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EVALUATION OF SAFETY AND EFFICACY OF LOW FLOW ANAESTHESIA USING DESFLURANE.

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ABSTRACT This research was done to study the efficiency and safety of low flow anaesthesia using desflurane as inhalational anaesthetic agent in major surgical procedures. **Methodology:** This study was a prospective observational study on a total of 70 patients, divided into 2 groups alternatively with 35 patients in each group based on surgery i.e., laparoscopic (n = 35) or non-laparoscopic (n = 35) in a tertiary medical college in India wherein effects of low flow desflurane was assessed in respect of hemodynamic parameters, equilibration time, duration of surgery, recovery time and desflurane consumption. **Observation and Results:** In this study, it was found that the equilibration time, duration of surgery and consumption of desflurane are similar in both groups. A Positive correlation of Equilibration time with Body mass index (BMI) is observed. Recovery time shows no correlation with duration of anaesthesia but shows positive correlation with Body mass index (BMI). The mean consumption of desflurane is calculated by coefficient for regression through origin is 19.32 mL/min as show.

KEYWORDS : Haemodynamic parameters, desflurane, low flow anaesthesia.

INTRODUCTION

Volatile anaesthetic agents are fluorocarbons, which are known to deplete the ozone layer and produce a greenhouse effect several times more potent than carbon dioxide. (1) due to its chemical stability, it lasts longer in atmosphere and has highest greenhouse gas equivalents among anaesthesia agents. (2) Low flow anaesthesia helps reduce expenses, operating room pollutants, and the ecological effects of volatile anaesthetic drugs by decreasing their use. (1) Low-flow anaesthesia is defined as an inhalation anaesthetic technique in which the rebreathing fraction of exhaled gases amounts to 50% which is returned to the patient after CO_2 removal in the next inspiration, which can be achieved when fresh gas flow (FGF) is reduced to 2 L/min or less. There is no universally accepted definition of low-flow anaesthesia, although it implies a lower carrier gas flow than is attainable with a non-absorber breathing system. (3)

Desflurane is highly fluorinated methyl ethyl ether (1,2,2,2-tetrafluoroethyl difluoromethyl ether), due to its higher cost and lower potency compared to other inhalational agents, increases the direct cost of providing anaesthesia care. However, due to early recovery from anaesthesia, particularly in elderly and obese patients, early mobilization, reduction in morbidity can reduce cost of care indirectly. Using the opioid adjuvants and low flow anaesthesia could reduce desflurane consumption and its associated cost and environmental impact.(2) (4)

Laparoscopic procedures offer significant advantages to the patient, including reduced incision size and stress, decreased postoperative pain, accelerated healing rates, a lower incidence of postoperative wound infections and fast turnover of patients.(5)

So, this study was undertaken to assess of low flow anaesthesia using desflurane as inhalational anaesthetic agent in Laparoscopic and Non-Laparoscopic surgeries.

METHODOLOGY

This study was a prospective observational study was carried out prospectively in Department of Anesthesiology after getting approval from institutional ethical committee.

Sample Size

Sample size is calculated by taking the mean with standard deviation of equilibration time of desflurane from previous study (6) and by taking absolute error of 5% with 95% confidence interval and 80% power.

Inclusion Criteria

Adult patients of age 18-65 years, ASA grade 1 or 2, and General surgery and Otorhinolaryngology patients posted for various surgical procedures under general anaesthesia.

Exclusion Criteria

Patients unwilling, ASA Grade 3 and 4, those with mental incapacity or language barrier, BMI over 35, active cancer, coagulation disorders, severe cardiac and respiratory diseases.

A total of 70 Patients were studied, divided into 2 groups alternatively with 35 patients in each group based on surgery i.e., laparoscopic (n = 35) or non-laparoscopic (n = 35).

Patients were pre medicated with Intravenous (IV) Glycopyrrolate 0.2mg, Midazolam 0.3mg/kg, and Fentanyl 2mcg/kg. Patients were preoxygenated with 100% oxygen using dual limb closed circuit till end-tidal oxygen concentration reaches 90%. Anaesthesia induction by administering intravenous (IV) Propofol 2 mg/kg, and Rocuronium 1 mg/kg. Patient were hand ventilated with help of a facemask using FGF of oxygen 6 L/min for 60 seconds. Trachea was then intubated using appropriate size Endotracheal tube. Desflurane was set at 6% on vaporizer dial.

Once the ratio of expired (Fe) to inspired (Fi) Desflurane concentration became 0.8, high FGF was reduced to the Low FGF mixture, i.e., 1 L/min of oxygen this event was defined as the "equilibration point" of the inhalational anaesthetic agent. Time for achieving Equilibration point from start of desflurane administration is noted. At the end of surgery, after last suture/removal of port, the vaporizer dial of Desflurane was turned off and oxygen flow was increased to 6L/min. The Recovery time is taken as time required to achieve modified Aldrete score >8 after switching of desflurane vaporizer was used to assess the recovery characteristics. Total consumption of Desflurane was recorded from the anaesthesia machine (Mindray WATO 55 Pro) software.

Continuous and categorical variables are expressed as mean ± standard deviation. Differences in subject characteristics between Laparoscopic and Non-Laparoscopic surgeries were analyzed using the t-test for continuous variables and the Chi-squared test/Fisher's exact test for categorical variables. Linear regression used for analyzing association between variables.

OBSERVATION AND RESULTS

No statistically significant difference is noted with respect to age, gender, weight, body mass index and ASA-PS (American society of anaesthesia – Physical status) as shown in table 1.

The equilibration time for non-laparoscopic and laparoscopic surgeries is similar, with respective durations of 4.91 ± 0.91 min and 5 ± 0.76 min, and a cumulative mean of 4.96 ± 0.84 min, as presented in Table 2. A Positive correlation of Equilibration time with BMI is observed by linear regression R2 = 0.478 and $F(1,68)= 62.32$, $p < 0.000$, indicating Equilibration time increases with BMI as shown in figure 1. There is no significant difference in the duration of surgery between non-laparoscopic and laparoscopic procedures, with mean values of 146 ± 13.76 min and 145.14 ± 16.04 min, respectively as represented in table 2.

Table 2 demonstrates that there is no significant difference in recovery time between non-laparoscopic and laparoscopic surgeries, with mean values of 7.17 ± 1.83 min and 7.82 ± 1.48 min, respectively.

No correlation between Recovery time and Duration of anaesthesia is observed by linear regression R2 = 0.005 and F(1,68)= 0.346, p = 0.558, indicating recovery time is not affected by duration of anaesthesia as shown in figure 2. Recovery time is positively correlated with BMI as shown in figure 3. The mean consumption of desflurane is calculated by coefficient for regression through origin is 19.32 mL/min as shown in figure 4.

While studying the haemodynamic parameters, it was found that there was no significant difference in Pulse rate between Laparoscopic and Non-laparoscopic group as shown in figure 5; while there was significant difference in Mean arterial pressure between Laparoscopic and Non-laparoscopic group, but the difference is not clinically relevant and is within normal range as shown in figure 6.

Expiratory O2 concentration followed similar trend as Inspiratory O2 but lesser than Inspiratory O2 (87.14+1.3 and 87.28+1.2 at equilibration and 87.14+1.3 and 87.28+1.2 at 30 min) as shown in figure 7. Although there was no clinically significant difference in initial ETCO2 values between non-laparoscopic and laparoscopic surgeries at 5 minutes, ETCO2 values increased significantly (p < 0.001) in laparoscopic procedures following pneumoperitoneum as shown in figure 8. However, these differences are not clinically significant and do not impact the concentration of inhalational agents used during the procedures.

DISCUSSION

The benefits and uses of low-flow anaesthesia have been advocated for many years. (7) The resurgence of interest over last few years because of breakthrough developments in modern anaesthetic machines, gas analyser monitors, precise vaporisers, and the introduction of more effective volatile drugs with limited absorption have eased the use of low flow anaesthesia. (3) The discovery of new low-solubility agents, such as desflurane and sevoflurane, has led to an increase in the use of this technique, which aims to save costs by adjusting the administration of fresh gas to meet patient needs. (2) This technique is gaining popularity among anaesthesiologists due to its various advantages and has become a necessity due to the rising awareness of environmental pollution and the need for cost-effective and day-care services.(8)

This is similar to the age distribution in a study by Shelgaonkar VC et al with age distribution in laparoscopic and non-laparoscopic surgeries with 31.92 ± 14.11 and 36.2 ± 11.33 respectively(7). But lesser than the age group in a study by Horwitz M et al (46 ± 12)(9). Patients with age >65 years were not included in the study as elderly patients may be at increased risk for hemodynamic changes during the perioperative period. Age-related changes in cardiovascular function, including decreased cardiac output, decreased peripheral vasomotor tone, and decreased baroreceptor sensitivity, can contribute to hemodynamic instability in the elderly.(10)

Patients were induced by administration of intravenous (IV) Propofol 2mg/kg and Rocuronium 1mg/kg. Patients were then ventilated with help of a facemak using Fresh gas flow of 6L/min for 60 seconds and trachea was then intubated. Only 100% oxygen was used till intubation and desflurane or any other inhalational agent is used before intubation since there is potential danger for laryngospasm and increased secretions with Desflurane use.(11)

The equilibration time refers to the time required to reach the equilibration point with a constant flow of fresh gas and fixed dial setting. In this study, the equilibration time for desflurane was found to be 4.95 ± 0.84 min at 6L/min FGF and 6% dial setting (table 2), which is similar to the equilibration times reported in previous studies by Malik et al (4.96 ± 1.6 min) (4) and Taol P et al (3.7 ± 0.5 min). (6) Equilibration time showed positive correlation with BMI of patients indicating longer time for induction in obese patients (Figure 1). Lemmens H et al. found no difference in desflurane absorption between obese and non-obese patients(12).

In the Equilibration method, the switch-over time is not fixed, but rather determined by achieving an adequate expiratory concentration of the inhalational agent, described as 80% of the concentration of the inspiratory fresh gas flow (Fe/Fi = 0.8). The ratio is the effective changeover point and aids in the effective denitrogenation and maintenance of a constant level of inhalational gent during the transition from high FGF to low fresh gas flow anaesthesia.(4)

Maintenance of Anaesthesia: The depth of anaesthesia for induction is ensured both clinically and achieving Bispectral index values between 40 – 60, though both methods are similar in outcome, (13) clinical assessment is better than Bispectral index guided monitoring due to a shortcoming in Bispectral index algorithm which limits the estimation of fentanyl induced potentiation of propofol sedation effect. Due to the use of 100% O2 as the carrier gas in this study, any potential paradoxical effects of N2O on Bispectral index were avoided.(14)

Hemodynamic monitoring: Pulse rate and Mean arterial blood pressure are monitored during the preoperative period till the complete recovery from anaesthesia. There is no clinically significant difference in pulse rate throughout the surgery between non-laparoscopic and laparoscopic surgeries respectively at 5min 80.91+10.43, 80.68+11.03 and at 70.94+10.62, 70.51+13.31 at 30 min (figure 5). The Mean arterial blood pressure was comparable at equilibration in both non-laparoscopic and laparoscopic groups 110.97¬+6.85, 110.57+6.15 respectively but significantly increased in laparoscopic group after pneumoperitoneum (96.71+6.71, 102.2+5.94 at 30 min p = <0.001)(figure 6) which could be attributable to increased arterial CO2 tension and physiologic effects of laparoscopic surgeries). (14) These findings are similar to that of a study by Tanrivedi et al.,(15).

There is no defined standard parameter for estimating recovery. After ensuring adequate recovery from effects of muscle relaxants as indicated by achieving adequate tidal volume on spontaneous ventilation, which minimizes the interference of muscle relaxant effect on Aldrete score, The recovery time from anesthesia was estimated using time required for achieving modified Aldrete score of greater than 8, after switching off the desflurane vaporizer. The mean recovery time was 7.5 ± 1.69 min (table 2) and was positively correlated with Body mass index (BMI) (figure 3) but not with the duration of surgery (figure 2). This could be attributable to desflurane's short context sensitive half-life (2) and significantly longer equilibration time with fat than the duration of the study(16).

Desflurane consumption during anesthesia depends on the set volume percent and fresh gas flow rate and can be predicted using Dion's formula (17). The estimated desflurane consumption for a 6% dial setting and Fresh gas flow of 1L/min was 19.53 mL/hr, which is similar to the consumption calculated by linear regression through origin (figure 4).

With low flow anaesthesia, the delivery of a hypoxic gas mixture is a major concern either due to differential uptake of agents, oxygen uptake remains constant at 200–250 ml/min, but uptake of anaesthetic agents including N2O will be minimal, or inadequate O2 gas flow failing to meet the patient's VO2. Pulse oximeter is a less sensitive surrogate sensor of tissue oxygenation; an oxygen analyser is required. The minimum acceptable value for FiO2 should be 0.30. To prevent hypoxic mixes and under/overdosing of anaesthetic drugs, continuous observation and frequent flow adjustments are essential. (3) Since we used 100% O2 as carrier gas, End-tidal O2 never decreased below 80% concentration as shown in figure 8 Delivery of hypoxic gas mixture is one of the major concerns with use of low flow anaesthesia. This is due to delivery of O2 in fresh gas is close to O2 consumption of the body. (3)(18)

Another key concern with Low flow anaesthesia is the increased use of CO2 absorbents, the possibility of hypercarbia, and CO2 rebreathing with frequent depletion of absorbers. Possible accumulation of unwanted trace gases, such as carbon monoxide, acetone, methane, hydrogen, ethanol, and compound A - haloalkene in the system.(3)

CONCLUSION

It was concluded that Desflurane with low flow anaesthesia technique is safe, economic and can be recommended for use in patients undergoing general anaesthesia for various procedures under both laparoscopic and non-laparoscopic surgeries.

Table 1 Showing Age And Gender And Weight-wise Distribution Of Patients In 2 Groups

Variables	Non-Laparoscopic surgeries (n=35)	Laparoscopic surgeries (n=35)	P value

Age	35.31 ± 12.86	39.94 ± 13.42	0.145
Gender (M/F)	14/21	17/18	0.637
Weight (kg)	65.28 ± 8.17	65.4 ± 8.06	0.174
Height (cm)	154.11 ± 6.04	154.6 ± 5.74	0.406
BMI	27.27 ± 3.17	27.99 ± 2.75	0.314
ASA – PS (1/2)	26/9	18/17	0.082

*Standard Deviation; **Body mass Index; ***American society of anesthesiology - physical status grading; Test applied: Chi-square test.

Table 2 Showing Age And Gender And Weight-wise Distribution Of Patients In 2 Groups.

Variables	Non-Laparoscopic surgeries (n=35)	Laparoscopic surgeries (n=35)	P value
Equilibration time	4.91 ± 0.91	5.0 ± 0.76	0.372
Duration of Anesthesia	146 ± 13.76	14.14 ± 16.04	0.28
Recovery time	7.17 ± 1.83	7.82 ± 1.48	0.104
MAS** at Extubation	9.11 ± 0.83	9.05 ± 0.85	0.992
Desflurane consumption	47.8 ± 6.47	47.34 ± 6.37	0.41

**Modified Aldrete score; Test applied: Chi-square test.

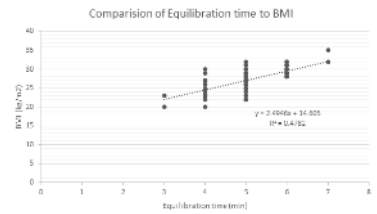

Figure 1 Showing Correlation Of Equilibration Time To BMI.

A simple linear regression was calculated to predict Equilibration time based on Body mass index (BMI). A significant regression equation was found (F(1,68)= 62.32, p < 0.000), with R2 of 0.478 when Equilibration time is measured in minutes and BMI in kg/m2.

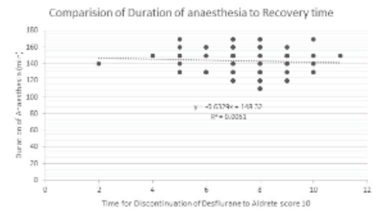

Figure 2 Showing Correlation Of Duration Of Anaesthesia To Recovery Time

A simple linear regression was calculated to predict Recovery time based on Duration of Anaesthesia. A Non - significant regression equation was found (F(1,68)= 0.346, p = 0.558), with R2 of 0.005 when Recovery time, which is defined by the time taken from stopping of desflurane vaporiser till achieving Aldrete score 10, and duration of anaesthesia are measured in minutes.

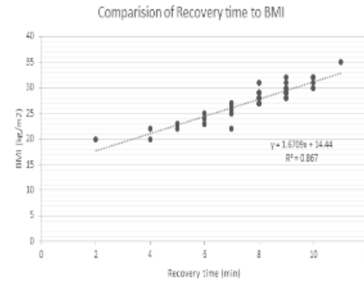

Figure 3 Showing Correlation Between Recovery Time And BMI.

A simple linear regression was calculated to predict Recovery time based on Body mass index (BMI). A significant regression equation was found (F(1,68)= 443.46, p < 0.000), with R2 of 0.867 when Recovery time, which is defined by the time taken from stopping of desflurane vaporiser till achieving Aldrete score >8, is measured in minutes and BMI in kg/m2.

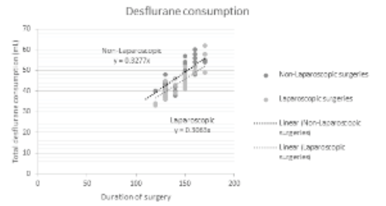

Figure 4 Showing Linear Regression Of Desflurane Consumption To Duration Of Surgery.

A multiple linear regression was calculated to predict Desflurane consumption based on duration, where duration is measured in minutes, and type of surgery (Laparoscopic and non-Laparoscopic surgery). A significant regression equation found (F(2,13) = 71.28, p < 0.000), with an R2 of 0.68. There is no significant difference in desflurane consumption between Laparoscopic and Non-Laparoscopic groups (p = 0.105).

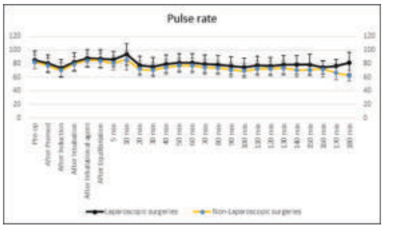

Figure 5 Showing Comparison Of Mean (SD) Heart Rate Changes Between Laparoscopic And Non-laparoscopic Group.

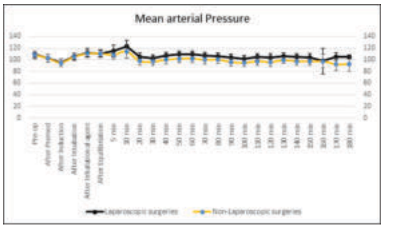

Figure 6 Showing Comparison Of Mean (SD) Mean Arterial Blood Pressure Changes Between Laparoscopic And Non-laparoscopic Group.

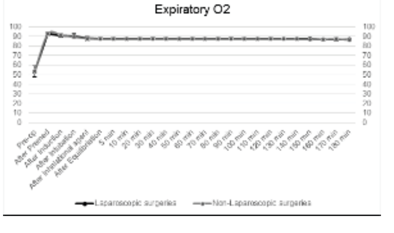

Figure 7 Showing Comparison Of Mean (SD) Expiratory O2 Changes Between Laparoscopic And Non-laparoscopic Group.

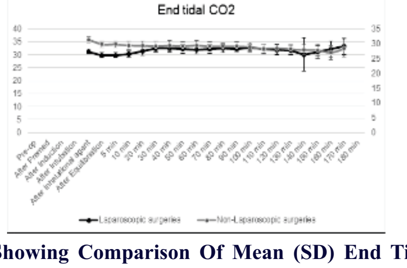

Figure 8 Showing Comparison Of Mean (SD) End Tidal CO2 Changes Between Laparoscopic And Non-laparoscopic Group.

REFERENCES

1. Hönemann C, Hagemann O, Doll D. Inhalational anaesthesia with low fresh gas flow. Indian J Anaesth. 2013 Jul; 57(4): 345-50.
2. Kapoor M, Vakamudi M. Desflurane - revisited. J Anaesthesiol Clin Pharmacol. 2012 Jan; 28(1): 92-100.
3. Upadya M, Saneesh P. Low-flow anaesthesia - underused mode towards "sustainable anaesthesia". Indian J Anaesth. 2018 Mar; 62(3): 166-72.
4. Mallik T, Aneja S, Tope R, Muralidhar V. A randomized prospective study of desflurane versus isoflurane in minimal flow anesthesia using "equilibration time" as the change-over point to minimal flow. J Anaesthesiol Clin Pharmacol. 2012 Oct; 28(4): 470-5.

5. Hayden P, Cowman S. Anaesthesia for laparoscopic surgery. Anaesth. Crit. Care Pain Med. 2011 Oct; 11(5): 177-80.
6. Toal P, Chiplonkar S, Panchal P. A randomised prospective comparison of equilibration point and changing gas composition during low-flow anaesthesia with sevoflurane vs desflurane. Indian J Anaesth. 2019 Oct; 63: 814-19.
7. Shelgaonkar V, Choudhary A. Low flow anaesthesia: economic, eco friendly and effective. Indian J Anaesth. 2017; 4(3): 382-7.
8. Naço M, Çeliku E, Gani H, Dibra A, Agaçi E. The calculated economic cost of inhalator volatile anesthetics in low flow anesthesia. AJMHS. 2019; 51.
9. Horwitz M, Jakobsson J. Desflurane and sevoflurane use during low- and minimal-flow anesthesia at fixed vaporizer settings. Minerva Anestesiol. 2016 Feb; 82(2): 180-5.
10. Gragasin F, Bourque S, Davidge S. Vascular aging and hemodynamic stability in the intraoperative period. Front Physiol. 2012 Apr; 2: 74.
11. Dalal K, Choudhary M, Palsania A, Toal P. Desflurane for ambulatory anaesthesia: A comparison with sevoflurane for recovery profile and airway responses. Indian J Anaesth. 2017 Apr; 61(4): 315-20.
12. Lemmens H, Saidman L, Eger E2, Laster M. Obesity modestly affects inhaled anesthetic kinetics in humans. Anesth Analg. 2008 Dec; 107(6): 1864-70.
13. Arya S, Asthana V, Sharma J. Clinical vs. bispectral index-guided propofol induction of anesthesia: A comparative study. Saudi J Anaesth. 2013 Jan; 7(1): 75-9.
14. Bharti N, Devrajan , Jagan. Comparison of Bispectral Index Values Produced by Isoflurane and Halothane at Equal End–tidal MAC Concentrations. Indian J Anaesth. 2007 Sep-Oct; 51(5): 401-4.
15. Tanrıverdi T, Tercan M, Halitoğlu A, Kaya A, Patmano G. Comparison of the Effects of Low-flow and Normal-flow Desflurane Anaesthesia on Inflammatory Parameters in Patients Undergoing Laparoscopic Cholecystectomy. Turk J Anaesthesiol. 2021 Feb; 49(1): 18-24.
16. Yasuda N, Lockhart S, Eger E2, Weiskopf R, Johnson B, Freire B, et al. Kinetics of desflurane, isoflurane, and halothane in humans. Anesthesiology. 1991 Mar; 74(3): 489-98.
17. Dion P. The cost of anaesthetic vapours. Can J Anaesth. 1992 Jul; 39(6): 633.
18. Venkatachalapathy R, Cherian A, Panneerselvam S. Changes in Gas Composition during Low Flow Anaesthesia without Nitrous Oxide. J Clin Diagn Res. 2017 Jul; 11(7): UC29-UC33.
19. O'Malley C, Cunningham A. Physiologic changes during laparoscopy. Anesthesiol Clin North Am. 2001 Mar; 19: 1-19.
20. Mandal T, Mukherjee M, Acharjee A, Chakrabarti S. The comparative effects of desflurane and isoflurane on intraoperative cerebral hemodynamics, cardiovascular changes, and post-operative recovery in patients undergoing craniotomy for supratentorial tumors. Asian J. Med. Sci. 2022 Jul; 13: 63-70.