CASE REPORT

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The Importance of Point-of-Care Ultrasound (POCUS) in the Management of Difficult Airways Caused by Neck Tumor: A Case Report

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Abstract

The Difficult Airway Society (DAS) has guidelines for managing difficult airways, though these primarily address general scenarios rather than specific cases such as neck malignancies. In this report, we aim to highlight the pivotal role of Point-of-Care Ultrasound (POCUS) in managing difficult airways due to a neck tumor. We present a case involving a 43-year-old female with a neck tumor measuring 25 cm in diameter, who presented with shortness of breath. We used POCUS as a guide to accurately locate the shifted trachea before performing a surgical tracheostomy (ST). Despite multiple failed attempts at intubation, the tracheostomy was successful and resulted in a positive outcome. In conclusion, the use of POCUS plays a lifesaving role in managing difficult airways. Its training should be mandatory for medical professionals and more widely implemented in clinical practice, particularly for tracing anatomical alterations of the trachea and other structures shifted by neck malignancies.

Keywords: Difficult airway; Point-of-Care Ultrasound (POCUS); Ultrasound; Neck tumor; Airway obstruction.

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Introduction

The 2022 guidelines of the American Society of Anesthesiologists define a Difficult Airway (DA) as a clinical situation where a physician trained in anesthesia care experiences anticipated or unanticipated difficulty or failure in managing the airway. This includes, but is not limited to, one or more of the following: facemask ventilation, laryngoscopy, ventilation using a supraglottic airway, tracheal intubation, extubation, or invasive airway management.[1] Approximately 93% of the population with difficult airways did not receive adequate airway anticipation, and as many as 25% were actual difficult airway cases with potentially difficult intubations. There still is no definitive predictor of a difficult airway with both high and reliable sensitivity and specificity.[2]

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Point-of-Care Ultrasound (POCUS) is used for initial screening and to determine medical treatment plans in primary care. Its application in the head and neck region plays a crucial role in diagnosing and managing narrowing upper airway stenosis.[3]

Point-of-Care Ultrasound has emerged as a promising tool for managing difficult airways due to its accessibility, safety, and non-invasive nature. It provides high-resolution images of the upper airway anatomy, comparable to those obtained with computed tomography (CT) and magnetic resonance imaging (MRI).[4]

In this article, we report a case of a difficult airway caused by a neck tumor, managed with POCUS to determine the shifted position of the trachea prior to the tracheostomy procedure.

Case Report

A 43-year-old female presented to the emergency room with a chief complaint of progressively worsening shortness of breath over the past week. She noticed a mass in her neck that had appeared 2-3 months earlier and had progressively enlarged (Figure 1A). She had no prior medical history of conditions such as hypertension or diabetes, and reported no other masses in other parts of her body. Her body mass index was 30.1 kg/m^2, indicating Grade I obesity.

The patient appeared weak but was fully conscious. She experienced shortness of breath with partial obstruction of the upper airway, classified as Jackson Upper Airway Obstruction Criteria Grade III. Her peripheral oxygen saturation was 98% on 12 liters per minute of oxygen via a non-rebreathing mask. She had normal blood pressure and a pulse rate of 126 beats per minute. The patient also exhibited diaphoresis, stridor, and visible retraction of accessory respiratory muscle. Head-neck examination revealed a 25 cm diameter mass with a fixated, solid hard consistency and indistinct, irregular edges. Pulmonary auscultation showed bilateral vesicular breath sounds with crackles.

Anteroposterior and lateral cervical X-rays revealed a mass measuring 11.3 x 19.6 cm on the left side of the neck, which displaced the trachea to the right side. The narrowest tracheal lumen diameter was 0.8 x 1.1 cm at the level of the third cervical vertebrae. The chest radiograph revealed a slight opacity suggesting mucus accumulation and sputum retention (Figure 1B-C). A computed tomography scan was not performed due to limited resources at our hospital. The arterial blood gas analysis revealed partially compensated respiratory acidosis with the following values: pH 7.34, bicarbonate (HCO_3) 27.5, partial pressure of carbon dioxide (pCO_2) 51 mmHg, partial pressure of oxygen (pO_2) 160 mmHg, fraction of inspired oxygen (FiO_2) 70%, and the ratio of arterial oxygen partial pressure to fractional inspired oxygen (P/F ratio) 228.

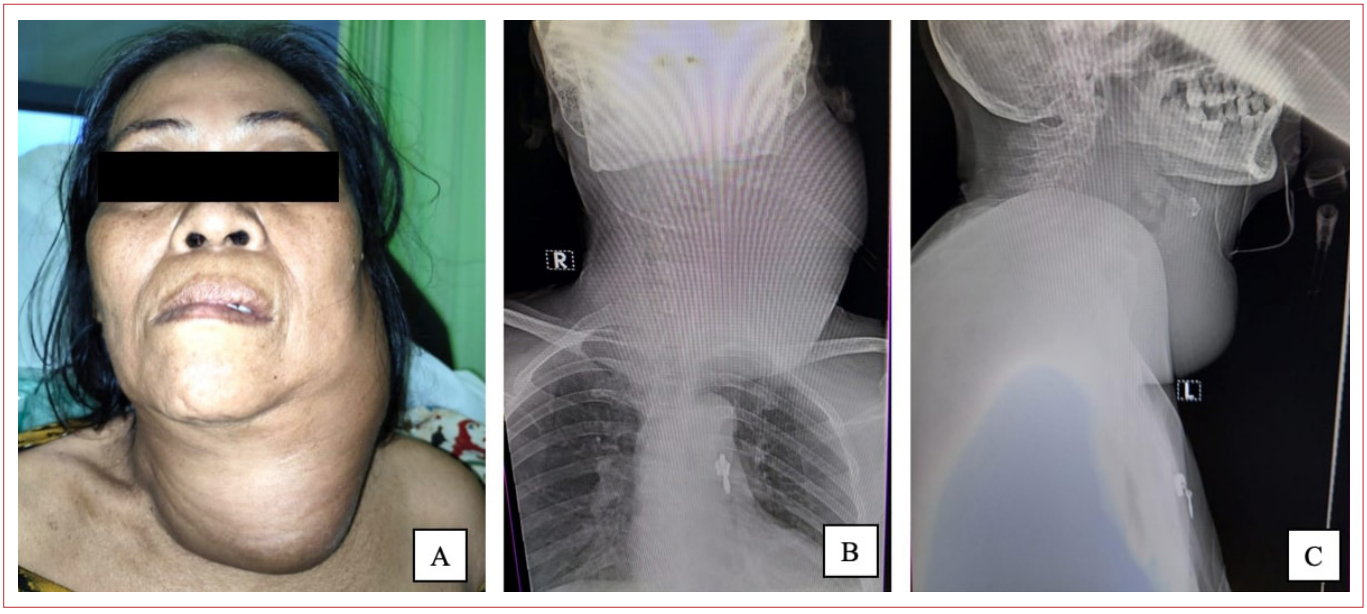

Figure 1. Clinical pictures and imaging of the patient before the procedure. **(a)** Front view of the cervical mass; **(b)** Anteroposterior cervical and chest X-ray showing an 11.3 x 19.6 cm cervical mass; **(c)** Lateral view of the cervical X-ray

The patient's status was classified as Physical Status-American Society of Anesthesiologists (PS-ASA) III due to a presumptive diagnosis of either non-Hodgkin's lymphoma in the neck region or thyroid cancer as a differential diagnosis, with impending upper airway obstruction. After consulting with the surgeon, an emergency surgical tracheostomy (ST) was planned immediately, and written informed consent was obtained from the patient and her family.

In preparation for the ST, we prepared some instrumentation to anticipate a difficult airway, including a laryngeal mask, bag valve mask, nasopharyngeal airway in three sizes, and a large-size suction. To conduct the intubation safely and effectively, the anesthesiologist used POCUS to determine the shifted location of the trachea and vascular structures displaced by the mass, minimizing the risk of injuring those critical structures. We used the GE Vivid™ S70N ultrasound with a 9L-D linear array probe set to a frequency of 7.2 MHz (range 4.8-8.0 MHz) and depth settings of 2-3 cm in a static method to locate the trachea. The trachea was identified by detecting the presence of white opacity indicating the epiglottis and the darker density next to it showing the tracheal lumen (Figure 2A). The anesthesiologist marked the patient's neck with a marker afterward (Figure 2B). Low-dose fentanyl (25 mcg) and midazolam (1 mg) were administered before intubation. After sedation, the patient remained calm yet alert, corresponding to a Richmond Agitation and Sedation Scale (RASS) score of 0. The first attempt at intubation using a video laryngoscope and the second attempt with a fiberoptic laryngoscope (FOL) was unsuccessful. Consequently, it was decided to proceed with an ST by the surgeon.

The surgeon began by making an incision at the marked site, first infiltrating with local anesthesia using 20 mg/mL of 2% lidocaine (up to a maximum of 10 mL). No additional dose of intravenous sedoanalgesia was required. During the ST procedure, the patient was still alert and breathing spontaneously with 12 liters-per-minute of oxygen via an over-face anesthesia mask. Airway protective reflexes were maintained without the need for additional instruments. There was no specific length requirement for the cannula; the standard Rüsch® CrystalClear™ tracheostomy cannula of 7.0 mm that we installed was sufficient to access the trachea (Figure 2C). The ST was successfully performed with satisfactory outcomes, achieving a tidal volume of 397 mL and a minute volume of 5.0 L/min, without any complications such as structural bleeding, cannula misplacement, pneumothorax, or subcutaneous emphysema. The patient was stable and transferred to the high-care unit after two hours of observation in the intensive care unit.

Discussion

Airway emergencies, including upper airway obstruction caused by cervical tumors, have a high mortality rate due to the compression of the trachea and surrounding structures, necessitating comprehensive management. A holistic approach that encompasses history-taking, disease predilection assessment, comorbidities evaluation, and physical assessment of facial and jaw landmarks, Mallampati score, neck mobility, and abnormal anatomy—supported by additional examinations—is essential to anticipate a potentially difficult airway

Figure 2. Clinical pictures and imaging of the patient during and after the procedure. **(a)** Ultrasound imaging of the narrowed tracheal lumen, located with Point-of-Care Ultrasound (POCUS); **(b)** Marked location of the shifted trachea, traced with POCUS; **(c)** Tracheostomy cannula installed on the marked neck after the procedure.

Table 1. Previous case reports of difficult airway management with the Point-of-Care Ultrasound (POCUS)

No	Author	Diagnosis	Procedure	Outcome
1.	Hodgson and Pillay[10]	Complicated dental sepsis extending into the neck	Awake percutaneous tracheostomy confirmed with ultrasonography	On day 3, sedation was stopped, and the patient breathed comfortably. Initially failed a T-piece trial due to thick secretion blocking the tracheostomy tube, but was successfully weaned to a T-piece on day 6 in the intensive care unit (ICU).
2.	Ortega et al.[11]	Thyroid Cancer Grade IV	Awake percutaneous tracheostomy confirmed with ultrasonography	Hemodynamically stable, alert, oriented, and breathing spontaneously through a patent tracheostomy.

caused by neck tumors.[5] However, several studies have found that more than 90% of difficult airways are not anticipated.[1] Various guidelines can be applied to patients with unanticipated difficult airways. At our center, we utilized the Difficult Airway Society (DAS) 2015 guideline for managing difficult airways. According to these guidelines, we initially attempted Plan A (tracheal intubation), but it was unsuccessful due to the altered anatomy of the neck, which presented significant challenges. We then proceeded to execute Plan B using a supraglottic airway device (SAD), but achieved the same result. The SAD could not be installed because the patient's trachea was narrowed and shifted by the tumor; however, we still managed to achieve oxygenation and ventilation. According to the guidelines, cricothyroidotomy is the recommended alternative to ensure patient oxygenation.[6] However, in this case, the cricothyroidotomy was not considered because it is not a definitive airway solution, the patient's altered neck anatomy made access difficult due to overlapping masses, and the risk of creating a false route was very high. A similar unsuccessful attempt at cricothyroidotomy in a difficult airway case caused by neck cancer has been reported for the same reasons.[7]

The American Society of Anesthesiologists 2022 guidelines emphasize the significance of using ultrasound in difficult airway cases to accurately locate the anatomical structure of the upper airway.[1] The exact position of the trachea should be determined beforehand. It was chosen for its high accuracy, accessibility, safety, and non-invasive nature, which facilitates the operator's ability to determine the incision site and reduce the risk of complications during tracheostomy procedures with real-time imaging.[8,9] In this case, ultrasound was employed prior to intubation, and POCUS was specifically used to determine the anatomical position of the trachea before proceeding with the tracheostomy.

Complications that could arise from a difficult airway with a shifted trachea include not only vascular lesions (particularly the carotid artery and jugular vein) but also other functional structures in the neck such as nerves, hormonal glands, and muscles.[1] Thus, the use of the POCUS was expected to minimize the risks of injuring those structures around. However, POCUS is operator-dependent, so the success of its application also depends on the operator's experience and skill.

The use of POCUS for tracheostomy procedures in patients with neck tumors is widely practiced,[10,11] especially in cases where cricothyroidotomy is difficult to perform (Table 1). A recent prospective cohort study involving 152 cases of difficult airways due to head and neck pathology demonstrated that the use of POCUS before a tracheostomy can expedite the procedure by 3.3 minutes ($p<0.05$) and improve oxygenation more effectively than procedures performed without POCUS ($p<0.02$).[12] The ability to perform tracheostomies quickly and accurately mark the trachea location with POCUS, coupled with good coordination, plays an important role in achieving positive patient outcomes.

Conclusion

The Point-of-Care Ultrasound can be a reliable tool to assist medical teams in emergencies by determining the structure of difficult airways, particularly in patients with neck tumors before surgical tracheostomy procedures. This technique should be implemented more widely. Increased reporting on the use of POCUS and

providing adequate training are necessary to enhance its implementation among medical professionals, as it has proven useful in managing difficult airways caused by head and neck tumors.

Informed Consent: Written informed consent was obtained from the patient and her family.

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