Combitube

M Frass

Citation

M Frass. *Combitube*. The Internet Journal of Anesthesiology. 2000 Volume 5 Number 2.

Abstract

The Esophageal Tracheal Combitube(r) (Tyco-Kendall, Mansfield, MA) has been developed in the early eighties. The intention of the device is to bridge the gap between a respiratory arrest situation and the institution of a definite airway when conventional endotracheal intubation is not immediately possible. The idea kept in mind was to allow for a quick and easy method securing the patient's airways and adequately ventilating the lungs.

HISTORY AND TECHNICAL FEATURES

The Esophageal Tracheal Combitube(r) (Tyco-Kendall, Mansfield, MA) has been developed in the early eighties. The intention of the device is to bridge the gap between a respiratory arrest situation and the institution of a definite airway when conventional endotracheal intubation is not immediately possible. The idea kept in mind was to allow for a quick and easy method securing the patient's airway and adequately ventilating the lungs.

DEVELOPMENT

The invention of the Combitube aimed to enter either the esophagus or the trachea and allowing ventilation and oxygenation in both positions. This aim was achieved by designing a double lumen tube (figure 1): one lumen resembling a tracheal tube, the other an esophageal obturator type tube with a distal blocked end and perforations at the pharyngeal level.

Figure 1

Figure 1: Diagram Combitube

As a further development, the Combitube provides a special oropharyngeal balloon for sealing of the oral and nasal cavity (figure 2). As a benefit of this balloon, the ventral part sits just behind the posterior part of the hard palate thereby guaranteeing strong anchoring during ventilation and transportation.

Figure 2

Figure 2: Combitube

Opposite to standard intubation, placement of the Combitube is most easily performed with the patient's head in a neutral, semi-flexed position, while some clinicians prefer to extend the head, and/or to use a small cushion. Sniffing position, however, should be avoided! Neutral position is another advantage in patients with suspected or evident cervical spine injury. Insertion is aided by full muscle relaxation, but may be unnecessary with the use of propofol. The position of the operator may be behind the patient, to one side of the patient's head, or face to face. Similar to the EOA, the back of the patient's tongue and lower jaw are grasped between the thumb and forefinger of the non-dominant hand, while a

jaw lift is performed (figure 3).

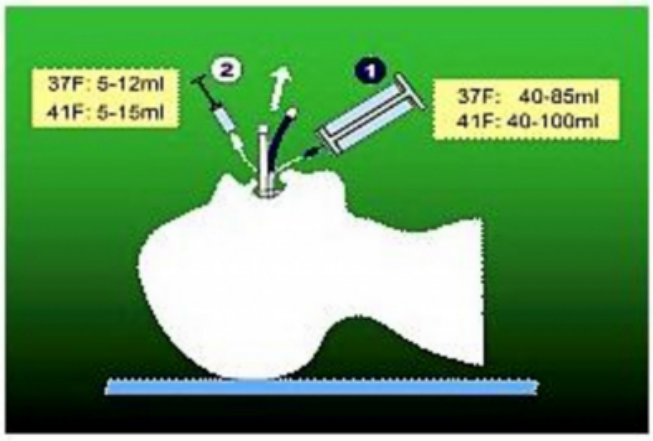
Figure 3

Figure 3: Insertion technique

Then the Combitube is inserted blindly with a gentle downward curved dorso-caudal movement along the tongue until the two printed ring marks lie between the teeth (figure 4), or the alveolar ridges in edentulous patients. Opposite to the laryngeal mask airway, the Combitube should not be inserted along the palate, it should be inserted along the tongue.

Figure 4

Figure 4: Insertion technique



Now, the oropharyngeal balloon is inflated with 85 ml (41 F: 100 ml) of air through port no. 1 with the blue pilot balloon using the large syringe. In many cases you may observe that the ETC moves out of the patient's mouth similar to a laryngeal mask airway in order to seal the upper airway and to fix the Combitube in the correct position. Significant resistance may be felt during inflation of the upper balloon. The plunger of the syringe should be held compressed while detaching the valve in order to assure a correct filling volume of the balloon.

Complete inflation of the recommended volume is mandatory in emergency situations. In elective cases, however, the minimal leakage technique should be used in order to avoid any potential stress to the pharyngeal mucosa: starting with 40 ml of air, the function of the balloon should be tested with respect to leakage (auscultation over the neck, comparison of inspiratory and expiratory tidal volume, etc.). In case of a leak, additional increments of 10 ml each are instilled until a sufficient seal is achieved. Usually, 40 to 85 ml of air are sufficient in order to obtain a tight seal, however, higher amounts up to 150 ml of air may be necessary in some individuals.

Following the oropharyngeal balloon, the distal balloon is then inflated with 5 to a maximum of 12 ml (41 F: 5 to a maximum of 15 ml) of air through the port no. 2 with the white pilot balloon using the small syringe. This balloon seals the esophagus or the trachea.

There is a high probability (up to 98%) of esophageal placement after blind insertion (figure 5).

Figure 5

Figure 5: Ventilation through Combitube with esophageal placement

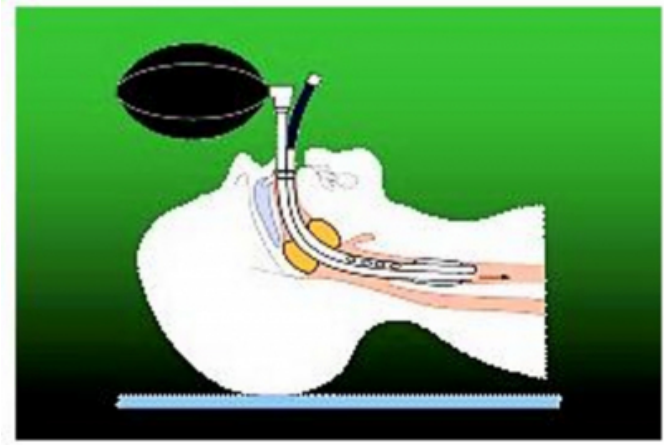
Therefore, test ventilation is recommended first through the longer blue tube, labeled no. 1 leading to the pharyngeal lumen. This blue or esophageal lumen is blocked distally. Thus, by ventilating through this lumen, air is forced through the holes into the pharynx. Since the oropharyngeal balloon forms a seal preventing escape of air through nose and mouth and the distal cuff seals the esophagus, the air passes over the epiglottis into the trachea. Expiration also occurs through the same holes in the pharyngeal lumen. Please confirm adequate bilateral breath sounds over the lungs by

auscultation in the absence of gastric insufflation when the Combitube has been placed in the esophagus. Capnography and esophageal detection method may be used for confirmation of the correct lumen. Ventilation is then continued through this lumen. The second lumen allows for immediate decompression of esophagus and stomach and the deflection elbow prevents the rescuer from soiling) or for suctioning with the help of a small suction catheter which is included in the kit.

If auscultation over the lungs is negative, the Combitube has been positioned in the trachea (figure 6). Now, ventilation is performed via the shorter transparent tube no. 2, leading to the tracheal lumen. Evaluation has to be performed again, and the air flows directly into the trachea.

Figure 6

Figure 6: Ventilation through Combitube with tracheal placement

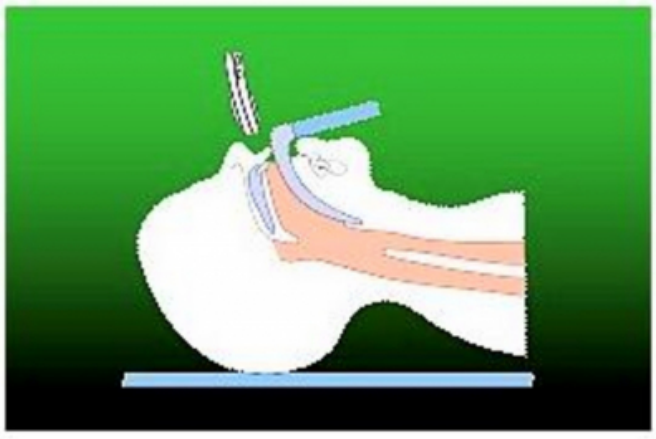


In rare cases, ventilation does not function neither via the esophageal nor the tracheal lumen. Then it might have happened that the Combitube had been positioned too deeply with the oropharyngeal balloon occluding the laryngeal aperture. In these cases, the balloons should be deflated, the tube be pulled back for about 2 to 3 cm, and both balloons re-inflated.

While the Combitube is easy to insert and to use, it should be trained in elective cases observing the above mentioned preliminary measures. Furthermore, clinical judgement as in any anesthetic procedure is mandatory to avoid any possible adverse effect. While the Combitube may be inserted blindly, the use of a laryngoscope is recommended whenever available (figure 7).

Figure 7

Figure 7: Insertion technique



The Combitube provides the following advantages: Non-invasive as compared to cricothyrotomy; ready to use; blind insertion technique, but laryngoscope recommended whenever feasible; neck flexion not necessary for intubation; minimized risk of aspiration due to protection of distal cuff and oropharyngeal balloon; simultaneous fixation after inflation of the oropharyngeal balloon without need for tape; controlled mechanical ventilation possible at high ventilatory pressures (50 cm H2O and more); independent of power supply (e.g. batteries of laryngoscope); well suited for obese patients; may be used in paralyzed patients who cannot be intubated or mask-ventilated; helpful under difficult circumstances with respect to space and illumination, works in either tracheal or esophageal position, etc.

SIZES, RECOMMENDATIONS FOR INSERTION (ESPECIALLY IN ELECTIVE CASES), BALLOON AND CUFF VOLUMES

Two sizes of the Combitube are available: the Combitube SA 37 F and the Combitube 41 F. While the manufacturer recommends to use the Combitube SA 37 F in patients from 4 to 51/2 feet, and the Combitube 41 F in patients 5 feet and taller, recent studies[1,2,3,4] suggest to use the Combitube SA 37 F in patients from 4 to 6 feet, and the Combitube 41 F in patients 6 feet and taller. Therefore, the Combitube SA 37 F is the preferred size.

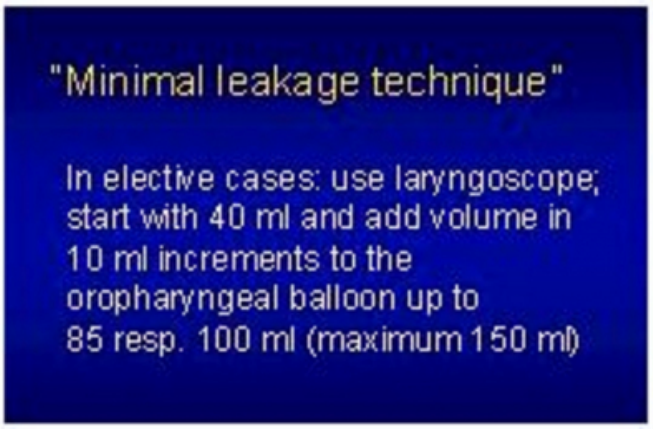
Insertion may be performed with or without the use of a laryngoscope: in case an endotracheal intubation has failed, the laryngoscope may be left in place and the Combitube inserted into the esophagus under direct visualization. The following points should be observed with blind insertion: the patient should be well anesthetized in elective cases; the

patient's head should be kept in a neutral or slightly elevated position, the chin maybe slightly lifted; holding the distal end of the Combitube bent for a few seconds ("Lipp maneuver") augments the curve and alleviates gliding of the Combitube around the tongue; the patient's mouth should be opened by grasping the back of the tongue and the jaw between thumb and forefinger and guiding the Combitube gently into the esophagus or trachea along the tongue in a curved downward motion with the distal end parallel to the chest (often it is tried to insert the Combitube directed against the neck so that the distal tip is caught at the posterior pharyngeal wall).

The volume to be inflated into the oropharyngeal balloon is 85 ml of air with the Combitube SA 37 F, and 100 ml with the Combitube 41 F. While these volumes should be inflated in an emergency (and even 50 ml additional air may be inflated in case of a leak), in elective cases volumes between 40 to 85 ml (using "minimal leakage technique": figure 8) are sufficient to obtain a tight seal.3,4 Reduced volumes help to decrease the potential danger of mucosal injury.

Figure 8

Figure 8: Minimal leakage technique



The distal cuff is inflated with 5 to 12 ml of air with the Combitube SA 37 F, and with 5 to 15 ml with the Combitube 41 F. The maximum volumes of 12 and 15 ml, respectively, should never be exceeded to avoid potential harm to the esophagus.[5]

Test ventilation is recommended via the longer blue tube connected to the so-called "pharyngeal" lumen[6]: if auscultation is positive, ventilation may be continued: the second, so-called "tracheoesophageal" lumen serves to "self-decompress" the esophagus as can be seen by evolving gastric secretions in many cases. If auscultation was negative, ventilation is performed via the shorter clear tube connected to the tracheoesophageal lumen and lungs are checked again. If ventilation does not work via both lumens, the Combitube has happened to be placed to deeply thereby the oropharyngeal balloon occludes the laryngeal aperture.[7] In this case, the Combitube has to be withdrawn for 2 to 3 cm and ventilation be performed via the blue tube again.

TEACHING

Several studies describe the easy way to place the Combitube after a short teaching instruction.[8,9,10,11] The Combitube homepage (www.combitube.org or www.combitube.net) is helpful for rapid instruction of Combitube novices. Insertion times in mannequins can be considerably shortened by observing the following suggestions:[12]

First, the Combitube and the mouth of the mannequin should be sprayed with silicone or a similar substance to avoid adhesion of plastic against plastic. The mouth of the mannequin should be opened with the thumb and index finger of one hand, the tongue grasped and pulled forward with the jaw and the Combitube passed gently into the patient's pharynx. Depending on the situation, we recommend insertion under laryngoscopical view specially in elective cases. Insertion may be difficult in certain types of mannequin heads. The Ambu mannequin head may be the most difficult to use since the pharyngeal area is open at the side and the Combitube may be displaced. The Laerdal mannequin heads work well, but the head has to be slightly extended, otherwise the Combitube cannot be fully inserted. The best mannequin head for the Combitube is produced by VBM (Medizintechnik, Sulz, Germany). With all mannequins, the Combitube has to be inserted using a curved downward movement with the lower part parallel to the chest. Insertion may be easier when the Combitube is inserted with a rocking motion. Bending of the Combitube at the pharyngeal portion between the balloons for a few seconds enhances the pre-formed curvature (so-called "Lipp–maneuver") and makes placement even more rapid. Furthermore, the fixation of the Combitube after inflation of the oropharyngeal balloon without the need for tape saves time in cardiopulmonary resuscitation.

NEW USES: TRAINING WITH THE COMBITUDE IN ELECTIVE CASES

To become familiar with the Combitube it is wise to use it five times in elective surgery in patients younger than 60 years.3,4 For elective cases, we recommend to use the laryngoscope and the minimal leakage technique. The

reduced price allows now for training of anesthesiologists.

CURRENT AND NEW USES OF THE COMBITUBE IN SURGERY, CARDIOPULMONARY RESUSCITATION, TRAUMA PATIENTS, AND AS A RESCUE DEVICE

The Combitube has been evaluated during elective surgery3,4,[13,14,15] and has proven to be a valuable tool in unforeseeable emergency situations.[16] Many difficult situations have been described and many more have been mastered without being published because of fear of potential legal problems, despite the fact that the Combitube worked excellent and made survival of patients possible when other means of managing the difficult airway had failed.

Interestingly, arterial oxygen tension is higher with the Combitube in esophageal position when compared to endotracheal airway with same respirator setting. This phenomenon may be explained by a higher inspiratory rising pressure, a prolonged expiratory flow time, and a build-up of a small PEEP.13

Similar results have been found in studies evaluating the use of the Combitube in cardiopulmonary resuscitation. A prospective study in Canada revealed that the Combitube was rated best by the EMT's with respect to airway patency, adequacy of ventilation, and overall performance when compared to PTLA and laryngeal mask.[17] In this study, some of the EMT's were trained with the laryngeal mask in the OR These findings are in accordance with a Japanese retrospective study, which showed that the Combitube was the most successful device with respect to insertion and adequate ventilation when compared to EGTA and laryngeal mask.[18] The Combitube has been successfully used in trauma patients with traumatic brain injury, mandible and facial fractures,[19] and cervical spine injury.[20] Its safety against aspiration and the applicability of high ventilatory pressures has been tested in several studies.[21,22,23] The Combitube is also a part of the emergency kit in the SARRRAH (Search and rescue, resuscitation, and rewarming in accidental hypothermia) project (www.sarrrah.de) as a rescue device for near drowning patients ventilated by EMT's in Germany.

SAFETY AGAINST ASPIRATION

There was no sign of gastric inflation as evaluated during surgery.3,4,21,22 The Combitube seals effectively with airway pressures as high as 50 cm H2O and higher.23 The Combitube is also the only alternate device used in the prehospital setting without danger of aspiration.17,18 Wissler recommends the Combitube as the first choice in parturients who cannot be mask-ventilated or endotracheally intubated.[24] The Combitube has been used successfully during C-sections (Urtubia R, personal communication, 2001).

PRECAUTIONS: ANESTHETIZE ACCORDING TO STATE-OF-THE-ART PROCEDURES

Inadequate use of the Combitube may be lead to serious injury:[25,26] the patient should be well anesthetized25, and the maximum filling volume of the distal cuff (12 ml with the Combitube SA 37 F, and 15 ml with the Combitube 41 F) should not be exceeded.26 The Combitube should not be inserted with force, furthermore, the use of a laryngoscope is recommended whenever feasible.

TRAINING, INCLUSION IN GUIDELINES

Data suggest that training is very short and shows the effectivity of the Combitube.[27] The Combitube is the only alternate airway device to be included in the Guidelines of the American Heart Association since 1992 and has been recently upgraded to a class IIa device.[28] It is furthermore recommended as a non-invasive alternative for the management of the difficult airway by he American Society of Anesthesiologists,[29] and by the European Resuscitation Council.[30]

FUTURE ASPECTS

Future developments include a pediatric size Combitube to be used in pediatric patients with a height of 3 to 4 feet, furthermore the inclusion of a "bronchoscopic hole" for fiberoptic replacement of the Combitube.[31]

AVAILABILITY

The Combitube is available in a rigid tray, in a roll-up kit, as well as in a single kit with a re-sealable pouch, the roll-up-kit and the single kit being considerably cheaper than the rigid tray. Furthermore, a "Combitrainer" (size 41 F only) with double thick cuffs for the use in mannequins is produced.

CONCLUSIONS: ALL-IN-ONE CONCEPT

The Combitube is the ideal rescue device including all advantages needed in extreme situations in one simple airway: Quick insertion time, adequate airway patency,17 simultaneous fixation, sufficient ventilation and oxygenation, prevention of aspiration, and applicability of high ventilatory pressures make it a device to be considered

as the first non-invasive alternate airway whenever endotracheal intubation is not immediately possible.[32,33] The Combitube has been shown to be a helpful and effective airway device in surgery as well as in cardiopulmonary resuscitation. It has gained worldwide interest and has been used in emergency situations by anesthesiologists as well as be medical personnel. Indications for experienced anesthesiologists and intensivists include bleeding and vomiting patients, parturients who cannot be successfully intubated endotracheally and emergency intubation in other non-fasting patients with respiratory failure. Recent described methods dealing with sterilizing the Combitube for repeated use may enhance its popularity.[34] Its increased use in routine surgery besides emergency intubation shows its efficacy with respect to oxygenation and ventilation, its safety against aspiration,[35] and to waste gas exposure as compared to endotracheal tube.[36]

References

1. Krafft P, Nikolic A, Frass M. Esophageal rupture associated with the use of the Combitube. Anesth Analg 1998; 87: 1457
2. Walz R, Davis S, Panning B. Is the Combitube a useful emergency airway device for anesthesiologists? Anesth Analg 1999; 88: 233
3. Urtubia RM, Aguila CM, Cumsille MA: Combitube: A study for proper use. Anesthesia Analgesia 2000; 90:958-962
4. Hartmann T, Krenn CG, Zoeggeler A, Hoerauf K, Benumof JL, Krafft P: The oesophageal - tracheal Combitube small adult. An alternative airway for ventilatory support during gynaecological laparoscopy. Anaesthesia 2000; 55:670-675
5. Vezina D, Lessard MR, Bussieres J, Topping C, Trepanier CA. Complications associated with the use of the Esophageal-Tracheal Combitube. Can J Anaesth 1998; 45: 76-80
6. Urtubia R, Aguila C. Combitube: A new proposal for a confusing nomenclature. Anesth Analg 1999; 89: 803
7. Green KS, Beger TH. Proper use of the Combitube. Anesthesiology 1994; 81: 513-4
8. Bishop MJ, KharaschED. Is the Combitube a useful emergency airway device for anesthesiologists? Anesth Analg 1998; 86: 1141-2
9. Yardy N, Hancox D, Strang T. A comparison of two airway aids for emergency use by unskilled personnel. The Combitube and laryngeal mask. Anaesthesia 1999; 54: 181-3
10. Doerges V, Sauer C, Ocker H, Wenzel V, Schmucker P. Airway management during cardiopulmonary resuscitation - a comparative study of bag-valve-mask, laryngeal mask airway and combitube in a bench model. Resuscitation 1999; 41: 63-69
11. Calkins MD, Robinson TD. Combat trauma airway management: endotracheal intubation versus laryngeal mask airway versus combitube use by Navy SEAL and Reconnaissance combat corpsmen. J Trauma 1999; 46: 927-32
12. Frass M, Staudinger T, Losert H, Krafft P. Letter to the editor: Airway management during cardiopulmonary resuscitation - a comparative study of bag-valve-mask, laryngeal mask airway and combitube in a bench model. Resuscitation 1999; 43:80-81
13. Frass M, R□r S, Frenzer R, Ilias W, Leithner C, Lackner F. Esophageal tracheal combitube, endotracheal airway and mask: Comparison of ventilatory pressure curves. J Trauma 1989; 29:1476-9
14. Wafai Y, Salem MR, Baraka A, Joseph NJ, Czinn EA, Paulissian R. Effectiveness of the self-inflating bulb for verification of proper placement of the Esophageal - Tracheal Combitube. Anesth Analg 1995; 80:122-6
15. Gaitini LA, Vaida SJ, Somri M, Fradis M, Ben-David B. Fiberoptic-guided airway exchange of the Esophageal-Tracheal Combitube in spontaneously breathing vs. mechanically ventilated patients. Anesth Analg 1999; 88:193-6
16. Kulozik U, Georgi R, Krier C. Intubation with the CombitubeTM in massive hemorrhage from the locus Kieselbachii. An□hesiologie, Intensivmedizin, Notfallmedizin, Schmerztherapie 1996; 31:191-3
17. Rumball CJ, MacDonald D. The PTL, Combitube, laryngeal mask, and oral airway: A randomized prehospital comparative study of ventilatory device effectiveness and cost-effectiveness in 470 cases of cardiorespiratory arrest. Prehospital Emergency Care 1997; 1:1-10
18. Tanigawa K, Shigematsu A: Choice of airway devices for 12,020 cases of nontraumatic cardiac arrest in Japan. Prehospital Emergency Care 1998; 2:96-100
19. Blostein PA, Koestner AJ, Hoak S: Failed rapid sequence intubation in trauma patients: Esophageal tracheal Combitube is a useful adjunct. J Trauma 1998; 44:534-7
20. Deroy R, Ghoris M. The Combitube elective anesthetic airway management in a patient with cervical spine fracture. Anesth Analg 1998; 87:1441-2
21. Vaida S, Gaitini L, Somri M. The effectiveness of the Esophageal-Tracheal Combitube(r) in mechanically ventilated patients undergoing laparoscopic cholecystectomy. Austrian International Congress, Vienna, Sept 29 - Oct 2, 1999, An□hesiologie, Intensivmedizin, Notfallmedizin, Schmerztherapie 1999; 34: S121 (D5)
22. Hartmann T, Z□ller A, Krenn CG, Brunner G, Krafft P. Randomized controlled study of the Esophageal-Tracheal Combitube SA(tm) as an airway during gynecological laparoscopy. Austrian International Congress, Vienna, Sept 29 - Oct 2, 1999, An□hesiologie, Intensivmedizin, Notfallmedizin, Schmerztherapie 1999; 34: S121 (D3)
23. Lipp M, Mainz, Germany, and Panning B, Hannover, Germany, personal communications
24. Wissler RN. The esophageal-tracheal Combitube. Anesth Review 1993; 20:147-52
25. Klein H, Williamson M, Sue-Ling HM, Vucevic M, Quinn AC. Esophageal rupture associated with the use of the Combitube. Anesth Analg 1997; 85: 937-9
26. Vezina D, Lessard MR, Bussieres J, Topping C, Trepanier CA. Complications associated with the use of the Esophageal-Tracheal Combitube. Can J Anaesth. 1998; 45: 76-80
27. Yardy N, Hancox D, Strang T: A comparison of two airway aids for emergency use by unskilled personnel - The Combitube and laryngeal mask. Anaesthesia 1999; 54: 181-183
28. Combination Esophageal-tracheal Tube. In: Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care. Recommendations of the 1992 National Conference of the American Heart Association. JAMA 1992; 268: 2171-2302; p 2203 and ECC Guidelines, Part 6: Advanced Cardiovascular Life Support, Section 3: Adjuncts for Oxygenation, Ventilation, and Airaway Control. Airway Adjuncts. Circulation 2000; 102:1-95
29. American Society of Anesthesiologists Task Force on

Management of the Difficult Airway. Practice Guidelines for Management of the Difficult Airway. Anesthesiology 1993; 78:597-602
30. Baskett PJF, Bossaert L, Carli P, Chamberlain D, Dick W, Nolan JP, Parr MJA, Scheidegger D, Zideman D: Guidelines for the advanced management of the airway and ventilation during resuscitation. Resuscitation 1996; 31:201-30
31. Krafft P, R□a M, Fridrich P, Locker GJ, Frass M, Benumof JL. ronchoscopy via a re-designed CombitubeTM in the esophageal position. A clinical evaluation. Anesthesiology 1997; 86:1041-5
32. Frass M: The Combitube: Esophageal/Tracheal Double Lumen Airway. In Jonathan L. Benumof (ed): Airway Management - Principles and Practice. Mosby, St. Louis, USA, 1996; 444-54
33. Benumof Jonathan L.: Management of the difficult adult airway. Anesthesiology 1991; 75:1087-110
34. Lipp M, Jaehnichen G, Golecki N, Fecht G, Reichl R, Heeg P: Microbiological, microstructure, and material science examinations of reprocessed Combitubes after multiple reuse. Anesth Analg 2000; 91: 693-97
35. Gaitini LA, Vaida SJ, Mostafa S, Yanovski B, Croitoru M, Capdevila MD, Sabo E, Ben-David B, Benumof J. The Combitube in Elective Surgery: A Report of 200 Cases. Anesthesiology 2001; 94:79-82
36. Hoerauf KH, Hartmann T, Acimovic S, Kopp A, Wiesner G, Gustorff B, Jellinek H, Krafft P: Waste gas exposure to sevoflurane and nitrous oxide during anaesthesia using the oesophageal-tracheal Combitube small adultTM. British Journal of Anaesthesia 2001; 86:124-26

Author Information

Michael Frass, MD
Professor of Medicine, Internal Medicine, Innere Medizin, Allgemeines Krankenhaus Wien