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SCIENTIFIC ARTICLE

A comparison of various supraglottic airway devices for fiberoptical guided tracheal intubation

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KEYWORDS
Difficult airway;
Fibreoptic intubation;
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Abstract
Background: Fiberoptical assisted intubation via placed supraglottic airway devices has been described as safe and easy procedure to manage difficult airways. However visualization of the glottis aperture is essential for fiberoptical assisted intubation. Various different supraglottic airway devices are commercially available and might offer different conditions for fiberoptical assisted intubation. The aim of this study was to compare the best obtainable view of the glottic aperture using different supraglottic airway devices.
Methods: With approval of the local ethics committee 52 adult patients undergoing elective anesthesia were randomly assigned to a supraglottic airway device (Laryngeal Tube, Laryngeal Mask Airway I-Gel, Laryngeal Mask Airway Unique, Laryngeal Mask Airway Supreme, Laryngeal Mask Airway Aura-once). After standardized induction of anesthesia the supraglottic airway device was placed according to the manufacturers recommendations. After successful ventilation the position of the supraglottic airway device in regard to the glottic opening was examined with a flexible fiberscope. A fully or partially visible glottic aperture was considered as suitable for fiberoptical assisted intubation. Suitability for fiberoptical assisted intubation was compared between the groups (*H*-test, *U*-test; $p < 0.05$).
Results: Demographic data was not different between the groups. Placement of the supraglottic airway device and adequate ventilation was successful in all attempts. Glottic view suitable for fiberoptical assisted intubation differed between the devices ranging from 40% for the laringeal tube (LT), 66% for the laryngeal mask airway Supreme, 70% for the Laryngeal Mask Airway I-Gel and 90% for both the Laryngeal Mask Airway Unique and the Laryngeal Mask Airway Aura-once.
Conclusion: None of the used supraglottic airway devices offered a full or partial glottic view in all cases. However the Laryngeal Mask Airway Unique and the Laryngeal Mask Airway Aura-once seem to be more suitable for fiberoptical assisted intubation compared to other devices.

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PALAVRAS-CHAVE
Via aérea difícil;
Intubação guiada por fibra óptica;
Dispositivo supraglótico

Uma comparação de vários dispositivos supraglóticos para intubação traqueal guiada por fibra óptica

Resumo
Justificativa: A intubação guiada por fibra óptica (IGFO) através de dispositivo supraglótico (DSG) tem sido descrita como um procedimento seguro e fácil para o manejo de via aérea difícil. No entanto, a visualização da abertura da glote é essencial para a IGFO. Vários DSG diferentes estão comercialmente disponíveis e podem oferecer diferentes condições para a IGFO. O objetivo deste estudo foi comparar a melhor visão obtida da abertura da glote com o uso de diferentes DSG.
Métodos: Com a aprovação do Comitê de Ética local, 52 pacientes adultos submetidos à anestesia eletiva foram randomicamente designados para um DSG (tubo laríngeo (TL), máscara laríngea (ML) I-Gel, ML Unique, ML Supreme, ML Aura-once). Após a indução padronizada da anestesia, o DSG foi colocado de acordo com as recomendações do fabricante. Após ventilação bem-sucedida, a posição do DSG em relação à abertura da glote foi examinada com um endoscópio flexível. Uma abertura da glote total ou parcialmente visível foi considerada como adequada para a IGFO. A adequação para a IGFO foi comparada entre os grupos (teste-H, teste-U; $p < 0,05$).
Resultados: Os dados demográficos não foram diferentes entre os grupos. A Colocação do DSG e a ventilação adequada foram bem-sucedidas em todas as tentativas. A visão da glote adequada para a IGFO diferiu entre os dispositivos, variando de 40% para o TL, 66% para a ML Supreme, 70% para a ML I-Gel e 90% para ambas as máscaras laríngeas Unique e Aura-once.
Conclusão: Nenhum dos DSG usados ofereceu uma visão total ou parcial da glote em todos os casos. Porém, as máscaras laríngeas Unique e Aura-once pareceram mais adequadas para a IGFO em comparação com os outros dispositivos.

Introduction

Successful airway management is a primary goal during general anesthesia as well as in many emergency situations. While tracheal intubation is considered as gold standard, it requires adequate skills. There is a reported incidence of difficult intubation ranging from 0.05% to 18%.[1] The American Society of Anesthesiologists (ASA) Task Force on Management of the Difficult Airway therefore emphasizes the importance of alternative, less invasive devices for adequate oxygenation in case tracheal intubation fails.[2] The laryngeal mask airway (LMA) is explicitly mentioned in the 2003 ASA recommendations. Various alternative LMAs (Fig. 1) were marketed since then. Different shapes and materials were used to achieve a better airway seal, less pharyngeal trauma and facilitate proper placement. In 1999 another supraglottic airway device (SAD), the laryngeal tube (LT) was introduced.[3] It is a single-lumen tube with oesophageal and pharyngeal cuffs connected to a single inflation line with a ventral opening for ventilation between the two cuffs (Fig. 1).[3] After blind insertion, all SADs provide a patent airway in the majority of patients at first attempt. This makes SAD an interesting alternative in emergency medicine.[4,5] The feasibility even without extensive training provides a simple tool for airway management.[3] According to various airway management algorithms emergency oxygenation of the patient can be achieved by inserting a SAD in case of a failed intubation. Nevertheless in emergency situations tracheal intubation is still required to protect the patient from aspiration.[3,6] When the replacement of the supraglottic device by a tracheal tube is necessary, maximum patient safety must be considered. The primarily inserted device is dedicated to maintain airway patency while other interventions are prepared or take place.[7] Ideally oxygen can be provided throughout the tube exchange process to avoid desaturation.

Various methods describe a safe replacement of the inserted SAD by a tracheal tube. Atherton described the blind insertion of a tube exchanger into the trachea via the placed LMA with a considerable success rate.[8] A more sophisticated procedure was described by Hawkins et al. To ensure proper placement of the tracheal tube, the tube exchanger is placed under fibre-optic guidance.[9] A very similar procedure was published by Genzwuerker et al. using a laryngeal tube as primary airway. Again the tube exchanger was placed under fibreoptic guidance and allowed the fast and easy placement of the tracheal tube.[10] Success rate of the fiberoptical assisted intubation (FAI) is significantly higher compared to the blind insertion of a tube or tube exchanger. This can easily be explained by the frequent suboptimal pharyngeal position of the SAD. The distal orifices of the SAD and the glottic aperture have to be in line if the SAD is used for tracheal intubation.

For all fiberoptical assisted procedures it is essential to visualize the glottic aperture though the distal lumen of the SAD. Various different SADs are commercially available. While all of these are suitable for emergency ventilation it remains uncertain if these devices can also serve as dedicated airways for fibreoptic guided intubation. With variations in shape and material it has to be assumed that

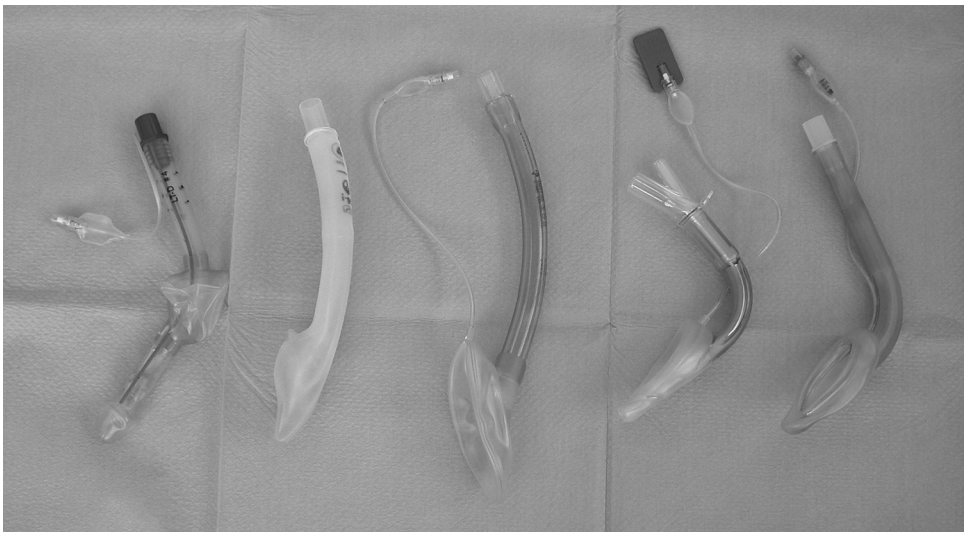

Figure 1 Used commercially available supraglottic airway devices left to right (LT-D, i-Gel, Unique, Supreme, Aura-Once).

the pharyngeal position of the commercially available SAD varies considerably.

Aim of this study was to evaluate the pharyngeal position of different supraglottic devices in respect to the glottis aperture and their potential feasibility as a dedicated airway for FAI. It has not yet been systematically examined which devices allow a proper visualization of the glottic aperture.

Methods

With approval of the local ethics committee 52 patients undergoing elective laser treatment for genital condylomas were examined by the three anesthesiologists (one 4th year resident and two attendings). All three anesthesiologists were familiar with and had adequate experience with the used SADs. Glottic view between the different devices was therefore compared between the laryngeal tube – LT-D (VBM Medizintechnik GmbH, Sulz a.N., Germany), the I-Gel LMA (Intersurgical, Sankt Augustin, Germany), the LMA Unique (Teleflex Medical GmbH, Kernen, Germany), the LMA Supreme (Teleflex Medical GmbH, Kernen, Germany) and the LMA Aura-Once (Ambu GmbH, Bad Nauheim, Germany) (Fig. 1). After prior written consent the patients were randomized to a specific SAD using independently prepared envelopes that were drawn right before anesthesia. They received 7.5 mg of midazolam orally one hour prior to surgery. Anesthesia was induced with Remifentanil (0.4 μg/kg/min) and Propofol (2.5 mg/kg bolus and 0.1 mg/kg/min continuous infusion). Anesthesia depth was monitored and face-mask ventilation was started at a BIS value below 40. The size of the SAD was chosen and inserted according to the manufacturer's recommendations. Before insertion, the cuffs were deflated and a water-soluble lubricant (Instru Gel, Dr. Deppe Laboratorium, Kempen, Germany) was applied. After pharyngeal placement the cuff was inflated to reach a cuff pressure of 20 mmHg. Successful ventilation was established and a 3.4 mm flexible fiberscope (10BS, Pentax, Hamburg, Germany) was inserted into the SAD using a bronchoscopy adapter by an examiner blinded to the device. The bronchoscope was advanced to the distal orifice of the SAD and a picture of the best possible glottic view was taken. During the examination anesthesia was maintained with continuous infusion of remifentanil and propofol. After removal of the fiberscope further care was provided according to our hospital standards.

The pictures of the glottic apertures were afterwards graded by an observer blinded to the device according to the following grading system, introduced by Brimacombe and Berry.[11] (full glottis view – I, glottic aperture partially visible – II, glottic aperture not visible – III) (Fig. 2) Full and partial view of the glottic aperture were considered as suitable for fibreoptic guided tracheal intubation.

All data is given as mean and interquartile range. Glottic visualization scores were compared between the groups using the Kruskal–Wallis-H-test and the Mann–Whitney-*U*-test with Win-STAT (R. Fitch Software, Bad Krozingen, Germany); $p < 0.05$ was considered statistically significant.

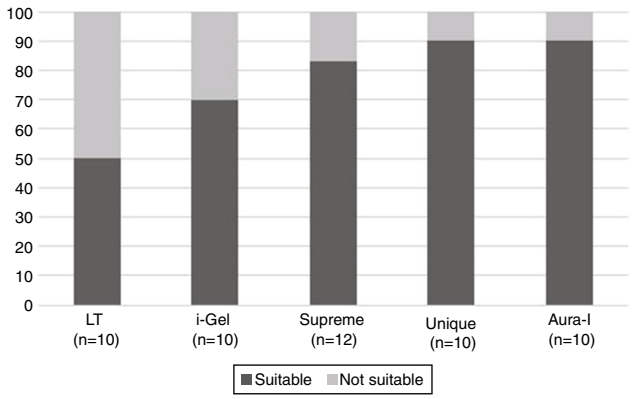

Figure 2 Suitable intubation conditions in percentage. Dark grey suitable, light grey not suitable for fiberoptical assisted intubation. There is a significant difference (*) between the Laryngeal Tube (LT) and the other examined devices.

Table 1 Demographic data of the examined patients. No difference between the groups was observed. Data as median and interquartile range.

	Age (years)	Weight (kg)	Height (cm)	Body mass index (kg/m^2)
LT ($n = 10$)	32 (29–33)	67 (61–79)	173 (168–175)	22 (21–26)
i-Gel ($n = 10$)	47 (34–48)	76 (69–85)	173 (169–178)	25 (24–27)
Unique ($n = 10$)	32 (30–46)	83 (68–101)	176 (168–185)	26 (22–30)
Supreme ($n = 12$)	33 (27–46)	89 (74–96)	176 (167–179)	29 (23–31)
Aura-I ($n = 10$)	33 (31–36)	82 (71–91)	180 (175–184)	26 (22–27)

Table 2 Glottic view at the distal aperture of the supraglottic airway device.

	Fully visible I	Partially visible II	Not visible III	Suitable for FAI	Not suitable for FAI
LT ($n = 10$)	3	1	6	4[a]	6
i-Gel ($n = 10$)	7		3	7[a]	3
Unique ($n = 10$)	9		1	9[a]	1
Supreme ($n = 12$)	8		4	8[a]	4
Aura-I ($n = 10$)	9		1	9[a]	1

[a] $p < 0.05$ significant difference between LT and the other devices. No differences between the other devices.

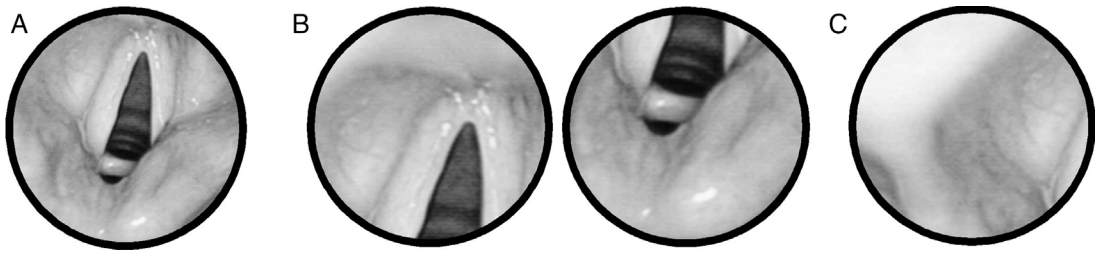

Figure 3 Glottic view obtained with the fibrescope ant the distal orifice of the supraglottic airway device. (A) Full view of the aperture; (B) partial view of the aperture; (C) no obtainable view of the aperture.

Results

Demographic data (age, weight, height) was not different between the examined groups (Table 1). Placement of the SAD was successful in all attempts and adequate ventilation was possible in all patients. Glottic view differed between the studied devices (Table 2).

Suitable conditions for FAI (full or partial glottis view) were given in 50% with the LT, in 83% with the LMA Supreme, in 70% with the LMA I-Gel and 90% with the LMA Unique and the LMA Aura-Once (Fig. 3).

Adverse events were not documented in any of the cases.

Discussion

Airway related complications are rare but potentially disastrous during general anesthesia and in emergency medicine. Approximately 600 people die worldwide from difficulties with intubation every year.[1] Many more develop severe neurological damage.[2] The incidence of difficult intubation for elective surgery ranges from 0.05% to 18%, depending on the type of surgery and the pre-existing medical conditions.[1] In emergency medicine the incidence of a difficult airway is even higher.

These and other results led to ASA recommendations for the use of alternative airway adjuncts that allow adequate ventilation and oxygenation first published in 1993.[12] The LMA was primarily mentioned in the published guidelines in 2003.[2] Since then various different SADs have been brought on the market. Variations in processed material and shape supposedly facilitate insertion and improved ventilation. It could be demonstrated all of these devices allow emergency oxygenation and ventilation in case of a failed tracheal intubation.

In many emergency situations and various other circumstances (e.g. abdominal or cardiothoracic surgery, surgery in a prone position) a tracheal intubation is still needed to achieve adequate airway control. The primarily inserted SAD only serves as bridge to tracheal intubation. Various approaches have been described to establish a definite endotracheal airway using a supraglottic airway as an aid. During the exchange of a SAD by an endotracheal tube it is of utmost importance not to jeopardize the already established airway. Adequate oxygenation and ventilation should continue while other airway interventions are prepared or take place.

The blind insertion of a tube or exchange catheter into the SAD has been described previously. Studies have shown that a blind insertion does not necessarily lead to an intratracheal position. The pharyngeal position of the LMA during

fibreoptic control was correct in only 59% of all cases.[13] This supports the idea of using a fiberscope rather than inserting a device blindly through any airway device. Because of the variable position of the blindly inserted SAD with respect to the glottic aperture, the use of a fibreoptic bronchoscope increases the success rate of tracheal intubation.[13,14] The orifice of the SAD and the glottic aperture have to be in line to allow insertion of tube or tube exchanger. A proper laryngeal alignment can only be verified by fiberopticaly. FAI via LMA has been described in case reports and was evaluated in various studies. It is considered a reliable and save method to manage a difficult airway. Similar results exist for the laryngeal tube that is gaining popularity in the prehospital setting.[3]

However it has to be considered that SADs do not always allow a FAI in all patients. A proper pharyngeal position is essential. With the variations in shape and material it has to be assumed that the pharyngeal position of commercially available SAD varies considerably. Aim of this preliminary study was to examine if some of the very different SADs have a better pharyngeal position to allow FAI. Up to now this has not been evaluated systematically.

The results of this study demonstrate that all the used SADs are suitable to adequately oxygenate and ventilate the patient. This confirms the role of SAD in emergency airway management. Ideally the position of the SAD in the pharynx involves a close relation of the distal orifice of the device and the glottic aperture to allow ideal air-flow. This however could not always be demonstrated in our study. The pharyngeal position of the SAD is variable, as shown before. Visualization of the glottis from the distal orifice of the inserted supraglottic airway is not always possible. This limits the possibility to perform a FAI and explains why a blind insertion potentially fails. Relevant differences were seen between the examined commercially available systems. The LMA Unique and the LMA Aura-i offered the best glottic views. Intubation would have been possible in 90% of the attempts. The results for the LT were less convincing. Tracheal intubation would have been possible in only 40% of the cases. The results for the LMA I-Gel and the LMA Supreme were acceptable with around 70% success rate. Apparently the shape and possibly the material of the LMA Unique and the LMA Aura-I lead to higher percentage of proper pharyngeal position. Our results also demonstrate that an accurate position is not necessarily needed to allow adequate oxygenation and ventilation. Only if the inserted airway is used as a bridge to guide tracheal intubation the pharyngeal position becomes relevant. In cases of a failed tracheal intubation with need for a save endotracheal airway it should be considered to primarily insert a device that allows FAI. Exchange of the SAD interrupts oxygenation and puts the patient at risk for aspiration.

The results providing a 90% success rate suggest that the concept of a supraglottic airway as guide for tracheal intubation is not only suitable for emergency situations. In conditions when head movement for direct laryngoscopy has to be avoided (e.g. instable fractures of the cervical spine) a tracheal intubation via SAD is a save and easy option. The described procedure might be a relevant alternative to awake fibreoptic intubation; an even more sophisticated procedure with potential discomfort for the patient. A relevant advantage of the use of a SAD as bridge to tracheal intubation is the possibility of continuous oxygenation and ventilation during endoscopy using a bronchoscopy adapter. The described concept of a dedicated airway is therefore not only an option for an unexpected difficult intubation but can also be used in a controlled setting. This allows training in fibreoptic intubation and ensures patient safety for anticipated difficult intubations.[7]

Limitations

Because of the preliminary character of the study only a small number of patients were examined per device. A larger number of patients need to be examined to verify the results. Difficult intubation often occurs in patients with an abnormal pharyngeal or laryngeal anatomy. If the results from this study can be transferred into this patient group also has to be subject to further trials.

Conclusion

All examined SDAs can serve as emergency airways to allow oxygenation in case of difficult intubation. Not all of the examined devices however have a pharyngeal position that allows a fibreoptic guided tracheal intubation. Further studies have to examine if these preliminary results can be verified.

Conflicts of interest

The authors declare no conflicts of interests.

Acknowledgements

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