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Clinical experience with the SensaScope®, a hybrid video intubation stylet for the difficult intubation

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Summary

Introduction. The existing video-assisted endoscopic instruments to facilitate difficult intubation are either rigid or flexible and have therefore specific limitations due to their basic characteristics. The SensaScope® is a hybrid video intubation stylet containing rigid and flexible parts, which has been designed to overcome these limitations. We evaluated this instrument for its suitability to manage normal and difficult airway situations in a routine clinical setting. ***Material and methods.*** From a growing number of continuously performed elective uses of the SensaScope®, we subjected the first 200 cases to an evaluation of success rate, intubation time, characteristics of use and side effects. ***Results.*** Tracheal intubation with the SensaScope® was considered easy and expedient in 94% of patients with various difficulty degrees of direct laryngoscopy. The remainder of 6% posed minor problems due to fogging and blurring of the optic, which could be easily overcome. In rare cases (1%) of a posteriorly adherent epiglottis, a special retreating manoeuvre with the SensaScope® was necessary to successfully perform video assisted intubation. ***Conclusion.*** The SensaScope® demonstrates high efficacy in overcoming difficult intubation scenarios of various kinds, which might be a consequence of the hybrid nature of this instrument unifying the advantages of rigid and flexible instruments in one device. *Anestezjologia i Ratownictwo 2010; 4: 281-287*

Keywords: equipment, SensaScope®, video assisted, video stylet, difficult airway, difficult laryngoscopy, difficult intubation

Introduction

Standard conventional direct laryngoscopy is, in the majority of cases, the best method to secure the airway in patients who have to undergo tracheal intubation for anaesthesia and surgery. This approach proves to be difficult in approximately 5% of cases and in at least 1 of app. 2,300 consistently fails, thus causing severe morbidity and mortality [1-3]. There are a multitude of alternative airway management techniques that have been proposed and successfully adopted in the case of difficult or impossible direct laryngoscopic intubation. Among them, the flexible fibreoptic intubation is considered as the gold standard, however, it is less effective in emergency cases, when the airway difficulty occurs unexpectedly [4]. The unpredicted difficult airway, which usually is encountered in patients who are already anaesthetised and paralysed, video-assisted variants of otherwise "conventional" intubation devices such as video laryngoscopes (e.g. Bullard, MacGrath, C-Mac, Glidescope, Pentax AWS, and Airtraq) [5-12] or video stylets (e.g. Bonfils, Shikani, and Levitan) [13-15] have the potential to solve the acute problems very fast and with a high probability of success.

The SensaScope® has been developed on the request and under the supervision of the author of this article in close cooperation with its manufacturer (Acutronic Medical Systems AG, CH-8816 Hirzel, Switzerland) in order to unify the advantages and to avoid the disadvantages of the existing equipment. The

meanwhile commercially available improved version of this instrument has recently been introduced into our institutional airway management concept for the emergency oral intubation of unpredicted difficult airway situations [16]. To improve the skills of our department's personnel in dealing with this device, and to obtain more evidence about its suitability, the SensaScope® is permanently used in elective intubation situations. This study represents the results of its application in the first consecutive 200 patients.

Description of the device

The SensaScope® is a hybrid video stylet having a 40 cm long rigid shaft with a sigmoid shape that ends with a 3 cm long steerable tip (Figure 1).

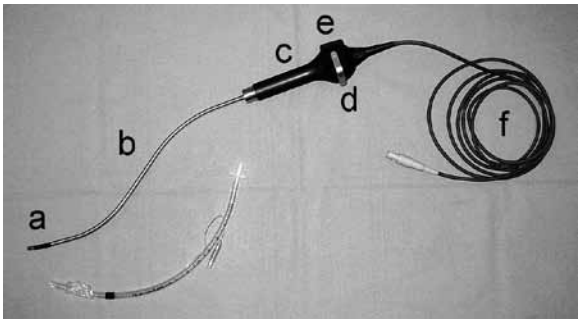

Figure 1. The SensaScope® as is detached from the video unit and the monitor screen. Its components are: a) steerable tip, b) sigmoid shaped rigid shaft, c) handle, d) control lever for the tip, e) plus/minus buttons to adjust light intensity, f) 2 m lightweight cable to be connected to the video unit.

Similar to flexible endoscopes, the tip is controlled with a lever at the handle of the device. In the tip a miniaturised CCD camera and a LED light source are included. The SensaScope® has to be connected by a slender cable to a video interface and monitor. The shape of the high resolution video image is rectangular and completely fills the screen of the monitor. The endoscope has no eyepiece and it works only with a video monitor that can be viewed by everybody who is nearby. In contrast to flexible fibreoptics, the SensaScope® can be handled with one (preferably the right) hand, while the left hand is free to insert the laryngoscope, as is recommended by experienced users [17]. To operate the system, one only has to press the start button. The light intensity can be modified with a plus/minus switcher which is included in both, the handle of the stylet as well as in the video interface.

Standard intubation technique with the SensaScope®

In the anaesthetised and paralyzed patient lying in supine position, the mandible and base of the tongue fall backwards and occlude the pharynx. Therefore, no free space is there for free viewing with any endoscopic device. To overcome this, elevation of the tongue base is necessary. The SensaScope® is operated with the right hand with the thumb resting on the lever, while the left hand holds the laryngoscope. It is not necessary to achieve a direct laryngoscopic view (which is anyway unavailable in difficult intubation conditions), but a brief assessment of the obtainable Cormack & Lehane grade (CL) is useful to estimate the severity of the airway problem [18]. Then, the SensaScope® is introduced in the sagital plane perpendicularly into the mouth with its tip close to the upper incisors. From this moment on, the user watches only the video monitor, where the uvula should be visible in the middle of the image. The SensaScope is slowly advanced along the palate straight to the uvula. After passing it, the tip is elevated by pulling the lever until the glottis opening appears on the screen (Figure 2). From here on, a very important and useful attribute of the SensaScope has to be considered: further advancement into the glottis is exclusively achieved by a rotation of the handle in cephalad direction. This is due to the fact that the shaft has a sigmoid shape and its distal curvature moves easily around the tongue base when the device is rotated this way. After passing the vocal cords, the tip of the endoscope points towards the anterior wall of the trachea, so that it has to be bended downward by elevating the lever with the thumb. Hence, this produces an axial view down the trachea, where the endoscope should be further advanced by continuation of the mentioned rotation. Ideally, the tip arrives 2-3 cm above the carina, where the device is held firmly while the tracheal tube is railroaded into its final position, which, in turn, should be confirmed by the endoscopic view. By holding the tracheal tube firmly with the left hand, the SensaScope® is easily withdrawn and removed with released lever by ventral rotation in the sagital plane.

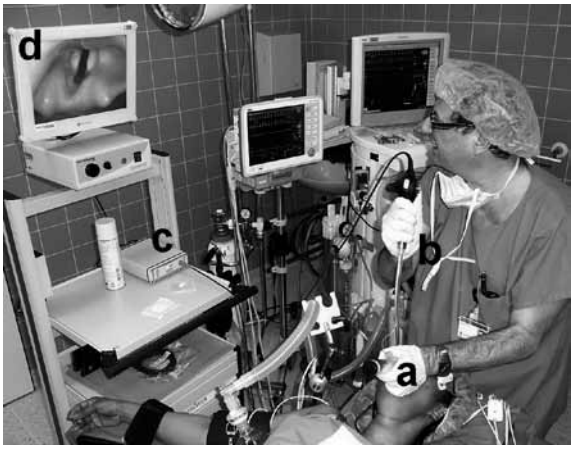

Figure 2. Intubation of an anaesthetised and paralysed patient with the SensaScope® performed by the author. The details are: a) direct laryngoscopy with the left hand, b) operating the instrument with the right hand and with the thumb on the steering lever, c) the video unit to which the scope is connected, d) video screen that displays the view from the tip of the scope.

Methods

Since the SensaScope® has been introduced into our departmental airway management program, and after a thorough training on an airway manikin, the author of this article performed a multitude of intubations in normal and difficult airway cases. The clinical use of the SensaScope® in elective patients has been approved by the Institutional Ethics Committee under the condition of meeting the listed exclusion criteria and obtaining of informed consent of the enlisted patients. The exclusion criteria for this investigation were: anamnestic evidence for a severe difficult airway, pregnancy, unfasted patients, trauma patients, risk of pharyngeal bleeding, vomiting, age below 18 years, and patients scoring 3 or 4 grade according the ASA classification. Consecutively, we continuously collect data from patients who could be included into the investigation. For this article, we present the results from the first 200 cases, thus this represents a randomised, retrospective investigation. Since the included cases occurred randomly when suitable patients and the sterilised endoscope were both available, we collected results from an otherwise unselected patient population reflecting the usual distribution of airway difficulties in a typical surgical unit of a tertiary hospital.

Anaesthesia was performed on orally premedicated patients who received 7.5 mg midazolam 45 minutes prior to the induction of general anaesthesia. After establishment of an i.v. line and placement of standard monitoring (heart rate, non-invasive blood pressure, pulse oxymetric saturation), all patients were pre-oxygenated to gain sufficient time to accomplish the airway related measures. Induction of anaesthesia was performed with propofol (4-6 $\mu g\ ml^{-1}$ TCI effect site target concentration), fentanyl 0.2-0.4 $\mu g\ kg^{-1}$ and atracurium or rocuronium to achieve full muscular relaxation under relaxometric control. During the use of the SesnaScope®, failure to insert the tracheal tube into the trachea in less than 120 seconds or a drop of SpO_2 below 90% was a trigger to abandon the intubation with this device and to resort to conventional direct laryngoscopy and intubation, or in case of expected difficulties to use an established alternative airway rescue technique such as the insertion of a supraglottic device (e.g. a laryngeal mask) or to intubate with a flexible fibreoptic.

The recorded data were: patient's characteristics, the resulting CL grade during best possible laryngoscopy, success rate of intubation, duration of intubation (time from insertion of the laryngoscope until the appearance of the first capnographic signal in seconds), lowest value of pulse oxymetric saturation during the intubation procedure, encountered difficulties during the intubation procedure, and airway related side effects as noticed until 4 as well as 24 hours after anaesthesia. The data were collected in an Excel table and subjected to further descriptive statistical analysis. As having no normal distribution, the data are presented as median, inter-quartile range (range between 1st and 3rd quartiles) and total range (minimum and maximum values).

Results

The involved patients were subjected to various elective surgical interventions for gynaecological, ophthalmological or maxillofacial operations in general anaesthesia requiring tracheal intubation. The characteristics of the involved 200 patients are summarised in Table 1. All intubations were performed by the author of this report. The distribution of the resulting best possible laryngoscopic views prior insertion of

the SensaScope® revealed a CL grading with 16% of 1°, 78% of 2°, 6% of 3° and no case of 4°. All patients were pre-oxygenated for 60 seconds prior to the induction and achieved satisfactory pulse oxymetric saturations (median 96, inter-quartile range 95-99, total range 94-100). From 200 intubations with the SensaScope® 183 succeeded in one attempt. In 15 cases, 2 or 3 attempts were needed due to extensive fogging or blurring of the lens by secretions, thus requiring interruption of the procedure to clean briefly the device and to apply suctioning of the oral cavity. In 2 cases, the intubation was hampered by a seemingly immobile epiglottis that appeared adherent to the posterior pharyngeal wall (which we call CL 3°b). This difficulty could be overcome by a special manoeuvre that is described in the discussion. All intubations with the SensaScope® were successful in terms that no oesophageal or bronchial intubation has finally resulted, and no intubation procedure lasted longer than 2 minutes and/or led to significant desaturation. In no case, a resistance was encountered when the SensaScope® was advanced, and never was applied a force larger than necessary for an easy advancement. The details of the intubations performance are summarised in Table 2.

There was no necessity to implement any of the prepared rescue procedures for the case of failing to intubate with the SensaScope® such as use of a laryngeal mask or of a flexible fibreoptic bronchoscope.

After extubation, the tracheal tubes were checked for blood stains, and in 19 patients there were minor traces of blood visible. This amounts to 9% of all cases. The presence of blood stains on the tube did neither correlate with the degree of difficulty of the intubation process, nor with the prevalence of sore throat during the postoperative period. Four hours after extubation, the patients were asked for airway related complaints, which resulted in 21 reports of sore throat (10%). All but one patients reported full recovery from sore throat next day, one patient presented mild hoarseness that vanished by the evening of the first postoperative day.

Discussion

In order to evaluate an airway device, it has to go through various tests and different settings. The first step is to try it in manikins with normal and gradually distorted anatomy by various users [19]. This has been extensively done in the past with the SensaScope® and the in vitro suitability of the device has been so far confirmed [17]. Now follows this trial in elective patients without suspected airway problems. Since some airway difficulties are unpredictable, it naturally occured that

Table 1. Characteristics of the investigated patients (median, ranges)

	Median	Inter-quartile range	Total range
Age (years)	48	34 – 55	19 - 69
Weight (kg)	71	54 – 69	41 - 97
Height (cm)	168	163 – 171	153 - 186
Gender distribution (n)	136 females / 64 males		
Cormack & Lehane grades distribution during direct laryngoscopy (n)	1° = 33 2° = 155 3° = 12 (of which 2 were 3°b) 4° = 0		

Table 2. Details from the intubation performance with the SensaScope® (median, ranges)

	Median	Inter-quartile range	Total range
Duration of intubation (s)	27	21 – 48	16 - 118
Lowest SpO_2 value (saturation trough)	96	93 – 98	89 - 100
Portion of vocal cords visible with the SensaScope® (n)	161 total (vocal cords completely visible) 37 sufficient (> 50% of vocal cords visible) 2 insufficient (< 50% of vocal cords visible)		
Subjective degree of difficulty as assessed by the user (n)	easy = 188 moderate = 10 (due to extensive fogging, blurring) difficult = 2 (due to CL grade 3b)		

the SensaScope® has been occasionally used in difficult airway cases too. With this, we could obtain valuable experience and knowledge about its suitability as a difficult intubation device. Considering the immediate high success rate of the SensaScope® in unexpectedly encountered difficult laryngoscopies, it seemed for us justified to move forward and to expand its use to suspected (but not yet confirmed) difficult cases, in particular when the user felt comfortable to apply the instrument in those particular cases. Even more, the prospect to use it in confirmed (and not only predicted) difficult airway was already discussed, albeit not yet implemented, when recently a report appeared about the successful use of the SensaScope® in 13 predicted difficult airway cases by Greif et al [20].

The reason why the author initiated, promoted and supported the development of the SensaScope® was the dilemma of having either rigid or flexible airway devices with their inherent limitations. Rigid endoscopes have the advantage of easy and intuitive handling and, in particular, they are characterised by an immediate transmission of manual manoeuvres to the tip of the device, while flexible endoscopes may produce a loop instead of advancing forward. This specific attribute of flexible endoscopes makes necessary to use both hands to operate them, thus needing a "third" hand to apply a jaw thrust or to insert a laryngoscope. Conversely, flexible endoscopes have the advantage of being able to penetrate indirect, complex and lengthy anatomical structures by being steered with a dedicated lever, while rigid devices cannot bend according to certain morphological structures. Thus, the expected benefit of the SensaScope® lies in its hybrid nature by unifying rigid and flexible elements in one instrument, combining their typical advantages while avoiding their typical disadvantages. Additionally, the intubation technique contains familiar features such as conventional laryngoscopy and the steering technique of flexible fibrescopes. This enables an easy and intuitive acquiring of intubation skills that might be successfully adopted in a wide variety of patients and airway difficulty scenarios. This has been confirmed in a previous study, where the learning curve for naïve users approached a median intubation time of 20 s after 4 attempts [17].

Summarizing the advantages and disadvantages of the SensaScope® as it could be deducted from our clinical experience so far, we can list here as follows:

- **Advantages**
  - high success rate and versatility in overcoming intubation difficulties of various kinds. The efficiency is not affected by reduced mouth opening, reduced neck mobility, anterior larynx displacement, large masses at the base of the tongue;
  - easy and familiar handling (technique containing well trained methods such as direct laryngoscopy, steering like a flexible fiberscope);
  - immediate readiness to use (no preparation, no light source to be connected, no focusing, no axial alignment, no white balance, no lubrication necessary);
  - excellent view of the involved anatomy during the whole insertion process starting with a panoramic overview (thus avoiding of getting lost);
  - although the scope shaft is rigid, its sigmoid shape enables to advance it deep down the trachea where an accidental misplacement of the tracheal tube during withdrawal of the scope is excluded;
  - a high resolution video display enables watching of the endoscopic image during the entire intubation procedure by anyone present at the site of action;
  - robust nature of the device, easy cleaning and sterilization (meanwhile a transparent covering sheet named "SensaSleeve" is available, which helps to keep the instrument sterile after use and reduces the expenditures for re-establishment).
- **Disadvantages**
  - is not suitable for nasal intubation (in the sense of direct railroading the tracheal tube, but it can be used to watch the advancement of the tube from outside via the oral route);
  - cannot be used for tracheal tubes with an ID < 6.5 mm (although with additional equipment and a special technique, smaller tubes down to 3 mm ID can be used too);
  - is not suitable for double lumen tubes;
  - optic is sensitive to fogging or blurring and needs sometimes to be wiped with an anti-fog solution;
  - not suitable if there is bleeding or vomiting (as any other visualising device);
  - has no working channel to be used for suctioning or oxygen insufflation.

In our investigation, a successful intubation with the SensaScope® was assumed if the tracheal tube could be placed correctly in mid tracheal position in less than 120 seconds (in thoroughly pre-oxygenated patients). The median intubation time for all cases (including the "difficult" ones) was with 27 seconds comparable

with the reported intubation durations done with other video-assisted devices [5-12,14]. We achieved with the SensaScope® an easy and expedient intubation with only one attempt in 188 cases (94%). The remainder of 12 cases has been finally also concluded with correct tracheal tube position, but a longer time up to 118 seconds was needed. However, neither has any patient suffered clinically significant desaturation, nor was harmed or injured. The reason for the delay in 10 cases was the necessity to retract and clean the endoscope tip due to fogging or salivation and additionally to perform suctioning of the oral cavity, and in 2 cases due to a specific configuration of the epiglottis which appeared strongly adherent to the posterior pharyngeal wall. These were those 2 patients in whom the visibility of the vocal cords was estimated "insufficient" (Table 2). A posteriorly adherent epiglottis completely covered the glottic entrance, and could not be elevated by attempts of lifting the laryngoscope blade. This configuration can be considered as an especially "unhappy" variant of a CL view 3° (we prefer to term it 3°b). This condition is generally worrisome for anaesthetists and represents a major difficulty to intubate with any kind of technique. Albeit direct laryngoscopy constantly fails in such cases, with the SensaScope® one has a fair chance to succeed if a specific technique is applied that can be termed "retreat manoeuvre": first the tip of the SensaScope® is gently forwarded in sagital plane behind the epiglottis, so that it enters the post-cricoid region (or entrance to the oesophagus). Then the tip is bended slightly upward by pulling gently the lever. This is followed by slowly retracting the endoscope, which should result in the sudden appearance of the glottic entrance on the screen as soon as the scope tip passes the larynx on its way backward. For this it is essential to keep both instruments - the laryngoscope with the left hand as well as the SensaScope with the right hand - strictly in midline sagital plane. In the encountered 2 cases, the retreat manoeuvre succeeded and the intubation could be performed with a longer time requirement of 87 and 118 s respectively. Although the successful conclusion of these 2 particularly difficult cases does not yet represent a clear evidence for the superiority of the method, it is at least a promising indication for the potential of the device that has to be evaluated in further investigations.

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References

1. Abernathy JH, Reeves ST. Airway catastrophes. Curr Opin Anaesthesiol 2010;23:41-6.
2. Gannon K. Mortality associated with anaesthesia. A case review study. Anaesthesia 1991;46:962-6.
3. Rose DK, Cohen MM. The airway: problems and predictions in 18,500 patients. Can J Anaesth 1994;41:372-83.
4. Peiris K, Frerk C. Awake intubation. J Perioper Pract 2008;18:96-104.
5. Hirabayashi Y. Ease of use of the Airway Scope vs the Bullard laryngoscope: a manikin study. Can J Anaesth 2007;54:397-8.
6. Malik MA, O'Donoghue C, Carney J, Maharaj CH, Harte BH, Laffey JG. Comparison of the Glidescope, the Pentax AWS, and the Truview EVO2 with the Macintosh laryngoscope in experienced anaesthetists: a manikin study. Br J Anaesth 2009;102: 128-34.
7. Lange M, Frommer M, Redel A, Trautner H, Hampel J, Kranke P, et al. Comparison of the Glidescope and Airtraq optical laryngoscopes in patients undergoing direct microlaryngoscopy. Anaesthesia 2009;64:323-8.
8. Malin E, Montblanc J, Ynineb Y, Marret E, Bonnet F. Performance of the Airtraq laryngoscope after failed conventional tracheal intubation: a case series. Acta Anaesthesiol Scand 2009;53:858-63.
9. Savoldelli GL, Schiffer E, Abegg C, Baeriswyl V, Clergue F, Waeber JL. Comparison of the Glidescope, the McGrath, the Airtraq and the Macintosh laryngoscopes in simulated difficult airways. Anaesthesia 2008;63:1358-64.

10. Walker L, Brampton W, Halai M, Hoy C, Lee E, Scott I, McLernon DJ. Randomized controlled trial of intubation with the McGrath Series 5 videolaryngoscope by inexperienced anaesthetists. Br J Anaesth 2009;103:440-5.
11. McElwain J, Malik MA, Harte BH, Flynn NM, Laffey JG. Comparison of the C-MAC videolaryngoscope with the Macintosh, Glidescope, and Airtraq laryngoscopes in easy and difficult laryngoscopy scenarios in manikins. Anaesthesia 2010; 19: March [Epub ahead of print].
12. Cavus E, Kieckhaefer J, Doerges V, Moeller T, Thee C, Wagner K. The C-MAC videolaryngoscope: first experiences with a new device for videolaryngoscopy-guided intubation. Anesth Analg 2010;110:1473-7.
13. Bein B, Yan M, Tonner PH, Scholz J, Steinfath M, Dörges V. Tracheal intubation using the Bonfils intubation fibrescope after failed direct laryngoscopy. Anaesthesia 2004;59:1207-9.
14. Shukry M, Hanson RD, Koveleskie JR, Ramadhyani U. Management of the difficult pediatric airway with Shikani Optical Stylet. Paediatr Anaesth 2005;15:342-5.
15. Levitan RM. Design rationale and intended use of a short optical stylet for routine fiberoptic augmentation of emergency laryngoscopy. Am J Emerg Med 2006;24:490-5.
16. Biro P, Spahn DR. The difficult intubation drill at the University Hospital Zürich. J Rom Anest Terap Intens 2009;16:147-53.
17. Biro P, Battig U, Henderson J, Seifert B. First clinical experience of tracheal intubation with the SensaScope, a novel steerable semirigid video stylet. Br J Anaesth 2006;97:255-61.
18. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia 1984;39:1105-11.
19. Sudrial J, Abdi W, Amathieu R, Luis D, Jabre P, Le Roux B, et al. Performance of the glottiscopes: A randomized comparative study on difficult intubation simulation manikin. Ann Fr Anesth Reanim 2010; 26: March [Epub ahead of print].
20. Greif R, Kleine-Brueggeney M, Theiler L. Awake tracheal intubation using the Sensascope in 13 patients with an anticipated difficult airway. Anaesthesia 2010; 19: March [Epub ahead of print].