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Case Report

C-MAC Video Stylet Assisted Endotracheal Intubation in Sedated but Spontaneously Breathing Patients Using Remimazolam and Trachospray Device: A Report of Two Cases

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Abstract: The C-MAC video stylet (Karl Storz KG, Tuttlingen, Germany) is proposed as a successor to the familiar retromolar intubation endoscope. With its flexible tip, it may be especially useful for patients with a limited mouth opening. An awake or sedated airway management technique is often preferred when a difficult airway is anticipated. Due to the challenges in preparation, sedation, topical airway anesthesia and the execution of such an airway management technique itself, these techniques are often clinically underused. The C-MAC video stylet seems to be well suited for an awake or sedated airway approach, as its handling is easier and faster than a flexible fiberscope. It does not exert pressure on the tongue as direct laryngoscopy or video laryngoscopy do. We report two cases of a difficult airway in which intubation was performed by using the C-MAC video stylet in sedated, spontaneously breathing patients. After a low dose of 3 mg midazolam IV, remimazolam was administered continuously (0.46–0.92 mg/kg/h). This was supplemented with a low dose of remifentanil (0.04–0.05 µg/kg/min). The Trachospray device (MedSpray Anesthesia BV, Enschede, The Netherlands) was used for topicalization of the upper airway by means of 4 mL of lidocaine 5%. In addition, a further 5 mL of lidocaine 5% was sprayed via an epidural catheter advanced through the oxygenation port of the C-MAC video stylet for further topicalization of the vocal cords and proximal part of the trachea. The well-coordinated steps described in these two cases may represent a blueprint and a good starting point for future studies with a larger number of patients.

Keywords: video stylet; spontaneous breathing; airway management; endotracheal intubation; remimazolam; remifentanil

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1. Introduction

Endotracheal intubation is performed during general anesthesia to secure the airway and enable controlled ventilation of the patient. Direct laryngoscopy with, e.g., a Macintosh laryngoscope, after induction of general anesthesia with complete muscle relaxation is the most widely used technique for endotracheal intubation.

Specific patient characteristics, like restricted mouth opening or limited neck movement, predict difficult endotracheal intubation [1]. In these situations, an awake or sedated airway management technique in order to keep the patient breathing spontaneously is often preferred in order to diminish the associated risks. However, such airway management techniques are often clinically underused due to the challenges in preparation, sedation, topical airway anesthesia and the execution itself. For example, according to the Difficult Airway Society (DAS), awake tracheal intubation is only performed in 0.2% of the cases, despite all reported incidences of difficult airway management (e.g., difficult facemask ventilation, intubation or combination of both) being higher [2].

An increase in the ease and speed of the procedure with enhanced comfort for the patient and anesthesia provider might lower the threshold for using awake or sedated

airway management techniques in the future. The C-MAC video stylet seems to be well suited for an awake or sedated airway approach, as its handling is easier and faster than a flexible fiberscope. It does not exert pressure on the tongue as direct laryngoscopy or video laryngoscopy do. Therefore, we outline a novel combined technique in order to improve the ease and speed of obtaining a secure airway by means of endotracheal intubation during an awake or sedative airway management procedure. The C-MAC video stylet (Karl Storz KG, Tuttlingen, Germany) is used for intubation [3], alongside the sedative agent remimazolam, topical airway anesthesia techniques (i.e., the Trachospray device (MedSpray Anesthesia BV, Enschede, The Netherlands)) [4] and the use of an epidural catheter for "spray-as-you-go" with the C-MAC video stylet [5].

2. Case Presentation

2.1. Case 1

A 79-year-old female was scheduled for surgical excision of a right-sided parotid tumor. The patient was screened and counseled by an anesthesiologist at the preoperative clinic. The airway assessment showed both a limited neck extension and mouth opening of approximately three centimeters, a Mallampati score of III, a normal thyromental distance and a normal neck circumference. She had dental crowns on her upper front teeth. Different options for airway management were discussed with the patient. Because of the combination of a limited mouth opening and a limited neck extension, intubation under topical anesthesia and sedation were agreed upon with the patient.

An epidural catheter was prepared for "spray-as-you-go" with the C-MAC video stylet, as recently described [5]. In short, the distal tip of a multi-orifice epidural catheter was cut in order to obtain a forward spray pattern. Subsequently, the epidural catheter was progressed through the oxygenation port of the video stylet and then through a standard 7.0 mm tracheal tube. Following this, the tracheal tube was slid over the C-MAC video stylet onto the specifically designed "ET Tube Holder". The epidural catheter, placed between the tracheal tube and the video stylet, was withdrawn until the epidural tip position was just proximal to the tip of the tracheal tube. Only 2–3 mm of the epidural catheter's tip remained outside the distal end of the tracheal tube (Figure 1). In order to make sure that the epidural catheter remains perfectly in place during the intubation, it may be fixed by a small tape to the oxygenation port, which should be able to be easily removed again in case of catheter migration during the procedure. Of note, in this setup, the catheter can only be retracted and not advanced any more.

At the start of the procedure, the patient was optimally positioned in a supine position, head up, and connected to the monitor to assess vital signs. Oxygenation was performed by means of a nasal cannula with five liters of oxygen per minute. After an initial bolus of 3 mg midazolam IV, the Trachospray device was used for topicalization of the upper airway [4]. The Trachospray device, which is placed between the lips of the patient, delivers a fine mist spray. The droplet size created by the Trachospray is designed for maximum coverage of the hypopharynx, tongue, epiglottis and larynx, with only minimal lung deposition. An in vitro study showed that the coverage of this area with the Trachospray was substantially superior to a jet nebulizer and a lidocaine spray pump [4]. In this case, 4 mL of lidocaine 5% was administered through the Trachospray during inhalation. Then, continuous infusions of remimazolam (0.5 mg/kg/h) and remifentanil (0.042 μg/kg/min) were administered. This resulted in an adequate depth of sedation (i.e., "−4 Deep Sedation" according to the Richmond Agitation Sedation Scale (RASS); no response to voice, but movement or eye-opening to physical stimulation). The patient remained spontaneously breathing with an unassisted open airway.

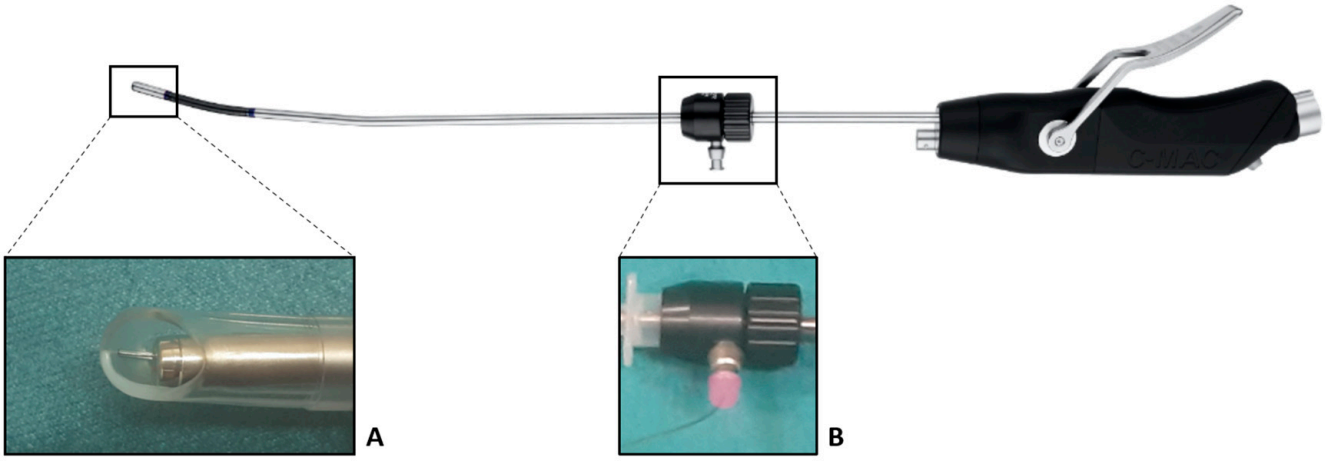

Figure 1. The C-MAC video stylet is shown, of which two areas (**A**,**B**) are enlarged. (**A**): the bevel of the tracheal tube and the tip of the epidural catheter are placed a few millimeters distal to the deflectable tip of the C-MAC video stylet. This way, they both remain visible through the camera of the video stylet but at the same time do not dazzle the anesthesiologist's sight completely. Also, this allows direct vision of where the "spray-as-you-go" pattern will distribute its local anesthetic. (**B**): the "ET Tube Holder" is shown on the left-hand side, connected to the tracheal tube, and its attachment to the tracheal tube can be secured by the wheel shown on the right-hand side. Furthermore, the epidural catheter is progressed through the oxygenation port, and in this case, it is attached by its included cap (pink), although a small tape holds it better in place according to our experiences.

The C-MAC video stylet, with its tip straight, was introduced over the tongue in a midline approach in a straight downward fashion. After passing the space between the tongue and uvula (i.e., progressing into the oropharynx), the handle of the C-MAC video stylet was pulled, resulting in a flection of the distal tip to provide a direct view of the epiglottis and partly the laryngeal structures behind the epiglottis (Figure 2). It is important to note that the distal tip of the device is capable of flexing with the tracheal tube still in its place, meaning that it is not required to retract the tracheal tube before pulling the handle. The patient did not react to the video stylet's introduction and maneuvering. The video stylet was advanced slightly further until the epiglottis. A soft jaw thrust was performed by a second person assisting the procedure to lift the epiglottis and give a full view of the larynx. The vocal cords were wide open with just minimal movements. With the C-MAC video stylet positioned directly in front of the larynx, a subsequent bolus of 5 mL of lidocaine 5% was sprayed through the tip of the epidural catheter on the vocal cords and into the proximal trachea. No coughing occurred during spraying. The tip of the C-MAC video stylet was progressed to just between the vocal cords; the pressure on the handle of the video stylet was released; and the tracheal tube was, with complete visual control, smoothly advanced into the trachea. The patient showed no movement reaction or coughing while advancing the tracheal tube into the trachea. While retaining the tracheal tube manually, the video stylet was withdrawn, and the tracheal tube was connected to the mechanical ventilator. Capnography confirmed an intratracheal tube position in a still spontaneously breathing patient. Then, the sedation was deepened to general anesthesia. Overall, the time from introducing the C-MAC video stylet to confirming the good intratracheal position of the tracheal tube was less than one minute.

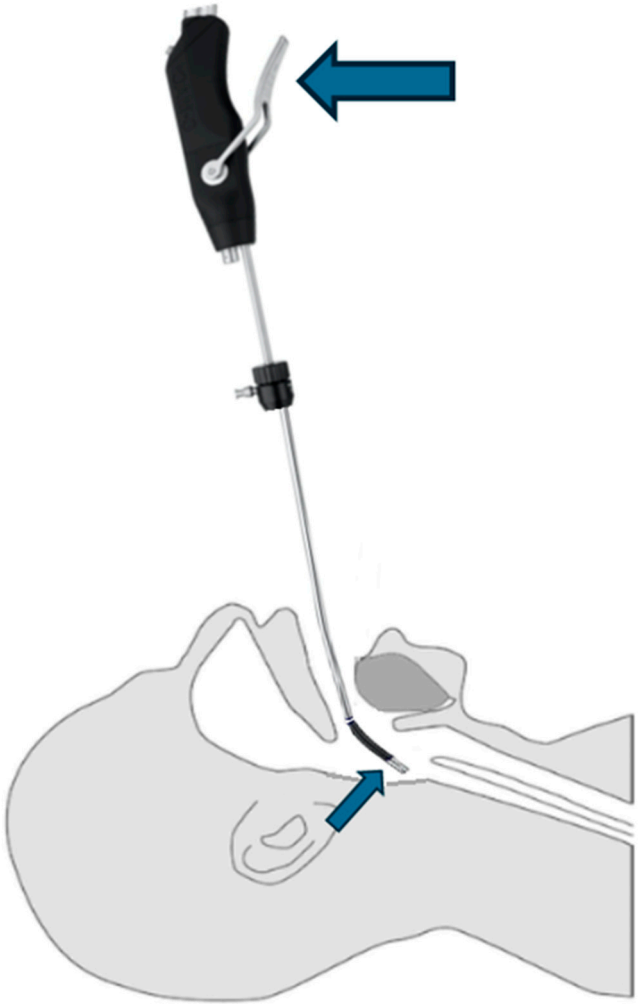

Figure 2. The use of the C-MAC video stylet: when the handle (big blue arrow) is pulled, the flexible distal tip (small blue arrow) will bend upwards (i.e., towards the laryngeal inlet).

2.2. Case 2

A 48-year-old male was scheduled for a jejunostomy under general anesthesia. The patient was screened and counseled by an anesthesiologist at the preoperative clinic. The airway assessment showed a significantly limited mouth opening of less than three centimeters, a Mallampati score of II, a normal thyromental distance and a normal neck extension and circumference. Due to the significantly limited mouth opening, intubation under topical anesthesia and sedation were agreed upon with the patient.

The patient was optimally positioned and connected to both monitoring equipment and a nasal cannula for oxygenation (five liters per minute). After an initial bolus of 3 mg midazolam IV, the Trachospray device was used for topicalization of the upper airway (4 mL of lidocaine 5%). Remimazolam was administered as a continuous infusion at a rate between 0.46 and 0.92 mg/kg/h. Simultaneously, a continuous infusion of remifentanil was started (0.048 µg/kg/min). The acquired RASS score was "−4 Deep Sedation". The patient remained spontaneously breathing with an unassisted open airway.

The handling and maneuvering of the C-MAC video stylet was performed identically to Case 1. Again, with the video stylet positioned in front of the larynx, an additional volume of 5 mL of lidocaine 5% was sprayed through the epidural catheter tip. The tracheal tube could be easily advanced into the trachea. The patient showed no movement or coughing during the procedure. Again, the time to intubation was less than one minute.

3. Discussion

In contrast to other rigid optical stylets, the C-MAC video stylet has a deflectable tip, which enhances the steerability of the device. In a manikin trial, Pius and Noppens [6] described a fast learning curve and intubation time regarding the C-MAC video stylet if used for both a normal airway and a simulated difficult airway. They showed that from five intubations onwards, the learning curve already flattened. Interestingly, in a recent study comparing a video laryngoscope, video stylet and flexible videoscope for transoral intubation in patients with difficult airways, the video stylet (i.e., not the C-MAC video stylet shown in this study) had the highest first-pass intubation success rate, the shortest time to tracheal intubation and, together with the flexible videoscope, the best level of glottic exposure [7]. Schweizer et al. [8] described the inclusion of 47 patients in an observational study of intubation success of the C-MAC video stylet. They reported a successful first attempt at orotracheal intubation in 91%, with the other 9% successfully intubated at the second attempt (100% overall success rate; median time until intubation: 27 s). The use of the C-MAC video stylet for intubation in an awake or sedated patient has recently been reported [9,10]. In this report of two cases, we reported our efforts to improve the sedated intubation technique with the video stylet. In general, fast and successful tracheal intubations were performed. Unlike direct or video laryngoscopy, the C-MAC video stylet seems well suited for the outlined approach, as it does not exert pressure on the tongue and only maneuvers in areas adequately covered by superficial topical anesthesia.

The DAS suggested the combination of midazolam and remifentanil for sedation during awake tracheal intubation in adults [2]. Both midazolam and remifentanil can be antagonized by flumazenil and naloxone, respectively. As an ester metabolized derivative of midazolam, remimazolam is a shorter acting benzodiazepine than midazolam. Remimazolam was approved in 2020 by the Food and Drug Administration for procedural sedation in adults. Recently, Hughes et al. described the use of remimazolam, in combination with midazolam and remifentanil, for sedation during fiberoptic intubation in an adolescent [11]. After 2 mg IV midazolam, continuous infusions of remimazolam (15 μg/kg/min) and remifentanil (0.05 μg/kg/min) were started, comparable to our doses in both cases. Of course, it would also have been possible to use a bolus of remimazolam instead of a bolus of midazolam before starting remimazolam continuously. The fast pharmacokinetic properties of remimazolam allow a deeper and better controllable level of sedation, which enhances its safety in this scenario in comparison to longer acting benzodiazepines like midazolam. Therefore, the technique described in this paper is substantially deeper than previously described techniques for sedated airway management with the C-MAC video stylet. For example, Nabecker et al. used only remifentanil (1–3 ng/mL, target controlled infusion) [10], and El-Aziz and Osman administered conscious sedation with only 30 μg fentanyl and 1 mg of midazolam [9]. In the reported cases, we used the clinical assessment of the depth of sedation (i.e., "−4 Deep Sedation", according to the Richmond Agitation Sedation Scale (RASS); no response to voice, but movement or eye-opening to physical stimulation). Of course, it would also have been possible to use an EEG monitor, like the BIS monitor, for the assessment (and titration) of the depth of sedation. But the use of BIS to measure the depth of remimazolam-induced sedation or anesthesia is still a subject of investigation. Although an acceptable correlation was recently established between the effect-site remimazolam concentration and depth of sedation measure with electroencephalogram parameters [12], it seems that with the use of remimazolam, a higher BIS is maintained in comparison with the use of propofol [13]. Therefore, the BIS level required for procedures such as sedated intubation has yet to be established. However, the BIS signal may easily be disturbed by small movements of the head during the intubation procedure and therefore may have little added value in our experience. Furthermore, considering the limited duration of the procedure (less than one minute to intubation), we chose a more practical approach.

In our case, the amnesic properties of remimazolam plus deep sedation provided a high level of comfort for the patient and anesthesia providers. We used the Trachospray device for topicalization of the airway, which seems to be less invasive, faster, easier

and better to standardize than similar methods previously described. Nabecker et al. anesthetized the mucosa of the upper airway (i.e., laryngopharynx) topically with lidocaine 10% (maximum 7 mg/kg) and additionally anesthetized the trachea with an invasive transcricoidal injection of 2 mL lidocaine 2% [10]. El-Aziz and Osman anesthetized the oral cavity with lidocaine spray 10%. Two puffs of 10 mg lidocaine were applied to the oral mucosa, back of the throat and hard palate. Lidocaine was kept in the mouth for about five minutes after puffing, until tingling of the upper airway occurred [9].

The DAS suggested the additional "spray-as-you-go" topicalization of the airway using an epidural catheter through the work channel of the fiberscope [2]. Whereas the C-MAC video stylet does not have a work channel, recently, a setup was proposed for introducing an epidural catheter via the oxygenation port of the C-MAC video stylet [5]. We therefore cut the distal 3 cm of the epidural catheter containing the closed end and the side holes of the epidural catheter, resulting in a forward spray pattern, and placed the epidural catheter via the C-MAC video stylet, as previously described.

Although we did not encounter poor visibility due to heavy mucus production in the patients, we suppose that prophylactic use of glycopyrronium may be considered. This anticholinergic drug has been proven to have a positive effect on reducing secretions in the throat, trachea and bronchial system, resulting in better visualization and faster intubation times with a rigid video stylet [14].

The small sample size in our report and the limited generalization due to specific patient characteristics can be seen as limitations of this report of the two cases.

4. Conclusions

Awake or sedated airway management techniques pose challenges in the preparation, sedation, topical anesthesia and execution. The well-coordinated steps described in this report of two cases regarding intubation with the C-MAC video stylet in sedated but spontaneously breathing patients may represent a blueprint for clinical practice. We also consider it a good starting point for future studies with a larger number of patients.

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Informed Consent Statement: Informed consent was obtained from both patients involved in the study (i.e., they explicitly approved that their already retrieved clinical data may also be used for this study, and that the study would be published). The approval was retrieved by phone. The informed consent statement of each patient, together with the date of the phone call and the name of the researcher who called the patient, are documented in the electronic health record of each patient.

Data Availability Statement: The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding authors.

Conflicts of Interest: J. Bruhn has a patent pending for the Trachospray device. The other authors declare no conflicts of interest.

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