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Insertion of the Esophageal—Tracheal Combitube® using Inhalational Anesthetic Induction with Sevoflurane

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ABSTRACT

Objective: Inhalational induction with sevoflurane allows the insertion of a variety of devices for airway management. We investigated whether the Combitube® 37 French SA (Small Adult) could be inserted using sevoflurane as a single agent in a group of elective surgical patients. In addition, we studied cost and quality of mask anesthesia and Combitube® insertion.

Materials and Methods: Fifty ASA I and II patients scheduled for elective gynaecological laparoscopy were included. All patients were premedicated with diazepam 5 mg orally the night before surgery. The respiratory circuit was primed for 30 seconds using sevoflurane 8% in 100% oxygen with 6-l/min fresh gas flow. We used the same gas mixture throughout anesthesia and the vital capacity induction technique. Ventilation was manually assisted until pupils' convergence. One minute after pupils converged, jaw relaxation was tested and if considered adequate according a predetermined score, blind Combitube® insertion was attempted. The time of exposure to the inhaled gas was either increased or decreased by 30-sec increments based on the failure or success of the preceding patient's response to Combitube insertion after a pre-selected exposure time. Failure was defined as coughing or bucking.

Results: Mask induction was well tolerated by all patients. Acceptable insertion conditions were obtained at a mean time of 4.9 $\pm$ 1.2 minutes. Blind insertion was successful in all cases (92% at the first attempt). The incidence of breath holding and bronchospasm was 10% and 4% respectively.

Conclusion: The Combitube® 37 F SA can be easily inserted using inhalational induction without neuromuscular blocking agents. Costs involved with the technique compare favorably with previously reported.

Key Words: Equipment; Combitube, airway, Anesthesia; Sevoflurane, inhalational induction, general anesthesia.

The Esophageal-Tracheal Combitube® (ETC, Tyco Healthcare, Mansfield, Massachusetts) is a double lumen tube allowing ventilation either in esophageal or tracheal position when inserted. Originally designed for rescue (1–3), it has been introduced to the anesthesiologic practice demonstrating attractive features (4,5). Among others, these include usefulness in cases of failed intubation, successful insertion regardless of patient's position (6), airway protection against regurgitation of gastric contents or vomitus and allowance of ventilation with high airway pressures.

Sevoflurane is a relatively new short acting inhalational agent with a blood:gas partition coefficient of 0.65:1. This feature allows rapid and soft inhalational induction in children and adults, with great ability to change anesthetic depth. It is also non-irritant, non-pungent and pleasant smelling, thereby making it much more acceptable for induction of anesthesia compared with other inhalational agents. The Volatile-Induction-and-Maintenance-Anesthesia (VIMA) technique is widely used for different procedures (7). Previously, (8) insertion of LMA and tracheal tube (TT) was described using sevoflurane as a unique induction agent in adult volunteers. We designed this study to investigate whether the ETC could be inserted using inhalational induction of anesthesia with sevoflurane in adult elective surgical patients.

MATERIAL AND METHODS

With Institutional Review Board approval and informed consent, 50 ASA physical status 1 and 2 patients undergoing elective gynaecological laparoscopy were included. Patients suffering from latex allergy and cardiopulmonary diseases were excluded.

During the preoperative visit, all patients' airways were classified according to the Mallampati-test (9) as modified by Samsoon and Young (10), to interincisor distance (11), and to thyromental distance (12). Patients were premedicated with diazepam 5 mg orally the night before surgery.

Standard non-invasive monitoring was used, including a gas analyser (Dräger, Julian, Germany).

Anesthetic Technique

After inserting a peripheral venous catheter and starting a saline solution, the attendant anesthesiologist instructed the patient about the induction technique: exhale to residual volume and take vital capacity breaths, holding inspiration for 5 seconds. Additionally, the patient was told that the anesthetic has a definite odour but would not be unpleasant to breathe. Anesthetic induction technique was performed as described by Muzi et al (8) but, contrary to these authors, we primed the respiratory circuit with sevoflurane 8% in O_2 at 6 $l.min^{-1}$ during 30 seconds (two fill/empty cycles of the occluded anesthesia circuit). We gently placed the facemask over the nose and mouth after a forced exhalation (to residual volume) and the patients took 3 vital capacity breaths of gas mixture, as previously instructed. Oxygen flow was decreased to 3 $l\text{-}min^{-1}$ at the moment the patient lost her lid-lash reflex. Both pupils were examined every 30 seconds for position and size after loss of lid-lash reflex. We recorded the time for the pupils to converge. One minute after convergence of pupils, jaw mobility was tested. If jaw was fully relaxed or exhibited mild resistance, ETC insertion was attempted. We determined the acceptability of placement of ETC using a grading system modified from Scheller et al (13), and data are summarized in

Table 2. To achieve an “acceptable” rating for ETC insertion, criteria score could not exceed 2 points for any of the conditions or responses.

Combitube Insertion Technique

We used an ETC 37 F SA (Small Adult) in all patients. One experienced anesthesiologist (RMU) and 6 anesthesiologists without previous experience with the device performed the insertions. We previously lubricated the device with normal saline and inserted blindly, according to inventor’s technique (1). After insertion, the tracheo-esophageal cuff (14) was inflated with 10 ml of air, while the pharyngeal balloon was inflated starting with 50 ml of air and titrating to air leak under mechanical ventilation (Vt 10 $ml.kg^{-1}$, RR 10 $cycles.min^{-1}$, I:E ratio 1:2) (15). We ventilated through the pharyngeal lumen leading to pharyngeal perforations.

Gases were sampled from the elbow between the ETC connector and the Y tubing. Using a gas analyser, we recorded end tidal concentration of sevoflurane in 29 patients after ETC insertion. We also noted the occurrence of spontaneous breathing, breath holding, expiratory stridor, laryngospasm, bronchospasm, or secretions.

Statistics and cost calculation

The "up-and-down" method of Dixon (16) was used to determine the mean and standard deviation of anesthesia duration for acceptable ETC placement. The results are represented as mean $\pm$ SD values.

To derive the cost of sevoflurane administered *via* mask to ETC placement, we applied the formula described in the Appendix section, using the average delivered sevoflurane concentration. Values are expressed in pounds (£).

RESULTS

Demographic data are summarized in Table 1. All patients had normal airways as determined by Mallampati test, interincisor distance and thyromental distance. Mean time for the entire anesthetic-surgical procedure was 41.7 $\pm$ 21.5 minutes.

In non-randomly trials, thirty-seven patients (74%) were intubated by the experienced anesthesiologist (RMU) and thirteen (26%) by the 6 non-experienced anesthesiologists. All patients were able to breathe according to the explained technique and inhalational anesthetic induction was accomplished without difficulties. Patients lost their lid-lash reflex at an average time of 31.7 $\pm$ 18.9 seconds after first breath and eyes converged within 201 $\pm$ 69 seconds. Acceptability of insertion score was <2 in all patients at 4.68 $\pm$ 0.92 minutes with mean sevoflurane end-tidal fraction of 5.8 $\pm$ 0.3 vol%. Insertion features and airway responses are summarized in Table 2. Most patients (92%) kept breathing spontaneously at the time of insertion, without worsening insertion conditions. Blind insertion was successful at first attempt in 45 patients (90%). The 5 patients (10%) who were intubated at a second attempt increased the insertion time to 4.9 $\pm$ 1.2 minutes. Mostly, the cause was patient’s cough or movement, due to an insufficient depth of anesthesia (see Table 2).

Ventilation was adequate in all cases with SpO_2 and $ETCO_2$ values within the normal range. Mean peak inspiratory pressure was 25.8 $\pm$ 6.9 cm H_2O during mechanical ventilation. The higher values were obtained in 2 patients due to

non-detected ETC upper ending kinking and severe bronchospasm in one patient with a smoking history.

Hemodynamic parameters did not significantly change from baseline values after insertion, except for 4 patients (8%) who developed transient and self-limited sinus tachycardia (range 105–158 beats.min^{-1}), not requiring treatment.

Awakening was soft and uneventful in all patients at a mean time of 10.6 ± 1.6 minutes. Five patients (10%) withdrew the ETC by themselves without difficulties.

Costs

With the described technique we found an average cost of sevoflurane for priming the circuit of £0.65 and an average cost of inserting the ETC of £4.01 per patient. In addition, we found an average cost of sevoflurane of £10.38 ± 3.6(£6.4–£20.6) for the entire surgical procedure.

DISCUSSION

The main finding of this study was that ETC could be successfully inserted using sevoflurane as a single agent.

There is no previous description of ETC insertion using inhalational induction with sevoflurane as a single agent. Muzi et al (8) studied LMA and TT insertion in non-premedicated volunteers using sevoflurane in nitrous oxide/oxygen, obtaining average insertion times of 1.7 minutes for LMA and 4.7 minutes for TT. When 100% oxygen was used, TT insertion time increased to an average of 6.4 minutes. Without priming the circuit and using sevoflurane 6 to 7%, they estimated that the time for acceptable intubating conditions occurred 2 minutes after pupil convergence in the sevoflurane /oxygen group. We tried to achieve acceptable intubating conditions as quickly as possible, not trying to determine the true minimum alveolar anesthetic concentration (MAC) associated with these induction times. We also speculated that priming the circuit and using sevoflurane 8% instead of 6 to 7%, and despite using O_2 100%, the time of achieving acceptable intubating conditions could be shortened to 1 minute after convergence of pupils. Indeed, ETC was successfully inserted in most patients (92%) 1 minute after pupil convergence. Compared to the findings of Muzi et al (8), ETC mean insertion time was intermediate between LMA and TT.

Inhalational agents such as sevoflurane may provide some advantages over intravenous agents for insertion of airway devices such as ETC and LMA. The main reason is that some clinical parameters to determine the best moment for insertion could be used (8,13), and a wide variability of efficacy between patients and the rapid redistribution of propofol could lead to lightening of the anesthetic depth before insertion is attained (17). In addition, induction side effects are different with the two techniques, since airway-related events are more frequent with sevoflurane and hemodynamic and motor events more frequent with propofol. Our study reports an incidence of airway-related events during anesthetic induction in 10% of the patients, mainly cough and bronchospasm. This incidence compares well with the 16% reported by Philip et al (18). We did not observed laryngospasm in this group of patients. Administration of opioids prior to inhalational induction could shorten induction time, improve the quality of induction and reduce the incidence of airway side effects (19). Interestingly, Muzi et al could not demonstrate an improved speed

of induction when nitrous oxide was used in their study. Theoretically, nitrous oxide would provide some benefit on speed of induction when combined with an anesthetic of high solubility.

Other implications of this study are that this technique could be used for management a potential difficult airway (20) because spontaneous breathing and oxygen reserve (using 100% O_2) are preserved in most patients. Thus, ETC can be used in surgical cases when tracheal intubation is not mandatory. In addition, whenever fiberoptic intubation is not available, patients could be managed using this strategy.

Cost of priming the respiratory circuit with sevoflurane 8% at 6-l/min fresh gas flow seems to be cheaper than the recommendation by Philip et al (18). Cost of the entire VIMA procedure in this study was comparable to previous reports (21,22). Recently, Hoerauf et al (23) reported that the use of the ETC during positive pressure ventilation is not necessarily associated with increased waste gas exposure with an inadvertent increase in costs.

Regarding costs associated to ETC use, each roll up kit costs £42.3 (see Appendix). In this study, we reused the ETC up 10 times without problems or changes in its features, therefore costs of £4.23 per tube per patient could be calculated. A previous study demonstrated that resterilisation and reuse of the ETC is possible from a microbiological point of view (24).

Limitations of this study are that only female patients were included so some gender variations could appear. In addition, as this study was designed as a clinical trial, no comparison with the tracheal tube was accomplished because it is not our practice to intubate the trachea without neuromuscular blocking agents.

In conclusion, the ETC 37 F SA can be easily inserted using sevoflurane for inhalational anesthetic induction without neuromuscular blocking agents. This is contrary to the belief that neuromuscular blockade is mandatory for ETC insertion.

ACKNOWLEDGEMENTS

We thank midwives and personnel of the operating room of the Obstetric Anesthesia Unit, Padre Hurtado Hospital, for their invaluable help.

APPENDIX

Total costs of sevoflurane per operation were calculated based on the current UK list price (BNF 38; September 1999): £123.00 for a 250 ml bottle. The cost of sevoflurane was calculated using the formula:

Cost (£) = {(fresh gas flow (ml) * % sevoflurane) / ml vapour per ml liquid anesthetic (182.7)} * (price of bottle/250).

ETC cost considered resterilisation giving an arbitrarial number of 10 reuses per unit. Cost of the roll up kit in UK is £42.3, according to the Domestic marketing price list.

Other drugs (fentanyl and atracurium) and disposables (cannulae, intravenous fluids, syringes, etc) were not included in costs.

Table 1 Demographic data. Mean ± SD and number (%). n=50

Mean age; years	37.5 ± 5.3
Mean weight; kg	67.4 ± 10.9
Mean height, cm	155.3 ± 5.5
ASA Grade	
1	30 (60%)
2	20 (40%)*

* 12 obese patients (height/weight index >30), 4 smokers (>10 cigarettes per day), 2 with connective tissue disease, 1 diabetic, 1 congenital agenesia of the left kidney.

Table 2 Airway conditions and responses for ETC placement (8,13).

	Success	**Failure**
Jaw mobility	**n(%)**	**n(%)**
1 Fully relaxed	46(92)	0
2 Mild resistance	4(8)	0
3 Tight but opens	0	0
4 Close	0	0
Coughing, movement		
1 None	46(92)	0
2 1 or 2 coughs	2(4)*	0
3 3 or more coughs	1(2)*	0
4 Bucking/movement	2(4)*	0
Other events		
Spontaneous ventilation	45(90)	0
Breath holding	5(10)	0
Bronchospasm	2(4)	0
Expiratory stridor	0	0
Tearing	0	0

* These patients were intubated at the second attempt.

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Meeting Report

Society for Airway Management Scientific Meeting with Workshops September 20-22, 2002

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ABSTRACT

Background: The course was designed to address the ASA's findings concerning adverse anesthetic outcomes following respiratory problems. The aim of the meeting was to present international speakers in different fields to discuss aspects of the difficult airway.

Main Topics: Main lectures covered the field of new devices, such as magnetic intubation, and new uses of old techniques, safety and airway management, research in airway mangement and video presentation, airway issues in the emergency room, patient safety, prehospital airway management issues, and definition of a difficult airway. Furthermore, animal laboratory workshops, as well as hands-on workshops and airway simulators for training of fiberoptics, lung isolation, laryngeal mask airways, Combitubes, cuffed oropharyngeal airways (COPA), different types of laryngoscopes, transtracheal jet ventilation, cricothyroidotomy, retrograde intubation, transillumination techniques, and pharyngeal airway devices were provided.

Conclusion: The meeting was a major advance in teaching and learning skills in difficult airway management.

Key Words: Society for Airway Management, difficult airway, laryngeal mask airways, Combitubes, cuffed oropharyngeal airways, laryngoscopes, transtracheal jet ventilation, cricothyroidotomy, retrograde intubation, transillumination techniques

The small village Newport Beach close to Los Angeles has served as a wonderful conference resort for the Annual Meetings of the Society for Airway Management (SAM) from 1993 to 1997. Again, this year the Sutton Place Hotel, former Le Meridien Hotel, was chosen as the conference venue. The marvelous hotel provided the exclusive atmosphere for high quality topics and lectures.

The course was designed to address the American Soceity of Anesthesiologists's (ASA) findings concerning adverse anesthetic

outcomes following respiratory problems. The aim of the meeting was to present international speakers in different fields to discuss all aspects of the difficult airway.

MAIN TOPICS

Main lectures covered the field of new devices, such as magnetic intubation, and new uses of old techniques. Professor Allan Reed, Mount Sinai Hospital New York, started with a review of the pharyngeal airway, which is a single use, latex free, supraglottic airway management tool. It consists of a long tube. One end of the tube offers a standard 15 m adapter for easy attachment to conventional breathing circuits and respiratory bags. The other end contains a hollow box with an anterior opening (hooded window). The box offers vertical struts (airway channels) that prevent occlusion by a downturned epiglottis. Beyond the box there is a flexible gilled tip. An oropharyngeal balloon is located just above the box. It has performed well in over 1,000 documented uses. Once properly seated, oxygenation and ventilation are generally maintained.

Prof. Takashi Asai, from the Kansai Medical University in Osaka, Japan, continued with the laryngeal tube. The laryngeal tube consists of an airway tube with a small balloon cuff attached at the tip and a larger balloon cuff at the middle part of the tube. The tube is inflated through a pilot tube and balloon. There is only one pilot tube to inflate both cuffs. The standard 15 mm connector on the proximal end can be attached to a breathing system. The device is made of silicone and is re-usable after sterilization in an autoclave. There are six sizes available, suitable for neonates to large adults.
An outstanding lecture was provided by Ricardo Urtubia, from the Mutual de Seguridad Hospial in Santiago de Chile. As an expert on the elective use of the Combitube, he successfully convinced the audience of the advantageds of the Combitube over many other airway alternatives, specially in patients in danger of aspiration. He emphasized careful introduction to avoid any potential danger to the pharyngeal mucosa and explained in detail the precautions to be observed during elective use.

David Ferson and Chandy Vergese, Royal Berkshire Hospital, Reading, United Kingdom, demonstrated the details of the different types of the laryngeal mask. This included the advantages of the LMA ProSeal providing an additional channel for decompressing the esophagus and stomach and a better seal against aspiration. However, the upper sealing pressure is 27 cm H_2O and therefore far below the sealing properties of the Combitube.

D. John Doyle lectured on human errors in airway management pointing to the diagnostic process, treatment, prevention, error of

omission, error of commission, extraneous act, sequential error, and time error.

Romolo Gaspari, University of Massachusetts, introduced magnetic intubation as a new and rapid technique for emergent intubation. The device invented by the presenter, is called MagnaTube and includes a laryngoscope, an external magnet, a magnetized flexible stylet and a collar. The external magnet guides the tube mounted with the magnetized stylet into the trachea. In a bench model, the success rate by inexperienced students was 80 %. In a pilot study on humans, all 14 patients could be successfully intubated.

The animal lab Workshop as well as the Hands-on-Workshops and Simulators provided an extraordinary option for training of several different devices and methods. The participants were highly motvated and rated the conference as an excellent means of training and maintaining their skills.

CONCLUSION: In summary, the SAM meeting was a major advance in teaching and learning skills in difficult airway management. Participation in the next years Annual Meeting in Miami, Florida, September 12 to 14, is strongly recommended.

POSTMASTER (IMPRESSUM)

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Meeting Report

The International Symposium on Crisis Management & the 6th Symposium of the Saudi Anesthestic Association in Anesthesiology and Intensive Care

September 25-26, 2002

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ABSTRACT

Background: The symposium was planned as an update and as a continuous training. It included a large number of international speakers for professional exchange of expertise.

Main Topics: The main topics included simulation of intensive care patients as well as simulation of preventive and risk strategies. Further topics were complications in anesthesia, alternative airways such as the Esophageal-Tracheal Combitube, and management of trauma patients. Other sessions were dedicated to new trends in the treatment of critically ill patients with special emphasis to respiratory insufficiency, military anesthesia, and disaster and emergency medicine.

Conclusion: The excellent organization as well as the scientific approach were an important step towards the maintenance and the improvement of skills in anesthesia, as well as intensive care medicine, disaster and emergency medicine.

Key Words: anesthesia, intensive care medicine, disaster medicine, emergency medicine, difficult airway, Esophageal-Tracheal Combitube, Airway Education & Research Foundation, Saudi Arabia

Dhahran has served as a wonderful conference resort for the The International Symposium on Crisis Management & the 6th Symposium of the Saudi Anesthestic Association in Anesthesiology and Intensive Care, taking place from September 25-26, 2002. The symposium was planned as an update and as a continuous training. It included a large number of international speakers for professional exchange of expertise.

MAIN TOPICS

The main topics included simulation of intensive care patients as well as simulation of preventive and risk strategies. Dr. Stefan Mönk, University of Mainz, Germany, talked about several approaches to imporve the intensive Care unit (ICU)-simulation capabilities using a short-term approach, supplementation of existing models, and statistical analysis. Professor Mohamed Abdullah Seraj, Professor and Chairman of the Department of Anesthesiology and Chairman of the Saudi Anesthestic Association, the "Father of Resuscitation in Saudi Arabia" spoke about the historical aspects of the use of simulators in cardiopulmonary resuscitation (CPR) training in Saudi Arabia. He emphasized the importance of using simulation for CPR training of Basic Life Support as well as Advanced Cardiac Life Support.

Dr. Christoph Grube from Heidelberg, Germany, spoke about preventive strategies and risk management for patient safety. He stated that analysis of mishaps, incidents and critical events seemed to be preventable in 75 % and were caused by human error. Typical examples for human error were lack of vigilance, non-effective communication, poor leadership in critical situations, and fixation error. Typical errors in anesthesia included syringe swap, injection into wrong access, and no/too late call for help.

Dr. Husam El Majed brought an overview on microsimulators in medical education. Microsimulators are purely desktop computer-based simulators. He stressed the advantage of microsimulators providing autonomous, cognitive training.

Professor Mohammad Takrouri, from the Department of Anesthesiology of the King Saud University, gave a lecture on critical incidents reports in the anesthesia department at Ksuh in Saudi Arabia. He has reviewed data collected in a seven years period. 143 incidents were reported during this period. Again, the most common incidents were due to human errors which accounted for nearly 28 %. Communication between the staff was in 23 %, and anesthesia technique complictaions was 17 % the underlying reason for adverse effects.

Mr. James Michael Rich, Chief Nurse Anesthetist from Baylor College, and Chairman of the Airway Education & Research Foundation (AERF) Dallas, Texas, gave a lecture on difficult intubation and airway injury. He focused on the problems of airway injury caused by difficult intubation. Therefore, he recommended direct laryngeal view, snifing poistion, use of blankets under the shoulders of obese patients, use of the gum elastic bougie, and proper application of external laryngeal manipulation. Dr. Mohammed Elgammal, Deputy Chairman of the Department of Anestehsia of the King Fahad National Guard

Hospital in Riyadh, reported on complications in pediatric anesthesia. Different to adults, laryngeal spasm, aspiration of gastric contents, bronchospasm, pneumothorax and hypotension are major complications in pediatric patients.

Dr. Michael Frass spoke on the use of the Combitbe especially in emergencies but also for use during elective surgery. The audience appreciated the video showing the selfintubabtion of an anesthesiologist.

CONCLUSION:

In conclusion, the International Symposium on Crisis Management & the 6th Symposium of the Saudi Anesthestic Association in Anesthesiology and Intensive Care was a marvelous conference and allowed exchange of experience and ideas in an international way.

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