertion of the SAD. Patients were ventilated in manual or controlled mechanical ventilation with a tidal volume of 6-8 mL/kg. Electrocardiography, non-invasive blood pressure, pulse oxymetry, and capnography monitoring were performed to all patients. None of the patients were administered neuromuscular blocking agent. Fluid resuscitation was accomplished with 5 % dextrose 0.45 % NaCl or Ringer's Lactate (3-5 mL/kg/h). All patients

received tramadol (2 mg/kg intravenously) for postoperative analgesia.

We reviewed all medical forms to record demographic data (age, gender, weight, duration of operation), hemodynamic parameters (heart rate, systolic and diastolic blood pressure), the number of trials and time to achieve an effective airway, end-tidal sevoflurane concentration (ETSevo), plateau pressure (P plateau), peak inspiratory pressure (PIP), $ETCO_2$ values, and complications (cough, oropharyngeal bleeding, laryngospasm, gastric distension). Our primary outcome measures were the effects on airway management of dexmedetomidine during the use of SADs. Secondary outcome measures were complications.

Statistical analysis

All analyses were conducted using commercial statistical software, SPSS Statistics, version 20.0, IBM. Categorical variables were expressed as numbers and percentages, whereas continuous variables were summarized using the mean and standard deviation or using median and minimum-maximum where appropriate. A chi-square test was utilized to compare categorical variables between the groups. A one-way analysis of variance (ANOVA) test was utilized for comparison of the groups. Bonferroni, Scheffe, Tamhane tests were used for multiple comparisons of groups to investigate the homogeneity of variances. Repeated measurements analysis was applied to evaluate changes in the measurements obtained during the operation. The statistical level of significance for all tests was set at 0.05.

RESULTS

Demographic and surgical data were similar between the groups ($p > 0.05$). The number of attempts and time to effective airway were statistically higher in the LMA group than the other groups ($p < 0.001$) (Table 1).There were no significant differences in hemodynamic parameters between the groups ($p>0.05$). The end-tidal sevoflurane concentration was significantly lower in the Dex+CobraPLA group than in the LMA and CobraPLA groups during first 45 minutes ($p < 0.001$), and it was significantly lower in the Dex+LMA group when compared with the LMA group at 10, 15 and 30 minutes ($p < 0.001$) (Table 2). Plateau pressure and PIP values were significantly higher in the LMA group than in the Dex+LMA and Dex+CobraPLA groups ($p < 0.001$). During the first 15 minutes, these pressures were higher in the CobraPLA group when compared with the Dex+CobraPLA group (Table 3 and Table 4).

The $ETCO_2$ measurements were higher in the CobraPLA and Dex+CobraPLA groups when compared with the LMA and Dex+LMA groups ($p < 0.01$). When PIP and plateau pressure values were evaluated within each group, there was no statistical difference ($p > 0.05$). The most common complications were cough and gastric distension. There was no statistically difference among groups in terms of complications ($p > 0.05$). Cough and gastric distension were seen 5 and 3 patients in the LMA group, 3 and 1 patients in the CobraPLA group, 1 and 4 patients in the Dex+LMA group, and 2 and 2 patients in the Dex+CobraPLA group, respectively.

Table 1. Demographic and instrumentation data

	Group LMA (n=28)	Group CobraPLA (n=29)	Group Dex+LMA (n=28)	Group Dex+CobraPLA (n=27)	P values
Age (month)	61.07 ± 35.70	56.24 ± 39.85	48.50 ± 34.82	60.32 ± 32.01	0.54
Gender (F/M)	4/24	4/25	7/21	6/21	0.62
Weight (kg)	18.34 ± 6.58	16.86 ± 9.30	15.96 ± 6.79	18.04 ± 8.01	0.65
Duration of operation (min)	62.11 ± 24.81	50.62 ± 20.28	56.25 ± 22.45	55.48 ± 20.41	0.28
The number of attempts (1/2)	16/12[a]	22/7	26/2	25/2	0.00
Time to achieve an effective airway (sec)	22.54 ± 1.75[a]	20.28 ± 1.85	19.82 ± 2.22	19.89 ± 1.76	0.00

Values are presented as number or mean ± standard deviation.; F: Female, M: Male.; [a]P < 0.05 for Group LMA vs other groups.

Table 2. The end-tidal sevoflurane concentration values

	Group LMA (n=28)	Group CobraPLA (n=29)	Group Dex+LMA (n=28)	Group Dex+CobraPLA (n=27)	P values
Induction	2.29 ± 0.44	2.36 ± 0.46	2.29 ± 0.36	2.30 ± 0.35	0.91
Instrumentation	2.11 ± 0.35	2.17 ± 0.41	1.94 ± 0.30	1.83 ± 0.33[a]	0.00
5th min	2.03 ± 0.27	2.01 ± 0.44	1.77 ± 0.45	1.51 ± 0.38[a]	0.00
10th min	1.88 ± 0.24	1.90 ± 0.46	1.56 ± 0.46[b]	1.32 ± 0.32[a]	0.00
15th min	1.78 ± 0.41	1.80 ± 0.40	1.46 ± 0.46[b]	1.19 ± 0.38[a]	0.00
30th min	1.71 ± 0.64	1.49 ± 0.47	1.30 ± 0.40[c]	1.11 ± 0.33[a]	0.00
45th min	1.63 ± 0.36	1.62 ± 0.42	1.30 ± 0.44	1.08 ± 0.35[a]	0.00
60th min	1.64 ± 0.37	1.51 ± 0.42	1.30 ± 0.43	1.06 ± 0.33[d]	0.00
75th min	1.50 ± 0.34	1.45 ± 0.45	1.41 ± 0.40	1.05 ± 0.33	0.27
90th min	1.42 ± 0.36	1.10 ± 0.14	1.03 ± 0.40	1.07 ± 0.40	0.40

Values are presented as mean ± standard deviation. ; aP<0.05 for Group Dex+CobraPLA vs Group LMA and Group CobraPLA ; bP<0.05 for Group Dex+LMA vs Group LMA and Group CobraPLA; cP<0.05 for Group Dex+LMA vs Group LMA; dP<0.05 for Group Dex+CobraPLA vs Group LMA

Table 3. Plateau pressure values

	Group LMA (n=28)	Group CobraPLA (n=29)	Group Dex+LMA (n=28)	Group Dex+CobraPLA (n=27)	P values
Induction	15.64 ± 3.91[a]	16.10 ± 4.01[b]	12.43 ± 4.53	12.81 ± 3.41	0.00
Instrumentation	17.75 ± 4.77 [c]	16.07 ± 4.83 [b]	13.79 ± 5.90	12.04 ± 2.88	0.00
5th min	17.86 ± 4.89[c]	15.79 ± 4.97 [b]	14.07 ± 5.70	12.00 ± 3.33	0.00
10th min	17.93 ± 4.83[c]	15.48 ± 4.82	13.82 ± 5.47	12.22 ± 3.48	0.00
15th min	17.93 ± 4.78[c]	15.79 ± 4.39[b]	14.11 ± 5.04	12.19 ± 3.08	0.00
30th min	18.00 ± 5.07[d]	14.73 ± 4.18	14.96 ± 4.84	11.93 ± 3.06	0.00
45th min	17.95 ± 4.30[d]	15.78 ± 3.87	15.18 ± 5.50	12.75 ± 3.32	0.00
60th min	17.94 ± 4.33[d]	16.14 ± 3.44	14.58 ± 4.46	13.36 ± 3.04	0.03
75th min	18.00 ± 4.69	14.75 ± 4.99	14.50 ± 6.89	16.25 ± 5.12	0.62
90th min	19.00 ± 5.52	11.00 ± 2.83	14.50 ± 9.11	12.67 ± 3.06	0.40

Values are presented as mean ± standard deviation.; aP<0.05 for Group LMA vs Group Dex+LMA; bP<0.05 for Group CobraPLA vs Group Dex+CobraPLA; cP<0.05 for Group LMA vs Group Dex+LMA and Group Dex+CobraPLA; dP<0.05 for Group LMA and group Dex+CobraPLA

Table 4. Peak inspiratory pressure values

	Group LMA (n=28)	Group CobraPLA (n=29)	Group Dex+LMA (n=28)	Group Dex+CobraPLA (n=27)	P values
Induction	18.64 ± 3.97	19.69 ± 4.51[a]	16.68 ± 5.76	16.48 ± 3.62	0.02
Instrumentation	22.07 ± 4.57[b]	19.28 ± 5.06[a]	17.61 ± 6.52	15.81 ± 3.13	0.00
5th min	21.57 ± 4.65[c]	19.31 ± 5.14[a]	17.71 ± 6.21	15.85 ± 3.67	0.00
10th min	21.18 ± 4.62[c]	18.90 ± 4.76	17.71 ± 5.74	15.85 ± 3.52	0.00
15th min	22.04 ± 5.18[b]	19.24 ± 4.85[a]	17.86 ± 5.20	15.67 ± 3.40	0.00
30th min	21.85 ± 5.00[b,d]	18.08 ± 4.41	17.93 ± 5.40	15.37 ± 2.96	0.00
45th min	21.30 ± 4.76[c]	18.72 ± 4.07	18.76 ± 5.43	16.05 ± 3.38	0.00
60th min	22.13 ± 5.30[c]	19.29 ± 3.90	18.67 ± 5.23	16.91 ± 3.11	0.04
75th min	20.56 ± 5.50	18.25 ± 4.35	18.50 ± 6.66	19.75 ± 5.06	0.87
90th min	20.60 ± 4.28	15.00 ± 1.41	18.25 ± 8.77	16.00 ± 3.61	0.61

Values are presented as mean ± standard deviation.; aP<0.05 for Group CobraPLA vs Group Dex+CobraPLA
bP<0.05 for Group LMA vs Group Dex+LMA and Group Dex+CobraPLA; cP<0.05 for Group LMA vs Group Dex+CobraPLA
dP<0.05 for Group LMA vs Group CobraPLA

DISCUSSION

Our results showed that anesthesia management with dexmedetomidine (administered as 1 μg/kg for 10 minutes, then adjusted to 0.5 μg/kg/h) and sevoflurane in the use of SADs reduced the number of attempts and time to achieve an effective airway, decreased sevoflurane requirements, and resulted in more stable intraoperative airway pressures and hemodynamic profiles.

In the present study, the success rate of the first attempt at insertion of SADs, was higher in the dexmedetomidine groups than only sevoflurane groups. During inserting airway instrumentation, adequate anesthesia depth should be established to guard against reflex responses to airway irritation when no neuromuscular blockade is used. In this context, sevoflurane may be insufficient, and higher concentrations may be needed. Dexmedetomidine, an anesthetic adjunct agent, is known to have hypnotic and analgesic properties. However, Mikami et al. investigated dexmedetomidine's effects on airway reflexes in guinea pig trachea; they found that dexmedetomidine suppressed acetylcholine (Ach) release from postganglionic cholinergic nerves and reduced both Ach-induced smooth muscle and C-fiber mediated contraction in airways[8]. These findings might be beneficial to explain dexmedetomidine's ability to reduce airway reactivity.

In recently meta-analysis, the insertion time for the Cobra PLA and the classic LMA are similar for experienced practitioners in the adult patients[13]. In our study, the insertion time of the LMA group was longer than all other groups. However, there was no difference between the dexmedetomidine groups. This result may be attributed to dexmedetomidine's relaxation effect on the airway. Additionally, the CobraPLA's rigid head allows for easier insertion than the LMA.

Previous studies reported that dexmedetomidine reduced hemodynamic responses to stressful intraoperative events[7,9]. The effect of dexmedetomidine on arterial blood pressure and heart rate is related to the rate of infusion and dose[14]. In a study conducted in pediatric patients by Yao et al., different doses (1 and 2 μg/kg) of intranasal dexmedetomidine for premedication provided a dose dependent reduction in hemodynamic parameters. However, they reported that these changes were clinically unremarkable[9]. Deutch at al. used a lower dose (0.5 μg/kg, intravenously) of dexmedetomidine combined with sevoflurane and desflurane in children and they observed a reduction in heart rate, without changes in arterial blood pressure[15]. Unlike these studies, our data indicate that dexmedetomidine (loading dose 1 μg/kg + infusion 0.5 μg/kg/h) provided hemodynamic stability without causing adverse effects (hypotension and bradycardia).

Several studies conducted in adult patients showed that dexmedetomidine attenuated the volatile anesthetics requirement[14,16]. Similar results were also encountered in children. In children undergoing ambulatory surgery, the ETSevo concentrations were reduced up to 67 % with dexmedetomidine (loading dose 1 μg/kg + infusion 0.1 μg/kg/h)[17]. Likewise, Patel et al. reported that intravenous dexmedetomidine 2 μg/kg followed by 0.7 μg/kg/h decreased ETSevo concentrations during tonsillectomy in pediatric patients[18]. In addition, Yao et al. and Savla et al. investigated the effects of intranasal dexmedetomidine on sevoflurane concentration for LMA insertion, and they showed that intranasal dexmedetomidine reduced the minimum alveolar concentration of sevoflurane up to 37 %, and proportionately decreases sevoflurane EC50 by 21 % for LMA insertion[5,9]. In the current study where dexmedetomidine is administered using a 0.5 μg/kg/h infusion dosage after a loading dosage of 1μg/kg for 10 minutes, findings are compatible with other studies. Furthermore, the effect of dexmedetomidine on reducing ETSevo concentration was more pronounced during installation of the CobraPLA device than the LMA (21.4 % vs 15.6 %). This result may be related to the easier and faster placement of the CobraPLA[13].

The manufacturers of both SADs recommend that peak airway pressure should not exceed 20 cmH_2O for routine using of these equipment[11]. Otherwise, high airway pressures may create gastric distention, and then the patient's risk of regurgitation and aspiration may increase. In our study, the peak and plateau pressures were lower in dexmedetomidine groups, and the effect of dexmedetomidine on airway pressures is consistent with results of studies by Lee et al. They stated that intravenous dexmedetomidine improved respiratory dynamics in the patients with chronic obstructive pulmonary disease during surgery[19]. However, these statistical differences in airway pressures have no clinical effect on complications. Nevertheless, we would like

to state that dexmedetomidine may provide for safety ventilation in patients with increased airway pressures such as bronchospasm.

The increase of dead space caused by the anesthetic circuits and SADs is an undesirable condition in children, and as a result of this, hypercarbia may occur. We stated that $ETCO_2$ values were within the range of 35-45 mmHg in all groups. However, $ETCO_2$ levels in the CobraPLA groups were higher than in the LMA groups, but these values were insignificant in clinical practice.

During the use of the SADs, sore throats and coughing are the most common problems in the postoperative period [3]. In the current study, coughing and gastric distension were observed as postoperative adverse events. However, the development of complications was similar in the four groups. Dexmedetomidine did not have any negative effect on possible complications of SADs. Additionally, no unfavorable hemodynamic changes, including bradycardia and hypotension, were encountered during the application of dexmedetomidine.

There are several limitations in the current study. First, this study is retrospective trial, and prospective controlled trials are needed to verify the outcome of our study. Second, the use of SADs was conducted by different senior anesthesiologist assistants; therefore, the results could be affected by the application conditions. Third, the evaluation of effective SADs placement was limited with available medical records; however, more data may need for prospective studies. Fourth, we cannot ignore the possibility of reporting bias as our data were removed from medical forms where underreporting of adverse events is probable.

In conclusion, the use of intraoperative dexmedetomidine 1 μg/kg loading dosage, followed by a 0.5 μg/kg/h infusion, decreased airway pressures and ETSevo concentrations in patients with SADs. When evaluated generally, CobraPLA plus dexmedetomidine may be an effective combination for airway management for children undergoing inguinal region surgery.

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