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Effect of dexmedetomidine on the stress reaction caused by sevoflurance anesthesia in school–age children with different personality characteristics

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ABSTRACT

Objective: To observe the effect of dexmedetomidine on the stress reaction caused by sevoflurance anesthesia during the perianesthesia period in school–age children with different personality characteristics. Methods: A total of 160 children who were admitted in our hospital for transumbilical single–port laparoscopic hernia inner ring ligation were included in the study and randomized into dexmedetomidine (D) group and midazolam (M) group. The children were performed with Eysenck Personality Questionnaire before operation (children edition). Children were divided into the emotion group (group I) and stable group (group II). The operation was performed under sevoflurance inhalation anesthesia. Patients in DI and DII groups were given 1 μg/kg DEX, MI and MII groups were given 0.05 mg/kg midazolam, for 15 min. MAP and HR one day before operation (T0), before anesthesia induction (T1), 1 min after pneumoperitoneum establishment (T2), the time after pulling out the laryngeal mask (T3), and the time after shifting from the recovery room (T4) were recorded. A volume of 6 mL venous blood 1 d before operation and 4 h after operation was collected. Blood sugar concentration, cortisol and IL–6 levels were detected. Results: MAP at T1, T2, T3, and T4 in DI and MI groups were significantly elevated when compared with at T0. MAP at T2 and T3 in DII group was significantly elevated when compared with at T0. MAP at T2, T3, and T4 in MII group was significantly elevated when compared with at T0. When compared with DI group, MAP at T1, T2, and T3 in DII group was significantly reduced; MAP at T2, T3, and T4 in MI group was significantly elevated; MAP at T1 in MII group was significantly reduced. When compared with DII group, MAP at T2, T3, and T4 in MI and MII groups was significantly elevated. HR at T1, T2, T3, and T4 was significantly elevated when compared with at T0. When compared with DI group, HR at T1, T2, and T3 in DII group was significantly reduced; HR at each timing point in MI group was significantly elevated; HR at T1 in MII group was significantly reduced, while at T2, T3, and T4 was significantly elevated. When compared with DII group, HR at each timing point in MI group was significantly elevated; HR at T2, T3, and T4 in MII group was significantly elevated. Except for DII group, the blood sugar, cortisol, and IL–6 levels were significantly elevated when compared with before operation. When compared with D1 group, the blood sugar and cortisol levels at T1 in DII group were significantly reduced; the blood sugar, cortisol, and IL–6 levels at T1 in MI and MII groups were significantly elevated. When compared with DII group, the blood sugar, cortisol, and IL–6 levels at T1 in MI and MII groups were significantly elevated. Conclusions: Application of hydrochloric DEX in sevoflurance anesthesia in children can effectively inhibit the excitability of sympathetic nervous system caused by operation, alleviate the stress reaction, and maintain the stability of hemodynamics, which is benefit for the postoperative rehabilitation.

1. Introduction

School-age children have a certain perception to the external environment, but due to the immature psychological development, excessive anxiety is presented before anesthesia, with severe stress reaction during the perianesthesia period. The activation of hypothalamic-pituitary-adrenal axis can increase the blood pressure, accelerate the heart rate, and elevate the levels of some stress hormones, such as cortisol, ACTH, and catecholamine[1]. The stress reaction can activate the cells to produce various acute phase reactive proteins and cytokines, such as CRP, IL-2, IL-6, and IL-10. The anxiety degree is different in children with different personality characteristics, which can induce different psychological behaviors. Midazolam can produce the sedation and oblivion effects, and

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alleviate the tension state to a certain degree, but will still produce a strong stress reaction. DEX is a new-type a2 adrenergic receptor agonist, is of high selectivity, and has a certain effect in reducing the stress reaction in children[2–4]. The study is aimed to explore the effect of dexmedetomidine on the stress reaction caused by sevoflurance anesthesia during the perianesthesia period in school-age children with different personality characteristics.

2. Materials and methods

2.1. Clinical materials

A total of 160 children who were admitted in our hospital from January, 2015 to July, 2015 for transumbilical single-port laparoscopic hernia inner ring ligation were included in the study (ASA I grade) and randomized into dexmedetomidine (D) group and midazolam (M) group with 80 cases in each group, aged from 5 to 12 years old. The children were performed with Eysenck Personality Questionnaire before operation (children edition). According to the test results, the children were divided into the emotion group (group I, score＞50) and stable group (group II, score ＜50); 44 in group DI, 36 in group DII, 41 in group MI, and 39 in group MII.

2.2. Anesthesia methods

A visit was paid before anesthesia. A communication was conducted to the children and their parents, and related knowledge was given. The children were performed with Eysenck Personality Questionnaire before operation (children edition). The children were fasting for 8h and deprived of water for 4 h before operation, with no medication before anesthesia, and entering the operation room on the operation day. According to the children's hobbies, toys, pictures, and books were prepared in order to eliminate the tension in an unfamiliar environment. The children were guided to be familiar with the mask. SBP, DBP, MAP, HR, ECG, SPO2, $P_{ET}CO_2$, and bispectral index (BIS) were routinely monitored. The oxygen flow was adjusted as 6 L/min, with sevoflurance concentration of 8% in order to let the breathing circuit being filled with sevoflurance. The children blew the balloons to take a deep breath. The mask was placed on the snout. For children with no cooperation, moderate constraints were performed to guarantee the anesthesia induction. After a complete disappearing of eyelash reflex, 3% sevoflurance was persistently inhaled, with assisted respiration. A venous channel was established. The children were given successively venous injection of atropine (0.2 mg/kg), dexamethasone (0.2 mg/kg), fentanyl (3 μg/kg), and cisatracurium besylate (0.2 mg/kg). The laryngeal mask was placed 1 min after injection, and the respiration was controlled, with tidal volume of 10 mL/kg, and respiratory rate of 16 times/min. Sevoflurance inhalation concentration was regulated, and appropriate anesthesia depth was maintained. After establishing the venous channel, the patients in DI and DII groups were given pumping injection of 10 mL normal saline diluent containing 1 μg/kg DEX, while the patients in MI and MII groups were given pumping injection of 10 mL normal saline diluent containing 0.05 mg/kg midazolam, for 15 min. The pneumoperitoneum pressure during operation was maintained at 9 mmHg. When the skin suturing began, sevoflurance inhalation was ceased. Until the conscious mind, cough and swallowing reflex, and autonomous reflex (＞12 times/min) were recovered, and oxygen saturation was greater than 95% after inhaling the air for 5 min, the laryngeal mask was removed, and the children were sent into the recovery room. When Steward score was 6, the children were shifted from the recovery room.

2.3. Observation indicators

2.3.1. Comparison of the hemodynamics among each group

MAP and HR one day before operation (T0), before anesthesia induction (T1), 1 min after pneumoperitoneum establishment (T2), the time after pulling out the laryngeal mask (T3), and the time after shifting from the recovery room (T4) were recorded.

2.3.2. Comparison of the stress reaction indicators among each group

A volume of 6 mL venous blood 1 d before operation and 4h after operation was collected. The biochemical method was used to detect the blood sugar concentration. The radioimmunoassay was used to detect cortisol and IL-6 levels.

2.4. Statistical analysis

SPSS 17.0 software was used for the statistical analysis. The measurement data were expressed as mean ± SD. The independent t test was used for the comparison between the two groups. ANOVA was used for the comparison at different timing points. Rank-sum test was used for the comparison of ranked data. $P<0.05$ was regarded as statistically significant.

3. Results

3.1. Comparison of the hemodynamic indicators at each timing point among groups

MAP at T1, T2, T3, and T4 in DI and MI groups were significantly elevated when compared with at T0 ($P<0.05$). MAP at T2 and T3 in DII group was significantly elevated when compared with at T0 ($P<0.05$). MAP at T2, T3, and T4 in MII group was significantly elevated when compared with at T0 ($P<0.05$). When compared with DI group, MAP at T1, T2, and T3 in DII group was significantly reduced ($P<0.05$); MAP at T2, T3, and T4 in

Table 2.

Comparison of the hemodynamic indicators at each timing point among groups.

	Groups	*n*	T_0	T_1	T_2	T_3	T_4
MAP	D Ⅰ	44	59.69±5.03	65.35±4.88*	70.59±7.31*	75.75±6.64*	65.75±5.35*
	D Ⅱ	36	56.84±4.22	59.28±5.24$^{\#}$	63.36±4.93$^{*\#}$	65.62±5.74$^{*\#}$	62.55±5.43
	M Ⅰ	41	58.53±6.64	66.64±5.12*	79.12±4.34$^{*\#\Delta}$	83.25±4.58$^{*\#\Delta}$	80.33±5.27$^{*\#\Delta}$
	M Ⅱ	39	57.09±5.16	59.63±4.48$^{\#}$	73.65±5.28$^{*\Delta}$	75.79±4.96$^{*\Delta}$	72.32±5.53*
HR	D Ⅰ	44	86.65±10.33	105.62±10.03*	119.55±12.37$^{*\#}$	125.75±11.64*	115.45±15.35*
	D Ⅱ	36	84.38±10.26	90.37±10.23$^{*\#}$	108.65±11.53$^{*\#}$	115.54±12.45$^{*\#}$	110.46±12.43*
	M Ⅰ	41	88.29±10.45	108.69±10.42*	135.32±15.13$^{*\#\Delta}$	142.68±13.03$^{*\#\Delta}$	130.14±14.25$^{*\#\Delta}$
	M Ⅱ	39	83.68±10.74	92.65±10.12$^{*\#}$	128.62±13.63$^{*\#\Delta}$	135.62±13.88$^{*\#\Delta}$	128.62±12.75$^{*\#\Delta}$

$^{*}P<0.05$, when compared with at T0; $^{\#}P<0.05$, when compared with DI group; $^{\Delta}P<0.05$, when compared with DII group.

MI group was significantly elevated ($P<0.05$); MAP at T1 in MII group was significantly reduced ($P<0.05$). When compared with DII group, MAP at T2, T3, and T4 in MI and MII groups was significantly elevated ($P<0.05$). HR at T1, T2, T3, and T4 was significantly elevated when compared with at T0 ($P<0.05$). When compared with DI group, HR at T1, T2, and T3 in DII group was significantly reduced ($P<0.05$); HR at each timing point in MI group was significantly elevated ($P<0.05$); HR at T1 in MII group was significantly reduced, while at T2, T3, and T4 was significantly elevated ($P<0.05$). When compared with DII group, HR at each timing point in MI group was significantly elevated ($P<0.05$); HR at T2, T3, and T4 in MII group was significantly elevated ($P<0.05$) (Table 2).

3.2. Comparison of the stress reaction indicators among groups

Except for DII group, the blood sugar, cortisol, and IL-6 levels were significantly elevated when compared with before operation ($P<0.05$). When compared with D1 group, the blood sugar and cortisol levels at T1 in DII group were significantly reduced ($P<0.05$); the blood sugar, cortisol, and IL-6 levels at T1 in MI and MII groups were significantly elevated ($P<0.05$). When compared with DII group, the blood sugar, cortisol, and IL-6 levels at T1 in MI and MII groups were significantly elevated ($P<0.05$) (Table 3).

Table 3.

Comparison of the stress reaction indicators among groups.

Indicators	Groups	*n*	T_0	T_1
GLU	D Ⅰ	44	4.75±0.57	6.28±0.64*
	D Ⅱ	36	4.72±0.48	5.48±0.57$^{\#}$
	M Ⅰ	41	4.68±0.62	8.68±0.79$^{*\#}$
	M Ⅱ	39	4.66±0.52	7.68±0.47$^{*\#}$
Cor	D Ⅰ	44	106.63±57.28	289.51±96.37*
	D Ⅱ	36	110.94±55.75	225.72±87.28$^{*\#}$
	M Ⅰ	41	108.54±65.77	361.35±106.24$^{*\#}$
	M Ⅱ	39	112.67±56.88	354.63±57.28$^{*\#}$
IL-6	D Ⅰ	44	34.55±13.37	104.68±18.35*
	D Ⅱ	36	33.78±13.26	98.58±19.47*
	M Ⅰ	41	36.67±12.19	154.68±16.65$^{*\#}$
	M Ⅱ	39	34.58±14.32	134.54±16.87$^{*\#}$

$^{*}P<0.05$, when compared with at T0; $^{\#}P<0.05$, when compared with DI group; $^{\Delta}P<0.05$, when compared with DII group.

4. Discussion

The anxiety state showed in the perioperative period in children not only can affect the treatment and outcome, but also has adverse effects on the emotion development, mental health, and social adaptation ability. Some researches demonstrate that[5] the younger the children are, the higher the preoperative anxiety degree is, and the worse the general anesthesia induction compliance is. Anxiety is easy to be occurred in children with unstable emotions during the perianesthesia period, who may have language or limb resistance, and even destructive behavior in the operation room. The results in the study showed that MAP and HR at T1 in DI and MI groups were significantly higher than those in DII and MII groups at T0, suggesting that in children with emotions, the preoperative anxiety is obvious, and the stress reaction is strong, with long duration and no easy calm restoring. Therefore, it is necessary to take appropriate intervention measures according to the children's mental and personality characteristics. The psychological protection during the perioperative period in children has been a general issue concerned by the medical workers.

Dexmedetomidine is a new-type a2 adrenergic receptor agonist, is of high selectivity, and has sedation, analgesia, and anti-sympathia effects[6,7]. The clinical researches demonstrate that[8–10] dexmedetomidine can reduce the occurrence rate of agitation after sevoflurance anesthesia, alleviate the stress reaction caused by various factors during the perioperative period, and stabilize the cardiovascular system. Midazolam is a kind of benzodiazepines sedative, characterized by rapid effect taking, short half-life period, anterograde amnesia, small respiratory circulation inhibition, and rapid metabolism, and has been widely applied in the sedation in children before operation, during operation, and ICU mechanical ventilation[11]. In the study, MAP and HR at T2 and T3 in DII group were reduced when compared with DI group, indicating that the hemodynamic change during operation in children with emotions is great; MAP and HR at T2, T3, and T4 in DI group were reduced when compared with MI group, indicating that in children with emotions, application of dexmedetomidine can produce a small

effect on the hemodynamics when compared with the midazolam group; MAP and HR at each timing point in DII group were reduced when compared with MI group, indicating that both emotion and dexmedetomidine can alleviate the hemodynamic change. The excitability of sympathetic-adrenal cortex system can rapidly elevate the hormone level in blood, among which the cortisol concentration can be elevated. Operation stimulation can cause the complements to activate the endothelial cells, macrophages, and monocytes to produce the inflammatory cytokines; therefore, detection of IL-6 level can accurately reflect the trauma stimulation and damage degree. In the study, the blood sugar and cortisol levels in DII group were significantly reduced when compared with DI group (P<0.05), indicating that in stable children, the stress reaction during operation is small; the blood sugar, cortisol, and IL-6 levels in DI group were significantly reduced when compared with MI group (P<0.05), indicating that in children with emotions, application of dexmedetomidine can produce less stress reaction when compared with the midazolam group; the blood sugar, cortisol, and IL-6 levels in DII group were significantly reduced when compared with MI group (P<0.05), indicating that both emotion and dexmedetomidine can alleviate the stress reaction. Therefore, the results in the study showed that dexmedetomidine can alleviate the stress reaction, relieve the immunosuppression, and enhance the postoperative recovery. Dexmedetomidine in reducing the sympathetic tone and inflammatory reaction, and maintaining the hemodynamic stability is superior to that by midazolam, with no respiratory depression, and delayed recovery.

In conclusion, adverse psychological state is prone to be occurred in children with emotions during the perioperative period. During the perianesthesia period, application of dexmedetomidine can reduce the sympathetic activity, and maintain the stability of hemodynamics, which is benefit for the postoperative rehabilitation.

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