Original Article

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A Comparative Study of Intraoperative Haemodynamic Changes with Low and Medium Fresh Gas Flow Rates in Patients Undergoing Abdominal Surgeries

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Abstract

Decreasing the fresh gas flow rate during anaesthesia in surgeries may minimise costs, reduce environmental pollution and preserve heat and humidity in the respiratory system.

Keywords: Haemodynamic; Low flow; Medium flow; Abdominal surgeries.

Introduction

Low flow anaesthesia is defined to be an inhalation anaesthetic technique in which the rebreathing fraction at least amounts to 50%, where at least 50% of the exhaled gas mixture is returned to the patient after CO_2 removal in the next inspiration. Using modern anaesthetic machines, this can be achieved when Fresh Gas Flow (FGF) is reduced to at least 2 L/min or less. Baker[1] suggested the following modification of Simionescu's[2] classification of flow rates of gases into anaesthetic circuits:

Metabolic flow	~250 ml/min
Minimal flow	250-500 ml/min
Low flow	500-1000 ml/min
Medium flow	1-2 l/ min
High flow	2-4 l/ min
Very high flow	> 4 l/ min

Reducing the fresh gas flows significantly lowers the cost of anaesthesia due to reduction in amount of anaesthetic gases and agents consumed. It conserves the heat and humidity present in exhaled gases, reduces environmental pollution and less danger of barotrauma. The major concerns with the use of low flows are danger of hypercarbia, uncertainty about inspired concentrations, accumulation of undesirable gases like carbon monoxide, acetone, methane and faster absorbent exhaustion. There is formation of Compound A with sevoflurane in low flow circuits. Desflurane has advantages for low/minimal flow anaesthesia but its pungency limits its use for inhalational induction.

Newer anaesthetics, better carbon dioxide absorber, improved monitoring have improved the acceptance of low flow rates. Therefore, this study was aimed to compare the intraoperative

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haemodynamic changes with low and medium fresh gas flow rates in adult patients of ASA class I and II physical status undergoing abdominal surgeries to establish the safety of low fresh gas flow rates in routine anaesthetic practice. Material and Methods - After approval from the ethical committee of the Institution, obtaining written and informed consent from the patient, the study titled 'A Comparative study of Intraoperative haemodynamic changes with low and medium fresh gas flow rates in patients undergoing abdominal surgeries'(IEC/MLNMC/2013/No.22) was carried out at SRN hospital (affiliated to M.L.N. Medical College, Allahabad) over a period of one year.

80 adult patients of either sex belonging to ASA physical status 1 and 2 scheduled for elective abdominal surgical operations like open cholecystectomy, partial gastrectomy, umbilical hernia repair, hemicolectomy, intestinal resection and anastomosis requiring general anaesthesia were studied according to an approved protocol under low fresh gas flow rates anaesthesia after thorough clinical and laboratory examination which included:

Haemoglobin, TLC, DLC Serum urea

Serum creatinine Random blood sugar

Serum electrolytes: Serum sodium, Serum potassium, Serum calcium Chest X ray.

ECG

Exclusion criteria

Immunocompromised patients

Chronic lung disease: obstructive or restrictive Chronic cardiac disease

Impaired renal function tests Patients with raised ICT BMI > 30

Haemoglobin <10 g/dl SpO_2 < 95%

The patients were allocated randomly to one of the following study groups i.e. 40 in each group.

Group 1: Patients were given fresh gas flow rates with oxygen 0.5 L/min and air 1 L/min as a carrier gas to make a total flow rate of 1.5 L/min termed as medium flow anaesthesia.

Group 2: Patients were given fresh gas flow rates with oxygen 0.25 L/min and air 0.5 L /min to make total flow rate of 0.75 L/min termed as low flow anaesthesia.

A closed circuit with soda lime for carbon dioxide absorption was used with Drager Fabius plus work station. In the Operating Room, patients were monitored using Drager Infinity Vista XL monitors. Pre-induction baseline values of Heart Rate (HR), Mean Arterial Pressure (MAP), Peripheral saturation of Oxygen (SpO_2) were obtained over a 3-5 minutes interval immediately prior to induction of general anaesthesia.After intravenous cannulation, all patients were premedicated with Inj. Midazolam 20 mcg/kg and Inj. Fentanyl 1 mcg/kg i.v. five minutes before induction. A standardised induction sequence consisting of Inj. Propofol 2 mg/kg, Inj. Atracurium 25 mg/kg for endotracheal tubation was used for all the patients.

High flow rates of 8-10 L/min of oxygen were used for first 5 - 10 minutes to flush the circuit and to replace the Functional Residual Capacity and to deliver a sufficient mass of volatile anaesthetic to provide for early uptake. Anaesthesia was maintained with Inj. Atracurium as a muscle relaxant and Isoflurane (0.6%-1%) as an anaesthetic agent using a Standard Vaporiser Vapor 2000 funnel fill.

Following parameters were observed :

Mean Arterial Pressure (MAP) Heart Rate (HR)

SpO_2 continuous recording $EtCO_2$ (End tidal carbon dioxide).

EG7+ ABG cartridge was used for ABG analysis with special emphasis on $PaCO_2$ arterial sample was used for ABG analysis with special emphasis on $PaCO_2$. The Arterial blood sample was taken during the mid of the surgery. At the time of surgical closure residual neuromuscular blockade was antagonised by Inj. Neostigmine 2.5 mg and Inj. Glycopyrrolate 0.5 mg i.v. After adequate clinical reversal of neuromuscular block, closed circuit was replaced with Bain circuit and 100% oxygen was administered at a flow rate of 10 L/min. Recovery time from reversal to extubation was noted. All patients were able to follow verbal commands within five minutes of extubation.

The haemodynamic changes were recorded from time to time and analysed statistically. Statistical analysis was performed using Microsoft Excel 2007 and statistical software and student t-test (unpaired). Data were presented as Mean+ Standard Deviation.

Results

Table1: Characteristics of patients in the two groups.

Characteristics	Group I	Group II	p Value
Male	19	20	>0.05
Female	21	20	>0.05
Age	26.58+5.17	26.15+5.09	>0.05
Weight	56.40+3.96	55.92+4.38	>0.05
Height	163+5.57	162.4+6.2	>0.05

Table 2: Analyses of heart rate in the two groups.

	Group I	Group II	p value
Baseline	78.20 ± 4.52	76.25 ± 4.73	0.097
After intubation	86.25 ± 3.98	87.33± 4.11	0.27
After 10 min	83.33± 3.16	82.60 ± 3.20	0.34
After 20 min	78.55 ± 3.39	78.65 ± 3.25	0.89
After 30 min	77.75 ± 3.36	77.30 ± 3.99	0.60
After 40 min	79.95 ± 4.89	80.75 ± 3.35	0.42
After 50 min	82.45 ± 3.46	81.60 ± 4.71	0.39
After extubation	94.85 ± 4.39	96.20 ± 4.48	0.21
After 10 min of extubation	77.65 ± 2.96	78.15 ± 3.25	0.49

Table 3: Analyses of Mean Arterial Pressure(MAP) in the two groups.

	Group I	Group II	p value
Baseline	85.15+2.90	85.48+2.80	0.62
After intubation	90.43+2.67	91.43+2.74	0.14
After 10 min	88.05+2.98	89.00+2.52	0.16
After 20 min	83.05+2.99	82.82+2.27	0.71
After 30 min	85.28+3.16	84.8+2.36	0.47
After 40 min	82.80+3.44	83.00+2.17	0.76
After 50 min	83.77+2.94	83.80+2.70	0.97
After extubation	90.72+2.75	90.23+2.48	0.43
After 10 min of extubation	84.60+2.85	85.22+1.75	0.27

Discussion

The two groups were comparable w.r.t. demographic profile i.e. age, sex, weight, height.We observed that there were no significant haemodynamic changes in the two groups intraoperatively.

Our study is in accordance with the study of Park JY et al[3] who studied the effect of fresh gas flow on Isoflurane concentration during low flow anaesthesia. Ninety patients (ASA physical status I or II) were randomly allocated to three groups (FGF 1 L/min, FGF 2 L/min and FGF 4 L/min). No haemodynamic changes were observed. The findings of this study are consistent with the findings of our study. In our study no significant haemodynamic changes (p value >0.05) were observed. Heart rate during various time periods fluctuated around the baseline value except for the value after extubation which was about 1.13 times the baseline value.

MV Avramov et al[4] the effect of the Fresh Gas Flow rate and the anaesthetic technique on the ability to control the acute hyper dynamic response to a specific surgical stimulus during surgery in 90 consenting ASA physical status I-II patients undergoing lower abdominal surgeries. Desflurane provided more rapid and reliable control of acute hyper dynamic responses to surgical stimulation than Isoflurane or esmolol when the volatile anaesthetics were administered at low FGF rates. This was consistent with our study in which Isoflurane (0.6 to 1.0 vol%) was sufficient enough to control the increase in MAP and HR. The average time to control the increase in MAP and HR was significantly shorter in low flow group as compared to medium flow group.

PC Ip Yam et al[5] did clinical evaluation of the Mapleson theoretical fresh gas flow sequence at the start of low flow anaesthesia with Isoflurane, Sevoflurane and Desflurane. Ninety adult patients of ASA I-II undergoing elective tonsillectomy under general anaesthesia were randomly allocated to one of the three groups (n=30) to receive Isoflurane, Sevoflurane or Desflurane in oxygen using plenum vaporisers. Haemodynamic changes were within acceptable limits of general anaesthesia for this type of surgery. This study was consistent with our study in which the two groups were comparable in terms of baseline characteristics and ASA status. There were no significant haemodynamic changes observed in the two groups.

Alan D Baxter et al[6] studied the pharmacokinetic behaviour and practical aspects of low (0.5 L/min) and minimal (0.25-0.5 L/min) flow. Low or minimal flow anaesthesia with a circle circuit avoids the need for incircuit humidifiers, raise the temperature of inspired gases by up to 6 degrees Celsius, reduce cost by about 25% by reduction of fresh gas flows to 1.5 L/ min and reduce environmental pollution with scavenged gas.In our study, the haemodynamics were stable in the two groups.There was less consumption of muscle relaxant.The anaesthetic uptake decreased with time as the actual time course varies with the anaesthetic solubility.

A.Cherian et al[7] attempted to assess the safety of Low Flow Anaesthesia at fixed flow rates with special reference to the incidence of a decline in FiO_2 below safe levels of 0.3 and to determine whether LFA can be used safely in the absence of an FiO_2 monitor. There was no incidence of adverse events necessitating the conversion from low flows to the conventional flows. This study was consistent with our study of low flow and medium flow which was uneventful and no episode of hypoxia was recorded.

S. Kulandayan et al[8] studied two different fresh gas flow techniques 1.5 and 1.0 L/min. There was no significant difference in gas analyzer monitoring and arterial blood gases, haemodynamic parameters in both the groups. The findings of this study was consistent with our study in which there were no significant differences in haemodynamic parameters and arterial blood gases.

Conclusion

Circle systems are often used with inappropriate high flow rates and recommendations have been made repeatedly for the reduction of flow rates in order to reduce costs. The emphasis in our study is to simplify matters for a busy anaesthesiologist to help him/her adopt low flow technique, which has a tremendous potential in developing countries. Ensuring a proper depth of anaesthesia to deliver ideal surgical anaesthesia on one hand and to ensure minimal variations in the physiological parameters of the patient on the other is the prime responsibility of the anaesthesiologist.

Safety of the patient is of prime concern at all times when studies of this nature are undertaken. Hypoxia, hypercarbia, under or over dosage of volatiles are the prejudice points against low flow to be kept in mind before using low flow technique. This technique needs high tech anaesthesia machines and multi gas analysers to ensure safety of the patient.

Low flow anaesthesia reduces the cost spent on gases, environmental pollution and reduces the heat loss in patients by latent heat of vaporization as well as preserving the mucociliary clearance of patients' respiratory tract.

The study groups were comparable w.r.t. ASA physical status,type and duration of operations and anaesthesia time.Intraoperative anaesthetic, analgesic and muscle relaxant requirements were similar. There were no significant differences in MAP and HR values during the Intraoperative period.There were no significant differences among the study groups w.r.t. the incidences of hypotension, tachycardia or bradycardia and in the recovery profiles. Intraoperatively, no patient developed oxygen desaturation and $EtCO_2$ was maintained between 25-35 mm of Hg. Arterial blood gases were within the acceptable limits. There were no complaints of Intraoperative awareness from the patients. At no time the low flows were converted to the conventional flows. The study on the whole was uneventful.

Our study showed no significant difference in low flow technique so it is preferable and suggested to use in intermediate and long duration surgical procedures as it will further reduce the cost and the pollution.

Thanks to current technological and pharmacological possibilities, low flow anaesthesia or closed circuit anaesthesia are not exclusively performed by a few anaesthesiologist or "risky fellows" with a deep interest in this technique, but are now normally utilised in every day clinical practice and it is quite important for this type of anaesthesia to become a common tradition amongst all anaesthesiologists.

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