Comparative study of gasman software with conventional dial setting for depth of anaesthesia using bis monitor in laparoscopic cholesystectomy

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Abstract

Introduction: Gas Man is a commercial product which allows anaesthesiologist to simulate and experiment with anaesthesia delivery systems. This type of virtual anaesthesia machine is an animated gas machine illustration on computer screen, which is modifiable when the user selects different gas flows, vapour concentration etc. Attaining and maintaining steady state of depth of anaesthesia is very essential during maintenance phase of anaesthesia which can be accomplished by monitoring the depth of anaesthesia.

Aims: This study was conducted to evaluate two methods (Conventional and Simulated) of delivering inhalational anaesthetic agent (Sevoflurane) with the help of end tidal anaesthetic concentration and correlate it with BIS monitoring.

Materials and Method: Sixty adults patients undergoing elective laparoscopic cholecystectomy were randomly distributed to two groups. Group - C: Low flow anaesthesia technique based on conventional dosing strategy (n=30) and Group -S: Low flow anaesthesia technique by utilizing dosing strategy developed by computer simulation studies using Gas Man software (n=30). The study was to compare two methods of anaesthesia delivery system during maintenance of anaesthesia and hence observations were made after 20 minutes of intubation.

Results: In Group S, all the cases BIS value remained less than 60 and end tidal concentration of Sevoflurane was found >1.5 MAC. Conclusion: FGF and dial setting of Sevoflurane according to Gas Man software maintains the end tidal concentration of anaesthetic agents in the predicted therapeutic window without awareness during maintenance phase of anaesthesia.

Keywords*:* BIS monitor, Depth of Anaesthesia, Gasman software, Laparoscopic Choleysystectomy.

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Introduction

Low flow anaesthesia can be possible with the use of closed system with carbon dioxide absorption and gas monitoring. There are many advantages of low flow anaesthesia technique like economy, reduction in the operating room pollution, heat and humidity conservation, less danger of barotrauma and estimation of anaesthetic agent used.(1) Today low flow anaesthesia is a safe technique and there is no reason not to use it routinely. Low flow anaesthesia permits rebreathing of expired gas volume of at least 50%. But the technique requires continuous monitoring of FiO2, end tidal CO2 and end tidal anaesthetic concentration. Thus safe practice of low flow anaesthesia needs high standards of integrated monitoring equipments with continuous analysis of inspiratory and expiratory gases.(2)

Gas Man is a commercial product which allows anaesthesiologist to simulate and experiment with anaesthesia delivery systems. One can vary fresh gas flow, circuit type, patient body habitus, cardiac output, vaporizer setting up and other parameters, while observing the effects on volatile agent uptake and distribution in several body compartments, excretion and cost. This type of virtual anaesthesia machine is an animated gas machine illustration on computer screen, which is modifiable when the user selects different gas flows, vapour concentration etc. Attaining and maintaining steady state of depth of anaesthesia is very essential during maintenance phase of anaesthesia which can be accomplished by monitoring the depth of anaesthesia. The desirable concentration of volatile anaesthetic agent in the alveoli as reflected by end tidal concentration can be monitored with gas analyser. Availability of these costly equipments in the developing country like India may not be possible at all levels and everywhere. However Gas man has an answer for this. The suggestions by this simulation software for Fresh gas flow and accordingly dial settings of sevoflurane prevents awareness and at the same time reduce the cost of anaesthesia. Low flow anaesthesia is practiced during maintenance and hence comparison of both the techniques of delivery of anaesthesia was done during maintenance period. The risk of awareness correlates with depth of anaesthesia which is frequently associated with poor anaesthetic techniques. The volatile's anaesthetic agent's minimal alveolar concentration (MAC) value describes the concentration required at 1 atmosphere ambient pressure, to prevent 50% of subjects moving in response to stimulus. However certain factors may cause the end tidal concentration to misrepresent the brain partial pressure of volatile agent, where monitoring with BIS can help to prevent awareness of anaesthesia.(3,4)

The present study was to evaluate maintenance of anaesthesia by conventional method and computer simulation method using Gas man software for delivery of fresh gas flow and inhalational anaesthetic agent in terms of depth of anaesthesia by monitoring with BIS monitor. BIS monitoring tailored anaesthesia was used in conventional method in our study and accordingly dial concentration of sevoflurane was changed.

Along with BIS, gas analysis monitor showing end tidal concentration of sevoflurane was also monitored to ensure adequate MAC delivery of inhalational anaesthetic agent.

Aims and Objectives

The aims of this present study were,

1. To familiarized with Gas Man software developed by James H Philip, ME (E), and MD of Harvard Medical School. And to experiment on it.
2. To compare two delivering techniques of low flow anaesthesia--conventional and simulation method using Gas man software.
3. To evaluate two methods (Conventional and Simulated) of delivering inhalational anaesthetic agent (Sevoflurane) with the help of end tidal anaesthetic concentration and correlate it with BIS monitoring.

Materials and Method

Sixty patients of ASA grade I and II between the ages of 17-68 years, undergoing elective laparoscopic choleycystectomy. They were randomly distributed to two groups after informed written consent.
Group - C: Low flow anaesthesia technique based on conventional dosing strategy (n=30)
Group -S: Low flow anaesthesia technique by utilizing dosing strategy developed by computer simulation studies using Gas Man software (n=30).

All the patients were examined pre operatively and routine investigations were carried out. Intravenous line was secured and all the patients were premedicated with Inj. Glycopyrrolate 0.2 mg i.v, Inj. Ondansetron 4 mg i.v, Inj. Midazolam 1 mg i.v and Inj. Fentanyl 100 µg, Inj. Ringer lactate was started. BIS sensors were applied on the forehead of the patients to monitor depth of anaesthesia. Anaesthesia workstation-(Drager Fabius GS Premium) having integrated closed circuit, ventilator, dedicated temperature and flow compensated sevoflurane vaporizer, ascending bellows ventilator and multi-modular monitor was used in all cases. Patients were preoxygenated with 100% O2 for 5 minutes. Induction of general anaesthesia was achieved by administration of 5 mg/kg of Thiopentone sodium intravenously followed by Injection Succinyl choline 2 mg/kg. After intubation with appropriate cuffed oral endotracheal tube, patients were maintained with Oxygen, nitrous oxide and sevoflurane. Injection Attracurium was used as long acting muscle relaxant in all patients.

Basic monitoring of all parameters like pulse rate, blood pressure, oxygen saturation, ECG, end tidal carbon dioxide, end tidal concentration of sevoflurane was done at every 5 minutes intervals. Our aim of the study was to compare two methods of anaesthesia delivery system during maintenance of anaesthesia and hence observations were made after 20 minutes of intubation.

In conventional Group (Group C), during maintenance of anaesthesia (20 min after intubation) low flow anaesthesia was administered with FGF of 3 L and sevoflurane vaporizer dial setting at 1.5vol%. Observations were made for how many times dial adjustments of sevoflurane vaporizer required to maintain BIS monitor reading 40-60 and to ensure that minimal end tidal concentration value for sevoflurane remained 1.5 MAC. In Simulation Group (Group S), during maintenance of anaesthesia (20 min after intubation) low flow anaesthesia was administered with FGF of 2 L and sevoflurane vaporizer dial setting at 2.8 vol%. BIS readings and end tidal concentrations of sevoflurane were recorded every 5 min.

Observation and Results

The study included 60 patients of ASA grade I and II with similar demographic data as shown in Table 1.

Table 1: ASA Demographic data

	Group S	Group C
Age (years)	34.9±15.02	36.33±15.37
Weight (kg)	58.1±5.08	59.06±5.9
ASA Grade I:II	22:8	24:6
Male: Female	13:17	13:17

Table 2: Parameters after 20 minutes after intubation

	Group S	Group C
Heart rate (Mean ± SD) (bpm)	82.26±4.35	83.93±4.21
Mean blood pressure (Mean ± SD)(mmHg)	90.29±4.54	93.26±4.41
Dial Concentration (vol%)	2.8	1.5
Fresh Gas Flow (litres)	2	3
BIS reading	44-46	42-51

Table 3: Duration of surgery in minutes

	Group S	Group C
Duration of surgery (Mean ±SD) (minutes)	84.16±27.79	74.66±23.99
Minimum duration (minutes)	45	45
Maximum duration (minutes)	135	145

Table 4: No of incidences of BIS reading value of > 60 during maintenance

No. of incidence	Group S	Group C
1	0	6
2	0	18
3	0	5
4	0	1

Table 5: No of incidences where dial setting was changed according to BIS reading

No of incidences	Group S	Group C
2	0	4
3	0	6
4	0	9
5	0	3
6	0	6
7	0	1
8	0	1

In Group C, almost all the cases required to change the initial dial setting as seen in Table 5. One case of Group C, required BIS guided changing of dial setting of Sevoflurane for 8 times because of prolonged surgery (145 minutes) as laparoscopic cholecystectomy was converted in to open surgery. In Group S, none of the case was having BIS value >60.

Chart 1: No of patients having BIS value >60 every 5 min

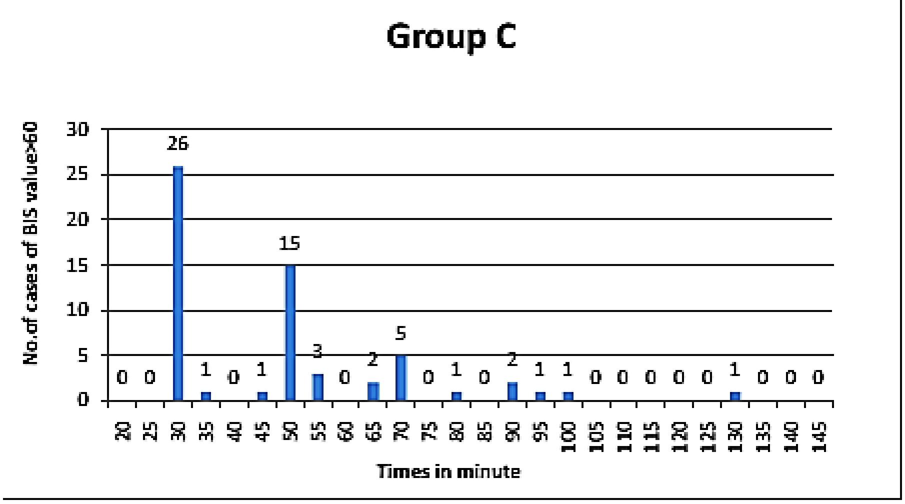
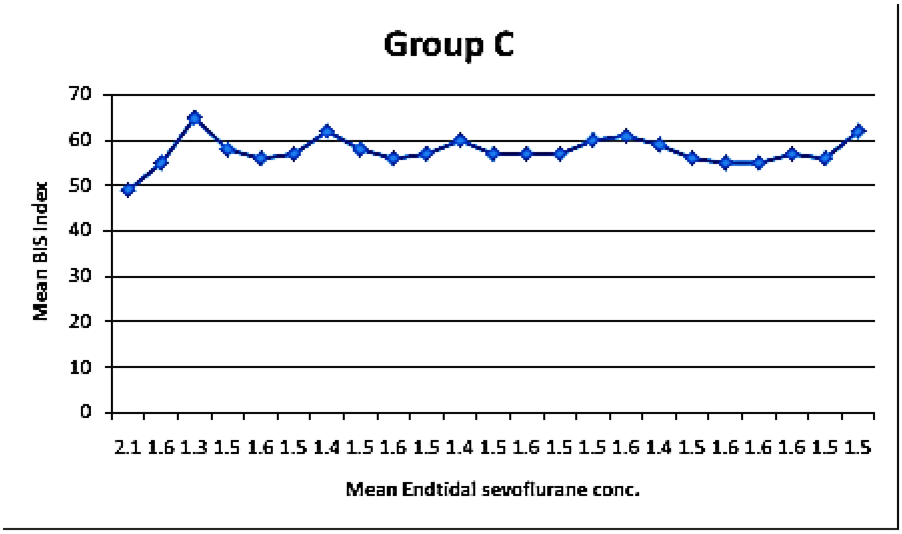
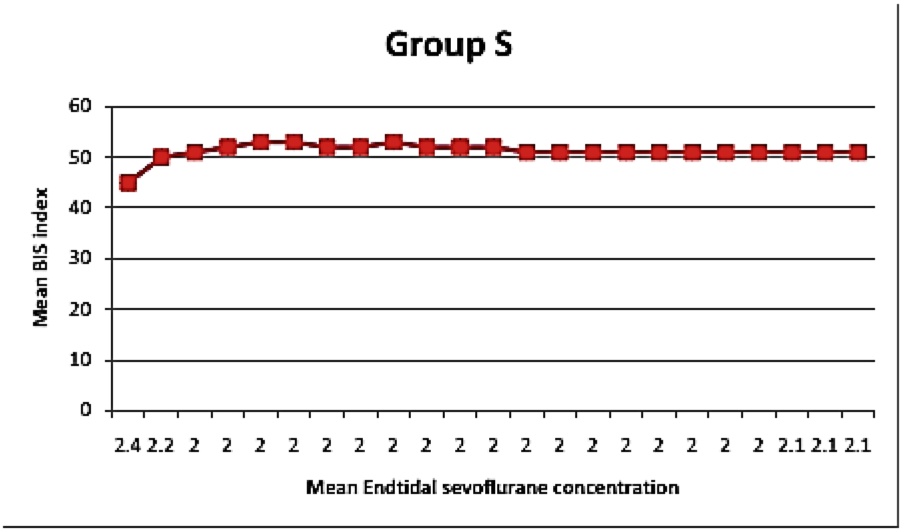


Chart 2: Correlation of end tidal Sevoflurane concentration with BIS index in Group C



BIS value was found increased whenever end tidal Sevoflurane concentration was decreased showing inverse relationship in Group C as shown in Chart 2.

Chart 3: Correlation of end tidal Sevoflurane concentration with BIS index with Group S



In Group S, in all the cases BIS value remained less than 60 and end tidal concentration of Sevoflurane was found >1.5 MAC as shown in Chart 3.

Discussion

The comparison between established conventional methods with strategies developed by computer simulation studies using Gas Man software, if found to be beneficial, would be a big step in the direction of establishing technique of low flow anaesthesia. If any strategy has a practical value and it is desired to be adopted by the practitioners, it should be appealing, attractively simple, effective and easily memorized.(5) Since an average clinical anaesthesiologist does not have access to a computer controlled system as well as gas analysis monitor, he has to resort to manual adjustments of the vaporizer settings based on personal experience. 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 with consideration of cost on the other is the prime responsibility of the anaesthesiologist.(6,7)

A major obstacle to the use of low –flow technique is the user's fear of increasing disparity between gas concentrations set at the anaesthetic machine and those in the breathing system.(9,10) Modern inhalational anaesthetic agents are metabolised to a small extent only and are largely exhaled unchanged. Although there are a number of strategies utilizing many mathematical and non-mathematical calculations described to attain a satisfactory anaesthesia in low flow conditions, a consensus is yet to be reached on the best possible method.(11) 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.(8) The emphasis in our study is to simplify matters for an anaesthesiologist to help him to adopt low flow technique, which has a tremendous potential in developing countries. The aim of our study was to compare conventional and simulated anaesthesia gas delivery systems during maintenance phase of general anaesthesia. The parameters for comparison were BIS index monitoring and end tidal concentration of Sevoflurane. Patients of both the groups were having similar demographic data and received same premedication. With the help of Gas man software and running it with different combination of Fresh gas Flow (FGF) and dial concentration FD (vaporizer dial setting), it is seen that steady state of anaesthesia is usually achieved after 20 minutes of induction and intubation(ref). For lower the Fresh gas flow higher FD (dial concentration) is required because when Fresh gas flow is reduced, the difference between FD and FI (inspiratory Concentration) increases. In Group C, 86.66% of the patient showed BIS index value more than 60 after 30 minutes of intubation. End tidal concentration of Sevoflurane also reached to less than 1.5 MAC requiring increase concentration of sevoflurane in vaporizer dial settings.(5)

The mean duration of surgery in Group C was 74.66 minutes and all the cases required change in initial dial settings of Sevoflurane vaporizer. Integrated monitor equipment's along with continuous gas analysis may not be possible in all set up, but if we follow Fresh gas flow and dial setting as suggested by Gas Man, we can safely practice low flow anaesthesia technique with steady state of depth of anaesthesia. In Group S, none of the patient had BIS value more than 60 and end tidal concentration of Sevoflurane also remained more than 1.5 MAC. This is evident by running Gas Man simulation with FGF (2 L) and dial concentration of Sevoflurane 2.8.(5)

In 2014,(4) Nirali N Panchal, Varsha N Swadia, Mamta G Patel, et al, also conducted a clinical study of correlation of BIS index with Sevoflurane concentration during various phases of conventional anaesthesia and compare end tidal with alveolar concentration of

Sevoflurane on Gasman in 25 ASA I and II paediatric patients. They concluded that on correlating BIS value with end tidal Sevoflurane concentration, inverse linear relationship was established. Their clinical finding correlated well with Gasman simulator programme.

Conclusion

From the present study we conclude that FGF and dial setting of Sevoflurane according to Gas Man software maintains the end tidal concentration of anaesthetic agents in the predicted therapeutic window without awareness during maintenance phase of anaesthesia.

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