This case report describes a posterior tracheal tear in a healthy 8-year-old girl. The child sustained the injury while riding her scooter, when the handlebars of the scooter dislodged after running into the curb, causing the shaft to strike her in the manubrium of the sternum. The child presented with subcutaneous emphysema of the neck and the supraclavicular region bilaterally. Before the patient's arrival, the surgical and anesthesia team had extensive discussion regarding the child's perioperative management, which included the need to maintain spontaneous ventilation to avoid opening the tracheal tear and producing a further increase in the size of the pneumomediastinum. The anesthesia machine was prepared for a general anesthetic along with a wide array of appropriately sized endotracheal tubes. In addition to appropriately sized laryngoscope blades, a fiberoptic scope and video laryngoscope were immediately available. Spontaneous respirations were maintained throughout the procedure, and the case proceeded uneventfully. This case represents the need for proper preparation and communication between providers to manage all possible scenarios of a traumatic tracheal tear.

Keywords: Spontaneous ventilation, subcutaneous emphysema, tracheal tear.
pared with appropriate instruments in the event that a cricothyrotomy should be required.

The anesthesia team discussed the surgical plan with the otolaryngology team before the child’s arrival, which included a diagnostic bronchoscopy and esophagoscopy. During this discussion the team members agreed that spontaneous ventilation should be maintained to avoid increasing the suspected tracheal tear with positive pressure ventilation. The team members agreed that if endotracheal intubation were required, the tube would need to be passed beyond the yet-to-be-identified tracheal tear. If the tear were too close to the carina, the developing preoperative plan included the placement of a double-lumen endotracheal tube or the placement of 2 smaller-diameter endotracheal tubes, 1 in each bronchus, and ventilation maintained with jet ventilation.

An immediate assessment before arrival in the operating room showed substantial subcutaneous emphysema to the face, anterior part of the neck, and supraclavicular region bilaterally. Chest auscultation, particularly in the apices, was hampered because of the subcutaneous emphysema, and the patient reported tenderness on palpation in the upper sternal area. The previously mentioned rounded linear red mark from the handlebar shaft to the manubrium of the sternum was apparent on chest examination as well as a small abrasion to her left knee. The child had been without food or drink for the past 7 hours.

The parents accompanied the child to the operating room, and the pediatric anesthesia team explained what would take place and the possibility that the child would require postoperative ventilation and intensive care management. The team also explained to the child in an age-appropriate manner what would take place. Informed consent for the anesthesia care was obtained, and 2 mg of midazolam was carefully titrated intravenously (IV). It was the decision of the anesthesia team to administer the IV midazolam and to invite the mother into the operating room for the induction of anesthesia to assure the child and minimize her anxiety, which could cause the tear to worsen. The girl’s initial vital signs in the operating room were temperature, 36.7°C; pulse rate, 95/min; respiration rate, 18/min; BP, 104/65 mm Hg; and SpO₂, 100% on room air.

In the operating room all standard monitors were placed, and the patient was given 100% oxygen by mask with no positive pressure applied. A continuous infusion of propofol was initiated at 250 μg/kg/min, and a bolus of 40 mg was given to induce anesthesia. The mother was escorted from the operating room after the child appeared to be asleep. The propofol infusion was then increased to 300 μg/kg/min, with an additional bolus of 40 mg.

The operating room table was then turned 90° to the ENT surgeon. The patient was positioned for direct laryngoscopy, bronchoscopy, and esophagoscopy. The surgeon visualized the vocal cords using a Miller No. 2 blade and applied a total of 1 mL of 4% lidocaine. Using a suspension laryngoscope, the surgeon obtained an excellent view of the glottic opening. This stimulation required an additional 40-mg bolus of propofol, followed immediately by another 20-mg bolus, and the continuous infusion was increased to 350 μg/kg/min while maintaining spontaneous ventilation.

The surgeon passed the rigid laryngoscope through the vocal cords into the trachea and provided supplemental oxygen via a side port in the rigid laryngoscope throughout the case. The child was given 8 mg of dexamethasone for the management of postoperative edema and 20 mg of lidocaine IV to minimize intraoperative coughing. Once the rigid laryngoscope was passed through the vocal cords, the child’s heart rate decreased from the upper 80s to the low 70s per minute. She was given 0.4 mg of glycopyrrolate IV, and the heart rate returned to the upper 80s per minute and held constant for the remainder of the procedure. The glycopyrrolate was also given to decrease the amount of secretions and improve visualization for the surgical team.

The patient’s airway was suctioned, and the rigid bronchoscope was passed to the carina for visual examination. A mucosal tear was evident to the right side of the posterior membranous trachea. The tear to the posterior trachea was located 3.5 cm above the carina and was 2.5 cm in length. The tear did not show any gapping or circumferential injury. Vital signs continued to remain stable, and her SpO₂ remained at 100% throughout the diagnostic examination. An esophagoscopy was performed, which did not reveal any blood or injuries to the esophagus.

Following a thorough anatomical assessment of the airway, the surgical team decided that the tracheal tear would heal spontaneously and that a definitive surgical intervention was not indicated. At this time it appeared that her subcutaneous emphysema had begun to resolve, and the edges of the tear were well approximated and not gapping. The bronchoscope was removed, and the propofol infusion was discontinued. Spontaneous respirations were maintained throughout the procedure, and the oxygen saturation remained 100% throughout the airway examination. Hemodynamics remained within 20% of baseline throughout the case. The patient was transferred to the pediatric intensive care unit in stable condition. She was discharged home the following day.

Discussion

Although this case proceeded uneventfully, it is important to be prepared for every possible scenario that could take place and to keep the patient breathing spontaneously throughout the procedure. Anesthesia providers should also become intimately familiar with emergency airway management algorithms. The American Society of Anesthesiologists’ (ASA) modified trauma algorithm that pertains to airway disruptions is an excellent source
A. Maintain spontaneous ventilation, even with modified rapid-sequence intubation techniques.
B. Place endotracheal tube below level of tear.
C. Do not pressurize above level of tear.
D. Do not use transtracheal jet ventilation or a laryngeal mask airway with positive pressure.
E. Consider use of a double-lumen tube, 2 small-diameter tubes, or a single-lumen tube with bronchial blocker.
F. Consider cardiopulmonary bypass via femoral route for major tears.
G. Do an awake fiber optic intubation for all major tears.
H. If above interventions are not adequate or are not working, go directly to surgical airway maintenance.

Table. Algorithm of Key Management Points of Airway Disruption

- to follow for tracheal tears (Table). The algorithm emphasizes some key management points that need to be followed, such as maintaining spontaneous respirations, which is especially important until the level of the tear has been determined by direct laryngoscopy and bronchoscopy. Once the level has been determined, the algorithm recommends placing the endotracheal tube below the tear to avoid increasing the pneumomediastinum and subcutaneous emphysema with positive pressure ventilation. If the tear is too low, close to the carina, or involves 1 bronchus, a double-lumen tube may be used. Alternatively, 2 endotracheal tubes can be inserted, 1 in each bronchus, and high-frequency positive pressure ventilation or high-frequency jet ventilation may be used. If the tear involves a complete dissection of the trachea or requires a complicated surgical repair, cardiopulmonary bypass may be needed. Fortunately for this patient, her tracheal tear did not need surgical intervention.

It is also important to document the injury very clearly and to take still pictures of the site for inclusion in the patient’s chart. This will aid future airway management for these patients, as these injuries often result in scarring that may impede smooth passage of an endotracheal tube in the future. Tracheal tears, as well as all severe airway damage, eventually lead to stenosis, stricture, and scarring, so documentation may prevent further damage and allow the next anesthesia team to take a different approach to intubation, such an awake fiberoptic intubation after viewing the airway and assessing for any obstructions.

As mentioned earlier, tracheal tears can be life-threatening, and patients often die before reaching definitive care. The use of removable stents to manage large acute tracheal tears is a new approach being used by some providers. These stents have often been used in tracheoesophageal fistulas, but until the case report by Creagh-Brown et al. their use in acute tracheal tears was not documented. The authors used a removable stent to manage an acute large tracheal tear and found that it resulted in rapid closure of the tear and healing. Nonremovable stents cause problems such as overgrowth of granulation tissue, which may require repeated surgical procedures to maintain the airway. Removable stents, although not well documented for this scenario, remain a viable option for treatment in outlying facilities that may not be able to manage a large tear surgically or one that may also require cardiopulmonary bypass.

Conclusion
This case report emphasizes the need to maintain spontaneous respirations throughout direct laryngoscopy, bronchoscopy, and esophagoscopy to prevent increasing the subcutaneous emphysema and pneumomediastinum by avoiding positive pressure ventilation. It also details the importance of being prepared in the operating room for any situation that may arise involving the airway once the level of disruption has been established. Proper preparation has always been a hallmark of anesthesia, and familiarity with airway algorithms improves the anesthesia provider’s ability to manage tracheal tears and provide a safe anesthetic for the patient.

REFERENCES

AUTHOR
Eric Barrett, CRNA, MSN, is a staff nurse anesthetist at Metro Anesthesia and Pain Management, West Des Moines, Iowa. At the time this article was written, he was a student at the University of Iowa, College of Nursing, Anesthesia Nursing Program, Iowa City, Iowa. Email: ericbarrett.crna@gmail.com.

ACKNOWLEDGMENTS
The author wishes to thank Martin Mueller, MD, and Cormac O’Sullivan, CRNA, PhD, for their encouragement and guidance, and John Aker, CRNA, DNAP, MS, for reviewing the manuscript.