CASE IN POINT

A Case Report of Unanticipated Difficult Intubation Due to Posterior Tracheal Angulation

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Background: Lateral tracheal deviation from mechanical compression is well-known, but anterior-posterior (A-P) deviation has been rarely reported.
Case Presentation: A 50-year-old male with a history of chronic cerebral venous sinus thrombosis and taking enoxaparin presented to the emergency department for recurrent headaches. The patient experienced cardiac arrest and endotracheal tube (ETT) advancement was difficult secondary to unexpected posterior tracheal deviation encountered during cardiopulmonary resuscitation. Flexible fiber-optic bronchoscopy was performed to traverse the acute angulation and advance the ETT.
Conclusions: Tracheal deviation in the A-P direction should be considered as a cause of difficult ETT advancement, and fiber-optic bronchoscopy should be performed early to diagnose such lesions.

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Tracheal deviation mostly occurs from mechanical compression of the trachea, and can be caused by a variety of clinical conditions, including trauma,[1] pharyngeal abscess,[2] neck hematoma,[3] thyroid enlargement,[4] and kyphoscoliosis.[5] These conditions often result in lateral tracheal deviation, which can be associated with tracheal compression and reduction in tracheal caliber.

Anterior-posterior (A-P) tracheal deviation has rarely been reported. Kyphoscoliosis, scarring after a tracheostomy, or innominate vein compression are probable causes of A-P tracheal deviation and can be associated with tracheal narrowing and vascular fistula formation. This report describes a case of difficult endotracheal tube (ETT) advancement secondary to unexpected acute posterior tracheal deviation encountered during cardiopulmonary resuscitation (CPR). A waiver of patient consent was obtained from the Human Research Protection Program at the US Department of Veterans Affairs (VA) Puget Sound Health Care System.

CASE PRESENTATION

A 50-year-old male with a history of chronic cerebral venous sinus thrombosis and taking enoxaparin, presented to the emergency department for recurrent headaches. He experienced sudden cardiac arrest, and CPR in the form of chest compression and bag mask ventilation was immediately initiated. With the patient's head in an extended position and using a video laryngoscope, a Cormack–Lehane grade 1 view of the glottic opening was obtained and the trachea was intubated with an 8 mm (internal diameter) polyvinyl chloride ETT. Tracheal intubation was confirmed by utilizing continuous $EtCO_2$ monitoring. The ETT was secured at 22 cm measured at the teeth.

After about 40 minutes of CPR, spontaneous circulation restarted and a portable A-P chest X-ray with the head in a neutral position indicated the ETT tip was at the level of the first rib (Figure 1). This finding, along with a persistent air leak, prompted blind advancement of the ETT to 26 cm at the teeth, but resistance to advancement was noted. A subsequent chest computed tomography (CT) with the head in a neutral position revealed the ETT remained inappropriately positioned with the tip measured 8.2 cm above the carina (Figure 2A). Concurrently, a sagittal CT view demonstrated significant posterior deviation of the mid and lower trachea. This deviation was determined to be the most likely cause of the difficulty encountered in advancing the ETT. No masses or lesions contributing to the acute tracheal angulation could be identified. Comparing CT imaging from 2 months prior, the trachea was of normal caliber and ordinarily aligned with the vertebral column (Figure 2B).

With the patient in Fowler position with the head midline, a flexible fiber-optic bronchoscopy was performed. Acute, almost 90-degree tracheal angulation was encountered and navigated by retroflexion of the flexible bronchoscope. Once the posterior tracheal wall was encountered, retroflexion was relaxed and the carina was visualized. The bronchoscope tip was placed near the carina, and the ETT was advanced over the fiber-optic bronchoscope to terminate 3 cm above the carina. A subsequent chest X-ray confirmed appropriate ETT position (Figure 3).

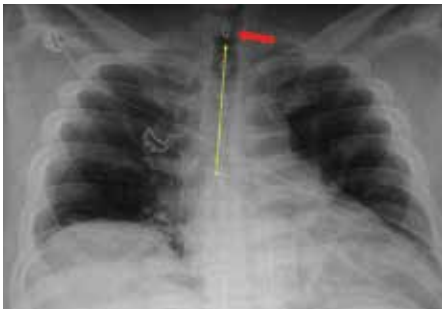

FIGURE 1. Portable anterior-posterior chest X-ray after intubation demonstrating endotracheal tube termination at the level of the first rib. Yellow double-headed arrow indicates distance from the patient end of the endotracheal tube to the carina. Red arrow indicates patient end of the endotracheal tube in the upper part of the trachea.

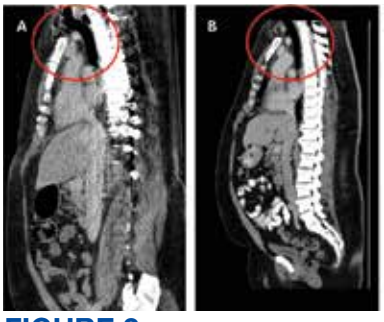

FIGURE 2. A, sagittal computed tomography following intubation with significant posterior deviation of the mid to lower trachea. B, Comparison computed tomography from 2 months prior demonstrating normal tracheal alignment without anterior-posterior deviation.

FIGURE 3. Chest X-ray following endotracheal tube termination advancement over fiber-optic bronchoscope confirming appropriate endotracheal tube termination 3 cm above the carina. Yellow arrow indicates distance from the patient end of the endotracheal tube to the carina. Red arrow indicates the patient end of the endotracheal tube appropriately positioned above the carina.

DISCUSSION

Tracheal deviation in the A-P dimension resulting in difficult tracheal intubation has rarely been reported. Previous reports have described anatomical lesions contributing to similar tracheal deviation, such as retrotracheal thyroid tissue, pronounced cervical lordosis, and severe kyphoscoliosis with destructive cervical fusion.[5-8] In a study of the anatomical correlation of double lumen tube placement while using positron emission tomography CT, Cameron et al evaluated the size and angulation of the glottis and proximal trachea using calibrated CT measurements and an online digital protractor and note nearly perfect alignment of the pharynx and glottis.[9] However, the trachea turned posteriorly relative to the glottis, resulting in an overall posterior angle of the proximal trachea compared to the glottis of 30.4 to 50.1 degrees, with no sex differences. The need to maneuver similar proximal tracheal angulation during endotracheal intubation has been reported as a cause of difficult intubation.[10]

In this case, the posterior angulation was not encountered in the proximal trachea but rather in the more distal trachea. The extreme A-P tracheal deviation was not associated with any identifiable masses or lesions. A CT performed 2 months prior demonstrated normal tracheal anatomy, and there was no interval history of neck trauma or tracheal obstruction suggestive of a likely cause for this deviation. This change in the patient's tracheal anatomy was only discovered after CPR had been performed and as part of the workup for cardiac arrest. Iatrogenic injuries are known to occur during CPR. Common CPR-related airway injuries include tracheal mucosal injury from traumatic intubation and bony injuries to the chest wall from compressions.[11] Laryngeal cartilage damage from intubation may also occur, but tracheal displacement following CPR has not been previously reported.[11]

This case of tracheal deviation is unlikely to be related to patient positioning, as the A-P deviation persisted in 3 separate head and neck alignments. First, during indirect laryngoscopy, performed in a standard sniffing position. Second, during the CT, performed in the supine position, with no head support. The acute A-P deviation seen in Figure 2 was clearly noted in this position. Lastly, flexible fiber-optic bronchoscopy was performed in a semiupright position with the head supported on a pillow. A-P deviation was encountered and navigated in this position during flexible fiber-optic guided ETT repositioning.

Using magnetic resonance imaging, alterations in the alignment of pharyngeal and tracheal axes have been described with changes in neck positioning; however, tracheal deviation has not been described with changes in head and neck alignment.[12] Although the clinical presentation in this case was consistent with prior reports, we were unable to identify any previously reported anatomic cause for the tracheal deviation.[5,6,8] Initial glottic visualization with a video laryngoscope was unremarkable, but

resistance to sufficient ETT advancement past the vocal cords and a persistent air leak due to cuff herniation through the glottic opening was noticeable. The ETT was maneuvered to an appropriate position in the trachea using a flexible fiber-optic bronchoscope. The acute angulation of the trachea that was appreciated on bronchoscopy did not result in kinking of the ETT both initially and after in-situ thermosoftening of the polyvinyl chloride tube.[13] Previously reported instances of A-P tracheal deviation have outlined the necessity of using alternative techniques to establish a patent airway, including the use of a laryngeal mask airway and a cuffless ETT with saline-soaked gauze packing.[5,8] In 1 reported case, awake fiber-optic intubation was performed when difficult tracheal intubation was anticipated due to known A-P tracheal deviation.[6]

Failure of ETT advancement can be due to obstruction from the arytenoids and at the level of the vocal cords.[14] When the ETT has been visualized to have traversed the vocal cords, tracheal A-P deviation should be considered as a cause of difficult ETT advancement. If an adequate endotracheal airway cannot be established, prompt consideration should be given to placement of a supraglottic airway. Early fiber-optic bronchoscopy should be used to establish the diagnosis and assist with proper ETT positioning.

CONCLUSIONS

This case illustrates the rare occurrence of A-P tracheal deviation leading to difficult intubation during CPR. The findings underscore the importance of considering A-P deviation as a potential cause of airway complications in emergency settings, especially in patients with previously normal tracheal anatomy. The successful use of flexible fiber-optic bronchoscopy in this case provides a valuable technique for addressing acute tracheal angulation. This report contributes to the limited literature on A-P tracheal deviation and serves as a reminder for clinicians to maintain a high index of suspicion for unusual airway challenges during critical interventions.

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Disclaimer

The opinions expressed herein are those of the authors and do not necessarily reflect those of *Federal Practitioner,* Frontline Medical Communications Inc., the US Government, or any of its agencies.

Ethics and consent

This manuscript adheres to CARE guidelines. A waiver of patient consent was obtained from the Human Research Protection Program at the Veterans Affairs Puget Sound Health Care System. No potentially identifying information was included in the manuscript.

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