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In the High and Low Flow Anesthesia, the Relationship Between the Anesthetic Agent Concentration and Time Constant

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Abstract:

Anesthesia vaporizer is a device that is used to vaporize a liquid anesthetic agent and to deliver a controlled amount to the patient. The most problems during the anesthesia application are caused from the fault of the personnel. Because of this, the error of the dose must be guessed. In result, the controlling and the measuring of the concentration of anesthetic agent causes the application of anesthesia safely. In anesthesia technique, the term that defines the reflection time of the changes of anesthetic agent concentration in fresh gas to the anesthetic agent concentration in the breath system, is time constant. The objective of this study, in the high and low flow anesthesia, is to investigate the relationship between the anesthetic agent concentration and time constant, and to attract attention to this relationship during the delivering of anesthesia and during the calibration measurements. In this study, the concentrations of the anesthetic agents were measured from the breath system by using Flow analyser. In high flow anesthesia, the flow was stable at 4L/min during all measurements. The anesthetic agent (isoflurane, sevoflurane) was adjusted to the 2% of concentration. The measurement time was 45 min. In the software-Flowlab, the changes of the anesthetic agent were investigated from the graph and the time point that the agent concentration became to the stable, was recorded. In low flow anesthesia, firstly, flow was 4L/min in approximately 20 minutes, after, this flow was decreased to the 1L/min and all concentration measurements were repeated. Thus, in high and low flow anesthesia, it was possible to investigate the relationship between the anesthetic agent concentration and time constant. By decreasing the current of fresh gas, it was seen that the anesthetic agent concentration decreased. In low flow anesthesia, the changes in the agent concentration of fresh gas reflected to the concentration of agents in the breath system in a long time.

Key words: vaporizer, breath system, anesthetic dose

INTRODUCTION

Anesthesia vaporizer is a device that is used to vaporize a liquid anesthetic agent and to deliver a controlled amount to the patient. Vaporizers are placed within the flow of fresh gas. High flow vaporizers can be also used for the applications of low flow anesthesia.

The most problems during the anesthesia application are caused from human error. Because of this, the error of the dose must be guessed. In result, the controlling and the measuring of the concentration of anesthetic agent causes the application of the anesthesia safely [1]. According to the American Society for Testing and Materials (ASTM) Standard ASTM F1161-88, anesthesia vaporizers are required to be concentration calibrated [2].

In anesthesia technique, the term that defines the reflection time of the changes of anesthetic agent concentration in fresh gas to the anesthetic agent concentration in the breath system, is time constant.

The objective of this study, in the high and low flow anesthesia, is to investigate the relationship between the anesthetic agent concentration and time constant, and to attract attention to this relationship during the delivering of anesthesia and during the calibration measurements.

MATERIALS AND METHODS

In this study, the measurements were taken from the breath system where the true anesthetic dose generated [3]. The concentration of anesthetic gases were measured by using the PF 301 Flow analyzer (imt medical- Switzerland).

In the high flow anesthesia, the flow was stable at 4L/min during the measurement. The anesthetic gas (isoflurane, sevoflurane), was adjusted to the concentration in the scale of 2% for the first 20 minutes. After this, it was adjusted to the concentration in the scale of 3%. All measurements were completed in totally 45 minutes. Because FlowLab-the software of PF 301, showed the anesthetic gas changes graphically, all concentration changes were examined from the graphs and the time that the anesthetic gas became stable was recorded.

In the low flow anesthesia, the flow, firstly, was stable at 4L/min. After 20 minutes, the flow was decreased to 1L/min. and the concentration was increased to the 3% concentration level. All measurements were repeated with the new adjusted values.

RESULTS

In the high flow anesthesia, the obtained measurement results were given on the Table 1. All the concentration changes were followed from Figure 1.

In the low flow anesthesia, the obtained measurement results were given on the Table 2. From Figure 2, all the concentration changes were followed.

Table 1. Concentration and time measurements in high flow anesthesia.

		High Flow Anesthesia (45 min. 4L/min.)	
Anesthetic Gas		Concentration	Time
İsoflurane	2%	1.89%	4 min.
	3%	2.88%	4 min.
Sevoflurane	2%	1.98%	3 min.
	3%	2.96%	3 min.

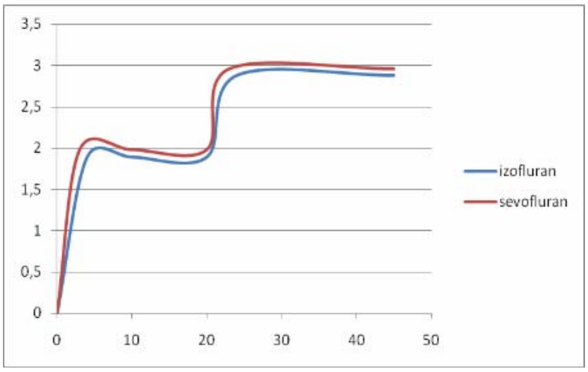

Figure 1. Concentration changes and time constant in high flow anesthesia.

Table 2. Concentration and time measurements in low flow anesthesia.

		Low Flow Anesthesia (20 min. 4L/min.) (60 min. 1L/min.)	
Anesthetic Gas		Concentration	Time
İsoflurane	2%	1.86%	4.5 min.
	3%	1.95%	40 min.
Sevoflurane	2%	1.90%	3 min.
	3%	2.01%	35 min.

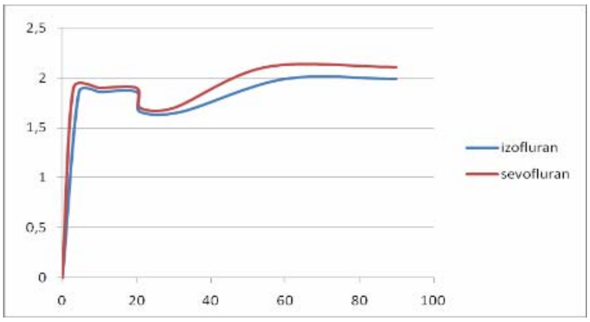

Figure 2. Concentration changes and time constant in low flow anesthesia.

As it was seen from the measurement results, in the high flow anesthesia, the changes of the fresh gas concentration (from 2% to 3%), reflected to the gas concentration within the breath system, in other words, reflected to the measurement results quickly. On the contrary, in the low flow anesthesia, the reflection time of the changes of the fresh gas concentration to the system concentration was long. It was caused from the long time constant. By decreasing the current of fresh gas, it was seen that the anesthetic agent concentration decreased. At this point, by adjusting the concentration level to the 3%, the concentration increased but the rise did not reach to the expected value.

DISCUSSION

The results show that, in the high flow anesthesia, the short time constant is possible, while the long time constant is possible in the low flow anesthesia.

It can be thought that the long time constant of the low flow anesthesia causes the risk because the anesthetis gas concentration doesn't change quickly. But, this problem can be solved by transition from the low flow to the high flow.

In the contrary, the long time constant of the low flow anesthesia can be an important safety function. In the emergency, if the description of the problem, solving of the problem and the transforming to the back position take the shorter time within the long time constant, the time requiring the life maintenance studies, increases. The long time constant of the low flow anesthesia prevent the problem that are caused from the wrong anesthetic agent dose. Because of this, the low flow anesthesia carries the lower risk than the high flow anesthesia.

When the low flow anesthesia is changed to the high flow anesthesia, because the gas concentration increases, the anesthetic gas concentration of the fresh gas must be decreased and it must be adapted to the new situation. Otherwise, the anesthetic concentration increases rapidly. When the fresh gas flow is decreased, the anesthetic agent concentration doesn't rise efficiently, the problem of lower anesthetic agent dose generates. This matter can be prevented by tracing and measuring the concentration of the anesthetic gas from the breath system.

REFERENCES

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