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Original Article

Effects of different doses of dexmedetomidine on stress responses and postoperative cognitive function in spine surgery for elderly patients

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Abstract: Objective: To investigate the effects of different doses of dexmedetomidine (DEX) on the stress response (SR) and postoperative cognitive function (POCF) in elderly patients with spine surgery (SS). Methods: A prospective study was conducted in 165 elderly patients who underwent SS. The patients were divided into Groups A, B and C (receiving 0.5 μg/kg DEX, 1.0 μg/kg DEX, and equal volume of normal saline, respectively). Surgical data, preoperative cognitive function and cognitive function on postoperative day 7 among the three groups were compared. Mean arterial pressure (MAP), heart rate (HR) and the levels of cortisol (Cor), angiotensin-II (A-II), tumor necrosis factor α (TNF-α), and interleukin 6 (IL-6) immediately after intubation (T0), 1 h postintubation (T1), immediately after extubation (T2), and 5 min postextubation (T3) were compared. Cognitive function was assessed with mini mental state examination (MMSE) before and after treatment; one day after treatment, the incidence of postoperative adverse reactions was measured and postoperative pain was assessed with visual analogue scale (VAS). Results: MAP, HR, and levels of Cor and A-II in Group B were lower than those in Groups A and C both at T1 and T2 (all $P<0.05$) and they were all lower at T2 than at T1 (all $P<0.05$). In Groups A and C, the above factors were higher at T3 than at T0 (all $P<0.05$). Instead, MAP and HR in Group B showed no statistical difference between at T3 and at T0 (all $P>0.05$). The levels of TNF-α and IL-6 at T1, T2, and T3 were higher than those at T0 in the three groups, and those of Group B were significantly lower than those of Groups A and C (all $P<0.05$). MMSE of Group B was significantly higher than those of Groups A and C (both $P<0.05$); while the incidence of postoperative reactions and VAS score in Group B were significantly lower than those in Groups A and C (all $P<0.05$). Conclusion: The application of DEX in SS for elderly patients can significantly relieve SR, improve POCF, and reduce the incidence of postoperative adverse reactions and postoperative pain.

Keywords: Dexmedetomidine, spine surgery, elderly patients, stress response, postoperative cognitive function

Introduction

Postoperative cognitive dysfunction (POCD) is a common complication after surgery, and the incidence is higher in the elderly. Fourteen percent of patients have cognitive decline and confusion during the first 3 months after surgery [1]. It has been found that POCD in elderly patients undergoing spinal surgery is a risk factor for the occurrence of postoperative delirium, leading to functional decline and increasing the possibilities of postoperative hospitalization and even death [2]. The stress response (SR) commonly occurs during surgery, causing hemodynamic and neuroendocrine changes as well as inflammation and immune responses. Prolonged SR time causes injury to the body, and increases the mortality of critically ill patients [3]. Anesthesia and surgical procedures are one of the main reasons for a SR [4]. Therefore, appropriate anesthesia methods can relieve the surgical SR and reduce POCD, thereby improving the outcomes of patients' surgical treatment and postoperative quality of life.

Dexmedetomidine (DEX) is a highly selective α-adrenergic agonist, which causes analgesic,

sedative and neuroprotective effects [5]. It has been confirmed that DEX can protect nerve function and reduce neuronal injury after thoracic aorta occlusion in mice [6]. A study of Tsaousi et al. included 913 patients undergoing spinal surgery found that propofol and morphine consumption was significantly reduced in patients treated with DEX, which had significant sedative and opioid-sparing effects [7]. Shen et al. treated an oxidative damage model of Kupffer cells with DEX and found that DEX hydrochloride could effectively prevent oxidative stress and inflammatory response of Kupffer cells by activating α2-adrenergic receptor [8]. Therefore, this study observed the effects of different doses of DEX in spine surgery (SS) for elderly patients, and compared the patients' SR and postoperative cognitive function.

Materials and methods

Clinical information

A prospective non-randomized controlled study was conducted in 165 elderly patients enrolled in the Hainan Hospital of PLA General Hospital, undergoing SS from April 2013 to July 2016. The patients were divided into three groups according to different doses of DEX for the induction and maintenance of anesthesia, all the way to the start of skin closure: Group A (n=57, male-female ratio of 34:23, an average age of 71.4±6.7 years, treated with 0.5 μg/kg/h DEX), Group B (n=62, male-female ratio of 40:22, average age 72.5±7.2 years, 1.0 μg/kg/h DEX) and Group C (n=46, male-female ratio of 27:19, average age 70.6±6.1 years, equal volume of normal saline). This study was approved by the Ethics Committee of Hainan Hospital of PLA General Hospital and the patients signed an informed consent.

Inclusion criteria: Diagnosed with spinal fractures by imaging and pathological examination; aged over 60 years old; patients whose condition required surgical treatment and was acceptable for surgery; patients with complete clinical information; patients who cooperated with the follow-up; patients who were informed about the purpose of this study and signed the informed consent.

Exclusion criteria: Allergic to the agents used; patients with preoperative cognitive impairment or delirium; co-infection patients; patients with other tumors; patients with severe inflammation; patients with severe immune deficiency; patients with congenital functional defects of liver, kidney and heart.

Reagents and kits

Cortisol (Cor) ELISA kit (E-EL-0157c; Elabscience Biotechnology Co., Ltd., China), angiotensin II (A-II) ELISA kit (JL10881; Shanghai Jianglai Biological Science & Technology Co., Ltd., China), tumor necrosis factor (TNF) α ELISA kit (QY-H10038; Qiyi Biological Technology (Shanghai) Co., Ltd., China), interleukin (IL) 6 ELISA kit (E-EL-H0102c; Elabscience Biotechnology Co., Ltd., China), propofol (Guangdong Jiabo Pharmaceutical Co., Ltd., China), DEX hydrochloride (Jiangsu Hengrui Medicine Co., Ltd., China), remifentanil hydrochloride ((Jiangsu Enhua Pharmaceutical Co., Ltd., China), rocuronium bromide (Zhejiang Huahai Pharmaceutical Co., Ltd., China), sevoflurane (Shanghai Hengrui Pharmaceuticals Co., Ltd., China), ramosetron (Shanxi Pude Pharmaceutical Co., Ltd., China), hydromorphone (Yichang Renfu Pharmaceutical Co., Ltd., China), fentanyl (Jiangsu Enhua Pharmaceutical Co., Ltd., China) and tramadol (Hubei Xinghua Pharmaceutical Co., Ltd., China) were all used in this study.

Anesthesia schemes

Before anesthesia induction, DEX was injected with target-controlled infusion at 0.01 μg/kg/min in Groups A and B, and remifentanil hydrochloride was injected at 0.01 μg/kg/min in Group C. After 10 min of injection, propofol was administered at 20 mg per for each 15-second interval. The total dose of propofol was 1-2 mg/kg propofol until bispectral index (BIS) reached to 40-50. Then 1 mg/kg rocuronium bromide was given, and endotracheal intubation was conducted 1 min after manual ventilation. Anesthesia was maintained in the three groups by continuous pumping of 3-12 mg/kg/h propofol and continuous inhalation anesthesia of sevoflurane (1-1.5 L/min). Continuous pumping of 0.5 μg/kg/h and 1.0 μg/kg/h dexmedetomidine after intubation was performed in the Groups A and B respectively, and an equal volume of normal saline was given in Group C. The BIS remained between 40 and 60, and the hemodynamic changes were all less than 20%

from the baseline value in the three groups. Sevoflurane, DEX and propofol were discontinued 15 min after surgery, at the start of skin closure, and after skin closure, respectively. After surgery, 0.3 mg of ramosetron was given to prevent postoperative nausea and vomiting. The patient was transferred to Postanesthesia Care Unit (PACU) and the trachea intubation was removed when the patients had adequate voluntary ventilation. Patient controlled analgesia (PCA) was applied after the patient opened his eyes. PCA was maintained with a 1 mL bolus injection of 12 mg hydromorphone +100 mL normal saline for 2 mL/h. For patients in PACU and general wards, 1 μg/kg fentanyl and 50 mg tramadol were injected intravenously as rescue analgesics, respectively [9].

Detection method

A total of 8 mL venous blood was extracted from the non-intravenous side immediately after intubation (T0), 1 h postintubation (T1), immediately after extubation (T2), and 5 min postextubation (T3) respectively. The blood was centrifuged at 3,000 rpm for 10 min, and the supernatant was aspirated. Cor, A-II, TNF-α and IL-6 levels were detected by ELISA according to the instructions of the kit.

Outcome measures

Main outcome measures: The changes of mean arterial pressure (MAP) and heart rate (HR), and Cor, A-II, TNF-α, and IL-6 levels at T0, T1, T2 and T3 were compared. Mini mental state examination (MMSE) was used to evaluate the cognitive function and the differences in cognitive function between pre-treatment and 7 days postoperative among the three groups were compared [10].

Secondary outcome measures: One day after treatment, the incidence of adverse reactions was measured, and postoperative pain was assessed with visual analogue scale (VAS) [11]. Postoperative pain among the three groups was compared.

Statistical analysis

Statistical analysis was conducted by SPSS 20.0 (SPSS Inc., Chicago, USA) software, and GraphPad Prism 7 (GraphPad Software, San Diego, CA, USA) was used to illustrate the figures. Count data were expressed as percent (%) and were analyzed by chi-square test. Measurement data followed a normal distribution and were expressed as mean ± standard deviation ($\bar{x} \pm SD$). Comparison of data between multiple groups was performed using one-way analysis of variance and post-hoc comparison was made using LSD method; comparison of data between multiple groups at different time points was performed using repeated measures analysis of variance and post-hoc comparison was made using Bonferroni method. Rank data were analyzed by the rank sum test. $P<0.05$ is considered statistically significant.

Results

Baseline clinical information

There was no statistical difference in the baseline clinical data among the three groups (all $P>0.05$). See **Tables 1-3**.

Surgical data of patients

There was no statistical difference in the total operation time, anesthesia time, BIS, and the amount of bleeding (all $P>0.05$), while consumption of propofol had significant difference ($P<0.05$) among the three groups. There was a progressive decrease in the consumption of propofol in Groups C, A and B, respectively (all $P<0.05$). See **Table 4**.

Changes of MAP and HR and the expressions of Cor and A-II

The results of the changes of MAP and HR were shown in **Table 5**. No statistical difference was seen in MAP and HR at T0 among the three groups (all $P>0.05$). MAP and HR at T1 were significantly higher than those at T0, while those at T2 were significantly lower than those at T1 in the three groups (all $P<0.05$). At T1, T2 and T3, MAP and HR in Group B were significantly lower than those in Groups A and C, and those in Group A were significantly lower than those in Group C (all $P<0.05$). Compared with those at T3, MAP and HR at T2 in the three groups had no statistical difference (all $P>0.05$), those at T3 were significantly higher than those at T0 in Groups A and C (all $P<0.05$), and there was no

Table 1. General information ($\bar{x}$ ± SD; n (%))

Factor	Group A (n=57)	Group B (n=62)	Group C (n=46)	χ^2/F	P
Gender				0.466	0.792
Male	34 (59.65)	40 (64.52)	27 (58.70)		
Female	23 (40.35)	22 (35.48)	19 (41.30)		
Age (year old)	71.4±6.7	72.5±7.2	70.6±6.1	1.085	0.340
Body mass index (kg/m^2)	21.65±2.14	22.37±2.42	21.78±2.31	1.650	0.195
Medical history					
Hypertension	18 (31.58)	17 (27.42)	12 (26.09)	0.432	0.806
Diabetes mellitus	11 (19.30)	13 (20.97)	11 (23.91)	0.328	0.849
Smoking				0.202	0.904
Yes	11 (19.30)	14 (22.58)	10 (21.74)		
No	46 (80.70)	48 (77.42)	36 (78.26)		
Alcohol abuse				0.940	0.625
Yes	8 (14.04)	9 (14.52)	4 (8.70)		
No	49 (85.96)	53 (85.48)	42 (91.30)		
Residence				0.562	0.755
City	44 (77.19)	45 (72.58)	36 (78.26)		
Village	13 (22.81)	17 (27.42)	10 (21.74)		

Table 2. Baseline information ($\bar{x}$ ± SD; n (%))

Factor	Group A (n=57)	Group B (n=62)	Group C (n=46)	F/Z	P
ASA classification				0.628	0.731
I	32 (56.14)	39 (62.90)	26 (56.52)		
II	21 (36.84)	19 (30.65)	17 (36.96)		
III	4 (7.02)	4 (6.45)	3 (6.52)		
Bone mineral density (mg/cm^3)	74.65±18.54	75.24±21.62	72.15±15.95	0.372	0.690
T	-2.25±0.84	-2.14±0.75	-2.21±0.81	0.289	0.749
Systolic blood pressure (mmHg)	137.65±24.82	141.65±21.57	135.45±20.54	1.073	0.345
Diastolic blood pressure (mmHg)	84.74±14.35	82.58±13.21	85.24±15.15	0.564	0.570
Hemoglobin (g/L)	114.58±17.84	118.58±21.37	117.68±19.82	0.651	0.523
Platelet (*10^9/L)	156.98±42.94	161.25±56.25	153.57±47.38	0.325	0.723
Blood sugar (mmol/L)	5.43±2.27	5.25±1.97	5.32±2.04	0.110	0.896

Note: ASA, American Society of Anesthesiologists.

Table 3. Fracture situation ($\bar{x}$ ± SD; n (%))

Factor	Group A (n=57)	Group B (n=62)	Group C (n=46)	χ^2	P
Fracture site				1.870	0.931
Fracture of cervical vertebra	11 (19.30)	10 (16.13)	6 (13.04)		
Fracture of thoracic vertebra	27 (47.37)	28 (45.16)	25 (54.35)		
Fracture of lumbar vertebra	16 (28.07)	19 (30.65)	13 (28.26)		
Fracture of sacral vertebral	3 (5.26)	5 (8.06)	2 (4.35)		
Single vertebral fracture	39 (68.42)	43 (69.35)	29 (63.04)	0.530	0.767
Multiple vertebral fracture	18 (31.58)	19 (30.65)	17 (36.96)		

statistical difference between those at T3 and T0 in Group B (both P>0.05). There were similar trends in the Cor and A-II levels and the results are shows in **Table 6**.

Table 4. Surgical data of patients ($\bar{x}$ ± SD)

Factor	Group A (n=57)	Group B (n=62)	Group C (n=46)	F	P
Total operation time (min)	143.65±24.65	147.27±26.47	146.74±25.12	0.337	0.715
Anesthesia time (min)	157.46±28.67	161.59±32.49	155.13±27.35	0.659	0.519
BIS	48.67±3.25	47.92±3.07	48.29±3.15	0.839	0.434
Amount of bleeding (mL)	294.26±34.25	297.38±32.76	302.57±41.37	0.689	0.503
Consumption of propofol (mg)	923.28±135.25	845.34±93.19[a]	1,037.48±172.37[a,b]	27.329	<0.001

Note: BIS, bispectral index. Compared with Group A, [a]P<0.05; compared with Group B, [b]P<0.05.

Table 5. Changes of MAP and HR ($\bar{x}$ ± SD)

Group	Group A (n=57)	Group B (n=62)	Group C (n=46)	F	P
MAP (mmHg)					
T0	87.44±9.76	86.87±9.51	86.25±9.70	0.194	0.824
T1	99.38±14.74[*]	95.38±12.32[a,*]	104.54±17.93[a,b,*]	5.001	0.008
T2	95.35±8.63[*,#]	90.64±8.24[a,*,#]	101.26±9.25[a,b,*,#]	19.843	<0.001
T3	93.52±8.98[*,#]	88.22±8.54[a,#]	99.27±9.47[a,b,*,#]	20.172	<0.001
HR (time/min)					
T0	76.88±8.20	77.17±8.36	75.59±8.12	0.526	0.592
T1	85.48±10.43[*]	82.56±9.46[a,*]	90.35±11.42[a,b,*]	7.479	<0.001
T2	83.62±9.74[*,#]	79.73±8.56[a,*,#]	87.75±10.84[a,b,*,#]	9.175	<0.001
T3	81.54±9.37[*,#]	77.42±8.34[a,#]	85.61±10.25[a,b,*,#]	10.418	<0.001

Note: MAP, mean arterial pressure; HR, heart rate. Compared with T0, [*]P<0.05; compared with T1, [#]P<0.05; compared with Group A at the same time point, [a]P<0.05; compared with Group B at the same time point, [b]P<0.05.

Table 6. The levels of Cor and A-II ($\bar{x}$ ± SD)

Group	Group A (n=57)	Group B (n=62)	Group C (n=46)	F	P
Cor (nmol/L)					
T0	225.76±59.43	231.74±64.98	218.25±43.75	0.719	0.489
T1	301.62±84.65[*]	267.54±77.14[a,*]	351.62±98.45[a,b,*]	12.604	<0.001
T2	283.16±82.15[*,#]	252.63±73.57[a,*,#]	317.14±89.48[a,b,*,#]	8.358	<0.001
T3	268.36±78.46[*,#]	238.63±68.53[a,#]	299.63±87.36[a,b,*,#]	8.210	<0.001
A-II (ng/dL)					
T0	41.63±11.24	40.06±10.32	40.65±11.05	0.315	0.731
T1	63.28±15.94[*]	57.24±12.76[a,*]	72.38±18.40[a,b,*]	12.458	<0.001
T2	55.72±13.43[*,#]	48.58±11.77[a,*#]	65.23±14.37[a,b,*,#]	21.297	<0.001
T3	49.27±11.36[*,#]	44.06±9.14[a,#]	58.37±13.58[a,b,*,#]	21.356	<0.001

Note: Cor, Cortisol; A-II, angiotensin II. Compared with T0, [*]P<0.05; compared with T1, [#]P<0.05; compared with Group A at the same time point, [a]P<0.05; compared with Group B at the same time point, [b]P<0.05.

TNF-α and IL-6 levels

There was no statistical difference in the TNF-α and IL-6 levels at T0 among the three groups (both P>0.05). TNF-α and IL-6 levels at T1, T2, and T3 were significantly higher than those at T0 in the three groups (all P<0.05). TNF-α and IL-6 levels in Group B were significantly lower than those in Groups A and C at T1, T2, and T3, and those in Group A were significantly lower than those in Group C at the same time points (all P<0.05). See **Table 7**.

MMSE before and after treatment

No significant difference was seen in MMSE among the three groups before treatment (24.13±4.63 vs. 25.84±4.53 vs. 25.63±4.75;

Table 7. The levels of TNF-α and IL-6 ($\bar{x}$ ± SD)

Group	Group A (n=57)	Group B (n=62)	Group C (n=46)	F	P
TNF-α (ng/L)					
T0	16.48±4.72	15.85±4.82	16.04±4.53	0.275	0.760
T1	20.84±6.42*	18.33±5.63^{a,*}	23.68±6.83^{a,b,*}	9.681	<0.001
T2	23.84±6.83$^{*,\#}$	21.32±6.13$^{a,*,\#}$	26.68±7.25$^{a,b,*,\#}$	8.476	<0.001
T3	26.75±7.62$^{*,\#,\&}$	23.94±6.84$^{a,*,\#,\&}$	29.46±8.42$^{a,b,*,\#,\&}$	8.118	<0.001
IL-6 (ng/L)					
T0	23.84±6.24	22.64±5.48	23.39±6.12	0.622	0.540
T1	28.65±7.94*	25.42±6.76^{a,*}	32.48±8.32^{a,b,*}	11.318	<0.001
T2	31.96±8.48$^{*,\#}$	28.58±7.71$^{a,*,\#}$	35.39±9.48$^{a,b,*,\#}$	8.540	<0.001
T3	34.87±11.36$^{*,\#,\&}$	30.26±9.14$^{a*,\#,\&}$	39.48±12.87$^{a,b,*,\#,\&}$	9.266	<0.001

Note: TNF, tumor necrosis factor; IL, interleukin. Compared with T0, *P<0.05; compared with T1, $^{\#}$P<0.05; compared with T2, $^{\&}$P<0.05; compared with Group A at the same time point, ^{a}P<0.05; compared with Group B at the same time point, ^{b}P<0.05.

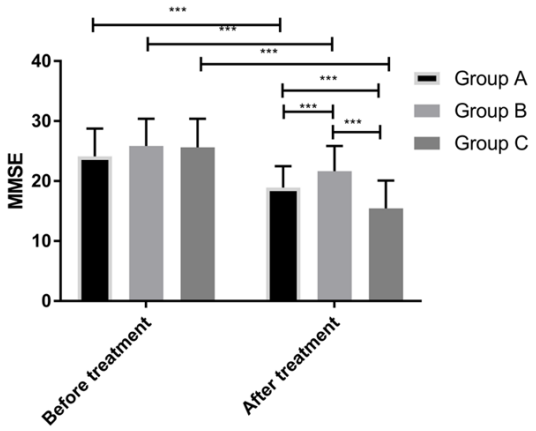

Figure 1. MMSE scores before and after treatment. After treatment, Groups A and B showed significantly higher MMSE score than Group C; Group B had significantly higher score than Group A. MMSE: mini mental state examination. ***P<0.001.

P>0.05). Postoperative MMSE scores in Group A (18.92±3.57) and Group B (21.65±4.21) were significantly higher than that in Group C (15.46±4.62; both P<0.05), and that in Group B was significantly higher than that in Group A (P<0.05). See **Figure 1**.

Incidence of postoperative adverse reactions

There was no statistical difference in confusion, somnolence, nausea and vomiting, astriction and skin itch (all P>0.05), while total incidence of postoperative adverse reactions had significant difference (P<0.05) among the three groups. Total incidence of postoperative adverse reactions in Group B was significantly lower than those in Groups A and C, and that in Group A was significantly lower than that in Group C (all P<0.05). See **Table 8**.

Postoperative VAS scores

Postoperative VAS scores of Group A (1.47± 0.62) and Group B (1.12±0.45) were significantly lower than that of Group C (2.31±0.73), and that of Group B was significantly lower than that of Group A (all P<0.05). See **Figure 2**.

Discussion

The study of Li et al. analyzed the effects of DEX on the inflammatory factor levels and cognitive function in elderly patients after femoral head replacement, and found that DEX could reduce the inflammatory factor levels, consumption of propofol, and the incidence of POCD [12].

In this study, the results of surgical data showed that there was a progressive decrease in the consumption of propofol in Groups C, A and B, respectively; which was consistent with the previous reports that DEX could reduce the consumption of propofol, and higher doses of DEX could reduce greater consumption of propofol. It was found that no significant difference was seen in MAP and HR among the three groups at T0. At T1, MAP and HR in the three groups were significantly increased; MAP and HR showed a progressive decrease in Groups C, A and B. MAP and HR in the three groups were decreased at T2 and T3; a progressive decrease of MAP and HR was seen in Groups C, A and B. This may be because the intraoperative SR of patients resulted in the increase of MAP and

Table 8. The incidence of postoperative adverse reactions ($\bar{x}$ ± SD)

Group	Group A (n=57)	Group B (n=62)	Group C (n=46)	F	P
Confusion	6 (10.53)	2 (3.23)	6 (13.04)	3.745	0.154
Somnolence	3 (5.26)	2 (3.23)	4 (8.70)	1.538	0.463
Nausea and vomiting	5 (8.77)	3 (4.84)	7 (15.22)	3.453	0.178
Astriction	4 (7.02)	2 (3.23)	5 (10.87)	2.497	0.287
Skin itch	2 (3.51)	2 (3.23)	4 (8.70)	2.051	0.359
Total incidence of postoperative adverse reactions	20 (35.09)	11 (17.74)[a]	26 (56.52)[a,b]	17.575	<0.001

Note: Compared with Group A, [a]P<0.05; compared with Group B, [b]P<0.05.

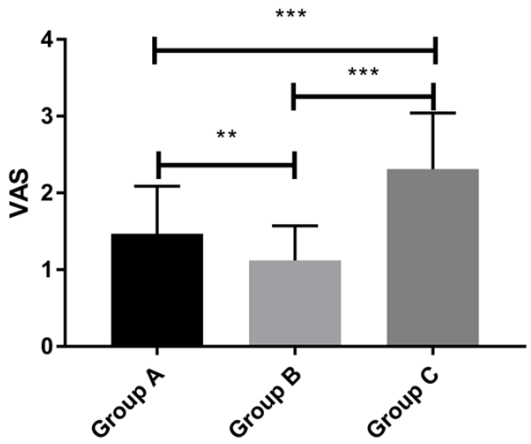

Figure 2. Postoperative VAS scores. Postoperative VAS score of Group B was significantly lower than those of Groups A and C, and Group A had significantly lower score than Group C. VAS: visual analogue scale. **P<0.01, ***P<0.001.

HR, but SR may be reduced after the application of DEX, and higher dose of DEX is even more conducive to reduce SR. A study compared the hemodynamic effects of midazolam and DEX in the perioperative period of hypertensive cerebral hemorrhage patients [13]; it was also found that DEX could reduce the sympathetic excitation caused by anesthesia or surgery, stabilize hemodynamics, and inhibit increased blood pressure and heart rate produced by laryngoscopy and endotracheal intubation.

Some studies have reported that intraoperative SR causes the changes of Cor and A-II levels [14, 15]. This study found that DEX could reduce Cor and A-II levels, and high dose of DEX has better effects than low dose. Recent studies have suggested that stress is mainly mediated by α-adrenergic and glucocorticoid receptors [16]; therefore, it was hypothesized that DEX, as a high-affinity α-adrenergic agonist, reduced SR by acting on the α-adrenergic receptor. We also found that DEX can reduce TNF-α and IL-6 levels, and high dose of DEX has better effects than low dose. Memiş et al. studied the effects of DEX on the inflammatory responses in critically ill patients receiving sedation therapy and they found that TNF-α, IL-1 and IL-6 levels caused by sepsis were significantly reduced after the application of DEX [17]; they believed that one of the mechanisms of anti-inflammatory action might be the regulation of cytokine production derived from macrophages and monocytes.

The study of Zheng et al. mentioned that the increased levels of Cor and TNF-α caused by surgical stress may be closely related to the decreased POCF [18]. The cognitive function before and after surgery among the three groups were compared through MMSE in this study and the results indicate that DEX can improve POCF and it is predicted that DEX inhibits further sympathetic neural activities in the brain by acting on α-adrenergic receptors, thereby reducing cognitive impairment. The work of Strawn et al. has also found that α-adrenergic receptor activation can inhibit further sympathetic nerve activities in the brain, and α-adrenergic agonist can inhibit central over activity [19]. In this study, it was shown that DEX reduced the incidence of postoperative adverse reactions and effectively alleviate pain in patients, and high dose of DEX has better effects.

However, this study also has certain limitations. First, the effect of DEX administration is dose-dependent and only two doses of DEX were compared in this study, without in-depth study on its optimal dose [20]. Secondly, the patients

included in this study were limited to elderly patients; however, it is not clear whether there is a difference in the changes of indicators and the applicable dose in non-elderly patients. Finally, a non-randomized controlled prospective study was conducted in this study, which produced some bias compared with the randomized controlled prospective study. Therefore, the specific mechanism of DEX needs to be explored and related randomized controlled studies are needed in the follow-up studies.

In summary, the application of DEX in SS for elderly patients can significantly relieve SR, reduce the inflammatory response, improve POCF, and reduce the incidence of postoperative adverse reactions and postoperative pain. More obvious effects and higher safety are apparent with higher dose of DEX.

Disclosure of conflict of interest

None.

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