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Comparison in anesthetic effects of propofol among patients with different ABO blood groups

Yiri Du, MD, Haixia Shi, MD, Jianshe Yu, MD*

Abstract

Our study was aimed to investigate anesthetic effects of propofol in patients with different blood groups.

A total of 72 participants were enrolled from patients arranged for surgeries of cholecystectomy, tonsillectomy, and spinal operation. Each blood group (A, B, AB, and O) contained 18 participants. Mean arterial pressure (MAP), heart rate (HR), and bispectral index (BIS) were assayed with Philips monitor. These indexes were observed before propofol anesthesia (T_0), and then were recorded when concentration of propofol was 1 μg/mL (T_1), 2 μg/mL (T_2), 3 μg/mL (T_3), and 4 μg/mL (T_4). The differences in MAP, HR, and BIS at T_0 among groups were compared with the χ^2 test. Multiple comparisons were adopted to calculate the differences in MAP, HR, and BIS between groups at T_1, T_2, T_3, and T_4.

No significant differences in age, sex, and weight of all groups were found ($P > .05$). Before propofol anesthesia (T_0), all the participants exhibited no differences in MAP, HR, and BIS ($P > .05$). Subsequently, we found obvious differences in ΔMAP, ΔHR, and ΔBIS between groups. The patients in the B blood group showed highest ΔMAP and ΔHR at each time point ($P < .05$ for both). As for ΔBIS, patients in A blood group exhibited highest value at T_3 and T_4 ($P < .05$).

The blood group remarkably affects the anesthetic effects of propofol.

Abbreviations: BIS = bispectral index, HR = heart rate, IR = ischemia-reperfusion, MAP = mean arterial pressure, RSE = refractory status epilepticus, VWF = Von Willebrand factor.

Keywords: anesthesia, blood group, propofol

1. Introduction

Propofol, 2, 6-disopropylpphenol, is the most popular intravenous anesthetic drug.[1] It has many advantages above other anesthetic drugs: rapid onset, short duration, few side effects, and prompt recovery.[2] The sedative efficacy of propofol for children has been confirmed in clinical trials since the 1900s.[3–5] However, most patients experience unpleasant pain at its injection site. Apart from anesthesia effects, many articles reported the nonanesthetic roles of propofol, such as antiemetic effects, anxiolytic effects, immunomodulatory activity, and analgesia.[6,7] Meanwhile, propofol and thiopental sodium are commonly used for managing refractory status epilepticus (RSE).[8,9] Until now, propofol, as an anesthestic agent, is widely used in various surgeries.

In the study of Hari Keerthy et al,[10] propofol behaved better than midazolam in minor oral surgery for fast recovery and onset of action. Chen et al[11] reported that propofol used for the maintenance of general anesthesia greatly reduced the incidence of postoperative nausea and vomiting and improved the postoperative patient well-being. Moreover, it resulted in obvious cost reductions. After the hernia surgery of children, propofol could impair short-term memory postoperatively, compared to sevoflurane.[12] For the patients undergoing donor hepatectomy, propofol exerted protective effects against ischemia-reperfusion (IR) injury.[13]

According to previous studies, the efficacy of propofol is affected by many factors. Obesity is potentially associated with the pharmacokinetic and pharmacodynamic profile of anesthetic drugs.[14] The study of Olutoye et al[15] suggested that obese children require lower dose of propofol for induction of anesthesia than normal-weight children. Meanwhile, elderly patients might need lower doses of propofol for procedural sedation in the Emergency Department, compared with younger adults.[16] Choong et al[17] concluded that more rapid propofol metabolism may occur in women than men. However, no research investigated the influence of ABO blood group on the efficacy of propofol.

The patients with different blood group arranged for surgeries were enrolled in the present research. Propofol was used as an anesthetic agent and the changes of mean arterial pressure (MAP), heart rate (HR), and bispectral index (BIS) indexes represented the influences of ABO blood group on efficacy of propofol.

2. Method

2.1. Patients' enrollment

The study was approved by ethics committee of The Affiliated Hospital of Inner Mongolia Medical University. Written

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YD and HS equally contributed to this study.

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Department of Anesthesiology, The Affiliated Hospital of Inner Mongolia Medical University, Huhhot, Inner Mongolia Autonomous Region, PR China.

* Correspondence: Jianshe Yu, Department of Anesthesiology, The Affiliated Hospital of Inner Mongolia Medical University, Huhhot, Inner Mongolia Autonomous Region, PR China (e-mail: vksdfh@163.com).

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informed consent was obtained from each patient. The participants were enrolled from patients arranged for surgeries of cholecystectomy, tonsillectomy, and spinal operation. The participants were required without cardiovascular and endocrine metabolic diseases. A total of 72 participants were enrolled. Each blood group (A, B, AB, O) contained 18 participants.

2.2. Anesthesia performance

Venous access was established on all the participants and no medicine was provided before anesthesia. MAP, HR, and BIS were assayed with Philips monitor. After 10 minutes, MAP, HR, and BIS were determined before propofol anesthesia (T_0). Then, 1 μg/mL propofol was injected at the initial time. The target concentration was 4 μg/mL. MAP, HR, and BIS were determined when the concentration of propofol was 1 μg/mL (T_1), 2 μg/mL (T_2), 3 μg/mL (T_3), and 4 μg/mL (T_4). When the concentration reached 4 μg/mL, fentanyl (2 μg/kg) and rocuronium bromide (0.6 mg/kg) were intravenously endotracheal intubated. Anesthesia maintenance was performed with target-controlled infusion of propofol and remifentanil. Rocuronium bromide was used to keep muscle relaxation.

2.3. Statistics

The differences in MAP, HR, and BIS at T_0 were compared with the χ^2 test. The same analysis was performed in age, sex, and weight. Multiple comparison was adopted to calculate the differences in MAP, HR, and BIS between group at T_1, T_2, T_3, and T_4. $P < .05$ indicates significant differences. The analysis was conducted in the SPSS 18.0 software.

3. Results

3.1. Baseline characteristics of participants

As shown in Table 1, there were no obvious differences in age, sex, and weight of all groups ($P > .05$). Meanwhile, MAP, HR, and BIS values at T_0 point were analyzed. Before propofol anesthesia, all the participants showed no differences in MAP, HR, and BIS ($P > .05$).

3.2. MAP, HR, and BIS changes of each group

Multiple comparisons of MAP, HR, and BIS indexes between groups were performed. The results were exhibited in Table 2. No significant differences of MAP, HR, and BIS values at each time point between groups were found. However, we observed differences in ΔMAP, ΔHR, and ΔBIS between groups. The patients in the B blood group showed highest ΔMAP at each time point ($P < .05$). Similar result was observed in ΔHR ($P < .05$). As for ΔBIS, patients in A blood group exhibited highest value at T_3 and T_4 ($P < .05$).

4. Discussion

MAP, HR, and BIS are important indexes representing the efficacy of anesthesia. MAP represents the hemodynamic responses. Decrease in arterial blood pressure is a main adverse reaction during propofol sedation. Erdman et al[18] found severe hypotension and bradycardia occurred in neurocritical care patients received dexmedetomidine or propofol, which was also observed by Yokoe et al.[19] BIS is valuable in guiding the administration of propofol intraoperatively.[20–23] The decreased

Table 1

Baseline characteristics of participants.

Index	A	B	AB	O	*P*
Age, y	52.11 ± 7.67	51.17 ± 5.68	48.44 ± 6.64	51.89 ± 4.87	.579
Sex, female/male	10/8	9/9	11/7	9/9	.893
Weight, kg	62.38 ± 6.95	60.44 ± 5.50	61.50 ± 6.20	60.78 ± 6.90	.808
MAP, mm Hg, T_0	93.50 ± 6.51	93.11 ± 6.95	93.38 ± 6.68	96.06 ± 9.07	.604
HR, beats min^{-1}, T_0	82.50 ± 4.59	86.06 ± 3.83	84.11 ± 4.30	85.56 ± 5.47	.097
BIS, T_0	94.78 ± 7.88	95.94 ± 8.03	97.06 ± 8.05	96.56 ± 6.66	.829

BIS = bispectral index, HR = heart rate, MAP = mean arterial pressure.

Table 2

Comparison of MAP, HR, and BIS between groups.

Index	Group	T_1	T_2	T_3	T_4
ΔMAP, mm Hg	A	14.72 ± 3.94	18.89 ± 5.97	18.67 ± 4.00	26.06 ± 3.89
	B	19.06 ± 5.78*	23.06 ± 4.90*	24.06 ± 4.90*	32.17 ± 5.82*
	AB	14.89 ± 3.08	19.50 ± 3.76	19.72 ± 2.63	24.11 ± 5.95
	O	15.78 ± 2.53	19.94 ± 2.71	21.11 ± 2.68	25.28 ± 19.94
ΔHR, beats min^{-1}	A	6.39 ± 3.33	9.72 ± 3.66	12.50 ± 4.11	12.39 ± 4.84
	B	12.56 ± 4.13*	16.06 ± 4.70*	18.39 ± 5.41*	18.50 ± 5.25*
	AB	6.17 ± 1.72	9.00 ± 3.69	11.50 ± 5.36	12.83 ± 3.88
	O	7.06 ± 1.95	11.33 ± 5.44	12.83 ± 2.46	13.33 ± 2.79
ΔBIS	A	21.11 ± 5.10	35.11 ± 5.77	46.00 ± 5.80*	51.06 ± 5.78*
	B	22.28 ± 5.70	35.00 ± 4.72	40.11 ± 6.49	44.06 ± 5.80
	AB	22.50 ± 5.34	34.61 ± 5.17	39.89 ± 6.04	44.72 ± 6.46
	O	21.06 ± 5.78	33.94 ± 5.97	41.11 ± 5.77	43.61 ± 6.24

BIS = bispectral index, HR = heart rate, MAP = mean arterial pressure.
* $P < .05$ compared to other 3 groups.

BIS level is observed in the anesthesia treatments of propofol and sevoflurane.[24] In our research, changes of MAP, HR, and BIS were also used to figure out the influences of ABO blood group.

The results indicated that the patients in the B blood group showed highest ΔMAP at T_1, T_2, T_3, and T_4. Meanwhile, the B blood group also exhibited highest ΔHR at each time point. In terms of ΔBIS, patients of A blood group showed highest value at T_3 and T_4. Above mentioned results indicated that the ABO blood group might exert strong effects on anesthetic efficacy of propofol.

However, the function mechanism of blood group in regulating the efficacy of propofol is unclear. As we all know, decreased blood flow velocity, hypercoagulable blood, and injuried vessel wall usually occurred during anesthesia performance in surgeries. Moreover, the patients with different ABO blood groups exhibited significantly different levels of Von Willebrand factor (VWF). The patients of O blood group had obviously lower content of VWF than the non-O blood group, which was directly related with incidence of thrombosis.[25–28] VWF is an adhesive glycoprotein synthesized by megakartocytes and endothelial cells.[29,30] It shows crucial roles in primary hemostasis and, moreover, has a pivotal role in thrombogenesis.[31] It has been demonstrated that the increased level of VWF is an important risk factor of thrombosis.[32,33] In vitro experiment suggested that removal of A and B antigens from purified plasma decreased VWF activity.[34] Moeller et al[35] thought that ABO antigens in vivo affected synthesis rate or proteolysis of VWF molecule rather than its structure and function. Meanwhile, many studies have demonstrated a tight correlation between the ABO blood group and hemostasis. The patients of group O are more likely to suffer bleeding complications.[36] Moreover, a number of studies reported the increased risk of venous thromboembolism in non-O individuals.[37,38] All the above-mentioned information suggests that ABO blood group might involve in the pharmacokinetic and pharmacodynamics, which was demonstrated in our study.

However, there existed deficits in our study. The specifically regulatory mechanism of ABO blood group on pharmacodynamics of propofol was not studied, which helps in understanding individual difference in response to propofol anesthesia. In addition, the sample size was relatively small. The broad-range investigation contributes to more accurate and reliable results.

In conclusion, the ABO blood group was related with the efficacy of propofol. Patients of B blood group showed highest ΔMAP and ΔHR at each time point. Patients of A blood group exhibited highest value of ΔBIS at T_3 and T_4.

References

[1] Hutchens MP, Memtsoudis S, Sadovnikoff N. Propofol for sedation in neuro-intensive care. Neurocrit Care 2006;4:54–62.

[2] Kotani Y, Shimazawa M, Yoshimura S, et al. The experimental and clinical pharmacology of propofol, an anesthetic agent with neuroprotective properties. CNS Neurosc Ther 2008;14:95–106.

[3] Borgeat A, Popovic V, Meier D, et al. Comparison of propofol and thiopental/halothane for short-duration ENT surgical procedures in children. Anesth Analg 1990;71:511–5.

[4] Reed MD, Yamashita TS, Marx CM, et al. A pharmacokinetically based propofol dosing strategy for sedation of the critically ill, mechanically ventilated pediatric patient. Crit Care Med 1996;24:1473–81.

[5] Reed MD, Blumer JL. Propofol bashing: the time to stop is now!. Crit Care Med 1996;24:175–6.

[6] Vasileiou I, Xanthos T, Koudouna E, et al. Propofol: a review of its non-anaesthetic effects. Eur J Pharmacol 2009;605:1–8.

[7] Wang P, Chen J, Mu LH, et al. Propofol inhibits invasion and enhances paclitaxel- induced apoptosis in ovarian cancer cells through the suppression of the transcription factor slug. Eur Rev Med Pharmacol Sci 2013;17:1722–9.

[8] Parviainen I, Uusaro A, Kalviainen R, et al. High-dose thiopental in the treatment of refractory status epilepticus in intensive care unit. Neurology 2002;59:1249–51.

[9] van Gestel JP, Blusse van Oud-Alblas HJ, Malingre M, et al. Propofol and thiopental for refractory status epilepticus in children. Neurology 2005;65:591–2.

[10] Hari Keerthy P, Balakrishna R, Srungeri KM, et al. Comparitive evaluation of propofol and midazolam as conscious sedatives in minor oral surgery. J Maxillofac Oral Surg 2015;14:773–83.

[11] Chen HP, Hsu YH, Hua KC, et al. Comparison of sevoflurane versus propofol under auditory evoked potential monitoring in female patients undergoing breast surgery. Biomed J 2013;36:125–31.

[12] Yin J, Wang SL, Liu XB. The effects of general anaesthesia on memory in children: a comparison between propofol and sevoflurane. Anaesthesia 2014;69:118–23.

[13] Ucar M, Ozgul U, Polat A, et al. Comparison of antioxidant effects of isoflurane and propofol in patients undergoing donor hepatectomy. Transplant Proc 2015;47:469–72.

[14] Cortinez LI, De la Fuente N, Eleveld DJ, et al. Performance of propofol target-controlled infusion models in the obese: pharmacokinetic and pharmacodynamic analysis. Anesth Analg 2014;119:302–10.

[15] Olutoye OA, Yu X, Govindan K, et al. The effect of obesity on the ED(95) of propofol for loss of consciousness in children and adolescents. Anesth Analg 2012;115:147–53.

[16] Patanwala AE, Christich AC, Jasiak KD, et al. Age-related differences in propofol dosing for procedural sedation in the Emergency Department. J Emerg Med 2013;44:823–8.

[17] Choong E, Loryan I, Lindqvist M, et al. Sex difference in formation of propofol metabolites: a replication study. Basic Clin Pharmacol Toxicol 2013;113:126–31.

[18] Erdman MJ, Doepker BA, Gerlach AT, et al. A comparison of severe hemodynamic disturbances between dexmedetomidine and propofol for sedation in neurocritical care patients. Crit Care Med 2014;42:1696–702.

[19] Yokoe C, Hanamoto H, Boku A, et al. The effect of nitrous oxide inhalation on the hypotensive response to propofol: a randomized controlled trial. Oral Surg Oral Med Oral Pathol Oral Radiol 2014;118:166–73.

[20] Gan TJ, Glass PS, Windsor A, et al. Bispectral index monitoring allows faster emergence and improved recovery from propofol, alfentanil, and nitrous oxide anesthesia. BIS Utility Study Group. Anesthesiology 1997;87:808–15.

[21] Cullen PM, Turtle M, Prys-Roberts C, et al. Effect of propofol anesthesia on baroreflex activity in humans. Anesth Analg 1987;66:1115–20.

[22] Coates DP, Monk CR, Prys-Roberts C, et al. Hemodynamic effects of infusions of the emulsion formulation of propofol during nitrous oxide anesthesia in humans. Anesth Analg 1987;66:64–70.

[23] Telci L, Esen F, Akcora D, et al. Evaluation of effects of magnesium sulphate in reducing intraoperative anaesthetic requirements. Brit J Anaesth 2002;89:594–8.

[24] Dahaba AA, Yin J, Xiao Z, et al. Different propofol-remifentanil or sevoflurane-remifentanil bispectral index levels for electrocorticographic spike identification during epilepsy surgery. Anesthesiology 2013;119:582–92.

[25] Jenkins PV, O'Donnell JS. ABO blood group determines plasma von Willebrand factor levels: a biologic function after all? Transfusion 2006;46:1836–44.

[26] Klarmann D, Eggert C, Geisen C, et al. Association of ABO(H) and I blood group system development with von Willebrand factor and Factor VIII plasma levels in children and adolescents. Transfusion 2010;50:1571–80.

[27] Souto JC, Almasy L, Muniz-Diaz E, et al. Functional effects of the ABO locus polymorphism on plasma levels of von Willebrand factor, factor VIII, and activated partial thromboplastin time. Arterioscler Thromb Vasc Biol 2000;20:2024–8.

[28] Ohira T, Cushman M, Tsai MY, et al. ABO blood group, other risk factors and incidence of venous thromboembolism: the Longitudinal Investigation of Thromboembolism Etiology (LITE). J Thromb Haemost 2007;5:1455–61.

[29] Ruggeri ZM, Zimmerman TS. The complex multimeric composition of factor VIII/von Willebrand factor. Blood 1981;57:1140–3.

[30] Ruggeri ZM. Structure of von Willebrand factor and its function in platelet adhesion and thrombus formation. Best practice & research. Clin Haematol 2001;14:257–79.
[31] Martinelli I. von Willebrand factor and factor VIII as risk factors for arterial and venous thrombosis. Semin Hematol 2005;42:49–55.
[32] Whincup PH, Danesh J, Walker M, et al. von Willebrand factor and coronary heart disease: prospective study and meta-analysis. Eur Heart J 2002;23:1764–70.
[33] Franchini M, Lippi G. von Willebrand factor and thrombosis. Ann Hematol 2006;85:415–23.
[34] Sarode R, Goldstein J, Sussman II, et al. Role of A and B blood group antigens in the expression of adhesive activity of von Willebrand factor. Brit J Haematol 2000;109:857–64.
[35] Moeller A, Weippert-Kretschmer M, Prinz H, et al. Influence of ABO blood groups on primary hemostasis. Transfusion 2001;41: 56–60.
[36] Horwich L, Evans DA, McConnell RB, et al. ABO blood groups in gastric bleeding. Gut 1966;7:680–5.
[37] Larsen TB, Johnsen SP, Gislum M, et al. ABO blood groups and risk of venous thromboembolism during pregnancy and the puerperium. A population-based, nested case-control study. J Throm Haemost 2005;3:300–4.
[38] Schleef M, Strobel E, Dick A, et al. Relationship between ABO and secretor genotype with plasma levels of factor VIII and von Willebrand factor in thrombosis patients and control individuals. Brit J Haematol 2005;128:100–7.