Scientific Research Publishing

Journal of Biosciences and Medicines, 2023, 11, 146-151
https://www.scirp.org/journal/jbm
ISSN Online: 2327-509X
ISSN Print: 2327-5081

Clinical Observation of Hemodynamic and Cerebral Protective Effects of Different Doses of Dexmedetomidine in Patients with Traumatic Brain Injury

Jiacai Dong, Lei Liu, Jingwei Liu, Yanling Peng*

Department of Anesthesiology, Qianjiang Hospital Affiliated to Renmin Hospital of Wuhan University, Qianjiang, China
Email: *qjsdzz06@163.com

How to cite this paper: Dong, J.C., Liu, L., Liu, J.W. and Peng, Y.L. (2023) Clinical Observation of Hemodynamic and Cerebral Protective Effects of Different Doses of Dexmedetomidine in Patients with Traumatic Brain Injury. *Journal of Biosciences and Medicines*, **11**, 146-151.
https://doi.org/10.4236/jbm.2023.112010

Received: December 22, 2022
Accepted: February 14, 2023
Published: February 17, 2023

Abstract

Background: Patients with craniocerebral trauma may suffer ischemic brain injury and neurological dysfunction due to immune inflammation and neuroendocrine reactions. Dexmedetomidine (Dex) is one of the commonly used anesthetic drugs in clinic. Studies have shown Dex has the function of protecting brain nerves and inhibiting inflammation. However, there are few studies on the effects of different doses of dexmedetomidine on patients undergoing surgery. The purpose of this study is to observe the effects of different doses of Dex on hemodynamics and brain protection in patients undergoing brain trauma surgery. **Materials and Methods:** Eighty patients with craniocerebral trauma surgery were randomly divided into study group (group A, n = 40) and control group (group B, n = 40) by random number table method. Dex pump volume was 0.5 μg/kg/h in group A and 1.0 μg/kg/h in group B. Heart rate (HR) and mean arterial pressure (MAP) were recorded before anesthesia induction (T0), immediately after endotracheal intubation (T1) and at the end of operation (T2). The serum levels of central nervous system specific protein (S-100β) and neuron specific enolase (NSE) were measured and compared between the two groups at T0 and T2. **Results:** HR and MAP in group A were significantly higher than those in group B at T2, and the difference was statistically significant ($P < 0.05$). The levels of HR and MAP in the same group were significantly lower in T1 and T2 than in T0, and the difference was statistically significant ($P < 0.05$). The concentrations of S-100β and NSE in both groups at T2 were lower than those at T0, and the concentrations of S-100β and NSE in group A were significantly lower than those in group B at T2 ($P < 0.05$). **Conclusions:** 0.5 μg/kg dose of Dex is stable in hemodynamics and has a better protective effect on brain function in patients

with traumatic brain injury.

Keywords

Dexmedetomidine, Craniocerebral Trauma, Brain Function

1. Introduction

Traumatic brain injury often affects the head directly or indirectly due to external violence, resulting in intracranial or skull injury, causing damage to consciousness and brain function, which is also the main cause of death and disability [1]. With the development of economy and society and the change of people's way of life and travel, its incidence is gradually increasing, which has caused a huge economic burden all over the world. Craniocerebral trauma causes damage to the central nervous system, resulting in neuronal injury and cell death, and the surgical prognosis is poor, so it is very important to maintain the stability of respiration and circulation during operation and to reasonably select anesthetics with protective effect on brain function [2] [3] [4]. Dex is a highly selective α_2-adrenergic receptor agonist, which produces pharmacological effects by acting on α_2-adrenergic receptors in the central nervous system and peripheral nervous system. It has sedative, analgesic, anti-inflammatory and protective effects on brain nerves, but has little effect on respiration [5]. Wu *et al.* studied animal brain injury models and found that different doses of dexmedetomidine could not only prevent tissue damage and cell death, but also reduce axonal damage and synaptic degeneration caused by brain injury [6]. DicleKarakaya *et al.* also found in the study of brain injury model that different doses of dexmedetomidine can reduce nerve inflammation by inhibiting different components of the neuroinflammatory process at different times, which is conducive to nerve recovery [7]. The main purpose of this study was to investigate the hemodynamic effects and brain protective effects of different doses of Dex on patients with craniocerebral trauma.

2. Materials and Methods

2.1. Patients

Eighty patients with craniocerebral trauma treated in our hospital from June 2018 to June 2022 were divided into study group (group A) and control group (group B). There were 40 patients in the study group, including 28 males and 12 females, aged from 40 to 77 years old, with an average age of (60.2 ± 9.0) years, and an average body weight of (63.2 ± 7.1) kg. In the control group, there were 25 males and 15 females with an average age of (59.0 ± 7.8) years and an average body weight of (63.1 ± 6.0) kg. The study was approved by the Ethics Committee of the hospital and informed consent was signed by the patients. There was no significant difference in general data between the two groups ($P > 0.05$).

2.2. Criteria for Inclusion and Exclusion

Inclusion criteria: 1) imaging examination diagnosed as craniocerebral trauma, 2) surgical indications, 3) no blood routine, coagulation, abnormal liver and kidney function, 4) can sign anesthetic consent form.

Exclusion criteria: 1) anesthetic allergy, 2) prior history of brain surgery, 3) history of mental illness. This study was approved by the hospital ethics committee and signed an informed consent form with the patients.

2.3. Anesthesia Methods

Patients in both groups were treated with intravenous combined general anesthesia. Electrocardiogram, blood oxygen saturation and body temperature were monitored before operation. Radial artery puncture and catheterization were performed under local anesthesia, and invasive arterial pressure monitoring was performed. Dex (national drug H20183149, specification: 2 mL:0.2mg, Jiangsu Hengrui Pharmaceutical Co., Ltd.) Hydrochloride injection was given before anesthesia induction 10 min. The study group was injected intravenously with Dex 0.5 μg/kg, and then continued with 0.5 μg/(kg·h) dose until the end of the operation. In the control group, Dex 1.0 μg/kg was injected intravenously and then 1.0 μg/(kg·h) was given until the end of the operation. Both groups were induced with propofol (national drug H20040300, specification: 50 ml: 0.5 g, Xi'an Libang Pharmaceutical Co., Ltd.) 2.5mg/kg, sufentanil 0.5 μg/kg, cisatracurium 0.2 mg/kg, and mechanical ventilation after endotracheal intubation. Anesthesia was maintained by intravenous infusion of propofol 4 - 6 mg/(kg·h), remifentanil 8 – 10 μg/(kg·h) and cisatracurium 0.1 - 0.15 mg/(kg·h). Atropine was given intravenously when HR was less than 50 beats/min. HR and MAP were recorded before anesthesia induction (T0), immediately after endotracheal intubation (T1) and at the end of operation (T2). S-100β and NSE levels were measured and compared between the two groups at T0 and T2.

2.4. Hemodynamic Parameters

1) MAP and HR were observed before anesthesia induction (T0), immediately after endotracheal intubation (T1) and at the end of operation (T2).

2) Detection of S-100β and NSE concentration: Peripheral venous blood samples were taken at T0 and T2 to detect S-100β and NSE concentration.

2.5. Statistical Analysis

SPSS 21.0 software was used for the analysis. Measurement data from the normal distribution are represented by mean ± standard deviation ($\overline{x} \pm s$), and the data that do not conform to the normal distribution are represented by the median. Paired sample *t*-tests was used for intra-group comparison, and independent sample *t*-tests was used for inter-group comparison. A *P*-value of less than 0.05 ($P < 0.05$) was considered statistically significant.

3. Results

3.1. Hemodynamic Changes

1) The HR of group A and group B at T0 were (83.0 ± 13.9) times/min and (82.1 ± 12.9) times/min respectively, and MAP were (98.5 ± 15.4) mmHg and (97.6 ± 11.7) mmHg respectively. There was no statistically significant difference between the two groups in HR and MAP ($P > 0.05$).

2) The HR of group A and group B at T1 were (80.3 ± 15.5) times/min and (76.2 ± 12.3) times/min respectively, and MAP were (88.6 ± 14.3) mmHg and (83.4 ± 11.0) mmHg respectively. There was no statistically significant difference in HR and MAP between the two groups ($P > 0.05$).

3) The HR and MAP of the two groups at T2 were (71.4 ± 12.6) times/min and (65.6 ± 8.4) times/min respectively, and (73.9 ± 12.4) mmHg and (67.0 ± 7.9) mmHg respectively. The HR and MAP of group A were significantly higher than those of the control group ($P < 0.05$). In the same group, HR and MAP were significantly lower at T1 and T2 than at T0 ($P < 0.05$) (Table 1).

3.2. Comparison of S-100β and NSE Levels between the Two Groups

1) The concentrations of S-100β in group A and group B at T0 were (1.11 ± 0.51) μg/L and (1.09 ± 0.47) μg/L respectively, and the NSE were (34.58 ± 1.23) μg/L and (34.72 ± 1.17) μg/L respectively. There was no statistically significant difference between the two groups in S-100β and NSE ($P > 0.05$).

2) The concentrations of S-100β in group A and group B at T2 were (0.83 ± 0.45) μg/L and (0.99 ± 0.48) μg/L respectively, and the NSE were (16.08 ± 1.42) μg/L and (21.83 ± 1.83) μg/L respectively. The S-100β and NSE of group A were significantly lower than those of group B ($P < 0.05$). In the same group, S-100β and NSE were significantly lower at T2 than at T0 ($P < 0.05$) (Table 2).

4. Discussion

It is very important to maintain hemodynamic stability during surgery, especially in craniocerebral trauma surgery. Surgical trauma, brain ischemia and hypoxia and ischemia-reperfusion injury can all cause damage to patients' nervous system, so it is very important to choose anesthetics with protection of brain function.

Table 1. Comparison of hemodynamic indexes between the two groups at different time points ($\overline{x} \pm s$).

Group	n	HR (beats/ min)			MAP (mmHg)		
		T0	T1	T2	T0	T1	T2
A	40	83.0 ± 13.9	80.3 ± 15.5*	71.4 ± 12.6*	98.5 ± 15.4	88.6 ± 14.3*	73.9 ± 12.4*
B	40	82.1 ± 12.9	76.2 ± 12.3*	65.6 ± 8.4*	97.6 ± 11.7	83.4 ± 11.0*	67.0 ± 7.9*
t		0.284	1.322	1.859	0.285	1.842	2.944
P		0.777	0.190	0.018	0.776	0.069	0.004

Note: *Compared with T0, ($P < 0.05$).

Table 2. Comparison of S-100β and NSE levels between the two groups.

Group	n	Time	S-100β (μg/L)	NSE (μg/L)
A	40	T0	1.11 ± 0.51	34.58 ± 1.23
		T2	0.83 ± 0.45$^{*\#}$	16.08 ± 1.42$^{*\#}$
B	40	T0	1.09 ± 0.47	34.72 ± 1.17
		T2	0.99 ± 0.48*	21.83 ± 1.83*

Note: Compared with the same group at T0, $^{*}P < 0.05$; compared with the control group, $^{\#}P < 0.05$.

Dex is an α_2-adrenergic receptor agonist. It has been confirmed in animal model studies that it can reduce the severity of nerve inflammation and neuronal apoptosis and protect nerve function [6] [8] [9]. In this study, different doses of Dex were used in the operation of brain trauma, the results showed that there was no significant difference in HR and MAP between the two groups at T0 and T1 ($P > 0.05$), but there was significant difference in HR and MAP at T2 ($P < 0.05$). In the same group, there were significant differences in HR and MAP at T1 and T2 compared to T0 ($P < 0.05$), indicating that Dex can reduce stress response and stabilize hemodynamics. During endotracheal intubation, stress reflex excitement is caused by stimulation of larynx and airway, which leads to increased heart rate, high blood pressure and even serious complications. Dex can well inhibit the stress response. Large dose of Dex can cause bradycardia and decrease cardiac output, so the HR and MAP of the control group are significantly lower than those of the study group at the end of the operation. At the same time, due to bradycardia (<50 beats/min), the frequency and dose of atropine were higher than those in the study group.

It has been found that NSE and S-100β can be used as indicators of brain cell metabolism and injury, and the levels of both are increased in patients with traumatic brain injury, and the degree of increase depends on the degree of injury [10] [11] [12]. In this study, postoperative NSE and S-100β concentrations in both groups were lower than those before surgery, indicating that Dex has a certain protective effect on the brain. NSE and S-100β concentrations in the study group were lower than those in the control group at T2, which may be due to the inhibition of norepinephrine release in the high dose group, the enhancement of vagus nerve impulse led to the decrease of heart rate and circulatory blood pressure, which affected cerebral perfusion and led to the damage to brain function. At the same time, due to the small sample size, the results of this study may need to be further verified by large samples and multicenter studies.

In conclusion, 0.5 μg/kg dose of Dex has a protective effect on brain function due to its stable hemodynamics and significantly decreased blood NSE and S-100β levels in patients with traumatic brain injury.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Capizzi, A., Woo, J. and Verduzco-Gutierrez, M. (2020) Traumatic Brain Injury: An Overview of Epidemiology, Pathophysiology, and Medical Management. *Medical Clinics of North America*, **104**, 213-238. https://doi.org/10.1016/j.mcna.2019.11.001

[2] Ganau, M., Lavinio, A. and Prisco, L. (2018) Delirium and Agitation in Traumatic Brain Injury Patients: An Update on Pathological Hypotheses and Treatment Options. *Minerva Anestesiologica*, **84**, 632-640.

[3] Bhattacharya, B. and Maung, A.A. (2016) Anesthesia for Patients with Traumatic Brain Injuries. *Anesthesiology Clinics*, **34**, 747-759. https://doi.org/10.1016/j.anclin.2016.06.009

[4] Hausburg, M.A., Banton, K.L., Roman, P.E., *et al.* (2020) Effects of Propofol on Ischemia-Reperfusion and Traumatic Brain Injury. *Journal of Critical Care*, **56**, 281-287. https://doi.org/10.1016/j.jcrc.2019.12.021

[5] Feng, X., Ma, W., Zhu, J., *et al.* (2021) Dexmedetomidine Alleviates Early Brain Injury Following Traumatic Brain Injury by Inhibiting Autophagy and Neuroinflammation through the ROS/Nrf2 Signaling Pathway. *Molecular Medicine Reports*, **24**, Article No. 661. https://doi.org/10.3892/mmr.2021.12300

[6] Wu, J., Vogel, T., Gao, X., *et al.* (2018) Neuroprotective Effect of Dexmedetomidine in a Murine Model of Traumatic Brain Injury. *Scientific Reports*, **8**, Article No. 4935. https://doi.org/10.1038/s41598-018-23003-3

[7] Karakaya, D., Cakir-Aktas, C., Uzun, S., *et al.* (2022) Tailored Therapeutic Doses of Dexmedetomidine in Evolving Neuroinflammation after Traumatic Brain Injury. *Neurocritical Care*, **36**, 802-814. https://doi.org/10.1007/s12028-021-01381-3

[8] Ning, Q., Liu, Z., Wang, X., *et al.* (2017) Neurodegenerative Changes and Neuroapoptosis Induced by Systemic Lipopolysaccharide Administration Are Reversed by Dexmedetomidine Treatment in Mice. *Neurological Research*: *An Interdisciplinary Quarterly Journal*, **39**, 357-366. https://doi.org/10.1080/01616412.2017.1281197

[9] Alam, A., Hana, Z., Jin, Z., *et al.* (2018) Surgery, Neuroinflammation and Cognitive Impairment. *eBioMedicine*, **37**, 547-556. https://doi.org/10.1016/j.ebiom.2018.10.021

[10] Pleines, U.E., Morganti-Kossmann, M.C., Rancan, M., *et al.* (2001) S-100β Reflects the Extent of Injury and Outcome, Whereas Neuronal Specific Enolase Is a Better Indicator of Neuroinflammation in Patients with Severe Traumatic Brain Injury. *Journal of Neurotrauma*, **18**, 491-498. https://doi.org/10.1089/089771501300227297

[11] Li, Y., Yu, Z.X., Ji, M.S., *et al.* (2019) A Pilot Study of the Use of Dexmedetomidine for the Control of Delirium by Reducing the Serum Concentrations of Brain-Derived Neurotrophic Factor, Neuron-Specific Enolase, and S100B in Polytrauma Patients. *Journal of Intensive Care Medicine*, **34**, 674-681. https://doi.org/10.1177/0885066617710643

[12] Cheng, F., Yuan, Q., Yang, J., *et al.* (2014) The Prognostic Value of Serum Neuron-Specific Enolase in Traumatic Brain Injury: Systematic Review and Meta-Analysis. *PLOS ONE*, **9**, e106680. https://doi.org/10.1371/journal.pone.0106680