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ORIGINAL ARTICLE

Comparison of bleeding in propofol and isoflurane anesthesia in lumbar disc and cerebral hemorrhage surgery

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Abstract

Introduction: The current study compared the amount of bleeding in propofol and isoflurane anesthesia in patients undergoing lumbar disc and cerebral hemorrhage surgery in Birjand teaching hospitals within 2017-2018.

Methods: This retrospective quasi-experimental study was conducted based on a nonequivalent group design. It was performed on patients within the age range of 18-75 years undergoing spinal surgery and cerebral hemorrhage who were referred to Imam Reza (AS) and Razi hospitals in Birjand within 2017-2018. Patient information was retrospectively collected using their medical records. The data were analyzed in SPSS software (version16) using the independent t-test, paired t-test, and Mann-Whitney test. A p-value less than 0.05 was considered statistically significant.

Results: A number of 36 and 35 patients underwent propofol and isoflurane anesthesia, respectively. Both groups were individually matched on gender, and the propofol patients were not significantly younger than the isoflurane patients (P=0.006). There was no significant difference between the two groups in terms of pre- and postoperative bleeding, hemoglobin level, systolic blood pressure, and diastolic blood pressure. Preoperative hemoglobin, systolic blood pressure, and diastolic blood pressure in the propofol group were reported as 13.8±1.69 g/dl, 127.2±15 mmHg, and 80±8 mmHg, respectively. These values decreased to 13.03±2.01 g/dl (P=0.0001), 122.3±12.8 mmHg (P=0.079), and 76.5±9.7 mmHg (P=0.034) postoperatively. On the other hand, in the isoflurane group, preoperative hemoglobin, systolic blood pressure, and diastolic blood pressure were obtained at 13.7±1.62 g/dl, 128.4±18 mmHg, and 78.5±12.6 mmHg, respectively. These values also decreased to 12.8±1.9 g/dl (P=0.0001), 124.1±15.8 mmHg (P=0.217), and 76.0±11.9 mmHg (P=0.365) postoperatively.

Conclusions: Based on the obtained results, the amount of bleeding is similar in patients undergoing central nervous system surgery under either propofol or isoflurane anesthesia. Nevertheless, hypotension was higher in propofol-anesthetized patients. Inhaled anesthesia is advantageous over propofol anesthesia due to the possibility of metabolic acidosis in patients with controlled hypotension.

Key words: Anesthesia, Central nervous system surgery, Hemorrhage, Isoflurane, Propofol

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Introduction

Spinal surgeries are often associated with heavy bleeding which is sometimes so severe that it requires the transfusion of blood and blood products (1). The reduction of bleeding is of great importance for the maintenance of hemodynamic stability and the creation of a blood-free field with good visibility for the surgeon. Reduced bleeding also decreases the risk of such complications as hemolytic and non-hemolytic reactions, acute lung damage, the transmission of viral and bacterial infections, hypothermia, and coagulation disorders by reduceding the need for blood products (2). Since surgery is associated with bleeding, it can cause hemodynamic disturbances in patients. Accordingly, controlled hypotension is used today to lower the blood pressure of these patients during surgery in order to reduce bleeding and the need for blood transfusions (3). Controlled hypotension has been successfully used in orthopedic and endoscopic sinus surgeries (4). This method has an extensive application in spinal surgery, and several studies have pointed to its efficiency in spinal surgery (5-7).

The use of antihypertensive medications during surgery can provide a good vision and environment for surgery(8-10). Numerous medications which are used to induce hypotension during surgery include alpha-dual adrenergic agonists, such as clonidine (11) (vasodilators), nitroprusside, nicardipine, nitroglycerin (beta-adrenergic agonists), propranolol, isoflurane, and sevoflurane. The ideal medication drug for lowering blood pressure should be easy to use, the rate of response should be predictable, and the effects of the drug should start and end quickly without the production of toxic mediators (12).

Inhalation anesthetics with vasodilator properties are considered suitable medications for controlled hypotension (13). In addition, these drugs are proved to exert protective effects on the brain and heart (3, 14). The metabolism of isoflurane is low, and its blood level is the same as all inhaled drugs with ventilation and the percentage of gas in the ventilated air (15). Propofol has been a popular drug for neurosurgery since its development in 1977 (15). Some studies indicated that it can reduce bleeding during various surgeries (16).

Excretion of this drug occurs through degradation and metabolism in all body tissues. It has an inhibitory effect on mitochondria; moreover, its high infusion doses, hypotension, prolonged injection, or patient-specific conditions, such as immaturity or metabolic acidosis, can cause drug accumulation and propofol infusion syndrome. Nevertheless, it is extensively used in cosmetic and spinal surgeries due to patient satisfaction, the feeling of well-being, and the reduction of bleeding (17).

A rapid recovery of consciousness after the discontinuation of infusion is regarded as the major advantage of this sedative-hypnotic agent. The rate of hypotension due to propofol injection depends on the applied dose and the concomitant use of opioids (18). Considering the relative advantage of propofol and its potential risks, the present study aimed to compare the amount of hemorrhage in propofol and isoflurane anesthesia in lumbar disc surgery and cerebral hemorrhage in Birjand teaching hospitals within 2017-2018.

Methods

This retrospective, quasi-experimental study was conducted based on a nonequivalent-group design. It assessed the medical records of patients within the age range of 18-75 years undergoing spinal surgery and cerebral hemorrhage referring to Imam Reza (AS) and Razi hospitals in Birjand within 2017-2018. Inclusion criteria consisted of the availability of patients' files, as well as the completeness of patients' files. On the other hand, the exclusion criteria were as follows: 1) diseases or medications which lead to hemorrhage, 2) sensitivity to anesthesiology drugs, and 3) trauma to an organ other than the brain.

Before the commencement of the study, the research design was approved by the Research Council and the Ethics Committee of Birjand University of Medical Sciences (Ir.bums.REC. 1398.134). Thereafter, administrative steps were taken to obtain approval for the research project and access to patients' files in teaching hospitals (Imam Reza and Razi hospitals) of Birjand. A researcher-made checklist, which was approved by a number of faculty members, was used for data collection. Participants were selected out of patients with lumbar disc surgery or cerebral hemorrhage who had an operation in Birjand teaching hospitals by referring to the patients' files. Using the mentioned checklist, patients' data were recorded, including the amount and type of anesthetic drug used, bleeding volume during and after surgery corresponding to the amount of blood suctioned during surgery, the amount of hemoglobin and hemodynamics of patients before and after surgery, and the rate of mortality during hospitalization. It was not possible to check postoperative bleeding. Since the records were not complete in terms of the amount of postoperative

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hemorrhage.

The sample size was estimated based on a study conducted by Hosseinzadeh et al. (19) using the following formula. The mean and standard deviation of anesthesia depth after anesthetics injection in the group receiving propofol plus remifentanil was obtained at 47.36±12.64, while those of patients receiving isoflurane was reported as 43.7±63.17. Using the formula of $N= (U^2 + V^2) (S_1^2 + S_2^2) / (m_1-m_2)^2$, the sample size was computed 29 subjects in each group (58 cases in total). Considering 20% sample attrition, 35 subjects were considered in each group. Sampling was performed non-randomly using convenience sampling from among the surgeries performed in the operating rooms of Birjand teaching hospitals within 2017-2018.

The collected data were analyzed in SPSS software (version 16) and reported by descriptive results using central indicators and dispersion. To analyze the data, the normality of the data was initially evaluated by the Kolmogorov-Smirnov statistical test. Moreover, the independent t-test and paired t-test were used due to the normal distribution of blood pressure, hemoglobin, hematocrit, and pulse rate. On the other hand, given the non-normal distribution of the variables of bleeding rate and blood intake during surgery, the Mann-Whitney non-parametric test was employed. A p-value less than 0.05 was considered statistically significant.

Results

The current study was performed on a total of 71 patients, out of whom 36 cases were assigned to the propofol group, and 35 subjects were allocated to the isoflurane group. Comparing the mean age of the two groups, the results showed that the patients in the isoflurane group were significantly older than their counterparts in the propofol group (45.94±11.38 years vs. 53.88±12.14 years, P=0.006). There was no significant difference in the frequency distribution of gender between the two groups (P=0.7). Regarding diabetes, the results of the present study denoted that the patients with this disease in the isoflurane group outnumbered their counterparts in the propofol group (22.9% vs. 2.8; P=0.01). No statistical differences were observed in dyslipidemia, hypertension, and ischemic heart disease. Concerning other heart disorders, the results of the present study indicated that only one patient in the propofol group had arrhythmic heart disorders. In addition, there was no significant difference between the two groups in terms of seizure rate (P<0.05). Table 1 illustrates the background information of the patients.

The intraoperative bleeding volume was reported as 81.94±187.1 cc in patients under propofol anesthesia and 118.6±255.3 cc in patients under isoflurane anesthesia; nonetheless, the observed difference was not significant (P=0.6). There was no significant difference in the mean number of heartbeats and the mean number of blood units received intraoperatively between the two groups. It is noteworthy that death was reported in none of the patients during surgery until 48 h later (Table 2).

Table 1: Background information of patients in propofol and isoflurane groups

	Propofol	isoflurane	
Age	11.38±45.94	12.14±53.88	t=2.84 P=0.006
Male gender (percentage) frequency	17 (47.2)	15 (42.9)	P=0.7 X^2=0.137
Diabetes	1 (2.8)	8 (22.9)	X^2=6.46 P=0.11
Dyslipidemia	1 (2.8)	5 (14.3)	fisher exact test P=0.11
hypertension	6 (16.7)	12 (34.3)	P=0.88 X^2 = 2.9
Ischemic heart disease	3 (8.3)	2 (5.7)	Fisher 's exact test P=1
Cardiac arrhythmia	1 (2.8)	0 (0)	fisher exact test P=1
Convulsions	0 (0)	1 (2.9)	P=0.49
Heart valve disorder	1 (2.8)	0 (0)	P=1

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Table 2: Comparison of bleeding volume, number of heartbeats, and average unit of blood received during surgery

	Propofol	isoflurane	
Intraoperative bleeding volume	187.1±81.94	255.3±118.6	z=0.52 P=0.6
Number of beats during operation (number per minute)	12.7±83	15.7±87.3	t=1.26 df=69 P=0.21
Average blood units received	0.45±0.19	0.74±0.46	Z=1.68 P=0.09

Table 3: Comparison of mean systolic and diastolic blood pressure, hemoglobin, and metocrit

		Before intervention mean±standard deviation	After intervention mean±standard deviation	Test	Change mean±standard deviation
Systolic blood pressure	Propofol	15.1±127.22	12.88±122.38	t=1.82 P=0.08	-16± 4.8
	Isoflurane	18.01±128.45	15.80±124.11	t=1.26 p=0.22	-20.4±4.34
	Test result	t=0.31	t=0.51		t=0.11 P=0.91
Diastolic blood pressure	Propofol	8.05±80.41	9.76±76.5	t=2.21 P=0.03	-10.6±3.9
	Isoflurane	12.67±78.57	11.90±76.08	t=0.92 P=0.36	-16±2.4
	Test result	t=0.73 P=0.46	t=0.16 P=0.87		t=0.44 P=0.66
Hemoglobin	Propofol	1.69±13.8	2.01±13.03	t=3.98 P<0.001	1.1±0.76
	Isoflurane	1.62±13.76	1.90±12.85	t=4.23 P<0.001	1.2±0.9
	Test result	t=0.09 P=0.93	t=0.38 P=0.71		t=0.5 p=0.62
Hematocrit	Propofol	4.49±40.20	5.53±37.70	t=4.76 P<0.001	3.14±2.49
	Isoflurane	4.31±39.80	4.91±36.54	t=5.24 P<0.001	3.68±3.26
	Test result	t=0.38 P=0.71	t=0.93 P=0.35		t=0.94 P=0.35

There was no statistically significant difference in mean systolic blood pressure before and after the intervention in the study groups, while the mean diastolic blood pressure in the propofol group showed a significant decrease after the intervention compared to before the intervention (P=0.03). The isoflurane group did not change significantly. In both propofol and isoflurane groups, the mean hemoglobin after the intervention was significantly lower than that before the intervention (P<0.001); however, the difference was not significant. As presented in Table 3, in both propofol and isoflurane groups, the mean hematocrit after the intervention was significantly lower than that before the intervention (P<0.001); nonetheless, the difference between the two groups was not significant (Table 3).

Discussion

The present study compared the bleeding volume in propofol and isoflurane anesthesia in lumbar disc surgery and cerebral hemorrhage in teaching hospitals of Birjand within 2017-2018. Based on the obtained results, the difference between patients under anesthesia with propofol

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and isoflurane was not significant in terms of bleeding volume, hemoglobin level, systolic blood pressure, and diastolic blood pressure before and after surgery. In the propofol group, hemoglobin, hematocrit, and diastolic blood pressure decreased significantly after surgery. However, changes in systolic blood pressure were not significant in this group of patients. On the other hand, in the isoflurane group, hemoglobin, and hematocrit significantly decreased after the surgery. Nevertheless, no significant changes were reported for systolic blood pressure and diastolic blood pressure.

Contradictory results have been reported on the impacts of propofol and isoflurane anesthetics on bleeding during surgery. The findings of a study carried out by Hassani et al. (2004) are in line with the results of the present study. In their study entitled " Comparison of Bleeding Extent in Propofol-Remifentanil Versus Isoflouran Remi-fentanil Anesthetic Procedures in Functional Endoscopic Sinus Surgery(FESS) in Rasoul-e-Akram Hospital", they observed no significant difference between the two groups in terms of the amount of bleeding and hematocrit levels before and after the surgery. In this respect, the results of the current study are consistent with those reported by Hassani et al. (20).

The results of a study conducted by Haghbin et al. were also consistent with the findings of the present study (2013). In their study entitled "Comparing the effects of propofol and isoflurane on the depth of anesthesia and blood loss during endoscopic sinus surgery", they showed that there was no significant difference between the two groups, and both methods of anesthesia reduced blood pressure during surgery (21). Regarding the absence of difference in bleeding rate, the results of a study carried out by Haghbin et al. were similar to the findings observed in the present study. On the other hand, the decrease in blood pressure observed in the present study was a significant reduction in diastolic blood pressure in the propofol group. Nevertheless, changes in blood pressure during surgery were not significant in the isoflurane group. In this regard, the findings of the present study are different from those obtained in a study conducted by Haghbin et al. who reported a significant reduction in blood pressure in both groups of patients under anesthesia with isoflurane and propofol.

Contrary to the results of the present study, the results of a study carried out by Ghodrati et al. (2011) showed that the rate of bleeding in patients under anesthesia with propofol was significantly lower. Their study was entitled "Comparison of blood loss in septorhinoplasty with two different anesthetic techniques; propofol or isoflurane". In the mentioned study, after controlling and matching the background variables and the characteristics of surgery and anesthesia between the two groups, they demonstrated that the mean bleeding in the propofol group (35.3±18.8 ml) was less than the bleeding rate in the isoflurane group (91±18.3 ml) ($P<0.001$). However, except for the bleeding volume, other hemodynamic variables (e.g., heart rate, systolic and diastolic blood pressure and arterial blood oxygen saturation) were not significantly different between the two groups, except for a few short periods during the operation (22). As indicated, the results of a study performed by Ghodrati et al. regarding the amount of bleeding are in disagreement with the findings of the present stud. However, there was no significant difference between patients under anesthesia with propofol and isoflurane. Nonetheless, in terms of other hemodynamic factors, the findings of the two studies are consistent.

In a study performed by Milonsky et al. (2013), the rate of bleeding was lower in intravenous anesthesia (23). However, propofol causes a decrease in diastolic pressure, especially in patients with underlying hypotension. This decrease in blood pressure, along with reduced blood flow to the heart and lower drug metabolism, exacerbates the cumulative effects resulting from drug accumulation in the body. These effects may eventually lead to the exacerbation of hypotension and lethal metabolic acidosis, which in turn, results in death. As mentioned earlier, the amount of bleeding in the two groups was not significantly different. Therefore, it is recommended to use the inhalation method to maintain anesthesia since the inhaled drug does not have significant metabolism, and its effects disappear in case of problems with patient ventilation. This is not the case with propofol, and its metabolism may decrease and its hemodynamic attenuation effects may become more pronounced when blood pressure decreases. In this respect, its hemodynamic effects are not as predictable as those of isoflurane (24, 25, 26).

Diverse methods have been proposed for screening patients to eliminate the possibility of acidosis in trauma patients by measuring the blood level of creatine phosphokinase. However, the use of this method for elective surgery (27) is a debated issue which can be studied in future investigations. One of the limitations of the present study was the incompleteness of patients' records regarding the amount of postoperative bleeding which made it impossible to examine the second purpose of the study. It is suggested that future

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studies be performed as prospective randomized clinical trials to compare the effects of anesthesia with propofol and isoflurane on different organs. It is also recommended that future studies compare other anesthetics, such as midazolam with and without propofol at different percentages of analgesia and in different surgeries.

Conclusions

As evidenced by the obtained results, there was no difference between patients under anesthesia with propofol and isoflurane in terms of bleeding volume and other hemodynamic factors, such as blood pressure. Nevertheless, in isoflurane-anesthetized patients, only hemoglobin level changed, while in propofol-anesthetized patients, apart from hemoglobin level, a significant decrease was also observed in diastolic pressure. Due to the possibility of metabolic acidosis in patients with controlled hypotension, inhalation anesthesia is advantageous over propofol anesthesia, especially in long-term surgery, patients with vascular problems, or patients with a possible metabolic defect.

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Conflict of Interest

The authors acknowledge that there was no financial or personal interest in the research process and the presentation of the article and the results.

References

1. Cole JW, Murray DJ, Snider RJ, Bassett GS, Bridwell KH, Lenke LG. Aprotinin reduces blood loss during spinal surgery in children. Spine. 2003; 28(21):2482-5. PMID: 14595168 DOI: 10.1097/01.BRS.0000090835.45437.7F
2. Ialenti MN, Lonner BS, Verma K, Dean L, Valdevit A, Errico T. Predicting operative blood loss during spinal fusion for adolescent idiopathic scoliosis. J Pediatr Orthop. 2013; 33(4):372-6. PMID: 23653024 DOI: 10.1097/BPO.0b013e3182870325
3. Degoute CS. Controlled hypotension. Drugs. 2007; 67(7):1053-76. PMID: 17488147 DOI: 10.2165/00003495-200767070-00007
4. Szpalski M, Gunzburg R, Sztern B. An overview of blood-sparing techniques used in spine surgery during the perioperative period. Eur Spine J. 2004; 13(Suppl 1):S18-27. PMID: 15480823 DOI: 10.1007/s00586-004-0752-y
5. Tzortzopoulou A, Cepeda MS, Schumann R, Carr DB. Antifibrinolytic agents for reducing blood loss in scoliosis surgery in children. Cochrane Database Syst Rev. 2008; 3:CD006883. PMID: 18646174 DOI: 10.1002/14651858.CD006883.pub2
6. Ker K, Prieto-Merino D, Roberts I. Systematic review, meta-analysis and meta-regression of the effect of tranexamic acid on surgical blood loss. Br J Surg. 2013; 100(10):1271-9. PMID: 23839785 DOI: 10.1002/bjs.9193
7. Yao HH, Hong MK, Drummond KJ. Haemostasis in neurosurgery: what is the evidence for gelatin-thrombin matrix sealant? J Clin Neurosci. 2013; 20(3):349-56. PMID: 23384508 DOI: 10.1016/j.jocn.2012.09.005
8. Degoute CS, Ray MJ, Gueugniaud PY, Dubreuil C. Remifentanil induces consistent and sustained controlled hypotension in children during middle ear surgery. Can J Anaesth. 2003; 50(3):270-6. PMID: 12620951 DOI: 10.1007/BF03017797
9. Degoute CS, Ray MJ, Manchon M, Dubreuil C, Banssillon V. Remifentanil and controlled hypotension; comparison with nitroprusside or esmolol during tympanoplasty. Can J Anaesth. 2001; 48(1):20-7. PMID: 11212044 DOI: 10.1007/BF03019809
10. Richa F, Yazigi A, Sleilaty G, Yazbeck P. Comparison between dexmedetomidine and remifentanil for controlled hypotension during tympanoplasty. Eur J Anaesthesiol. 2008; 25(5):369-74. PMID: 18294411 DOI: 10.1017/S0265021508003761
11. Taghipour Anvari1 Z, Afshar-Fereydouniyan N, Imani F, Sakhaei M, Alijani B. Oral clonidine premedication reduces blood loss in lumbar spinal posterior fusion surgery. Anesthesiol Pain. 2011; 2(2):1-9 .
12. Bajwa SJ, Kaur J, Kulshrestha A, Haldar R, Sethi R, Singh A. Nitroglycerine, esmolol and dexmedetomidine for induced hypotension during functional endoscopic sinus surgery: a comparative evaluation. J Anaesthesiol Clin Pharmacol. 2016; 32(2):192-7 .PMID: 27275048 DOI: 10.4103/0970-9185.173325
13. Nazir O, Wani MA, Ali N, Sharma T, Khatuja A, Misra R, et al. Dexmedetomidine and esmolol as agents to induce hypotension in lumbar spine surgery. Trauma

[DOI: 10.32592/jsurgery.2020.8.3.102]

Mon. 2016; 21(3):e22078 .PMID: 27921016 DOI: 10.5812/traumamon.22078

14. Snidvongs K, Tingthanathikul W, Aeumjaturapat S, Chusakul S. Dexmedetomidine improves the quality of the operative field for functional endoscopic sinus surgery: systematic review. J Laryngol Otol. 2015; 129(3):8-13. PMID: 26044578 DOI: 10.1017/S0022215115001334
15. Miller RD, Eriksson LI, Fleisher LA, Wiener-Kronish JP, Cohen NH, Young WL. Miller's anesthesia e-book. Amsterdam, Netherlands: Elsevier Health Sciences; 2014.
16. Bryson HM, Fulton BR, Faulds D. Propofol. An update of its use in anaesthesia and conscious sedation. Drugs. 1995; 50(3):513-59. PMID: 8521772 DOI: 10.2165/00003495-199550030-00008
17. Kam PC, Cardone D. Propofol infusion syndrome. Anaesthesia. 2007; 62(7):690-701. PMID: 17567345 DOI: 10.1111/j.1365-2044.2007.05055.x
18. Reilly CS, Nimmo WS. New intravenous anaesthetics and neuromuscular blocking drugs. A review of their properties and clinical use. Drugs. 1987; 34(1):98-135. PMID: 3308413 DOI: 10.2165/00003495-198734010-00004
19. Hosseinzadeh H, Sharabiani B, Movassagi R, Rahimi Panahi J, Naderpour M. Comparison of hemodynamic stability between propofol plus remifentanil and isoflorane during middle ear surgery by equal bispectral index signal. Med J Tabriz Univ Med Sci Health. 2012; 34(1):13
20. Hassani V, Farhadi M, Daneshi A, Naser Nejad S, Koochak M, Khan Niarak E. Comparison of bleeding extent in propofol-remifentanil versus isoflouran remifentanil anesthetic procedures in functional endoscopy sinus surgery (FESS) in Rasoul-e-Akram Hospital. Razi J Med Sci. 2004; 11(43):737-42.
21. Haghbin MA, Hakimzadeh H, Shabani M. Comparing the effects of propofol and isoflurane on depth of anesthesia and blood loss during endoscopic sinus surgery. Feyz J. 2013; 17(5):447-52.
22. Ghodrati M, Zadimani A. Comparison of blood loss in septorhinoplasty with two different anesthetic technique; propofol or isoflurane. J Anesthesiol Pain. 2011; 2(5):1-8.
23. Miłoński J, Zielińska-Bliźniewska H, Golusiński W, Urbaniak J, Sobański R, Olszewski J. Effects of three different types of anaesthesia on perioperative bleeding control in functional endoscopic sinus surgery. Eur Arch Otorhinolaryngol. 2013; 270(7): 2045-50. PMID: 23263204 DOI: 10.1007/s00405-012-2311-1
24. Choi YJ, Kim MC, Lim YJ, Yoon SZ, Yoon SM, Yoon HR. Propofol infusion associated metabolic acidosis in patients undergoing neurosurgical anesthesia: a retrospective study. J Korean Neurosurg Soc. 2014; 56(2):135-40. PMID: 25328651 DOI: 10.3340/jkns.2014.56.2.135
25. Ichikawa T, Okuyama K, Kamata K, Masui K, Ozaki M. Suspected propofol infusion syndrome during normal targeted propofol concentration. J Anesth. 2020; 34(4):619-23. PMID: 32222909 DOI: 10.1007/s00540-020-02773-z
26. Fudickar A, Smigaj K, Ensenauer R, Fischer G, Dütschke P, Steinfath M, et al. Effect of propofol and sevoflurane on acid-base balance during pediatric heart catheterization. Minerva Anestesiol. 2013; 79(6):626-33. PMID: 23511362
27. Schroeppel TJ, Fabian TC, Clement LP, Fischer PE, Magnotti LJ, Sharpe JP, et al. Propofol infusion syndrome: a lethal condition in critically injured patients eliminated by a simple screening protocol. Injury. 2014; 45(1):245-9. PMID: 23742861 DOI: 10.1016/j.injury.2013.05.004

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