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Use of point-of-care ultrasound to assess esophageal insufflation during bag mask ventilation: A case report

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ABSTRACT

Bag-valve-mask ventilation is a basic airway management technique often used in patients with acute respiratory failure. Although highly effective in providing oxygenation and ventilation, this technique has been associated with gastric regurgitation and tracheal aspiration. In this case, the esophagus was visualized with bedside ultrasonography during bag-mask ventilation of an unresponsive and critically ill patient. Images were obtained both with and without cricoid pressure. Additionally, images were obtained during ultrasound-guided probe pressure on the lateral neck. Esophageal insufflation was identified consistently during bag mask ventilation. Cricoid pressure did not prevent esophageal insufflation. Ultrasound-guided probe pressure attenuated esophageal insufflation. This case depicts a unique instance of using a novel method to assess breath delivery during bag mask ventilation of a critically ill patient.

1. Introduction

Point-of-care ultrasound (POCUS) has been increasingly utilized in various fields of medicine and has been shown to have reliable diagnostic power for both cardiac assessment and gastrointestinal interrogation [1,2]. More recently, attention has been drawn to the use of ultrasound in airway assessment and management. For example, Kei et al. utilized POCUS to visualize the passage of carbonated beverages in the esophagus of healthy volunteers both during and without cricoid pressure, showing that cricoid pressure did not prevent passage of liquid [3]. Additionally, Bouvet et al. demonstrated that POCUS can identify air in the stomach during facemask ventilation of anesthetized patients in an operating room [4]. Due to the safety, reliability, and ease of use of POCUS, its uses continue to expand.

Bag mask ventilation is a common initial ventilation technique in acutely unresponsive patients, but can inadvertently propel air into the esophagus and stomach, causing gastric insufflation, regurgitation, and aspiration of gastric contents. A retrospective review of patients suffering from in-hospital cardiac arrest in the United Kingdom showed that regurgitation was much more likely to occur when advanced airway management was preceded by bag-mask ventilation, as opposed to when a laryngeal mask airway (LMA) was placed immediately (incidence of regurgitation 12.4% vs. 3.5%, respectively, $p < 0.05$) [5]. Similarly, a recent multicenter randomized controlled trial in France and Belgium, though inconclusive for primary endpoints such as neurologic outcome and survival, demonstrated that bag mask ventilation as an initial airway management technique was associated with a significantly higher incidence of regurgitation when compared to endotracheal intubation alone (15.2% vs 7.7%, respectively) [6].

There is currently a paucity of literature describing the use of ultrasound to evaluate bag mask ventilation or pulmonary aspiration. This case describes the use of ultrasound to assess esophageal insufflation during bag mask ventilation of an acutely unresponsive patient. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

2. Case description

A 60-year-old female with a history of coronary artery disease and hypothyroidism developed acute loss of consciousness and respiratory arrest on postoperative day 3 after coronary-artery bypass surgery. Vital signs were significant for hypoxia (oxygen saturation 80%), bradycardia

Abbreviations: POCUS, Point of care ultrasound.

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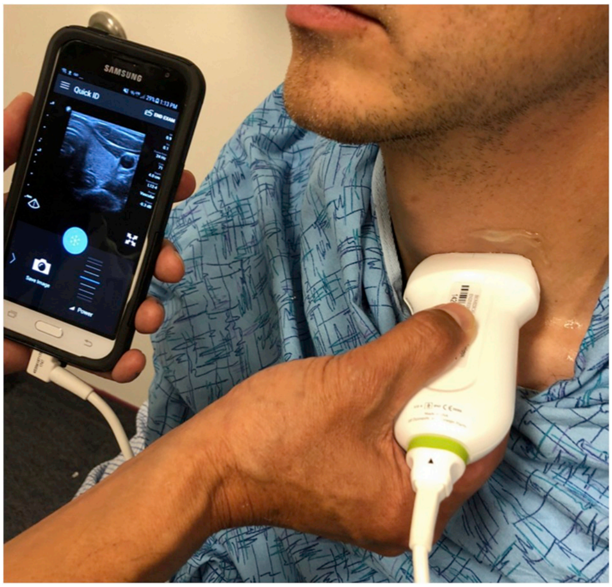

Fig. 1. Placement of a Philips L12-4 vascular probe on the lateral neck allows for visualization of the esophagus.

(heart rate 46 bpm), and hypotension (mean arterial pressure 15 mmHg as transduced by a right radial arterial line). As first responders, two respiratory therapists (RTs) initiated two-handed bag-mask ventilation, with one respiratory therapist providing chin lift and mask seal, and the other squeezing the bag to provide breaths. A femoral pulse was palpated, therefore compressions were not initiated.

An ultrasound-certified physician arrived at the bedside. A pocket-sized ultrasound device (Lumify, Philips Healthcare) with an L12-4 vascular probe was placed in the anterior triangle of the left lateral neck. Using the probe position shown in Fig. 1, the esophagus was identified. During bag-mask ventilation, an air signal was visualized in the esophagus with each bag-delivered breath (Fig. 2A). The air signal disappeared between breaths (Fig. 2B). Next, cricoid pressure was applied by a third party as bag mask ventilation continued. During cricoid pressure, the air signal in the esophagus became attenuated, but not eliminated (Fig. 2C). Subsequently, cricoid pressure was released, and ultrasound-guided esophageal pressure was applied to the lateral neck by the ultrasound user with the ultrasound probe itself. This maneuver virtually eliminated esophageal air (Fig. 2D). Notably, the carotid artery was visualized and did not compress during the application of ultrasound probe pressure on the lateral neck.

The patient was subsequently intubated. Regurgitation of gastric contents did not visibly occur. Passage of an endotracheal tube into the tracheal lumen was visualized with ultrasound. Appropriate placement was confirmed with chest auscultation, end-tidal carbon dioxide monitoring, and chest radiography.

3. Discussion

Patients receiving bag mask ventilation are known to have an increased risk of gastric regurgitation, presumably due to gastric insufflation. This is the rationale for the use of a rapid sequence induction and intubation (which classically avoids bag mask ventilation entirely) for patients thought to be at high risk of pulmonary aspiration [7]. The risk of overly large bag mask breaths leading to gastric insufflation is likely particularly elevated for high acuity situations due to stress response of a rescuer, *even* when the rescuer is trained in emergency airway management [8].

In this case, bag mask ventilation was seen to result in esophageal insufflation, confirming this known side effect of bag mask ventilation (Fig. 2A). What is most interesting is that bedside ultrasonography allowed for visualization of this phenomenon in real time. This prompted rescuers to alter their airway management to minimize gastric insufflation. The technique utilized for this case (seen in Fig. 1) is easily replicable and the esophagus is easily identified. However, further studies must be performed in order to fully evaluate the possibility of large scale applicability of this technique.

Interestingly, in this case, esophageal compression and cricoid pressure both resulted in attenuation of air entry into the esophagus (Fig. 2C and D). Classically, cricoid pressure has been used to prevent gastric regurgitation in unresponsive patients with an unsecured airway, yet in recent years the benefit of cricoid pressure has been called into question [9–13]. In 2017, Kei et al. showed that cricoid pressure could not prevent liquid from entering the esophagus [3]. In addition to having questionable efficacy, cricoid pressure is also associated with certain negative outcomes, such as cricoid cartilage fracture [11], airway obstruction [12], or an impaired laryngeal view during intubation [13]. Due to various controversies, the American Heart Association guidelines for adult advanced cardiovascular life support now discourage the routine use of cricoid pressure in cardiac arrest [14]. These drawbacks are not known to be associated with direct ultrasound-guided esophageal pressure.

4. Conclusion

Point-of-care ultrasound (POCUS) can be used to visualize esophageal insufflation during bag mask ventilation. Ultrasound-guided probe pressure and cricoid pressure both attenuate air entry into the esophagus during bag mask ventilation.

Financial disclosures

Paola L. Baskin: This author has no competing interests or financial disclosures.

Bruce J. Kimura: This author has no competing interests or financial disclosures.

Declarations of interest

None.

Contributions

Paola Lopomo Baskin: This author compiled patient data and wrote the manuscript.

Bruce J. Kimura: This author acquired the ultrasound images and edited the manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rmcr.2019.100928.

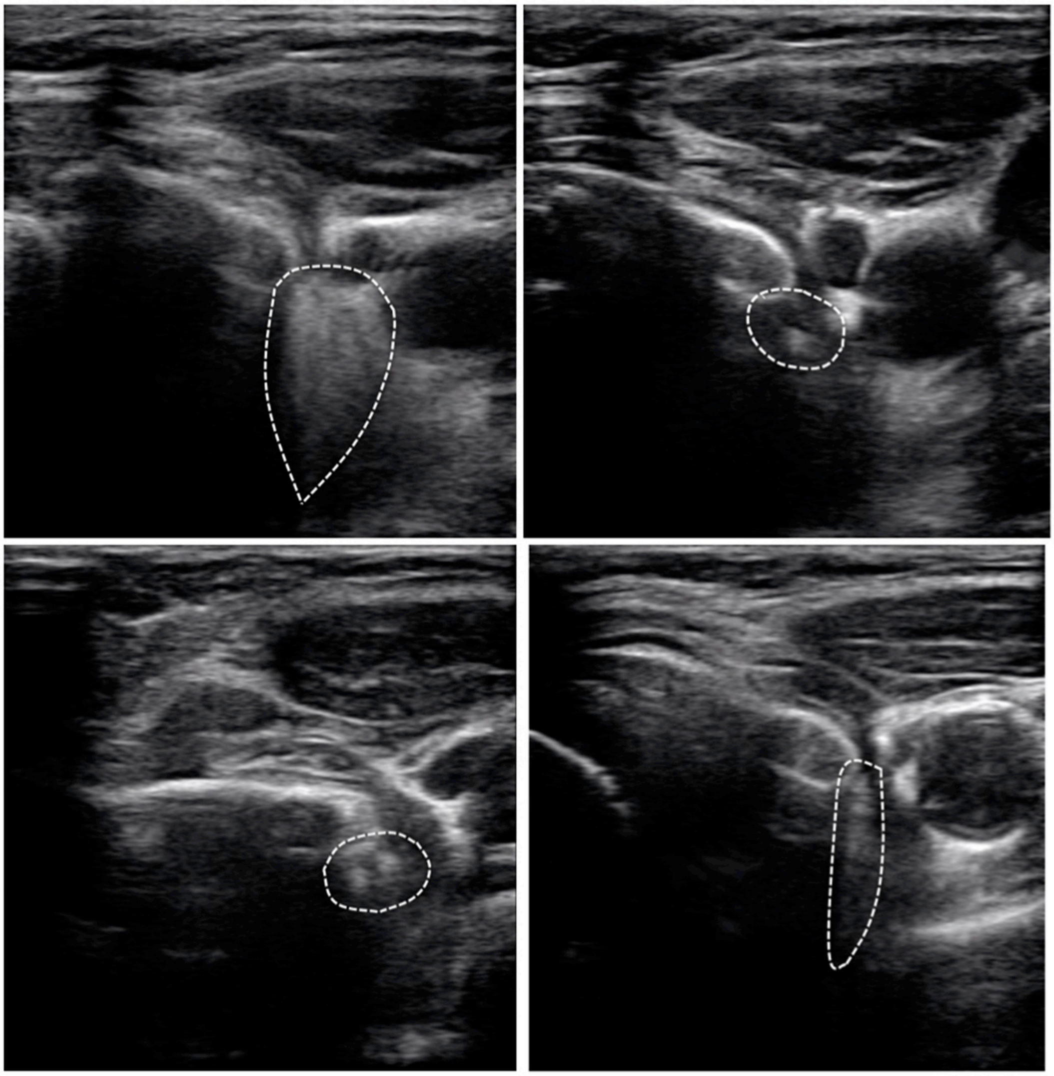

Fig. 2. Images obtained during bag mask ventilation. (A) The dotted line outlines the air signal seen in the esophagus during a bag-delivered breath. (B) The dotted line outlines the esophagus between breaths. There is no air signal. (C) The dotted line outlines the esophagus with a small air signal during cricoid pressure. (D) The dotted line outlines the narrow air signal seen in the esophagus during ultrasound probe pressure.

References

[1] B.J. Kimura, G.W. Gilcrease 3rd, B.K. Showalter, et al., Diagnostic performance of a pocket-sized ultrasound device for quick-look cardiac imaging, AJEM (Am. J. Emerg. Med.) 30 (1) (2012) 32–36.
[2] P. Van de Putte, A. Perlas, Ultrasound assessment of gastric content and volume, Br. J. Anaesth. 113 (1) (2014) 12–33.
[3] J. Kei, E.E. Utschig, R.J. van Tonder, Using ultrasonography to assess the effectiveness of cricoid pressure on esophageal compression, J. Emerg. Med. 53 (2) (2017) 236–240.
[4] L. Bouvet, M.L. Albert, C. Augris, et al., Real-time detection of gastric insufflation related to facemask pressure-controlled ventilation using ultrasonography of the antrum and epigastric auscultation in nonparalyzed patients: a prospective, randomized, double-blind study, Anesthesiology 120 (2) (2014) 326–334.
[5] B. Stone, P. Chantler, P. Baskett, The incidence of regurgitation during cardiopulmonary resuscitation: a comparison between the bag valve mask and laryngeal mask airway, Resuscitation 38 (1) (1998) 3–6.
[6] P. Jabre, A. Penaloza, D. Pinero, et al., Effect of bag valve mask ventilation versus endotracheal intubation during cardiopulmonary resuscitation on neurological outcome after out-of-hospital cardiac arrest: a randomized control trial, J. Am. Med. Assoc. 319 (8) (2018) 779–787.
[7] Rhona CF. Sinclair, Mark C. Luxton, Rapid sequence induction, Cont. Educ. Anaesth. Crit. Care Pain 5 (Issue 2) (April 2005) 45–48. https://doi.org/10.1093/bjaceaccp/mki016.
[8] A. Khoury, S. Hugonnot, J. Cossus, et al., From mouth-to-mouth to bag-valve-mask ventilation: evolution and characteristics of actual devices - a review of the literature, BioMed Res. Int. 2014 (2014) 6, article ID 762053.
[9] N. Bhatia, H. Bhagat, I. Sen, Cricoid pressure: where do we stand? J. Anesthesiol. Clin. Pharmacol. 30 (2014) 3–6.
[10] C.M. Algie, R.K. Mahar, H.B. Tan, et al., Effectiveness and risks of cricoid pressure during rapid sequence induction for endotracheal intubation, Cochrane Database Syst. Rev. 18 (11) (2015) CD011656.
[11] K.J. Heath, M. Palmer, S.J. Fletcher, Fracture of the cricoid cartilage after Sellick's manouvre, Br. J. Anaesth. 76 (6) (1996) 877–878.
[12] G.D. Shorten, P.H. Alfille, R.E. Gliklich, Airway obstruction following application of cricoid pressure, J. Clin. Anesthesiol. 3 (5) (1991) 403–405.
[13] T. Harris, D.Y. Ellis, L. Foster, D. Lockey, Cricoid pressure and laryngeal manipulation in 402 pre-hospital emergency anaesthetics: essential safety measure or a hindrance to rapid safe intubation? Resuscitation 81 (7) (2010) 810–816.
[14] M.S. Link, L.C. Berkow, P.J. Kudenchuk, H.R. Halperin, E.P. Hess, V.K. Moitra, R. W. Neumar, B.J. O'Neil, J.H. Paxton, S.M. Silvers, R.D. White, D. Yannopoulos, M. W. Donnino, Part 7: adult advanced cardiovascular life support: 2015 American heart association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care, Circulation 132 (suppl 2) (2015) S444–S464.