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A CAPNOGRAPHY AIDED CLINICAL COMPARATIVE STUDY TO DETERMINE EFFICACY OF CIRCLE ABSORPTION SYSTEM AND BAIN BREATHING SYSTEM IN CONTAINING HYPERCARBIA DURING LAPAROSCOPIC CHOLECYSTECTOMY WITH CARBON DIOXIDE PNEUMOPERITONIUM

Anesthesiology

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ABSTRACT

Aim of the Study: To compare efficacy of the Circle absorption system and the Bain breathing system in containing hypercarbia by ETCO2 modulation with the help of capnographic monitoring, during laparoscopic cholecystectomy with carbon dioxide pneumoperitonium.

Materials and Methods: Fifty adult patients of ASA-I or II physical status undergoing laparoscopic cholecystectomy under general anesthesia were allocated into two groups. In group A the Circle absorption system and in group B the Bain breathing system was used for delivery of the anesthetics and performance of IPPV. Same drugs and anaesthetic technique excepting the breathing system with variable Fresh Gas Flow (FGF) as per group were used.

Results and Observations: ETCO2 variables in both the systems were found to be homogenous. The Bain system differed significantly with regard to rebreathing characteristics signified by higher FiCO2.

Conclusion: Apart from the variation of fresh gas flow both the systems are equally effective in terms of Carbon dioxide elimination and both can be effectively used for maintaining optimal CO_2 level during laparoscopic cholecystectomy with carbon dioxide pneumoperitonium.

KEYWORDS

Circle absorption system, Bain breathing system, Capnography, Carbon Dioxide Pneumoperitonium, laparoscopic Cholecystectomy.

Introduction

Carbon dioxide pneumoperitonium during laparoscopic cholecyst ectomy causes passive absorption of significant amount of CO_2 from the peritoneal cavity into blood which is subsequently eliminated from the circulation by hyperventilation.

Carbon dioxide pneumoperitonium reduces lung and chest wall compliance along with functional residual capacity and increases resistance of the respiratory system without influencing oxygenation but it increases the end-tidal carbon dioxide tension which correlates closely with the arterial carbon dioxide tension.[1] It significantly increases the amount of CO_2 and bicarbonate ion in the body and due to sustained elevation of arterial Carbon dioxide tension ($PaCO_2$) entire body storage of CO_2 gets recruited including bones and skeletal muscles.[2].

Some deleterious intra operative ventilatory and circulatory manifestations due to CO_2 pneumoperitonium and elevated intra abdominal pressure (IAP) are unavoidable but these effects are insignificant in healthy patients, but carries significant risks for patients with compromised cardiopulmonary, hepatic or renal diseases.[3]

When ventilation is not proportional to CO_2 output, hypercarbia sets in necessitating modulation of ventilator settings. Capnography aided controlled hyperventilation to contain hypercarbia with an ideal breathing system is the standard practice.

Bain and Spoerel[4] modified the Mapleson D system into a simple coaxial one with many advantages over the Circle absorption system but it has a rebreathing characteristics.

The Circle absorption system is efficient in terms of CO_2 elimination and fresh gas utilization but it is heavier and offers more resistance to breathing.

The efficiency of any breathing system is measured in terms of its ability to wash out Carbon dioxide, thus Capnography can be utilized for assessment of carbon dioxide eliminating capacity of a breathing system.During procedures lasting more than three hours Capnography should be supported by regular arterial blood gas analysis for optimal ventilator adjustments.[5]

In patients undergoing laparoscopic Cholecystectomy with carbon dioxide pneumoperitonium the expired CO_2 comprises of both metabolic and absorbed carbon dioxide, changes in carbon dioxide output can be monitored by $PaCO_2$ or $ETCO_2$ and it can be adjusted by adjusting ventilatory frequency.

Materials and Methods:

Inclusion criteria

- American Society of Anesthesiologists (ASA) I or II physical status.
- Patients undergoing laparoscopic Cholecystectomy under General Anesthesia lasting up to one hour.
- Patients without any gross systemic diseases.

Exclusion criteria

- Patients of pediatric age group.
- Patients below the weight of 20kg.
- Patients with any gross systemic diseases.

Grouping of the Patients:

50 patients were randomly allocated in two groups in equal numbers.

Group A: The circle absorption system was used with a fresh gas flow of 4.5 Liters (O_2 1.5 Liters. & N_2O 3Liters) for delivery of the anesthetics and performance of IPPV

Group-B: The Bain breathing system was used with a fresh gas flow of 6 Liters (O_2 2 Liters. and N_2O 4 Liters) for delivery of the anesthetics and performance of IPPV.

Results and Observations

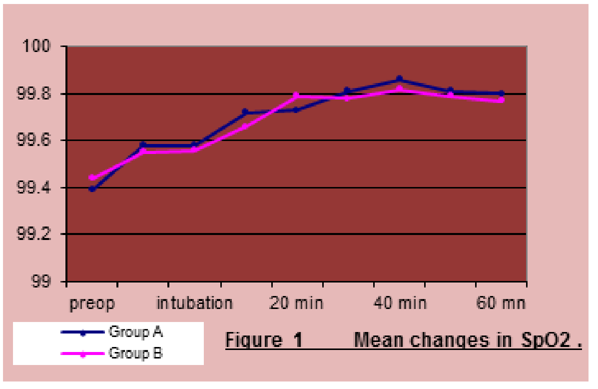
Pulse rate, Oxygen saturation of arterial blood (SpO2), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Mean Arterial Pressure (MAP) were recorded at pre induction, during induction, after intubation and every 10mins thereafter till the time of reversal.

$ETCO_2$and $FiCO_2$ was recorded immediately after intubation, at the time of carbon dioxide Insufflation and every 10mins thereafter till the time of reversal.

Characteristics	Group-A Circle absorber System.	Group-B Bain breathing System.
No of patients	25	25
Mean age (yrs.)	35.12 ± 13.72	34.96 ± 11.46
Mean body wt. (Kg.)	61.08 5.24	62.29 5.46
Sex (M : F)	17 : 8	16 : 9
ASA (I : II)	22 : 3	23 : 2

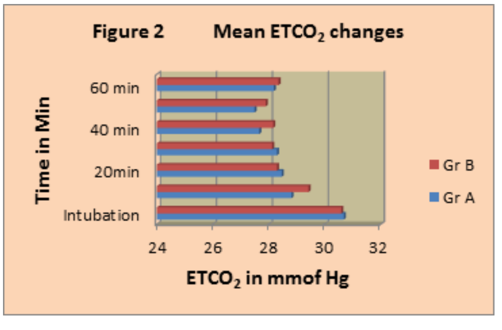
Table 1 Demographic data of the patients

Both the groups are comparable with respect to demographic patterns, age, sex, ASA and weight distributions and exhibited fair amount of homogeneity.

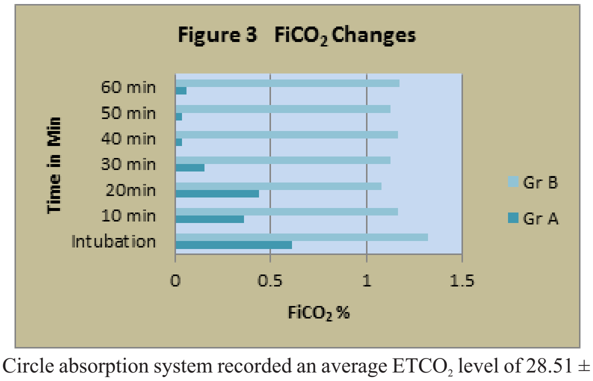


The groups were found to be homogeneous with respect to pulse rate, MAP and SpO2 for observed mean differences..No influence of the breathing systems could be demonstrated with regard to Oxygenation. (Figure 1)

Mean EtCO2 value of 28.51±0.98 with circle absorber system and 28.69 ±0.89 with The Bain system was found to be homogenous and the systems bear no significant difference between them.(Figure 2) The set of data was also subjected to Students T test for statistical analysis and the result suggested no significant difference at ($p < 0.05$).



The Bain system differ from the Circle absorption system by its rebreathing characteristic which is signified by higher FiCO2 status (Figure-3) The set of data was subjected to Students T test for statistical analysis and the result suggested significant difference at ($p < 0.05$).



Circle absorption system recorded an average $ETCO_2$ level of 28.51 ± 0.98 mm of Hg which is in close proximity with the average $ETCO_2$ level of 28.69± 0.89 mm of Hg recorded with the Bain breathing system. In group A the average $FiCO_2$ level was in the order of 0.39± 0.07 %, however in group B the average $FiCO_2$ level recorded was higher in the order of 1.18±0.08 %.

Results suggested that the system A and B do not have any significant difference with regard to $ETCO_2$ status. However, the systems differ significantly as far as their rebreathing characteristic is concerned, which is signified by higher FiCO2% status of the Bain system.

Discussion:

This study comprised of fifty ASA I&II adult patients randomly allocated in two groups each consisted of 25 adult patients irrespective of their age and sex. All the patients required laparoscopic cholecystectomy under General Anesthesia and none of them had any gross Cardiovascular, Respiratory, Renal, and Hepatic or Metabolic disorders

In group A the Circle absorption system and in group B the Bain breathing system was used for delivery of the anesthetics and performance of IPPV. Same premedications, anaesthetic drugs and anaesthetic technique excepting the breathing system with variable FGF as per group were used to avoid variation in observations.

Circle absorption system is cumbersome owing to its double limbs, bulky swivel, more dead space and resistance but efficient in terms of CO_2 elimination fresh gas utilization, conservation of respiratory heat and humidity and useful for low-flow Anaesthesia.

Bain and Spoerel modified Mapleson D system to a coaxial system and the inventors advocated this breathing circuit as a universal circuit suitable for use in patients of all ages and during controlled as well as spontaneous respiration.

The Bain system requires higher fresh gas due to its rebreathing characteristics. Moderate reduction in fresh gas flow demonstrated no significant effect on minute volume or $ETCO_2$.

Bain and Spoerel demonstrated that an average inflow of 65.8 ml/kg/min could maintain a mean $paC0_2$ of 35.8 mmHg and they concluded that an inflow of 70 ml/kg/minute can be selected reliably. In this study the Bain system when used with a fixed flow of 6 Liters/minute recorded a mean $ETCO_2$value of 28.69± 0.89.

Henville and Adam[6] used Bain breathing system during controlled ventilation and obtained mean $PaCO_2$ of 40.8 mmHg at a fresh gas inflow of 70 ml/kg/minute and mean $PaCO_2$ of 34.3 mmHg at a fresh gas inflow of 100 ml/kg/minute. Chu et al[7] recommended FGF of 70 ml/kg/minute and Rose and Froese[8] observed $PaCO_2$ values between 30 mmHg to 37 mmHg with FGF of 90 ml/kg/minute.

In this study the average $ETCO_2$ of 28.69± 0.89 and the predicted $PaC0_2$values of 32.69 with Bain breathing system are consistent and in conformity with the findings of earlier researchers, however fresh gas flow rate being a fixed flow of 6 Liters/minute it can be theoretically concluded that a FGF of 96.40ml/kg/min were used as the mean body weight of our study population is 62.29± 5.46.

In this study the Circle absorber system is used with a fixed fresh gas flow of 4.5 liters where the mean body weight of our population of study (Group A) is 61.08±5.24 Kg and theoretically FGF can be calculated at 73.67 ml/Kg/min.

The mean $ETCO_2$ level of 28.51±0.98 attained using Circle absorber system and 28.69± 0.89 with Bain circuit are in close proximity. Hence it can be concluded that $ETCO_2$ status of both the breathing systems are homogenous and the systems bears no significant difference between them.

The striking observation with Bain breathing system is the magnitude of rebreathing demonstrated by high $FiCO_2$ Preferably $PaCO_2$ should be measured when the circuit is used for long periods of time with intentional hypocarbia.[9]

In this study an effective $ETCO_2$level of 28.51±0.98 mm of Hg. could be maintain using the Circle absorber system with a fixed fresh gas flow of 4.5 litres and the average $FiCO_2$level in the order of 0.39 ±0.07 %.Similarly an effective $ETCO_2$level of 28.69± 0.89 mm of Hg. could be maintained using the Bain circuit with a constant Fresh Gas Flow of 6l/min however the average $FiCO_2$level was in the order of 1.18 ± 0.08 %, suggesting a significant differences with regard to $FiCO_2$ status. The rebreathing characteristic of the Bain system is in agreement with the findings of the other investigators.

Conclusion: On analysis of the inherent structural and functional uniqueness of the Bain breathing system with the help of capnography and comparing it with the still popular Circle absorption system with regard to Carbon dioxide elimination, fresh gas utilization and rebreathing characteristics, it can be concluded that apart from the rebreathing characteristics of the Bain breathing system both the systems are equally effective with regard to Carbon dioxide elimination and both the system can be effectively used for maintaining optimal CO_2 level during laparoscopic Cholecystectomy with carbon dioxide pneumoperitonium

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