DOI: 10.14744/ejmi.2019.60926
EJMI 2019;3(4):255–259

Research Article

Comparison of Effects of Low and High Flow Desflurane Anaesthesia on Hemogram Parameters

Hamit Yoldas,[1] Ibrahim Karagoz,[1] Ayhan Ekici,[2] Abdulhamit Es,[3], Isa Yildiz,[1] Abdullah Demirhan,[1] Murat Bilgi[1]

[1]Department of Anesthesiology and Reanimation, Bolu Abant Izzet Baysal University, Faculty of Medicine, Bolu, Turkey
[2]Department of Gynecology and Obstetrics, Abant Izzet Baysal University Faculty of Medicine, Bolu, Turkey
[3]Department of Business Administration, Abant Izzet Baysal University Faculty of Economics and Administrative Sciences, Bolu, Turkey

Abstract

Objectives: To compare the effects of low and high flow desflurane anaesthesia on hemogram parameters in lower abdominal surgeries.

Methods: Sixty female patients who underwent lower abdominal surgery under general anaesthetic were included in this prospective study. Patients were randomly divided into two groups, as Group I (low flow) and Group II (high flow), and then compared with each other according to their demographic features and hemogram parameters.

Results: Groups were statistically similar, and there were no significant differences in terms of demographic data between the groups ($p>0.05$). The comparisons of hemogram parameters within the groups showed that there were significant differences in plateletcrit, platelet-lymphocyte ratio and neutrophil-lymphocyte ratio values in Group I ($p<0.05$). The comparisons of hemogram parameters within Group II showed a statistically significance in plateletcrit and platelet-lymphocyte ratio values. A statistically significant difference was found for red cell distribution width, neutrophil-lymphocyte ratio, platelet-lymphocyte ratio and plateletcrit values between groups for the pre-operative and post-operative values of hemogram parameters ($p<0.05$).

Conclusion: Our study showed that the administration of low flow anaesthesia led to a positive effect on the inflammatory response by lowering neutrophil-lymphocyte ratio, platelet-lymphocyte ratio and red cell distribution width values, in comparison to high flow anaesthesia.

Keywords: Desflurane, hemogram parameters, low and high flow anaesthesia

Cite This Article: *Yoldas H, Karagoz I, Ekici A, Es A, Yildiz I, Demirhan A, et al. Comparison of Effects of Low and High Flow Desflurane Anaesthesia on Hemogram Parameters. EJMI 2019;3(4):255–259.*

In light of developments in technical features of anaesthesia devices and monitors and the increase in knowledge of the pharmacodynamic and pharmacokinetic properties of inhalation anaesthetics, low flow anaesthesia methods have gained wider popularity worldwide.[1] The low flow anaesthesia method aims to re-induce at least 50% of the fresh oxygen flow to the patient together with the required amount volatile anaesthetics to meet the metabolic need of the body after the carbon dioxide is eliminated in the gas exhaled from the patient by means of the rebreathing anaesthesia system.[2, 3] Some of the advantages of the low fresh gas flow anaesthesia method are suggested to be reducing cost, prevention of environmental pollution, protection of trachea and

Address for correspondence: Hamit Yoldas, MD. Bolu Abant Izzet Baysal Universitesi Tip Fakultesi, Anesteziyoloji ve Reanimasyon Anabilim Dali, 14280, Golkoy, Bolu, Turkey
Phone: +90 374 253 46 56 **E-mail:** yoldashamit@hotmail.com

Submitted Date: May 19, 2019 **Accepted Date:** July 12, 2019 **Available Online Date:** October 01, 2019

bronchial physiology by preventing hypothermia.[3]

As desflurane has low solubility and a vaporiser which is adjustable for a wide range of dosages, it stands out as the ideal anaesthetic agent for use in low flow anaesthesia techniques. The low flow administration methods are found to be advantageous in clinical practice due to its minimal cardiovascular side effects and rapid recovery.[4, 5]

It is known that general anaesthesia and surgery effect the distribution of leukocytes in patients due to the immunodepression.[6] Most of the information concerning the immune-related effects of volatile anaesthetics has been obtained from in-vitro studies. Much of the information suggest that volatile anaesthetics inhibit dose-dependent neutrophil functions, supress cytokine release in peripheral blood mononuclear cells, reduce lymphocyte proliferation and cause lymphocyte apoptosis.[7] Neutrophil lymphocyte ratio (NLR) is a parameter that is easily evaluated by the ratio of neutrophil and lymphocyte counts, determined by complete blood count and is considered as one of the markers of inflammation. Recently, its effectiveness is being assessed frequently for various diseases. There are also various publications indicating that it can be used as a means for diagnosis of many diseases (such as coronary artery diseases, malignancies, diabetes mellitus, appendicitis, etc.), as well as for prognosis for certain diseases.[8, 9]

There are various studies in the literature indicating that platelet count (PLT), mean platelet volume (MPV), plateletcrit (PCT), platelet distribution width (PDW) and platelet lymphocyte ratio (PLR) can be used in the assessment of inflammatory response and the determining the prognosis.[10–15] Further, among the hemogram parameters, red cell distrubition width (RDW) is found to be in relationship with thyroid cancer and COPD.[16, 17]

The aim of this study was to compare the effects of low and high flow desflurane anaesthesia on hemogram parameters in lower abdominal surgeries.

Methods

The necessary permissions were obtained by the decision of the institutional medical research Ethics Committee, dated 24.04.2017 and referenced 815. Participants of the study were 60 female patients who admitted to our hospital between the ages of 18 and 65 years with planned lower abdominal surgeries of the ASA I-II status to be conducted under general anaesthetic and lasting between 1-3 hours. Both low flow and high flow anaesthesia are routinely administrated in daily clinical practice in selected patients without any contraindications for both anaesthesia methods, and these patients were included in this study. The patients were randomly assigned to Group I (low flow anaesthesia administration) and Group II (high flow anaesthesia administration) by using the computerized randomization method. Checks were conducted to ensure there were no leaks in the anaesthesia circuits, calibration of the gas monitors were carried out before the operation and the CO_2 absorbent was changed daily. Sodalime (Sorbo-lime, Berkim, Turkey) was used as the CO_2 absorbent. Those patients with morbidly obesity have a history of malign hyperthermia or have a history of malign hyperthermia in their family, are opioid sensitive, have alcohol or medicinal addictions, have chronic obstructive lung disease, coronary artery disease, congestive heart disease, those with laboratory abnormalities such as significant anaemia, polycythaemia, thrombocytopenia, electrolyte imbalance, leucopoenia or leucocytosis, those with a history of liver or kidney disease, hypovolemia, hypertension, systemic inflammatory response syndrome, sepsis, decompensated diabetic patients, pregnant women or lactating women and those patients with allergies to medication excluded from the study.

Intravenous access was ensured with a 18G cannula in patients taken into the operating room and 5-10 ml/kg/h %0.9 sodium chloride infusion was started. Peripheral oxygen saturation (SpO_2), heart rate (HR) and non-invasive blood pressure (NIBP) were monitored in all patients, and premedication was administered post-operatively with 1–2mg IV midazolam (Dormicum®). In addition, pre-oxygenation was ensured with face mask for 3 minutes with 100% O2 at the pre-induction stage. 2 mg/kg propofol (Propofol Lipuro %1 ampule, B.Braun, Germany), 1.5mcq/kg fentanyl (Fentanyl amp 0.05 mg/ml, Jansenn, Belgium), 0.5mg/kg rocuronium (Myocron vial 50mg/5ml, Vem Ilaç, Turkey) was administered by IV as the anaesthesia induction. Following the endotracheal intubation, patient was connected to mechanical ventilator with anesthesia device (Drager-Primus, Germany) with a tidal volume of 6-8 ml/kg and end-tidal of CO_2 35–45mm Hg. As a result of the computerized randomization, Group I (n=30) was administered low flow and Group II (n=30) was administered high flow Desflurane anaesthesia. The haemoglobin, haematocrit, platelets, leucocytes, neutrophils, mean platelet volume (MPV) and red cell distribution width (RDW) values, which were obtained in the last 24 hours before the patients' surgery, were recorded. Heart rate (HR) and mean arterial pressure (MAP) values were recorded at the pre-operative stage, before and after induction, before intubation and at the 1st, 2nd, 3rd, 4th, 5th and 10th minute after intubation. During maintenance of anaesthesia, 50% O_2 and 50% air was administered together with 4-6% desflurane (Suprane, Baxter, Puerto Rico, USA). The flow continued at 4L/min in the first 10 minutes and the flow was reduced to 1L/min in the patients in Group I (D). The flow was reduced to 2L/min at for patients in Group II (Y). At 10 min-

utes remaining to the completion of the surgery, the flow was increased once again to 4L/min and then increased to 6L/min with the addition of fresh gas flow. To reverse the neuromuscular blocker, atropine sulphate (0.15 mg kg-1) and neostigmine (40 mcg kg-1) was used. Once adequate spontaneous ventilation was ensured, the patients were extubated. Blood analysis was carried out in the 2nd post-operative hour, recording the haemoglobin, haematocrit, platelets, leucocytes, neutrophils, mean platelet volume (MPV) and red cell distribution width (RDW) values.

Statistical Analysis

The analyses of the data were conducted using the Statistical Package for Social Sciences version 15.0 (SPSS Inc., Chicago, Illinois, USA). Kolmogorov Smirnov test was used to determine whether the distributions of continuous variables were normal or not. For the analyses of normally distributed continuous variables independent samples t-test was used. Non-parametric Mann Whitney U test was used for non-normal data. Categorical variables were analyzed using chi-square tests. Whereas continuous variables that fit to normal distribution were expressed as mean±standard deviation, the variables that were not fit to normal distribution were expressed as median (minimum-maximum). Categorical variables were presented as frequency and percentage for each group. A p value of less than 0.05 was accepted as statistically significant.

Results

A total of 60 female patients were enrolled in the study, where 30 subjects were included in the low flow anaesthesia group and 30 subjects were included in the high flow anaesthesia group. When the groups were evaluated according to demographic data, there were no statistically significant differences between the groups (p>0.05) (Table 1).

The comparisons of hemogram parameters within the groups showed that there were statistically significant differences in PCT, PLR and NLR values in Group I (p<0.05). There were no significant differences in RDW values within Group I (p>0.05) (Table 2).

The comparisons of hemogram parameters within Group II showed a statistically significance in PCT and PLR values. A comparison of pre-operative and post-operative groups for the high flow anaesthesia group did not find a statistically significant difference for the RDW and NLR values (p>0.05) (Table 3).

A statistically significant difference was found for the PCT, RDW, PLR and NLR values between groups for the pre-operative and post-operative values of hemogram parameters (p<0.05) (Table 4).

Discussion

This study found that NLR, PLR, PCT and RDW values, which were obtained by hemograms during the low flow anaesthesia and considered as inflammation markers, were lower.

General anaesthesia leads to changes in the distribution of subgroups due to disorders in leucocyte function.[18] It is stated that inhalational anaesthetics cause different effects in inflammatory pathways during the administration of low and high flow anaesthetics.[19, 20] It is shown that these agents trigger the release of inflammatory mediators, which cause an increase proinflammatory cytokine gene expression and inflammatory response.[21–23] This leads to the disorder of inflammatory response, systematic inflammatory response and the development of post-operative complications such as sepsis and multi-organ failure.[24]

Table 1. Demographic characteristics of cases according to groups

Variables	Group I (n=30)	Group II (n=30)	p
Age (years)	46±2	46±1.9	0.809
Gender (Female), (%)	30 (50)	30 (50)	
ASA 1/2	24/6	24/6	0.930
Duration of Anaesthesia (min)	136±49	117±34	0.191

ASA: American Society of Anesthesiology.

Table 2. Low flow anaesthesia group

Hemogram parameters	Pre-operative	Post-operative	p
PLR	0.06±0.02	0.16±0.10*	0.01
NLR	3.47±4.01	8.17±7.32*	0.01
PCT	0.20±0.03	0.18±0.04*	0.01
RDW	17.39±4.27	16.97±4.03	0.09

NLR: Neutrophil lymphocyte ratio; PCT: Plateletcrit; PLR: Platelet lymphocyte ratio; RDW: Red cell distribution width. *: Within group statistically significant p<0.05.

Table 3. High flow anaesthesia group

Hemogram parameters	Pre-operative	Post-operative	P
PLR	0.06±0.02	0.22±0.18*	0.01
NLR	4.70±8.62	8.84±8.95	0.09
PCT	0.18±0.04	0.17±0.04*	0.01
RDW	16.46±2.51	16.24±2.42	0.14

NLR: Neutrophil lymphocyte ratio; PCT: Plateletcrit; PLR: Platelet lymphocyte ratio; RDW: Red cell distribution width. *: Within group statistically significant p<0.05.

Table 4. Comparison of hemogram parameters for Group I and Group II

	Group I		Group II		p
	Pre-operative	Post-operative	Pre-operative	Post-operative	
PLR	0.06±0.02	0.16±0.10	0.06±0.02	0.22±0.18	0.01
NLR	3.47±4.01	8.17±7.32	4.70±8.62	8.84±8.95	0.01
PCT	0.20±0.03	0.18±0.04	0.18±0.04	0.17±0.04	0.01
RDW	17.39±4.27	16.97±4.03	16.4±62.51	16.2±42.42	0.02

NLR: Neutrophil lymphocyte ratio; PCT: Plateletcrit; PLR: Platelet lymphocyte ratio; RDW: Red cell distribution width.

As the response of leucocytes in circulation to inflammation leads to an increase in the number of neutrophils and decrease in the number of lymphocytes, the ratio of these two sub-groups (NLR) are considered to be a marker for inflammation.[25] In in-vitro studies using volatile anaesthetics, Rem et al.[26] found that there was a decrease in peripheral lymphocytes due to apoptosis. Neutrophilia and lymphopenia was found in patients with trauma and systemic inflammatory response syndrome.[27] A study by Markar et al.[28] found that increased NLR in suspected appendicitis is more sensitive than an increased number of white cells.

In the existing literature, it can be seen that thrombocyte count increases when megakaryopoiesis is triggered by inflammatory reactions.[29] According to a study by Türkmen et al.[30] one of the best indicators in cases of inflammation is PLR. Plateletcrit (PCT), one of the platelet index obtained from hemogram is stated as being an important indicator of severe inflammation, such as platelet distribution width (PDW) and mean platelet volume (MPV).[31]

Red cell distribution width (RDW) is an index which shows the distribution of the size of red cells in the circulatory system. An increase in RDW is associated with chronic inflammation and increased oxidative stress.[32] Fukuta et al.[33] found that RDW levels had increased, among other inflammatory markers, in coronary artery diseases.

The decreased NLR, PLR, PCT and RDW values in the patients who were in the low flow anaesthesia group of the study led to the belief that low flow anaesthesia showed a positive effect on the inflammatory cascade. We thought that this was the result of the suppresed inflammatory pathways and mediator release. However, there is a need for experimental and clinical studies to confirm this.

The major limitation of this study was the small sample size. Other considerable limitations of the study were that it was mono-centric study and did not consider other inflammatory markers such as C-reactive protein, sedimentation rate and interleukin-6.

Conclusion

In conclusion, the results of the study demonstrated that in comparison to high flow anaesthesia, the administration of low flow anaesthesia led to a positive effect on the inflammatory response by lowering NLR, PLR and RDW values.

Disclosures

Ethics Committee Approval: The study was approved by Bolu Abant Izzet Baysal University Clinical Researches Ethics Committee (approval date: 24.04.2017, decision number: 815).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – H.Y., I.K., A.E.; Design – H.Y., I.K., I.Y.; Supervision – H.Y. A.D., M.B.; Materials – H.Y., A.E.; Data collection &/or processing –H.Y., A.E.; Analysis and/or interpretation – H.Y., A.E.; Literature search – H.Y., I.Y.; Writing – H.Y., A.D.; Critical review – I.K., A.E., A.E., I.Y., M.B.

References

1. Yıldız TS, Baykara N, Bozkurt N, Oysu DA, Solak M, Toker K. Effect of clonidine on shivering in low-flow desflurane anesthesia. Turk. Anesthesia Reanimation J 2005;33:29–35.
2. Eger EI II. Uptake and distribution. In: Miller RD, ed. Miller's Anesthesia. 6th ed. Philadelphia: Elsevier Churchill Living Stone; 2005.p.131–53.
3. Baum JA, Aitkenhead AR. Low-flow anaesthesia. Anaesthesia 1995;50:37–44. [CrossRef]
4. Erbay RH, Tomatır E, Hancı V, Serin S, Atalay H. Desflurane-N2O, sevoflurane- N2O Comparison of costs in minimal flow and propofol-remifentanil anesthesia. Turkey Clinics J Anaesth 2009;7:11–8.
5. Çukdar G, Özkoçak Turan I, Ayoğlu H, Hancı V, Yurtlu S, Özer Y. Comparison of the effects of low and high flow desflurane anesthesia on hemodynamics and anesthetic gas consumption. Turk. Anaesth J 2008;36:222–9.
6. Salo M. Effects of anaesthesia and surgery on the immune response. Acta Anaesthesiol Scand 1992;36:201–220. [CrossRef]
7. Jay A. Homburger, Steffen E. Meiler. Anesthesia drugs, immunity, and long-term outcome. Curr Opin Anaesthesiol LippincottWilliams&Wilkins 2006:19:423–8. [CrossRef]

8. Prajapati JH, Sahoo S, Nikam T, Shah KH, Maheriya B, Parmar M. Association of high density lipoprotein with platelet to lymphocyte and neutrophil to lymphocyte ratios in coronary artery disease patients. J Lipids 2014;2014:686791. [CrossRef]
9. Chen ZY, Raghav K, Lieu CH, Jiang ZQ, Eng C, Vauthey JN, et al. Cytokine profile and prognostic significance of high neutrophil-lymphocyte ratio in colorectal cancer. Br J Cancer 2015;112:1088–97. [CrossRef]
10. Gasparyan AY, Ayvazyan L, Mikhailidis DP, Kitas GD. Mean platelet volume: a link between thrombosis and inflammation? Curr Pharm Des 2011;17:47–58. [CrossRef]
11. Davì G, Patrono C. Platelet activation and atherothrombosis. N Engl J Med 2007; 357:2482–94. [CrossRef]
12. Liu H, Wu Y, Wang Z, Yao Y, Chen F, Zhang H et al. Pre treatment platelet-to-lymphocyte ratio (PLR) as a predictor of response to first-line platinumbased chemotherapy and prognosis for patients with nonsmall cell lung cancer. J Thorac Dis 2013;5:7839.
13. Çalışkan A, Yazıcı S, Karahan O, Demirtaş S, Yavuz C, Güçlü O, et al. The investigation of complete blood counting parameters in deep venous thrombosis. Dicle Med J 2014;41:118–122.
14. Karahan O, Yavuz C, Kankilic N, Demirtas S, Tezcan O, Caliskan A, et al. Simple blood tests as predictive markers of disease severity and clinical condition in patients with venous insufficiency. Blood Coagul Fibrinolysis. 2016;27:684–90. [CrossRef]
15. Velioglu Y, Yuksel A. Complete blood count parameters in peripheral arterial disease. Aging Male 2019:1–5. [CrossRef]
16. Aktas, G, Sit, M, Karagoz, I. Could red cell distribution width be a marker of thyroid cancer? J Coll Physicians Surg Pak 2017;27:556–8.
17. Koçak, MZ. Evaluation of red cell distribution width levels during acute exacerbation in patients with chronic obstructive pulmonary disease. Biomed Res 2017;28:3009–11.
18. Nakagawara M, Takeshige K, Takamatsu J, Takahashi S, Yoshitake J, Minakami S. Inhibition of superoxide production and Ca++ mobilization in human neutrophils by halothane, enflurane, and isoflurane. Anesthesiology 1986;64:4–12. [CrossRef]
19. Crozier TA, Müller JE, Quittkat D, Sydow M, Wuttke W, Kettler D. Effect of anaesthesiaon the cytokine responses to abdominal surgery. Br J Anaesth 1994;72:426. [CrossRef]
20. Pirttikangas CO, Salo M, Mansikka M, Grönroos J, Pulkki K, Peltola O. The influence of anaesthetic technique upon the immune response to hysterectomy: a comparison of propofol infusion and isoflurane. Anaesthesia 1995;50:1056–61. [CrossRef]
21. Kotani N, Lin CY, Wang JS, Gurley JM, Tolin FP, Michelassi F, et al. Loss of alveolar macrophages during anesthesia and operation in humans. Anesth Analg 1995;81:1255–62. [CrossRef]
22. Kotani N, Hashimoto H, Sessler DI, Yasuda T, Ebina T, Muraoka M et al. Expression of genes for proinflammatory cytokines in alveolar macrophages during propofol and isoflurane anesthesia. Anesth Analg 1999;89:1250–6. [CrossRef]
23. Goode HF, Cowley HC, Walker BE, Howdle PD, Webster NR. Decreased antioxidant status and increased lipid peroxidation in patients with septic shock and secondary organ dysfunction. Crit Care Med 1995;23:646–51. [CrossRef]
24. Wakefield CH, Carey PD, Foulds S. Changes in major histocompatibility complex class II expression in monocytes and T cells of patients developing infection after surgery. Br J Surg 1993;80:205–209. [CrossRef]
25. Zahorec R. Ratio of neutrophil to lymphocyte counts-Rapid and simple parameter of systemic inflammation and stress in critically ill. Bratisl Lek Listy 2001;102:5–14.
26. Rem J, Brandt MR, Kehlet H. Prevention of postoperative lymphopenia and granulocytosis by epidural analgesia. Lancet 1980;1:283–4. [CrossRef]
27. Heffernan DS, Monaghan SF, Thakkar RK, Machan JT, Cioffi WG, Ayala A. Failure to normalize lymphopenia following trauma is associated with increased mortality, independent of the leukocytosis pattern. Crit Care 2012;16:R12. [CrossRef]
28. Markar SR, Karthikesalingam A, Falzon A, Kan Y. The diagnostic value of neutrophil: lymphocyte ratio in adults with suspected acute appendicitis. Acta Chir Belg 2010;110:543–7.
29. Paulus JM, Bury J, Grosdent JC. Control of platelet territory development in megakaryocytes. Blood Cells 1979;5:59–88.
30. Turkmen K, Erdur FM, Ozcicek F, Ozcicek A, Akbas EM, Ozbicer A et al. Platelet-to-lymphocyte ratio better predicts inflammation than neutrophil-to-lymphocyte ratio in end-stage renal disease patients. Hemodial Int 2013;17:391–6. [CrossRef]
31. Zhang WW, Liu KJ, Hu GL, Liang WJ. Preoperative platelet/lymphocyte ratio is a superior prognostic factor compared to other systemic inflammatory response markers in ovarian cancer patients. Tumour Biol 2015;36:8831–7. [CrossRef]
32. Ferrucci L, Guralnik JM, Woodman RC, Bandinelli S, Lauretani F, Corsi AM, et al. Proinflammatory state and circulating erythropoietin in persons with and without anemia. Am J Med 2005;118:128. [CrossRef]
33. Fukuta H, Ohte N, Mukai S, Saeki T, Asada K, Wakami K et al. Elevated plasma levels of B-type natriuretic Peptide but not C-reactive protein are associated with higher red cell distribution width in patients with coronary artery disease. Int Heart J 2009;50:301–12. [CrossRef]