

A CLINICAL COMPARATIVE STUDY TO ASCERTAIN EFFICACY OF CIRCLE ABSORPTION SYSTEM AND BAIN BREATHING SYSTEM IN MAINTAINING EFFECTIVE HYPOCAPNIA DURING INTRACRANIAL SURGERYJoyanta Kumar Choudhury¹**HOW TO CITE THIS ARTICLE:**

Joyanta Kumar Choudhury. "A Clinical Comparative Study to Ascertain Efficacy of Circle Absorption System and Bain Breathing System in Maintaining Effective Hypocapnia during Intracranial Surgery". Journal of Evolution of Medical and Dental Sciences 2015; Vol. 4, Issue 77, September 24; Page: 13364-13376, DOI: 10.14260/jemds/2015/1919

ABSTRACT: AIM OF THE STUDY: To ascertain efficacy of the Circle absorption system and the Bain breathing system in maintaining effective hypocapnia to create a favorable environment for smooth conduct of intracranial surgery, with the help of Capnographic monitoring. **MATERIALS AND METHODS:** In the study fifty adult patients of ASA-I or II physical status requiring intracranial surgeries under General Anesthesia were selected irrespective of sex and randomly allocated in two groups. In one Group the Circle absorption system and in another Group the Bain breathing system was used for delivery of the anesthetics and performance of IPPV. To avoid variation in observations same premedications, anaesthetic drugs and anaesthetic technique excepting the breathing system varying as per group were used in all the patients of both the groups. Circle absorption system was used with a fresh gas flow of 4.5 Liters and Bain breathing system was used with a fresh gas flow of 6 Liters for maintenance of anaesthesia and performance of IPPV. Pulse rate, SpO₂, SBP, DBP and MAP were recorded before induction of Anaesthesia, during induction, after intubation, at the time of incision and every 10mins thereafter till the time of reversal. EtCO₂ and FiCO₂ were recorded immediately after intubation, at the time of incision and every 10mins thereafter till the time of reversal. Desired level of EtCO₂ was maintained by moderate hyperventilation as and when required. Brain relaxation was graded in consultation with the surgeon and by simple visual assessment. **RESULTS AND OBSERVATIONS:** The study involved analysis of capnometric information acquired following use of both the breathing systems. The ability of both the breathing systems to effectively eliminate Carbon dioxide and their rebreathing characteristics were analyzed from the data obtained. **CONCLUSION:** It can be concluded that apart from the variation of fresh gas flow required in each system and the rebreathing characteristics of the Bain breathing system both Circle absorption system and the Bain breathing system are equally effective in terms of Carbon dioxide elimination and both can effectively provide a conducive environment for intracranial procedures. **KEYWORDS:** Circle absorption system, Bain breathing system, Capnography, EtCO₂, FiCO₂ Hyperventilation, Brain relaxation, Neuroanaesthesia.

INTRODUCTION: AIM OF THE STUDY: Although Neurosurgery dates back to the earliest ages of human history it continued to evolve with the developments in operative technology, advances in neuro-imaging, better understanding of neurophysiology and advancement of monitoring technology. Success of any Neurosurgical procedure is necessarily dependent upon some undeniable deciding factors like intraoperative cerebral protection and specific monitoring to detect and prevent intraoperative ischemic insults so that the brain and the spinal cord may be protected from harmful and frequently inevitable events due to the type of surgery, patient positioning, haemodynamic changes or any other associated events.

ORIGINAL ARTICLE

The role of Capnography aided controlled hyperventilation and deliberate hypocapnia during neuroanaesthesia is integral to maintenance of optimal surgical environment and neuroprotection. Nevertheless an optimal breathing system is always the key to maintenance of such an ideal environment.

This study is intended to ascertain efficacy of the Circle absorber system and the Bain breathing system in maintaining effective hypocapnia to create a most favorable environment for smooth conduct of neurosurgical procedures, with the help of Capnographic monitoring.

Introduction of newer monitoring devices necessitated setting newer monitoring standards, enhancing patient's safety and allowing better appreciation of our Anaesthesia delivery mechanisms.

Emergence of CO₂ in our expired air is an excellent indicator of global wellbeing and manifestation of successful culmination of metabolism, transport and ventilatory activities of our body. Growing interests in CO₂ monitoring provided recognition to Capnography as a standard of monitoring during anesthesia and considered mandatory for Laparoscopic and neuroanaesthesia.

The role of Capnography aided controlled hyperventilation and deliberate hypocapnia during neuroanaesthesia is integral to maintenance of optimal surgical environment and neuroprotection. Nevertheless an efficient breathing system always plays the vital role in maintenance of such an ideal environment

The popular single limb breathing system like the Magill attachment or Mapleson A system is inconvenient owing to its relatively heavy weight pop-off valve located close to the patient's face, which usually gets buried under the sterile drapes and the anesthetist is positioned close to the surgical site due to the short length of the system.

Bain and Spoerel,¹ modified the Mapleson D system into a coaxial one in the year 1972. The structural simplicity, efficiency, and versatility of this system impressed and prompted many investigators to work in the direction of establishing it as a universal breathing system.

Apart from the rebreathing characteristics this popular Bain breathing system has many inherent advantages over the Circle absorption system and compared favorably with other popular semi closed breathing systems in maintaining satisfactory arterial Carbon dioxide level (PaCO₂). The Circle absorption system is unquestionably efficient in terms of CO₂ elimination and fresh gas utilization; however it offers more resistance to breathing and is heavier.

A favorable surgical environment can be achieved by Capnography aided controlled hyperventilation and deliberate hypocapnia,² resulting in brain relaxation conducive of safe surgery. Deliberate hypocapnia in anaesthetic management of intracranial surgery is an accepted practice; it is effective in management of intracranial hypertension during induction, maintenance of anaesthesia and prior to dural exposure. Hypocapnia reduces cerebral blood volume thereby reduces the brain bulk.

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 elimination status of a breathing system. Capnography is considered reliable even in extremes of neurosurgical positioning in terms of the accuracy of ETCO₂, however in neurosurgical procedures lasting more than three hours capnography should be supported by regular arterial blood gas analysis,³ for making optimal ventilatory adjustments. Arterial blood gas analysis was not routinely performed as all the patients under this study underwent neurosurgical procedures lasting less than three hours.

ORIGINAL ARTICLE

MATERIALS AND METHODS: The study is intended to compare efficiency of the two breathing systems e.g. Circle absorber system and Bain breathing system in maintaining effective hypocapnia to create an ideal environment for smooth conduct of neurosurgical procedures with the help of Capnography.

Inclusion Criteria:

- ASA-I or II physical status.
- Both male and female.
- All the patients required intracranial surgeries under General Anesthesia.
- 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.

- Group A: The circle absorption system was used for delivery of the anesthetics and performance of IPPV.
- Group-B: The Bain breathing system was used for delivery of the anesthetics and performance of IPPV.

Same Anaesthetic technique excepting the breathing system varying as per group and drugs were used in all the patients of both the study groups. Same premedications were administered to all the patients of both the groups to avoid variation in observations. All the patients were pre oxygenated with 100% oxygen for 3minutes and induced with Thiopentone sodium.⁴ Vecuronium bromide was chosen to facilitate intubation and ventilation. O₂, N₂O and Isoflurane⁴ were used for maintenance of Anaesthesia. Thiopentone reduces elevated intracranial hypertension and seizure activity. Isoflurane produces similar level of metabolic depression as barbiturates but does not cause cardiovascular depression or delayed recovery.

FRESH GAS FLOW:

Group A: Circle absorption system was used with a fresh gas flow of 4.5 Liters (O₂ 1.5 Liters. & N₂O 3 Liters), for maintenance of anaesthesia and performance of IPPV.

Group B: Bain breathing system was used with a fresh gas flow of 6 Liters (O₂ 2 Liters. and N₂O 4 Liters), for maintenance of anaesthesia and performance of IPPV.

Parameters Recorded: Pulse rate, SpO₂, SBP, DBP and MAP were recorded before induction of Anaesthesia, during induction, after intubation, at the time of incision and every 10mins thereafter till the time of reversal.

EtCO₂ and FiCO₂ were recorded immediately after intubation, at the time of incision and every 10mins thereafter till the time of reversal. Desired level of EtCO₂ was maintained by moderate hyperventilation as and when required. Brain relaxation was graded in consultation with the surgeon and by simple visual assessment.

ORIGINAL ARTICLE

RESULTS AND OBSERVATIONS: The study involved analysis of capnographic as well as capnometric information acquired following use of both the breathing systems during intracranial surgery. In neurosurgical procedures ability of a breathing system to effectively eliminate Carbon dioxide and its rebreathing characteristics plays a pivotal role in maintenance of hypocarbia, which reduces intra cranial pressure (ICP) and facilitates surgical exposure.

(Table 1) Demographic patterns of both the study groups were more or less homogeneous.

The age distribution of patients in both the groups exhibit fair amount of homogeneity. (Figure 1). The summary of descriptive statistics shows that the groups have more or less same weight distributions. (Table 2).

Majority of the patients were of ASA grade I physical status. Group A -22(88%) and group B -23(92%). ASA II Physical status group A-3(12%) and group B-2(8%). So both the groups are comparable with respect to ASA status of patients (Table 6). The Chi-square results further imply that the ASA status of the patients is independent of the groups.

Mean Pre induction vitals. The groups were found to be homogeneous with respect to preoperative pulse rate, MAP and SpO₂ for observed mean differences across the groups. (Figure 2)

Both the groups displayed similar pattern of variations of pulse rate. Pulse rate starts to rise immediately after induction and peak occurred at the time of intubation, thereafter the pulse rate tends to drop in both groups and remained below the baseline. (Figure 3)

No influence of the breathing systems could be demonstrated with regard to Oxygenation. (Figure 4)

The EtCO₂ variation of both the breathing systems at different time intervals was found to be homogenous and the systems bear no significant difference between them. (Table 3, Figure 5) It is seen that the Mean and Standard deviations of EtCO₂ data of both the systems at 20 min as well as at 60min are found to be almost similar, hence it can be concluded that EtCO₂ status of both the breathing systems are homogenous and the systems bears no significant difference between them. The same set of data was also subjected to Students T test for statistical analysis and results were found to be much smaller than the tabulated values, at 5% and 10% level of significance.

The Bain system differ significantly as far as their rebreathing characteristic is concerned, which is signified by higher FiCO₂ status in comparison to Circle absorption system. (Table 4, Figure 6). Homogeneity of FiCO₂ values are established at different time intervals i.e. at 20min &60min. The same set of data was also subjected to Students T test for statistical analysis and results were found to be much smaller than the tabulated values, in both 5% and 10% level of significance.

Circle absorption system recorded an average EtCO₂ level of 28.23±0.99mm of Hg which is in close proximity with the average EtCO₂ level of 28.40±0.89mm of Hg. Recorded with the Bain breathing system, this compares favorably with the findings of Henville and Adam,⁵ Chu et al.,⁶ and Rose and Froese.⁷ The predicted PaCO₂ values are also consistent and in conformity with the findings of Bain and Spoerel.

In group A the average FiCO₂ level was in the order of 0.39±0.07%, however in group B the average FiCO₂ level recorded was higher in the order of 1.18±0.08% but in agreement with the findings of earlier investigators. Results suggested that the system A and B do not have any significant difference with regard to ETCO₂ 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.

ORIGINAL ARTICLE

Analysis of mean Pre-induction Vitals in each Group: Pulse, SpO₂, Systolic blood pressure, Diastolic blood pressure & Mean arterial pressure (MAP) in mmHg, were recorded before induction of Anaesthesia, during induction, after intubation, at the time of incision/10mins and every 10mins thereafter till the time of reversal (Table 5). Pre induction vital parameters exhibited homogeneity in both the groups; the acquired data from both the groups were tested for homogeneity with respect to preoperative pulse rate, MAP and SpO₂ by using Two Sample T-test for observed mean differences across the groups. The results did not indicate any statistical significance. Nonetheless, the groups were found to be homogeneous with respect to the preoperative pulse rate, MAP and SpO₂. The changes in pulse rates at various times after induction in both the groups when tested by Analysis Of Variance were found to be insignificant (P>0.05). Nothing in contravention to the findings of the other investigators could be demonstrated with regard to variations in SpO₂ or any influence of these breathing systems on Oxygenation, Pulse rate and Mean arterial pressures, in spite of induced hypocarbia and concomitant rebreathing which was even higher with Bain breathing system.

Fluid management is of paramount importance in the neurosurgical patients as inappropriate fluid management may lead to brain oedema and rise in ICP. Use of 5% Dextrose may present such a situation. Investigators have advocated lactated ringers solution as the fluid of choice.

Keeping in view suggestions of the earlier investigators lactated ringers solution were routinely infused as the maintenance as well as replacement fluid during intraoperative period and a careful balance between input and output was maintained.

Mannitol,⁸ has ability to rapidly reduce cerebral oedema and minimize tissue damage by scavenging free radicals is widely used and at times with Frusemide,⁹ which can also reduce ICP.. Many investigators suggested that reduction of ICP and brain volume is more marked when Mannitol, Frusemide and Hyperventilation were used in tandem.

All the patients were awakened from Anaesthesia uneventfully and shifted to recovery unit or Intensive care units according to the requirement of the patients.

DISCUSSION: The aim of this study was to compare efficiency of Circle absorber system with that of Bain breathing system in maintaining effective hypocarbia and thereby creating a suitable environment for smooth conduct of neurosurgical operations with the help of Capnography, simultaneously addressing the need of an ideal delivery system for Neuroanesthesia in the context of patient's safety, surgeon's comfort and our convenience.

In view of extremes of operative positioning and the site of surgery the delivery systems are desired to be lightweight which does not create any facial distortion or does not drag the endotracheal tube. The delivery system should be long enough to position the anesthetist away from the surgical field and at the same time be user friendly.

This study comprised of fifty ASA I&II patients irrespective of their age and sex, excluding the patients of pediatric age group and patients below the body weight of 20kgs All the patients required intracranial surgeries under General Anesthesia and none of them had any gross Cardiovascular, Respiratory, Renal, Hepatic or Metabolic disorders.

The cases were randomly allocated in two groups. Group A Consisted of 25 patients undergoing various intracranial surgeries under general Anaesthesia irrespective of age, sex and proposed surgery. The circle absorption system was used in this group of patients for delivery of the anesthetics and performance of intermittent positive pressure ventilation (IPPV).

ORIGINAL ARTICLE

Group B also consisted of 25 patients undergoing various intracranial surgeries under general Anaesthesia irrespective of age, sex and proposed surgery. The Bain breathing system was used in this group of patients for delivery of the anesthetics and performance of intermittent positive pressure ventilation (IPPV).

The results and observations obtained from this study were compared in the light of similar observations of other workers. The demographic characters of the patients and the type of operations in the study were comparable in both the groups.

Same Anaesthetic technique excepting the breathing system varying as per group, same pre medications and Anaesthetic drugs were used in all the patients of both the study groups to avoid variation in observations.

Rapid post-operative recovery and extubation after intracranial surgery is desirable for early detection of intracranial complications.¹⁰ High dose of narcotics were avoided in Premedication to prevent narcosis induced respiratory depression which can lead to hypoventilation and eventually increase in CBF and elevated ICP. Narcotics depresses the level of consciousness, induces nausea and vomiting

All the patients were pre-oxygenated with 100% oxygen for 3 minutes and induced with Thiopentone sodium 2.5% solution at 5-7mg/kg-body weight. A non-depolarizing muscle relaxant was chosen to facilitate intubation and ventilation. Vecuronium bromide is considered appropriate being virtually devoid of effects on both ICP and the cardiovascular system.

Vecuronium bromide at the dose of 0.1 mg/kg administered and tracheal intubations were carried out after achieving Optimal-intubating condition after 3 minutes of mask ventilation with oxygen and nitrous oxide with a flow of 2 liters each. Cuffed endotracheal tubes were used. Armoured endotracheal tube was used wherever surgical position of the patient demanded its use. Before incision all the patients were infiltrated with local anaesthetic with adrenaline solutions along the incision line to obtund the incisional stress responses, to minimize blood loss while raising the craniotomy flap.¹¹

Although the single limb Magill system was in use for long time it failed to gain much popularity owing to its relatively heavy weight pop-off valve located close to the patient's face, which usually becomes buried under the sterile drapes, leaving the anesthetists in an awkward position to adjust the tension of this valve.

Circle absorption system proved to be more cumbersome than the Magill system owing to its double limbs, bulky swivel, more dead space, and offers more resistance in spite of its undeniable efficiency in terms of CO₂ elimination fresh gas utilization, ability to deliver gases at Constant inspired concentrations, Conservation of respiratory heat and humidity and even 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 with trimmed gas flow.

The Bain breathing circuit was evaluated with regard to oxygenation and CO₂ elimination under controlled conditions and compared with the presently popular semi closed circuits with CO₂ absorber, it was also demonstrated that the Bain system compares favourably with the popular semi closed circuits in regard to oxygenation while maintaining a favorable PaCO₂. Disadvantages of this system are requirement of higher fresh gas flow and rebreathing characteristics. Moderate reduction

ORIGINAL ARTICLE

in fresh gas flow demonstrated no significant effect on minute volume or ETCO_2 , till the degree of rebreathing is small enough to be accommodated in the dead space at the end of inspiration.

Bain and Spoerel observed paCO_2 values of 31-38mm Hg in patients with fresh gas flow of 87.7 ml/kg/min and paCO_2 values ranging between 25-42mmHg during controlled ventilation using fresh gas flow (FGF) of 7 liters/minute. Later on Bain and Spoerel demonstrated that an average inflow of 65.8 ml/kg/min could maintain a mean paCO_2 of 35.8mmHg and they concluded that an inflow of 70 ml/kg/minute can be selected reliably. In this study tidal volume selected for ventilating the lung was 10ml/kg and a frequency of respiration, 12-14/minute.

Results of this study are found to be encouraging when the Bain breathing system was used with a fixed flow of 6 Liters/minute. EtCO_2 values recorded at different time intervals were 30.56 ± 1.73 mm of Hg after intubation, 29.12 ± 1.73 mm of Hg after 10mins, 28.2 ± 1.08 mm of Hg after 20min, 27.72 ± 0.98 mm of Hg after 30 min, 28.08 ± 1.18 mm of Hg after 40mins, 27.9 ± 1.11 mm of Hg after 50 min and 28.05 ± 0.96 mm of Hg after 60min. Our results compares favourably with the findings of Henville and Adam, Chu et al and Rose and Froese.

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

Study of different breathing systems during controlled ventilation established that when FGF is very high the PaCO_2 becomes ventilation dependent like spontaneous respiration and when the minute volume exceeds the FGF considerably; then PaCO_2 is dependent on the FGF.^{8,11}

In this study the average EtCO_2 of 28.52 ± 1.00 and the predicted PaCO_2 values of 32.52 are consistent and in conformity with the findings of Bain and Spoerel. However fresh gas flow rate being a fixed flow of 6 Liters/minute in can be theoretically concluded that a FGF of 96.40ml/kg/min were used as the mean body weight of our study population is 62.24 ± 5.41 kg. But routine moderate hyperventilation was employed in the range of 14-16/min, unlike that reported by Bain and Spoerel.¹² Routine Hyperventilation during intracranial surgery is a widely accepted principle and commonly employed to reduce ICP and facilitate surgical exposure.

As far as efficiency of Circle absorber system is concerned the populations in Group A have shown promising results as ever, both in terms of CO_2 elimination and fresh gas utilization.

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 ± 5.06 Kg and theoretically FGF can be calculated at 73.67mi/kg/min.

The average EtCO_2 level attained using Circle absorber system was in the range of 28.17 ± 1 and is in close proximity of EtCO_2 values obtained with Bain circuit.

EtCO_2 levels achieved at different time variables were; after intubation 30.72 ± 1.72 mm of Hg at 10min after intubation 28.91 ± 1.22 mm of Hg at 20 min 28.48 ± 1.05 mm of Hg, at 30min 28mm Hg, at 40min 27.68 ± 0.80 mm of Hg at 50min 27.56 ± 0.71 mm of Hg, and at 60min 27.5 ± 1.01 mm of Hg.

The EtCO_2 data recorded using both the systems at various time intervals are found to be almost similar, 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 difference observed with the system B is the magnitude of rebreathing demonstrated by different levels of FiCO_2 in the capnograph in spite of maintaining hypocarbia. It is

ORIGINAL ARTICLE

recommended that the circuit should not be used for long periods of time without measuring arterial CO₂ tension or in situations where intentional hypocarbia is desired.¹³

However in this study, although intentional hypocarbia was maintained the duration of the surgical procedures were seen to be limited to less than two hours only.

FiCO₂ levels could be contained with institution of hyperventilation approximately at around 14-16/min. fresh gas flow remaining constant at 6 litres/min. Bain system demonstrated rebreathing even at considerably higher fresh gas flows.¹⁴

In this study an effective EtCO₂ level of 28.23±0.99 mm of Hg. Could be maintain using the Circle absorber system with a fixed fresh gas flow of 4.5 litres and the average FiCO₂ level was in the order of 0.39±0.07%.

Similarly an effective EtCO₂ level of 28.39±0.85 mm of Hg. could be maintained using the Bain circuit with a constant Fresh Gas Flow of 6 l/min however the average FiCO₂ level was in the order of 1.18±0.08 % which is in agreement with the findings of other investigators. FiCO₂ values displayed in the tabular form were analyzed at different time variables but homogeneity could not be established. Suggesting that system A and B has significant differences with regard to levels of FiCO₂. The rebreathing characteristic of the Bain system is in agreement with the findings of the other investigators.

Brain relaxation was maintained in consultation with the surgeon and by simple visual assessment after turning of the dural flap. Brain tension was assessed after craniotomy. Mannitol & Frusemide were also used along with controlled hyperventilation for attaining adequate brain relaxation, reduction of ICP and brain volume is more marked when Mannitol, Frusemide and Hyperventilation are used in tandem.

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 effectively provide a conducive environment for intracranial procedures.

ACKNOWLEDGEMENT: I express my immense gratitude and indebtedness to my distinguished teacher, Dr. A. K. Deka DA, MD, former Professor and Head of the Department of Anaesthesiology and Critical Care, Gauhati Medical College and Hospital, Guwahati and to my colleague Dr. Rajib Hazarika, MD for their invaluable guidance & constant inspiration all through this study.

REFERENCES:

1. Bain JA, Spoerel WE. A streamlined anaesthetic system. *Can Anaesth Soc J.* 1972; 19: 426-35.
2. *Ann Fr Anesth Reanim.* 1995; 14(1): 70-6. [Is there still a place for routine deep hypocapnia in intracranial surgery?]. [Article in French] Young WL¹, Freymond D, Ravussin P.
3. Grenier, Bruno; Verchere, Eric; Mesli, Abdelghani; Capnography Monitoring During Neurosurgery: Reliability in Relation to Various Intraoperative Positions. *Anesthesia & Analgesia.* 88(1): 43-48, January 1999.
4. Toner CC, Stamford J. General anesthetics as neuroprotective agents. In: Bailliere Tidall, editor. *Bailliere's Clinical Anesthesiology. International practice and research.* UK, Saunders, 1996, Vol. 10/ No. 3: 515-33.

ORIGINAL ARTICLE

5. Henville JD, Adams AP. The Bain anaesthetic system. An assessment during controlled ventilation. *Anaesthesia*. 1976 Mar; 31(2): 247-56.
6. YK CHU, KH RAH, CP BOYAN Is_the_Bain_breathing_circuit_the_future_anesthesia_system?_An_evaluation. *Anesthesia & Analgesia*, 1977 - journals.lww.com.
7. Rose_DK, Froese_AB. The regulation of PaCO₂ during controlled ventilation of children with a T-piece. *Can_Anaesth_Soc_J*. 1979 Mar; 26(2): 104-13.
8. Bullock R. Mannitol and other diuretics in severe neurotrauma. *New Horiz* 1995 Aug; 3 (3): 448-52.
9. Andrews RJ, Giffard RG. Clinically useful nonanestheticagents. In: Andrews RJ, editor. *Intraoperative Neuroprotection*. USA: Williams and Williams, 1996.
10. Bruder NJ. Awakening management after neurosurgery for intracranial tumours. *Curr Opin Anaesthesiol*. 2002 Oct; 15(5): 477-82.
11. Biswas BK¹, Bithal PK, Dash HH. Cardiovascular responses to scalp infiltration with reduced concentration of adrenaline. *Neurol India*. 2002 Jun; 50(2): 168-73.
12. Bain JA, Spoerel WE. Flow requirements for a modified Mapleson D system during controlled ventilation. *Can Anaesth Soc J*. 1973 Sep; 20(5): 629-36.
13. Ramanathan S, Chalon J, Capan L, et al. Rebreathing characteristics of the Bain anesthesia circuit. *Anesth Analg*. 1977; 56: 822-5.
14. Chan_AS, Bruce_WE, Soni_N. A comparison of anaesthetic breathing systems during spontaneous ventilation. An in-vitro study using a lung model. *Anaesthesia*. 1989 Dec; 44(12): 1008-9. Magill Department of Anaesthesia, Westminster Hospital, London.

Abbreviations:

ASA American Society of Anesthesiologists
 ABG Arterial Blood Gas
 B.P Blood Pressure
 CBF Cerebral blood flow.
 CO₂ Carbon Dioxide
 DBP Diastolic Blood Pressure
 ETCO₂ End Tidal Carbon Dioxide Tension
 ETCO₂ End tidal Carbon dioxide
 FGF Fresh Gas Flow
 FiCO₂ Inspired Carbon Dioxide concentration.
 FiO₂ Inspired Oxygen concentration
 ICP Intracranial pressure.
 IPPV Intermittent positive pressure ventilation.
 MAP Mean Arterial Pressure
 mm Hg Millimeter of Mercury.
 NIBP Non-Invasive Blood Pressure
 N₂O Nitrous Oxide
 PaCO₂ Partial pressure of CO₂ in arterial blood
 SpO₂ Oxygen saturation of arterial blood.
 SBP Systolic Blood Pressure.
 S.D Standard Deviation.

ORIGINAL ARTICLE

Characteristics	Group-A Circle Absorber System.	Group-B Bain Breathing System.
No of patients	25	25
Mean age (yrs.)	35.12±13.76	35.96±11.47
Mean body wt. (Kg.)	61.08±5.06	62.24±5.41
Sex (M : F)	19 : 6	18 : 7
ASA (I : II)	22 : 3	23 : 2

Table 1: Demographic data of the patients

Group	No. of pts.	Minimum weight	Maximum weight	Mean weight	Std. Deviation
Gr. A	25	52	72	61.08	5.06
Gr. B	25	53	75	62.24	5.41

Table 2: Descriptive statistics of weight

Group	After Intubation	10min	20min	30min	40min	50min	60min	70min	80min	90min
Gr. A	30.72± 1.72	28.92± 1.2	28.24± 1.09	27.8± 1.04	27.68± 0.81	28± 0.71	27.8± 1.04	27.68± 1.00	27.66± 0.55	28.2± 0.84
Gr. B	30.56± 1.73	29.12± 1.73	28.32± 1.18	27.72± 0.98	28.08± 1.18	27.56 ±1.09	28.05 ±0.97	27.56 ±1.03	28.07 ±1.00	28.27 ±1.10

Table 3 Mean and standard deviation Values of EtCO₂

Group	After Intubation	10min	20min	30min	40min	50min	60min	70min	80min	90min
Gr. A	0.52 ±0.65	0.36 ±0.49	0.44 ±0.51	0.16 ±0.47	0.04 ±0.02	0.04 ±0.02	0.06 ±0.24	0.18 ±0.39	0.4 ±0.55	0.4 ±0.55
Gr. B	1.32 ±0.48	1.16 ±0.55	1.08 ±0.49	1.12 ±0.6	1.16 ±0.48	1.12 ±0.6	1.21 ±0.42	1.31 ±0.48	1.17 ±0.39	1.09 ±0.67

Table 4: Mean and standard deviation Values of FiCO₂

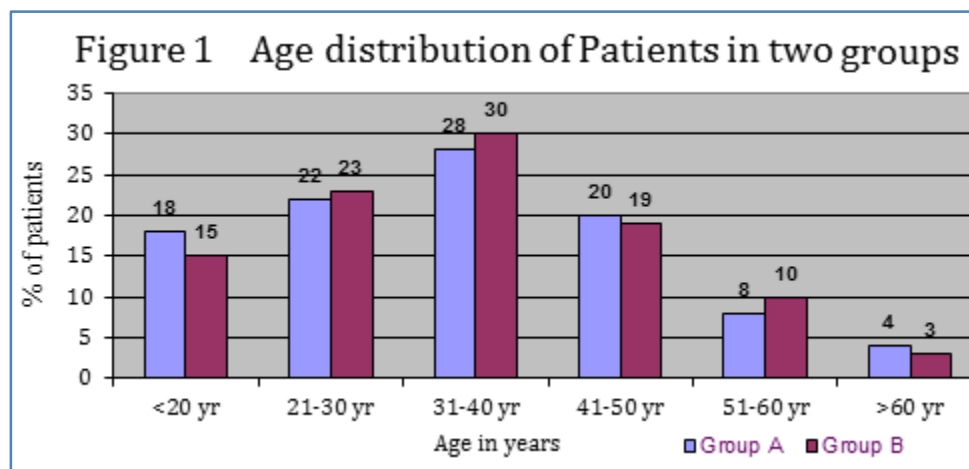
ORIGINAL ARTICLE

Parameters	Groups	Pre-operative								
			Induction	Intubation	10 min	20 min	30 min	40 min	50 min	60 min
Pulse /min Mean ± SD	Gr. A	89.84 ±20.60	98.32 ±19.59	104.28 ±16.60	91.76 ±15.78	88.56 ±15.50	83.28± 16.23	83.64± 16.048	79.92± 14.44	80.72± 16.32
	Gr. B	92.84 ±18.38	100.76 ±15.35	101 ±16.64	90.56 ±17.16	90.68 ±15.56	89.6± 12.64	87± 15.01	84± 14.89	84.58± 18.86
MAP mmHg Mean ± SD	Gr. A	100.12 ±14.55	102.72 ±13.30	106.8 ± 12.77	100.28 ±11.54	99.41 ±11.62	96.44± 13.07	97.12± 13.11	95.76± 12.60	94.77± 10.99
	Gr. B	106.29 ±12.57	107.52 ±19.10	104.64± 16.19	96.04 ±12.79	98.36 ±15.62	98.04± 17.87	97.48± 10.63	96.33± 10.57	96.88± 10.07
SpO ₂ mm Hg Mean ± SD	Gr. A	99.32 ±0.98	99.6 ± 0.57	99.8± 0.408	99.87 ± 0.33	99.83 ±0.408	99.88± 0.33	99.76± 0.522	99.88± 0.33	99.84± 0.50
	Gr. B	99.44 ±1.22	99.45 ±1.2	99.56± 0.96	99.8± 0.408	99.64 ±0.90	99.68± 0.627	99.8± 0.5	99.71± 0.56	99.70± 0.58

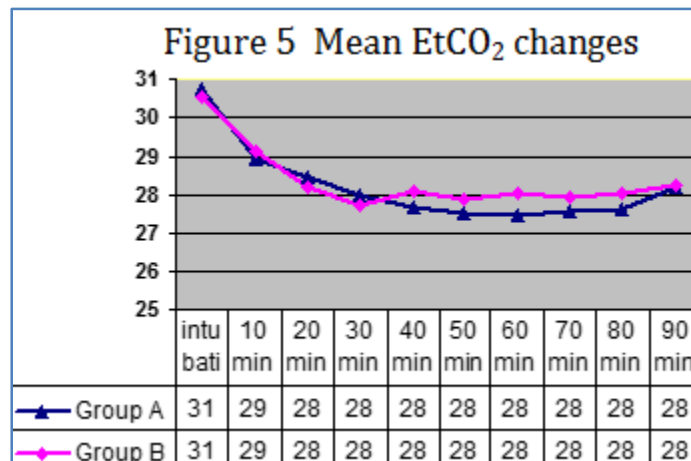
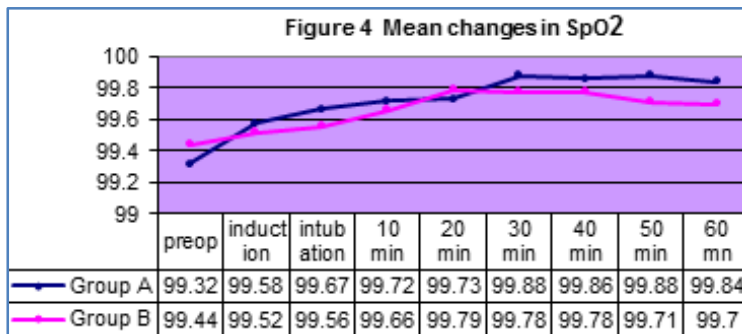
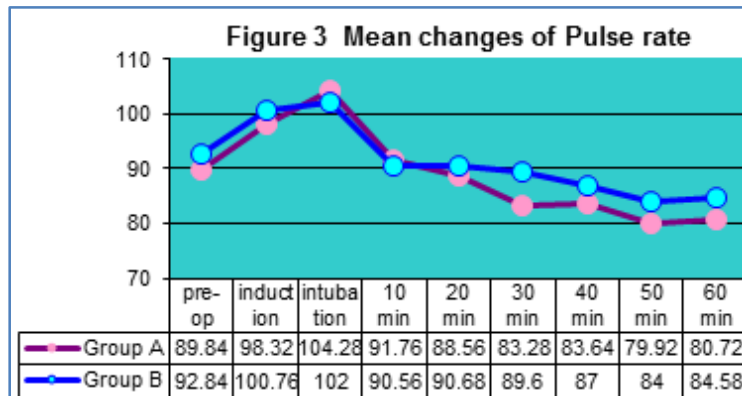
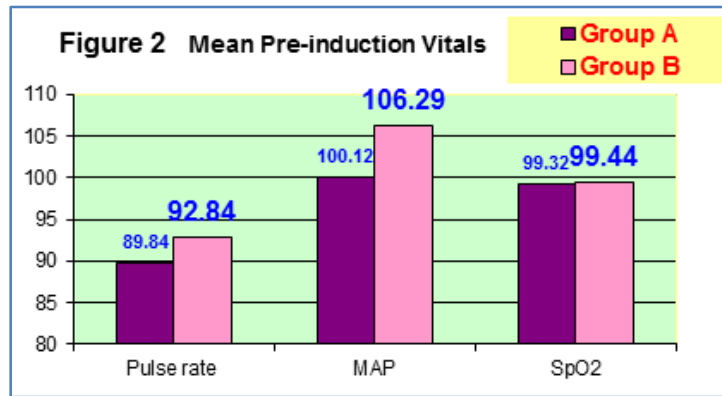
Table 5: Post Induction changes (up to 1 hour)

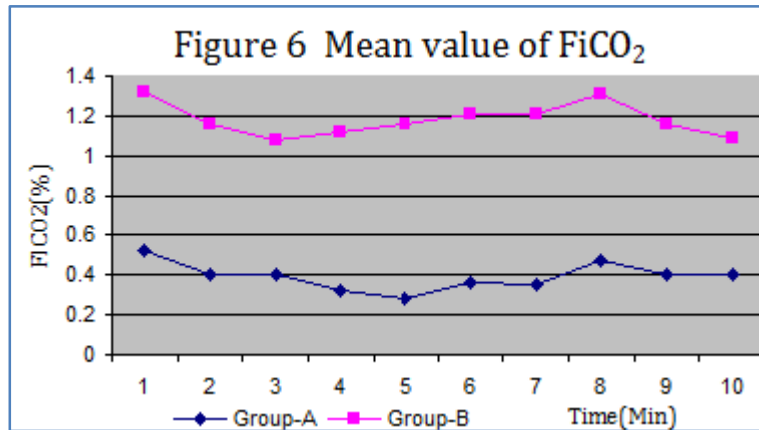
ASA Status	Group A		Group B		Total
	No of Patients	Percentage	No of Patients	Percentage	
ASA I	22	88%	23	92%	45
ASA II	3	12%	2	8%	5
Total	25	100%	25	100%	50

Table 6: ASA Status of study population of both the groups



ORIGINAL ARTICLE



**AUTHORS:**

- Joyanta Kumar Choudhury

PARTICULARS OF CONTRIBUTORS:

- Assistant Professor, Department of Anaesthesiology & Critical Care, Gauhati Medical College & Hospital, Guwahati, Assam.

FINANCIAL OR OTHER

COMPETING INTERESTS: None

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Joyanta Kumar Choudhury,
2C Ornate Enclave, August Kranti Path,
Opposite Novadaya Jatiya Vidyalaya,
Beltola Bazar Road.
P. O. Beltola, Guwahati-781028,
Assam.
E-mail: drjkc2008@gmail.com

Date of Submission: 11/09/2015.
Date of Peer Review: 12/09/2015.
Date of Acceptance: 18/09/2015.
Date of Publishing: 23/09/2015.