Original Research Article

Medical Air-Oxygen versus Nitrous Oxide-Oxygen: A comparative study in Patients Undergoing Laparoscopic Cholecystectomy under General Anaesthesia

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Abstract

Background: Laparoscopic procedures are gaining more popularity over conventional open abdominal surgeries.Nitrous oxide is still a popular anaesthetic carrier gas as it is cheap and reliable, provides powerful analgesia, decreases the need for maintenance anaesthetics, etc. However one of the most notable side effects of nitrous oxide is its ability to expand air-filled cavities such as the bowel. Medical air is an inert gas, environment friendly and does not have greenhouse effect as seen with nitrous oxide. However, it can cause awareness and increase requirement of anaesthetic agents to maintain depth of anaesthesia.**Objective**: To compare Propofol doses used for maintaining the depth of anaesthesia and to observe clinical signs of awareness in patients receiving oxygen-air and oxygen-nitrous oxide in undergoing laparoscopic cholecystectomy**.** **Methods**:80 adult patients of ASA grade I and II scheduled for elective laparoscopic cholecystectomy surgeries under GA were randomly divided into two groups of 40 each. Group A received oxygen and air (FiO2 0.4) and Group B received oxygen and nitrous oxide (FiO2 0.4). Dose of IV propofol infusions to maintain depth of anaesthesia, clinical signs of awareness and post op hypoxaemia were assessed. Data obtained was analyzed with suitable statistical tests.**Results**: Propofol requirements in both the groups were comparable. The total mean dose of Propofol required in Group A was 424.20±14.37 mg whereas in Group B, it was 402.20±14.56 mg (p=0.001) to maintain the depth of anaesthesia. There was no incidence of awareness or post op hypoxaemia in both the groups.**Conclusion**: Air can be used as a carrier gas instead of nitrous oxide with a significant increase in requirement of anaesthetic agentbut no increased incidence of hypoxaemia or signs of awareness.

Keywords: Propofol, nirous oxide, medical air, general anaesthesia

Introduction

The objective of laparoscopic surgery is to have minimal trauma of the procedure and in addition still attain an acceptable therapeutic result. The advantages are lessened post-surgery pain, speedy recovery, swift return to regular activity, etc.[1,2,3] Total intravenous anesthesia(TIVA)and a combination of intravenous anaesthetics with volatile anaesthetics are the two popular techniques of general anaesthesia[4,5]Amongst the available carrier gases, nitrousoxideis one of the most widely used. Its low cost and reliability, good analgesia, lower requirement of anaesthetic agents for maintenance, avoidance of awareness intra operatively, rapid onset and offset in view of less solubility in blood, obscuring of the cardiac depressant effect of other anaesthetics and no metabolism make it very suitable**.**[6,8] However, expansion of cavities like the bowel by nitrous oxide is a major adverse effect. It is when used along with oxygen eliminates the risk of hypoxia, visceral injuries and air embolism. The aim of designing the present study is to compare the medical grade air-oxygen Propofol and nitrous oxide-oxygen Propofol in patients undergoing laparoscopic cholecystectomy under general anaesthesia.

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Aims And Objectives: The aim of the study was to compare medical grade air-oxygen Propofol and nitrous oxide-oxygen Propofol in patients undergoing laparoscopic cholecystectomy under general anaesthesia.The objectives were:

- To compare Propofol doses used to maintain anaesthesia depth
- To observe any clinical signs of awareness
- To compare hemodynamic variables (Heart rate, Systolic blood pressure, diastolic blood pressure, mean arterial pressure, SpO2)
- To record complications if any

Materials and Methods

After obtaining institutional ethics committee permission (Ref no. TMMC&RC/IEC/18-19/004), the study was conducted in the Department of Anaesthesiology,Teerthanker Mahaveer Medical College & Research Centre,Moradabad from 2018-2020.

Sample Size: The study population was calculated by using G-power software in which the mean of prevalence was 50% and the Incidence was reduced to 18% given in the article by Martin et al . The sample size was calculated with 80% power and 5% significance level. The total sample size was determined to be 80.

Selection of study population : This prospective, comparative, open label study was conducted on patients undergoing Laparoscopic Cholecystectomy Surgeries under General Anaesthesia (GA) in the Department of Anaesthesiology, Teerthanker Mahaveer Medical College & Research Centre, Moradabad from 2018-2020. Adult patients of age 18-60 years, ASA(American Society of Anaesthesiologists) Grade I and II undergoing laparoscopic cholecystectomy electively under GA and Mallampati Grade 1 and 2 willing to give written informed consent were included in the study. The exclusion criteria were patients at risk of pulmonary aspiration e.g. obstetric patients and those with severe medical comorbidities such as impaired renal, liver or respiratory function and diabetics. After obtaining approval and clearance from the Institutional Ethics Committee, a total of 80 patients were enrolled in the study. The study subjects fulfilling the inclusion criteria were randomly assigned into two groups of forty patients each using chit and box method. Group Areceivedoxygen, air and propofol (FiO20.4) and Group N receivedoxygen,nitrous oxide and propofol FiO20.4)

Study Parameters: Pulse rate, Systolic and Diastolic blood pressure, Oxygen saturation, $ETCO_2$ and Ramsay Sedation Score were assessed and compared between the two groups

Study procedure:A detailed history, complete physical examination and routine & appropriate investigations were done for all patients. All patients underwent premedication and induced with propofol according to the normal hospital protocol. Patients were intubated with a cuffed endotracheal tube.IPPV was provided with O2-Air (FiO2 0.4) in group A and O2-N2O (FiO2 0.4) in group N. The FiO2 0.4 was measured with an oxygen analyser (Allied Sl no.00214). Muscle relaxation was maintained by Inj. Vecuronim 0.04mg/kg IV intermittently. Both groups received IV Propofol 10mg/kg/hr for 10minutes followed by 8mg/kg/hr for 10 minutes followed by 6mg/kg/hr with clinical signs of awareness as the end point i.e. increase in blood pressure and heart rate (≥20% increase), movement, sweating, lacrimation, eyelash reflex, frowning of frontalis[7]. Carbon dioxide was used for pneumoperitoneum intra-abdominal pressure and flow rate were noted. Onset of pneumoperitoneum with the introduction of Veress needle and associated HR, BP were recorded.If clinical signs of awareness appeared, then rescue drugs IV Fentanyl (1mcg/kg) bolus was given with a ceiling dose of 5mcg/kg/hr[8] if required.Timings for insufflations and de-sufflation were noted. The intra-abdominal pressure was uniformly maintained between 12-15 mmHg. During pneumoperitoneum the controlled ventilation were adjusted to maintain end tidal carbon dioxide (ETCO2) in the range of 35-40mmHg. The duration of the surgery was also noted. All patients received local infiltration at port sites with 0.25% bupivacaine + 1% lignocaine and IV Paracetamol (15mg/kg) at the end of the surgery. Reversal was done according to standard hospital protocol.The pulse rate, blood pressure, oxygen saturation and $ETCO_2$ were noted. Sedation was assessed by Ramsay Sedation Scale.

"Ramsay Sedation Scale **[9]** was assessed as follows:

1. Patient is anxious and agitated or restless, or both
2. Patient is co-operative, oriented, and tranquil.
3. Patient responds to commands only
4. Patient exhibits brisk response to light glabellar tap or loud auditory stimulus
5. Patient exhibits a sluggish response to light glabellar tap or loud auditory stimulus.
6. Patient exhibits no response."

"Patients were also be observed for post-operative nausea and vomiting (PONV) for 12 hours. Patients were interviewed for awareness during the surgery with questions from the BRICE questionnaire." [10,16]

Statistical analysis: The data was analyzed using SPSS software version 21.0. The quantitative data was depicted as mean and standard deviation. For qualitative data, frequency and percentage were used. Student t-test was applied for comparing the mean values whereas chi-square test was applied for comparing the frequency. P-value was considered to be significant when less than 0.05.

Results

A total of 80 patients were enrolled based on inclusion and exclusion criteria

Distribution of study population according to age, sex, in both the groups

Table 1:Distribution of study population according to age, sex, in both the groups

Groups	Group A	Group N	p-value
Sex (Male/ Female)	16/24	15/25	0.77#
Age (Years)(Mean ±SD)	34.42±11.60	36.08±8.66	0.567#
ASA Grading (ASA Grade 1&2)	28/12	25/15	0.65#
* Significant # Non Significant			

Pulse rate: The mean pulse rate at intubation, insufflation of gas, desufflation and post-extubation was compared between group A and group N (unpaired t-test).No statistically significant difference was observed between the two groups (Figure 1)

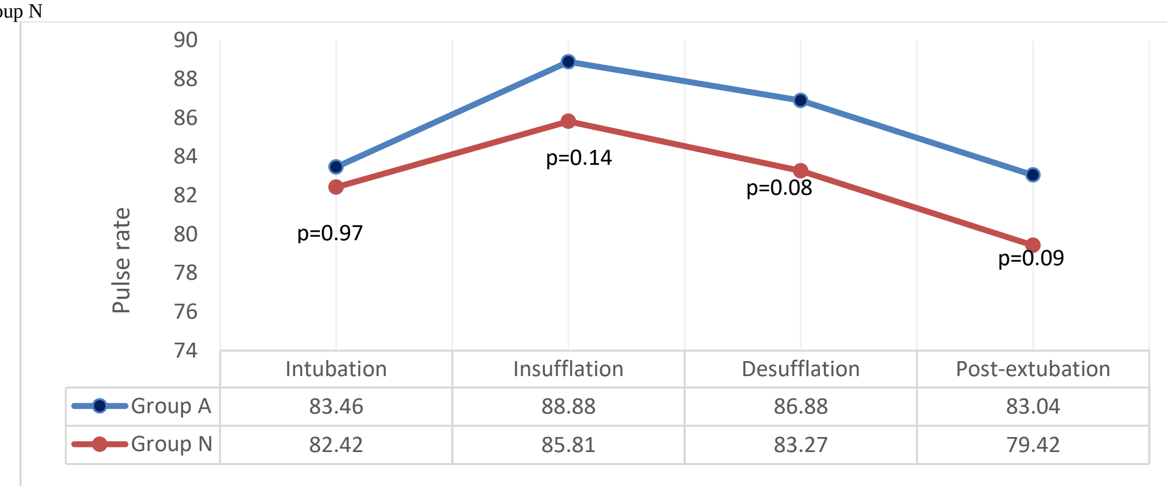

Fig 1: Mean Pulse Rate

Systolic and Diastolic blood pressure

The mean systolic blood pressure and diastolic blood pressure at intubation,insufflations of gas, desufflation and post-extubation was comparable between group A and group N(unpaired t-test)(Figure 2, Figure 3).

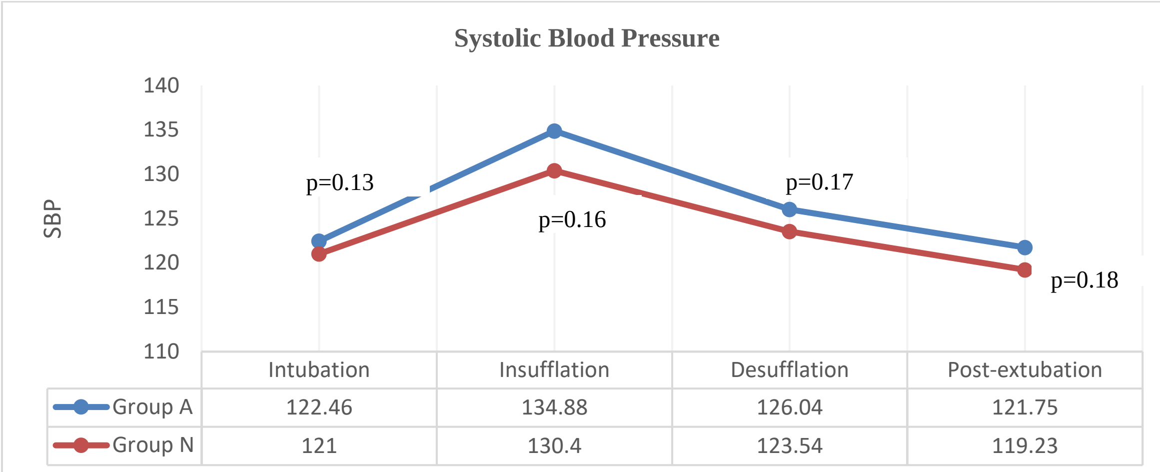

Fig 2: Systolic Blood Pressure

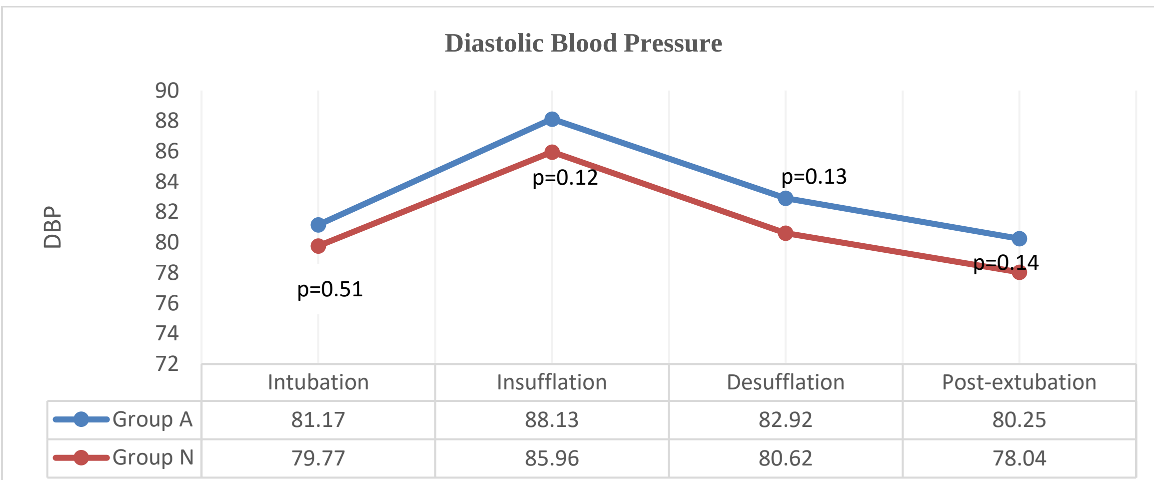

Fig 3: Diastolic Blood Pressure

Mean arterial pressure: The mean MAP at intubation,insufflation of gas, desufflation and post-extubation was comparable between group A and group N(Figure 4).

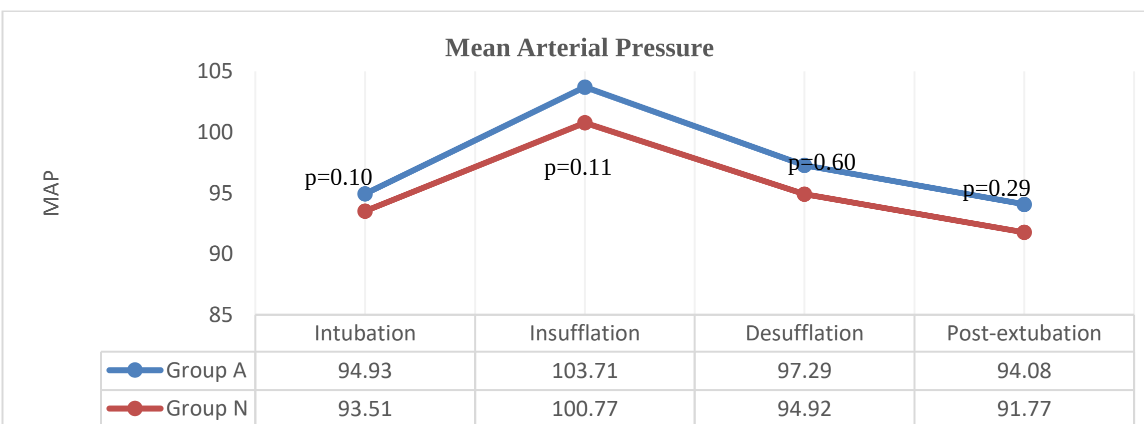

Fig 4: Mean Arterial Pressure

ETCO2 and SPO2: No statistically significant difference was observed in mean $ETCO_2$ and mean SpO_2 at intubation ,insufflations of gas, desufflation and post-extubation between the groups (Fig 5, Fig 6)

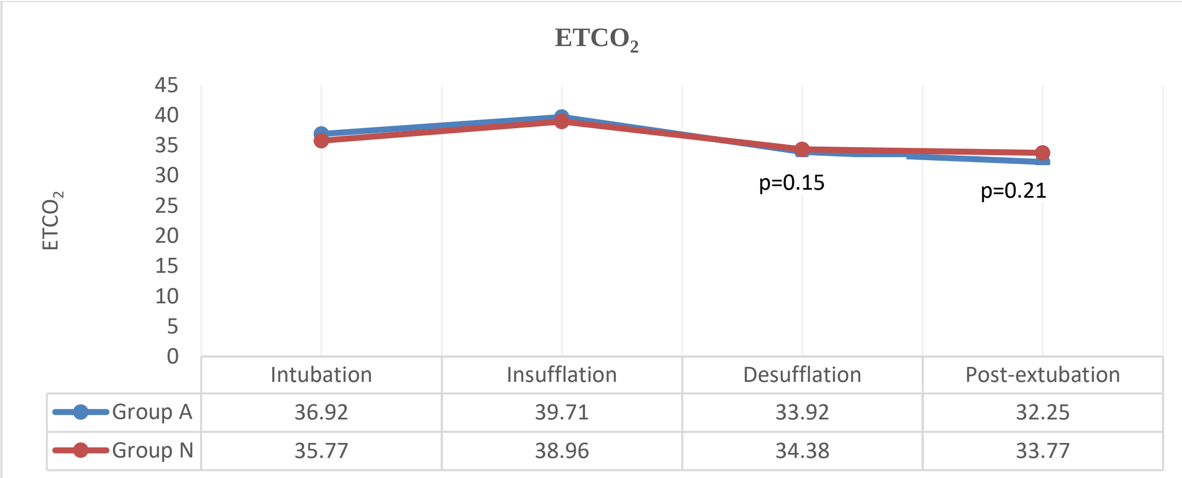

Fig 5: Mean $ETCO_2$

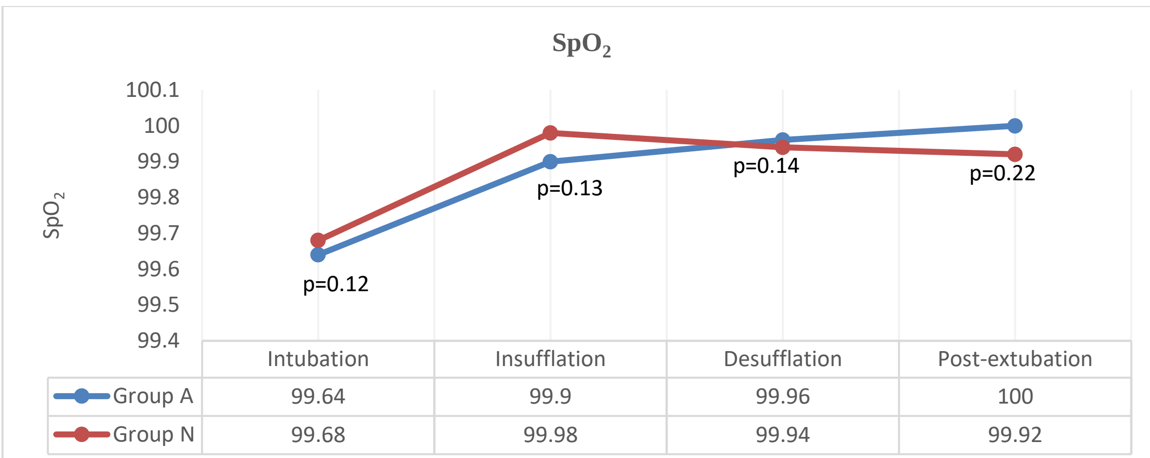

Fig 6: Mean SpO_2

Mean propofol dose: Mean Propofol dose required in Group A was significantly higher than Group N as shown in Figure 7.

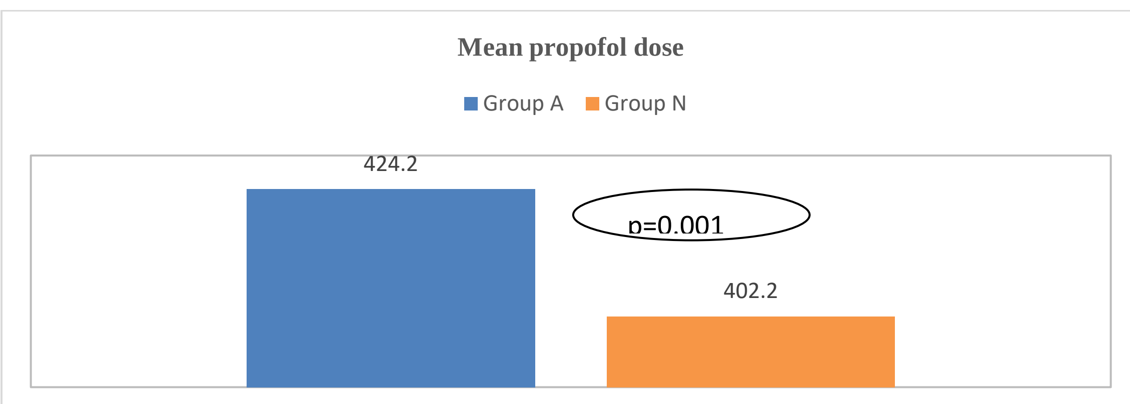

Fig 7: Mean propofol dose

Ramsay Sedation Scale: The distribution of Ramsay Sedation Scale was compared between group A and group N(Fig 8).

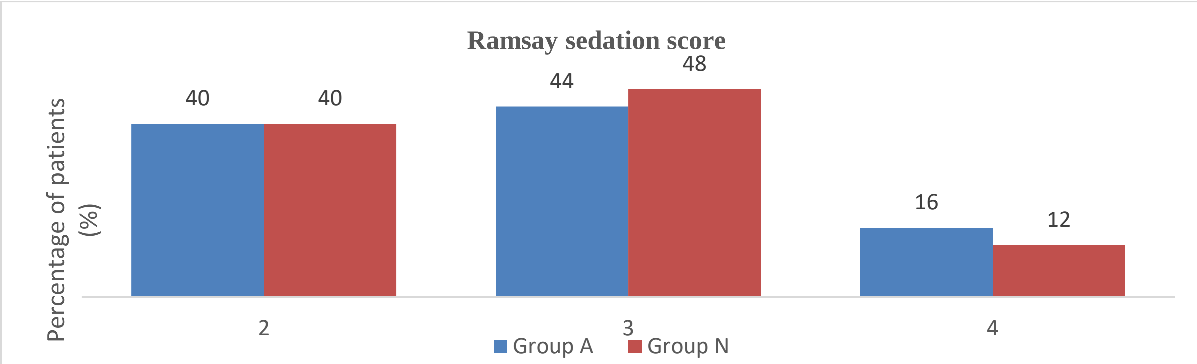

Fig 8: Ramsay Sedation Scale

Table 2:Distribution of Ramsay Sedation Scale between group A and group N

Ramsay Sedation Scale	Groups		Total
	Group A	Group N	
2	16	16	32
	40.0%	40.0%	40.0%
3	18	19	37
	44.0%	48.0%	46.0%
4	6	5	11
	16.0%	12.0%	14.0%
Total	40	40	80
	100.0%	100.0%	100.0%
$\chi 2$ value= 0.186, p-value = 0.911			

Complications

There was no incidence of hypoxaemia, atelectasis, postoperative nausea/vomiting or any other complication in both the groups.

Discussion

The essential components of anaesthesia include immobility, unconsciousness, and suppression of autonomic responses. This can be achieved with the judicious use of multiple drugs, which include inhaled and intravenous agents. The combination of drugs that potentiate the anaesthetic effects enable the usage of fewer drugs, which subsequently reduce complications.Medical air is an inert gas, environment friendly and does not have green house effect as seen with nitrous oxide.[10] During general anaesthesia, a commonly used intravenous induction agent is propofol. This is used alone or in combination with benzodiazepines, opioids, or inhalational agents[11].Adult patients of age 18-60 years, ASA (American Society of Anaesthesiologists) Grade I and II undergoing laparoscopic cholecystectomy electively under GA and Mallampati et al [12] Grade 1 and 2 willing to give written informed consent were included in the study.

Demographics

In current study, the difference in mean age and gender distribution was not statistically significant between group A and group N which is in line with the study by Swain et al,[13] and Jain et al,[19] with similar mean age and gender distribution in both the groups.

Haemodynamic parameters

The haemodynamics was slightly elevated in group A than group N which might be due to higher propofol required in this group[14]. However, the difference was not statistically significant. In line with this study, *Jain et al* showed that there was no significant change in SBP, DBP, and MAP after intubation, intraoperative period, and after extubation in both groups. *Swain et al*, reported that haemodynamic changes were within ±20% in both the groups with no significant difference.

The hemodynamic effects of N_2O are due to its property to stimulate the sympathetic nervous system; however, it is a direct myocardial depressant, but arterial blood pressure, cardiac output, and HR are unchanged or slightly elevated because of sympathetic stimulation and catecholamine release.

Propofol dose required

In present study, the mean Propofol dose required was significantly more among Group A compared to Group N. This coincided with the study by *Swain et al*, in which the mean dose of propofol was 802.12±206 mgs among O_2-air group compared to 546.67±124 mgs among O_2-N_2O_2 group.In study by *Jain et al*, the induction dose and induction time in Group FN were significantly lower than in Group FO.

Ramsay Sedation Scale

There was no significant difference in distribution of Ramsay Sedation Scale between group A and group N in this study.[15]

Postoperative pulmonary complication

Patient was assessed in the post operative care room for pulmonary complications, no fall in SpO2, dyspnoea, or tachypnoea were observed in the present study in any of the group. No undesirable effect of 100% oxygen ventilation was reported by *Lampron et al.* and *Lemaire et al.* The beneficial effect of 100% oxygen ventilation is attributed to protection of the lung from hypoxic pulmonary vasoconstriction by neutralization of Euler-Liljestrand mechanism. *Edmark et al* stated that significantly more atelectasis formation was seen when breathing 100% oxygen for induction of anesthesia than breathing 60-80% of oxygen which leads to intrapulmonary shunting thus contributing to pulmonary complications postoperatively.[16,17]

During general anesthesia,concomitant use of nitrous oxide(N2O)as inhalational agent reduces the induction and maintenance dose requirement of propofol.[15,18,19]. However, the effect of both drugs on over all dynamics remain controversial [20,21,22].

Efforts are being made to replace the usage of nitrous oxide as a carrier gas with medical air during general anasethesia.[23,24,25]

Postoperative nausea/vomiting (PONV)

No incidence of postoperative nausea/vomiting was observed in the current study. A high risk of PONV was found to be associated with N_2O in a study by *Leslie et al.*[26,27]

The specification for using the medical air oxygen as carrier gas is that it should be clean and free from bacterial contamination, moisture, toxic products, flammable or toxic vapours and odours at all time points in the pipeline systems. Medical air (air for breathing) is defined by NFPA (national fire protection association) air, regardless of its source, that has no detectable liquid hydrocarbons, less than 25 ppm hydrocarbons, less than 5mg/cubic metre of particulates of 1 μ size or greater at normal atmospheric pressure and dew point at 50 psig of less than at 390 F.

Mosley et al.[28] showed that substituting air was more cost effective as compared to nitrous oxide with oxygen cost lowered by 32%. The difference in recovery time or recovery room stay was also not significant between these groups. *Mandal* and *Parray*.[29] also concluded that air oxygen based anesthesia technique is a relatively safer and better technique than conventional nitrous oxide based anesthesia for laparoscopic surgical procedures.

Conclusion

The study concluded that air can be used as carrier gas instead of the nitrous oxide though the requirement of anaesthetic and analgesic agent increases.The risk of hypoxia is completely eliminated and there is no gastric distension and visceral injury. Medical air is environment friendly while nitrous oxide is hazardous to the environment and increases the global warming. The practice of using the medical air as component of carrier gas however is expensive and costs more than nitrous oxide supplies but its advantage is high enough to compensate it.

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