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CASE REPORT

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Use of the flexible bronchoscope and Infrared Red Intubation System in a known difficult airway in the intensive care unit

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Abstract

This case report describes a patient in the ICU in need of urgent intubation, for whom video laryngoscope-guided intubation had previously failed. The *Infrared Red Intubation System (IRRIS)* may enhance the chance of successful flexible bronchoscope intubation, especially when performed by non-expert anesthesiologists.

KEYWORDS

awake tracheal intubation, flexible bronchoscope, ICU, Infrared Red Intubation System, IRRIS

1 | INTRODUCTION

Some patients cannot be intubated with a hyperangulated videolaryngoscope (HA-VL).[1–4]

This case report describes a patient in respiratory failure requiring acute intubation, with previous impossible HA-VL intubation. If invasive techniques are to be avoided, *acute Awake Tracheal Intubation with a Flexible Bronchoscope (ATI-FB)* may be the best option.[1,3,4]

The *Infrared Red Intubation System* (*IRRIS* – Guide In Medical, Nazareth, Israel)[5] may enhance the chances of success, especially, if the ATI-FB has to be performed by non-expert anesthesiologists, who only infrequently perform FB.

2 | CASE PRESENTATION

A 49-year-old woman (144 cm; 60 kg) experienced spontaneous, upper leg pain. She was bedridden with gradually worsening of dyspnea and finally called an ambulance.

In early childhood, the patient was diagnosed with severe juvenile idiopathic arthritis. She had undergone multiple previous surgeries all of which were performed with ATI-FB. On one occasion, after securing the airway, inducing unconsciousness and neuromuscular relaxation, attempts at introducing a HA-VL (McGrath-MAC X-Blade™, Medtronic, MN, USA) were unsuccessful due to severely limited mouth opening.

In the emergency department, the patient was diagnosed with a femoral fracture and pneumonia (Figure 1). She deteriorated and was transferred to the intensive care unit. The respiratory rate was 40 breaths/min, peripheral oxygen saturation was 88%–95% (with 5 L/min oxygen delivered via nasal cannula), heart rate was 120 beats/min, and blood pressure was 130/70 mmHg. Intermittently, the patient could still follow commands (such as squeezing a hand), but no longer opened her eyes or responded verbally. After non-invasive ventilation (NIV) on maximal settings, her arterial gas showed pO2 at 8.2 kPa, pCO2 at 12.8 kPa, pH at 7.30, lactate at 0.6 mmol/L, and base excess at 13.1 mmol/L. Airway examination revealed a mouth opening of 13 mm, severely limited neck movement (<80º), severe retrognathia, and a short neck that was difficult to palpate (Figure 1).

The patient was positioned upright sitting and preoxygenated with NIV, followed by high-flow nasal oxygen (HFNO) for the intubation itself. Glycopyrrolate 0.2 mg (Meda) was administered slowly intravenously. The cricothyroid membrane was identified and marked. Sedation was achieved with midazolam 0.25 mg (Hameln, Hameln, Germany) and s-ketamine 5 mg (Pfizer), which were both titrated slowly and administered intravenously. For the sake of speed and simplicity, lidocaine 2% with epinephrine 5 μg/ml (Amgros) was used for topicalization supplemented with spray application of lidocaine 10% (Xylocaine Pump Spray 100 mg/ml, AstraZeneca). Nebulization on the NIV machine (5 ml × 2), spray application (3 puffs × 2), transtracheal injection (2 ml × 1), infiltration superficially to the cricothyroid membrane (3 ml × 1), nasal atomizing (MAD Nasal™, Teleflex), and direct nasal application with a local anesthetic soaked ribbon gauze (1 ml × 2 and 5 ml × 1, respectively) were applied. Oral intubation was then performed with an FB (Ambu® aScope™ Regular, Ambu), a Portex® Soft Seal® tracheal tube with an internal diameter of 7.0 mm (Smiths Medical) and a size 8-cm Berman Intubating Airway (Vital Signs), which maximally compressed could just be inserted between the teeth. The flashing bright light from the *IRRIS* momentarily allowed identification of the relevant structures. During the procedure (see Video S1), vital signs remained stable including peripheral saturations at 85%–95%. Total time from initiation of topicalization to successful intubation was 13 min, whereas the intubation itself took <2 min. Visual confirmation of tube placement, gentle cuff inflation, and immediate capnography were followed by propofol infusion and initiation of mechanical ventilation.

3 | DISCUSSION

Guidelines for the *management of known difficult airways*[1,6] and for *intubation in critically ill adults*[7] have been published.

In known difficult airways, ATI is still considered the standard approach.[1,2,6,8] The benefits of ATI are, that spontaneous breathing is preserved (hence oxygenation), that the patient can be sitting up (thus providing maximal airway diameter and avoiding atelectasis), and that there is some protection against aspiration (preserved reflexes and muscle tone).[2,6,8] Traditionally, ATI is performed with a FB.[1,2,6,8]

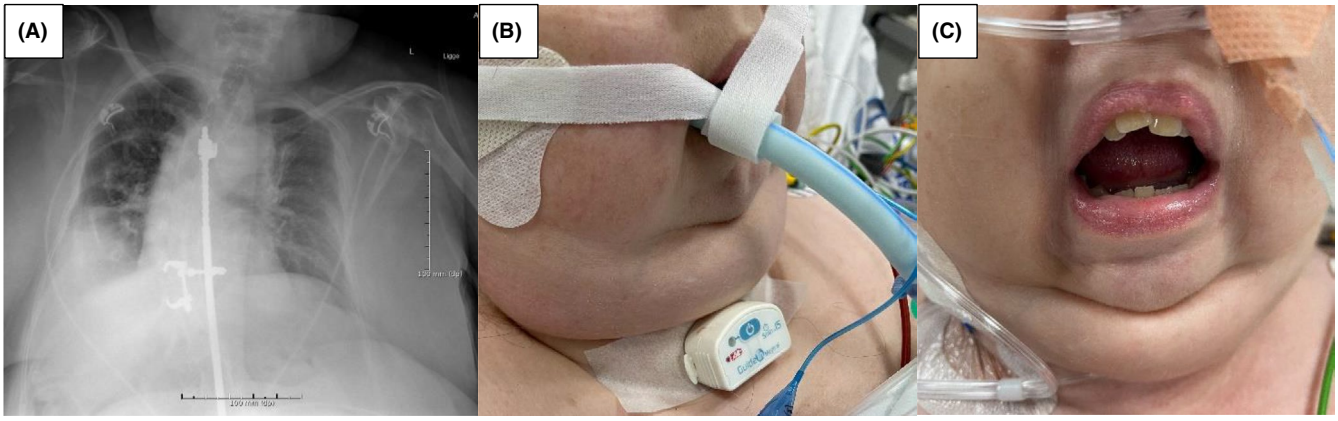

FIGURE 1 *Patient's* chest X-ray before intubation showing bilateral pneumonia, atelectasis, and severe scoliosis with a Harrington rod (A). The patient after intubation, Infrared Red Intubation System placed on outer trachea (B). The patient after extubation, demonstrating maximal mouth opening of 13 mm (C)

The VL revolutionized airway management, since even previously difficult airways only manageable with the FB now often were manageable with the VL. Accordingly, awake airway techniques and FB intubation skills in particular may have become less frequently needed/practiced by the typical anesthesiologist and are underutilized techniques.[9] Prior to the widespread adoption of VLs, only approximately 50% of anesthesiologists considered themselves to be skilled in FB intubation.[10] Reluctance to perform ATI-FB may be because of lack of training and concerns related to time delay and patient discomfort.[6,8,9] With the right preparations though, the time spent on the procedure is acceptable[2,11,12] and most patients do not experience discomfort.[2,11,13,14]

If ATI-FB, performed by a non-expert anesthesiologist is required, considerations should be made early *before* the patient's physiological status has deteriorated. The cricothyroid membrane should be identified (if necessary guided by ultrasound) and marked in advance in the extended-neck position.[2,15] The patient should be positioned upright sitting and face-to-face with the anesthesiologist, providing both maximal luminal patency and maximal patient comfort and, hence, a reduced need for sedation.[3,4,6]

The most common problems with acute ATI-FB in critically ill patients may be categorized as follows:

1. Problems with oxygenation/circulation
2. Problems with inadequate sedation/topicalization
3. Problems with visibility of relevant structures
4. Problems with tube advancement
5. Impossible FB intubation necessitating a backup strategy

Preoxygenation can be achieved using NIV with 100% oxygen while performing sedation/topicalization,[7] NIV can be changed to HFNO at 100% oxygen and maximal flow, for the intubation itself. The patient should be fully monitored, including arterial line and large bore venous line (if time permits central venous line) and vasopressors/inotropes should be ready and used proactively.[7]

In the elective ATI-FB, no superior sedation/topicalization regime has been identified.[8] In the critically ill, a non-opioid based regime could theoretically provide a safety benefit and minimal sedation should be titrated cautiously. Over-sedation would be dangerous due to the risk of secondary airway obstruction, hypoventilation/hypoxia, and circulatory collapse.[6,8] Optimal airway topicalization is the key to success.[2,6,8] Oral intubation is preferred to avoid epistaxis,[2] and to employ a sufficiently large tube size, if a period of ventilator therapy is expected. As last resort plans, the nasal route is prepared from the start (backup if oral route access fails) and subcutaneous local anesthetics can be placed superficially to the cricothyroid membrane (backup if invasive techniques have to be performed). The maximal dose of topical lidocaine is 9 mg/kg.[1,6]

The visibility of relevant structures is enhanced if the upper airway diameter is enlarged, secretions and blood do not obscure the vision with the FB, and the glottis and vocal cords can be identified expediently. Simple maneuvers can contribute to this (Figure 2). The upright sitting position has the most significant impact on airway patency.[6] Specialized oral airways for FBs (e.g., Berman), increase the upper airway diameter, but insertion might be impossible in cases of severely limited mouth opening. If the patient's cerebral status deteriorates (or due to over-sedation), biting on the FB or tube may make oral intubation impossible. Insertion of an oral airway, bite block, or a HA-VL blade intraorally as conduit for the FB may alleviate this problem (otherwise the nasal route can be considered). Thick purulent secretions can cover the mucosal surfaces, thus acting as a mechanical barrier for optimal topicalization of these areas and can hinder visualization with the FB. Cautious suctioning should thus be performed before topicalization. Early administration of an antisialologue (e.g., glycopyrrolate) has a mucosal drying effect, and vasoconstrictor agents applied to the mucosa (especially nasally) can minimize epistaxis.[6] The idea of retrograde light-guided laryngoscopy is not new.[16,17] A method with direct laryngoscopy and a flashlight placed on the front of the neck has previously been published.[16,17] When *IRRIS* is placed superficial to the patient's cricothyroid membrane or trachea, it emits flashing infrared light through the skin.[5] When a FB is introduced into the airway, the infrared light will become visible as a flashing white light on the FB's video-screen, showing the pathway to the vocal cords and trachea.[5] The main advantage of *IRRIS* is to provide an easily identifiable landmark to aim for, particularly where the view may be suboptimal. *IRRIS* has been shown beneficial in the elective VL-guided intubation of lean, respectively, extreme obese patients,[18,19] elective ATI-FB in known difficult airways[20] and in ATI-FB of an obstetric patient with a known difficult airway.[4]

The incidence of tube impingement is reduced, if specialized tubes are used (e.g., LMA® Fastrach™ ETT, Teleflex), the opening of the bevel is oriented posteriorly and the gap between the tube and the FB is minimized.[6]

In general, there are often clear advantages to intubation rather than the more invasive alternatives. In some clinical scenarios, though, the maneuvers suggested for *acute ATI-FB* may not be possible. In hospitals *with* ear, nose, and throat (ENT) surgical expertise, *awake surgical tracheostomy* would have been a viable backup option and could also have represented the primary plan.[2,3] In

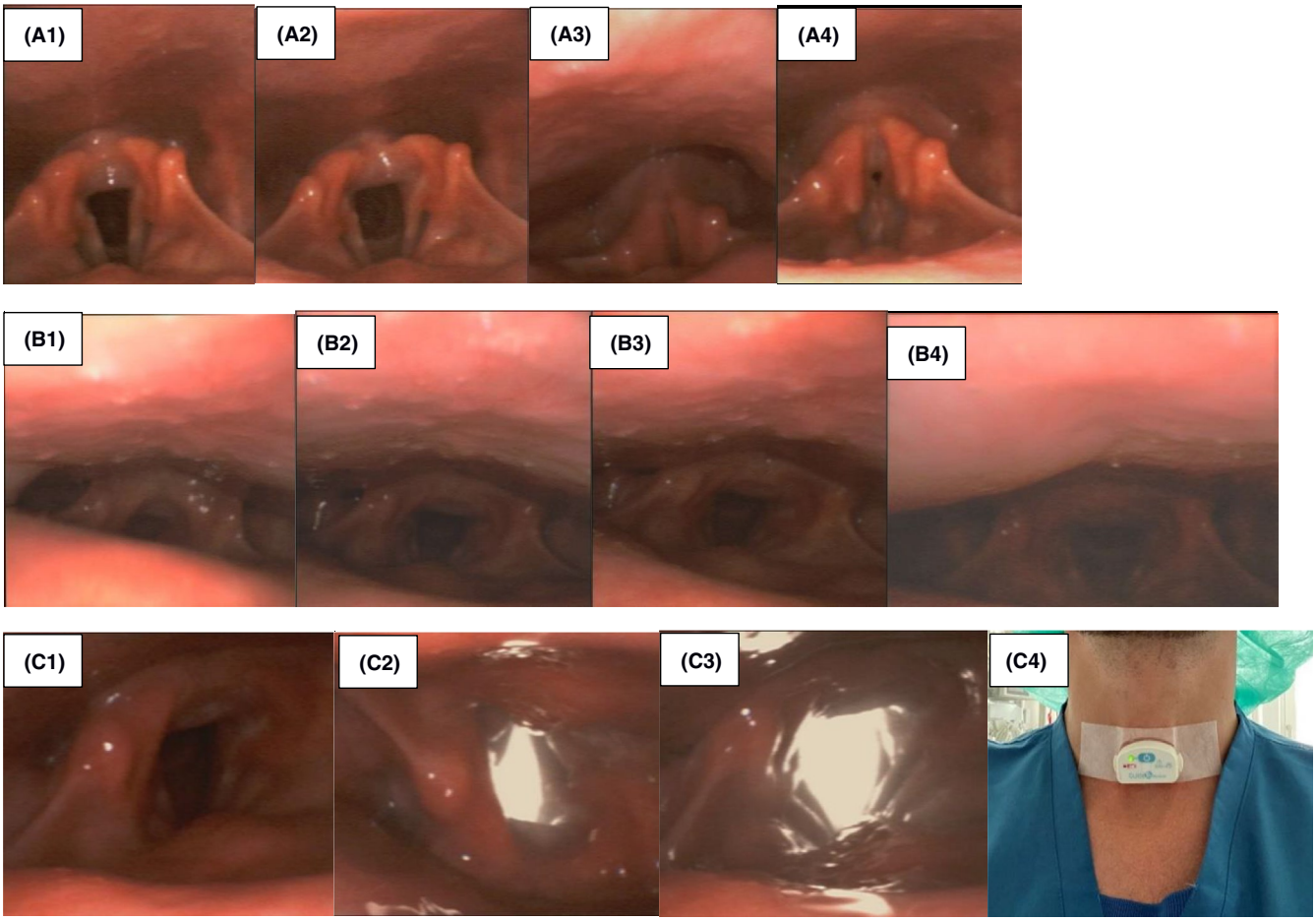

FIGURE 2 Flexible bronchoscope view of a *normal airway in a healthy man* (43 years; 195 cm; 90 kg).
Upright sitting position with optimal airway diameter. Additional maneuvers for optimizing visibility of relevant structures (since vocal cord movements or air bubbles may become visible): Normal breathing (A.1), "take a deep breath" (A.2), Valsalva maneuver (A.3) and "say eee" (A.4).
Supine position with partial airway collapse. Maneuvers for optimizing airway diameter: Normal breathing (B.1), "stick out tongue" (B.2), "jaw thrust" (B.3) and continuous positive airway pressure with high-flow nasal oxygenation with maximal flow (B.4).
Infrared Red Intubation System (IRRIS). For optimizing visibility of relevant structures: Turned off (C.1), turned on—normal breathing (C.2), turned on—deep breath (C.3) and seen from the outside—placed on upper trachea (C.4)

hospitals *without* ENT surgical backup as in this case, immediate relocation of the patient with NIV to another hospital can be considered, if the clinical status is expected to be very stable for the duration of the transport. If *acute ATI-FB* is attempted and fails, *awake cricothyroidotomy* (by an anesthesiologist) or *awake percutaneous dilatational tracheostomy* (by an experienced intensivist) can be considered.[3] *Emergency cricothyroidotomy* after high-risk general anesthesia with full relaxation should remain the last resort, since failure rates may be over 50% when performed by an anesthesiologist in a "cannot-intubate-cannot-oxygenate" situation.[9,11]

4 | CONCLUSION

Optimally, expert anesthesiologists should manage intubation of patients, who cannot be intubated with a HA-VL. In a time-critical setting where non-experts need to perform the acute ATI-FB, *IRRIS* may enhance the probability of success, since it provides an easily identifiable landmark to aim for, especially in cases where the view with the FB is suboptimal.

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CONFLICTS OF INTEREST
None.

AUTHOR CONTRIBUTION
KEH involved in performing the procedure, drafting and revising the article. MSK, RWH, CJ, and AMG involved in revising the article. All authors have read and approved the final manuscript and agreed to be accountable for all aspects of the work.

ETHICAL APPROVAL

Approval from the Central Denmark Region Committee on Health Research Ethics was not required.

CONSENT

Written informed patient consent for publication was obtained.

DATA AVAILABILITY STATEMENT

No data were used during the study.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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