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Low Flow Anesthesia Benefits and Implementation in a Secondary Health Care Institute

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Abstract: ***Low - flow anaesthesia is a technique that employs a fresh gas flow that is less than the alveolar ventilation. It is one of the best under used modalities of delivering general anesthesia which had not gained much acceptance until now due to difficulty in calculation of accurate MAC values. However, with increasing awareness of the dangers of theatre pollution with trace amounts of the anaesthetic agents and the prohibitively high cost of the new inhalational agents, have helped in the rediscovery of low - flow anaesthesia. [1] Therefore time has come for new age anesthetists to use this technique to ensure that they also participate in reducing green house gases, environment pollutants and contribute to a cleaner and greener planet. This article not only explains various methods of LFA but also how the implementation of this technique improved patient outcome in our institution.***

Keywords: Economical, environmental, low - flow anaesthesia, rebreathing, sustainable anaesthesia

1. Introduction

Ever since the evolution of anaesthetic technique from the era of ether, using open - drop method, through the semi - closed and closed breathing systems, the concept of reusing the anaesthetic agents in the exhaled gas gained significant attention. [1] With the advent of modern anesthetic techniques need of low flow anesthesia has also revived with the advent of new age modern anesthetic workstations, with advanced monitoring systems like BIS to tide over the absolute need of having a correct value of MAC which is questionable in LFA. The staggering amount of environmental pollution due to anaesthetic gases during the present day practice virtually mandates every anaesthesia provider to take that extra bit of effort to use the available facilities to implement low - flow anaesthesia (LFA). [2]

Development of Low flow Anesthesia

The use of LFA is as old as the use of chloroform and ether, as a modality of anesthesia by re inspiration by Snow. Later on there was development of to and fro system by Waters and circle breathing systemswith soda lime by Brian sword. Even after the availability of closed breathing system use of high fresh gas flows was in common practice. Virtue, in 1974, reduced gas flows even further in his minimal flow anaesthesia technique. [3] Early 1980s witnessed efforts to actively revive the ideas of low - flow and closed system anaesthesia by Aldrete et al. [4] and Lowe and Ernst. [5] The use of halogenated anesthetic agents and hydrocarbons depleted the ozone layer and contributed to green house effect, this lead to revival of interest in use of low flow anesthesia techniques. LFA also preserves heat and humidity. Less consumption of new age expensive halogenated gases especially sevoflurane and desflurane has rendered this technique more economical. This is more applicable if Xenon were to be used as an anaesthetic gas in clinical practice. [7]

Definition

There is no universally accepted definition of low flow anesthesia. Any technique that employs Fresh Gas flow that is less than the alveolar ventilation can be designated as low - flow anaesthesia. [8] or in simple terms when fresh gas flow is less than 2 ltrs/min [6] is considered as LFA. Here 50% of the exhaled gas mixture is inspired after removal of carbon dioxide. Baker [8] has classified the FGF used in anaesthetic practice as medium/low/minimal/metabolic flow [Table 1]

Table 1: Fresh gas flow categories**,** as described by Baker

FGF category	FGF	Remarks
Medium flow	1-2 L/min	The fresh gas volume is more than sufficient for the basic requirements and to compensate the problems
Low flow	500-1000 ml/min	If the inspiratory O_2-concentration falls below 30%, the O_2-flow must be increased by 10% of the total gas flow (about 100 ml/min)
Minimal flow	250-500 ml/min	If the inspiratory O_2-concentration falls below 30%, the O_2-flow must be increased by about 50 ml/min
Metabolic flow	About 250 ml/min	O_2 should be used as sole carrier gas since 250 ml/min is the absolute minimal oxygen requirement for metabolic processes at rest in a normothermic patient. Anaesthesia provider should precisely detect whenever the metabolic demands exceed oxygen supply

FGF – Fresh gas flow

Advantages of LFA

Following are the various advantages of using LFA -

a) Economical with reduced gas consumption and savings upto 70% of gas volume.
b) Reduced operation theatre pollution and less exposure to gases.
c) It is also beneficial in reducing green house gases and ozone depletion.

d) Preserves heat and humidity and reduces moisture loss and drying of respiratory tract.
e) less chances of post operative nausea, vomiting and respiratory depression.
f) Fast and early recovery.

Disadvantages of LFA

Following are the various disadvantages of using LFA -
a) There is slower induction and recovery due to time constant.
b) One has to very vigilant to avoid both hypoxia and over dosage of anesthetic agents.
c) Risk of Hypercarbia.
d) Formation of trace gases like compound A. Excessive heating of soda lime canister, can lead to burns

Requirements for LFA

Following are the requirements for proper use of LFA
a) Anesthetist familiarity with the system.
b) Flow meters calibrated to 50ml/min. Oxygen sensor calibration done.
c) Leak proof circle breathing system and cuffed ETTs.
d) Gas monitoring system with inspired and expired carbon dioxide measurement.
e) Monitor with MAC values.
f) Properly calibrated vaporizers designed to deliver at low gas flows.
g) Minimal internal reserve volume of breathing systems.

If any of the following requirements are not met in any of the set up one should not undertake LFA.

Conduction methods of LFA

There are various popular methods of conducting low flow anesthesia depending upon the infrastructure available and the preference of anesthetist.

Induction of Anesthesia

a) Use of high flows of fresh gas[at]10 ltrs/min, at the time of induction. This helps to reach the MAC values. Patients are asked to take deep breaths so that there is rapid denitrogenation and simultaneous achievement of desired MAC with flows kept twice the normal values.
b) Use of prefilled circuits is also a good option. In this technique the breathing circuit is attached with the bag and the system is allowed to run on a ventilator which primes the circuit with the anesthetic gas. As soon as the patient is attached to the mask connected to system he achieves the desired concentration.
c) Injection of 2ml of liquid anesthetic agent is another method of induction in LFA. In this 2 ml of liquid is injected in the inspiratory arm of the circuit.

Priming dose (ml vapour) = Desired concentration × ([FRC + circuit volume] + [cardiac output × blood gas coefficient]) [1]

Maintenance of Anesthesia

In this phase the fresh gas flows are usually kept between 250ml/min to less than 2ltrs/min, depending upon the proficiency and comfort zone of the operator. Vigilant monitoring is required in this phase to avoid any catastrophe like hypercarbia or hypoxia. The concentration of oxygen and nitrous oxide in the fresh gas mixture is kept in 50: 50 ratio.

Termination of LFA

It is done by increasing the flow of oxygen in the fresh gas in the inspired gas mixture. As the concentration of oxygen is increased the anesthetic gases and nitrous oxide are washed out rapidly. Therefore it leads to early emergence from the general anesthesia.

2. Conclusion

Anaesthesiologists should take up environmental stewardship as a prime priority. Because the anaesthesia professional decides FGF, we are directly responsible for the environmental impact of anaesthetic vapours and gases. [1] In this endeavor LFA can prove to be highly effective tool. Modern anesthetic techniques have become patient friendly and highly advanced systems are available even in secondary care institutes of developing countries like INDIA. This has made LFA easier to administer. So lets implement this amazing technique and reduce the burden both on planet and patient.

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Conflict of interest

There is no conflict of interest

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