

Endotracheal stent placement for pediatric blunt traumatic tracheal perforation



Michael J. Stack, MD,^a David M. Shore, MD,^b Anthony Y. Tsai, MD,^c Michael F. Reed, MD,^d Jennifer W. Toth, MD,^b and Afif N. Kulaylat, MD, MSc,^c Hershey, Pa

From the ^aDepartment of Surgery, ^bDivision of Pulmonary, Allergy, and Critical Care Medicine, Department of Medicine, and ^dDivision of Thoracic Surgery, Department of Surgery, Penn State Health Milton S. Hershey Medical Center, Hershey, Pa; and ^cDivision of Pediatric Surgery, Penn State Children's Hospital, Hershey, Pa. IRB: This study did not require Institutional Review Board approval as single-patient case report based on retrospective medical record reviews are exempt at the Pennsylvania State University.

Received for publication Sept 30, 2024; revisions received Nov 25, 2024; accepted for publication Nov 29, 2024; available ahead of print Dec 26, 2024.

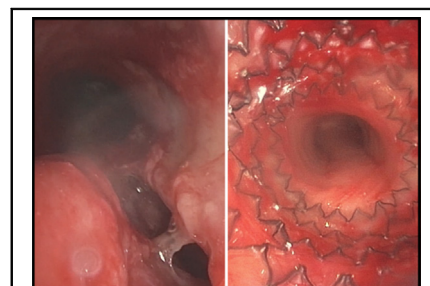
Address for reprints: Afif N. Kulaylat, MD, MSc, Division of Pediatric Surgery, Penn State Children's Hospital, 500 University Dr, Hershey, PA 17033 (E-mail: akulaylat@pennstatehealth.psu.edu).

JTCVS Techniques 2025;30:132-6

2666-2507

Copyright © 2024 The Author(s). Published by Elsevier Inc. on behalf of The American Association for Thoracic Surgery. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

<https://doi.org/10.1016/j.jtc.2024.12.007>



Bronchoscopy showing tracheal perforation and deployed stent in a pediatric patient.

CENTRAL MESSAGE

Endotracheal stent placement can offer a safe and effective alternative to prolonged intubation or surgery for blunt traumatic tracheal injuries in appropriately selected pediatric patients.

▶ Video clip is available online.

Traumatic tracheobronchial injuries are rare and potentially life-threatening.¹ Although traditional management involves neck exploration with or without partial sternotomy, or right thoracotomy, endoscopic therapies have expanded the interventions available.^{2,3} We present a case of pediatric traumatic tracheal perforation successfully managed with endotracheal stent placement that avoided prolonged intubation or open surgical repair.

CASE REPORT

A 12-year-old boy with no significant medical history was transferred as a level-1 trauma patient after a bicycle accident with a handlebar injury to the neck. Physical examination revealed a circular abrasion to the anterior neck, subcutaneous emphysema, and no respiratory distress. Computed tomography scanning of the neck and chest demonstrated a posterior tracheal perforation, pneumomediastinum, and cervical emphysema without vascular injury (Figure 1, A and B). The computed tomography scan was shared before transfer, enabling a multidisciplinary team, including pediatric surgery, adult thoracic surgery, and interventional pulmonology to prepare for the patient's arrival. Despite worsening subcutaneous emphysema, the patient remained hemodynamically stable and breathing spontaneously, so intubation was deferred for expedited transfer and to avoid further injury to the airway. Due to

the injury location and the patient's stable condition, endotracheal stent placement was chosen to minimize the morbidity associated with open surgical repair in a pediatric patient. The absence of severe respiratory distress further supported the decision to pursue endoscopic management. In the event of stent failure, we planned to perform primary repair via a transcervical approach using a low cervical collar incision with midline extension and manubrial spreading if additional exposure became necessary.

The patient was taken to the operating room for emergency treatment, where an adult diagnostic bronchoscope (Olympus BF-H190) was introduced through a laryngeal mask airway (Video 1) revealing a 3.0-cm longitudinal full-thickness, level 3A membranous wall tear on the right side of the trachea, at the junction of membranous wall and cartilaginous ring, with direct visualization into the mediastinum during respiration (Figure 1, C). The defect ends were 2.5 cm distal to the cricoid and 5.5 cm proximal to the carina. A Pulmonary Jagwire (Boston Scientific) was placed down the right main bronchus, and an AERO 16 × 40 mm self-expanding fully covered nitinol tracheobronchial stent (Merit Endotek) was deployed over the

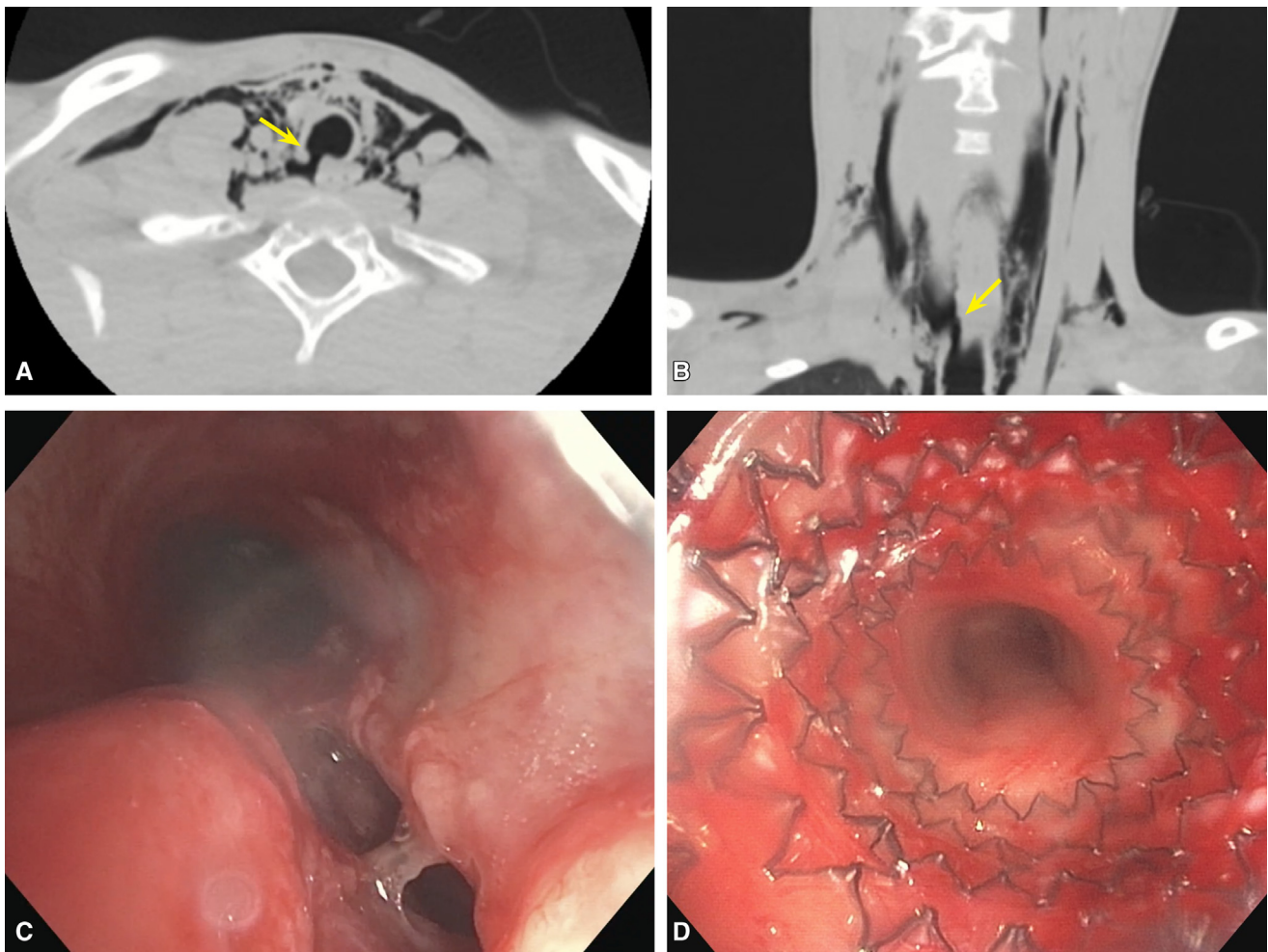
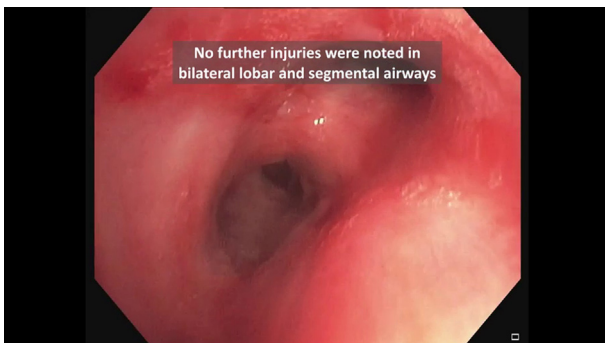


FIGURE 1. A and B, Computed chest tomography demonstrates right posterior membranous tracheal perforation with pneumomediastinum (yellow arrows). C, Right posterior tracheal laceration with visualization into the mediastinum with respirations. D, Fully covered nitinol tracheobronchial stent positioned with appropriate coverage of tracheal defect.

wire under fluoroscopy, covering approximately 1 cm proximal and distal to the injury (Video 1 and Figure 1, D). Esophagoscopy before stent placement revealed no associated esophageal injury.



VIDEO 1. Bronchoscopic examination of injury and endotracheal stent placement. Video available at: [https://www.jtcvs.org/article/S2666-2507\(24\)00516-9/fulltext](https://www.jtcvs.org/article/S2666-2507(24)00516-9/fulltext).

The patient was monitored in the pediatric intensive care unit for 48 hours postoperatively for potential stent migration. Chest radiography on postoperative days 1 and 2 confirmed appropriate stent position. Pulmonary hygiene, including scheduled nebulized 3% saline and albuterol, was administered to promote mucous clearance, whereas antimicrobial therapy was administered for mediastinal prophylaxis until stent removal. Bronchoscopic examination on postinjury day 8 revealed a moderate accumulation of secretions within the stent, necessitating more frequent surveillance to prevent stent occlusion and airway compromise (Figure 2, A). After stent removal, the laceration was healing with granulation tissue, but a residual defect persisted that required stent replacement. The patient was then discharged with follow-up (Figure 2, B and C). By day 18 postinjury, bronchoscopy revealed robust granulation tissue covering the defect, and due to adequate healing by secondary intention, the stent was not replaced. Surveillance bronchoscopy, 2 months postinjury, revealed a

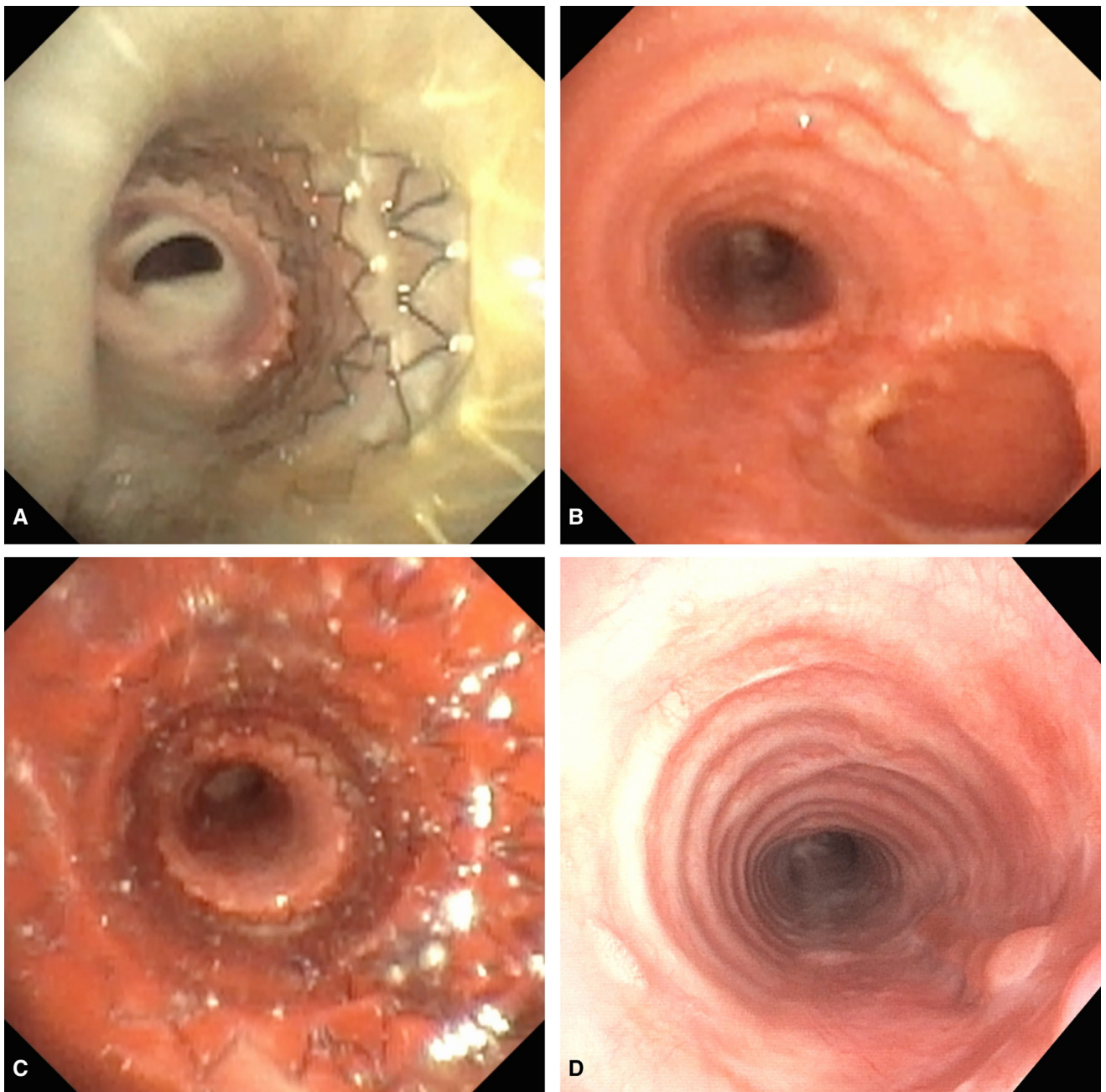


FIGURE 2. A, Bronchoscopic examination postinjury day 8, accumulation of secretions within stent lumen. B, Tracheal defect still present, laceration healing with surrounding granulation tissue. C, replacement of tracheal stent. D, Bronchoscopic surveillance 2 months postinjury demonstrates a well-healed tracheal wall without evidence of tracheal stenosis or malacia.

well-healed tracheal wall without stenosis or malacia (Figure 2, D).

This single-patient case report was exempt from Pennsylvania State University Institutional Review Board review. The patient's legal guardian provided informed written consent for publication of the study data.

DISCUSSION

This report highlights a pediatric trauma involving blunt tracheal perforation managed with a tracheal stent to avoid intubation or open surgical repair. Early diagnosis and management of tracheobronchial injuries is critical. Cardillo and colleagues⁴ proposed a classification for postintubation

tracheobronchial lacerations to guide treatment strategies, but no consensus guidelines exist for traumatic injuries. Nonoperative strategies and endoscopic stenting are increasingly utilized based on clinical condition and extent of airway injury.²

Tracheal stent placement for injury management is mostly reported in adults with iatrogenic postintubation injuries.^{5,E1,E2} Serio and colleagues³ first described pediatric cases treated with temporary stents, but these involved patients who required endotracheal intubation or tracheostomy before endoscopic evaluation and stent placement due to respiratory failure. To our knowledge, no pediatric cases of blunt traumatic tracheal injury have successfully utilized endotracheal stenting without prior intubation or tracheostomy. In this case, securing the airway in the trauma bay was deferred to avoid worsening the tracheal injury, proceeding directly to definitive endoscopic management.

Conservative management may include observation, tracheostomy, and endotracheal intubation distal to the injury for clinically stable patients with spontaneous breathing, minimal ventilatory requirements, level-1 or -2 injuries, and defects <2 cm, with stable subcutaneous emphysema or pneumomediastinum.^{2,E3-E5} Despite the patient's clinical stability, the defect exceeded 2 cm and was accompanied by worsening subcutaneous emphysema, precluding conservative management as a viable treatment strategy.

Surgical repair is generally indicated for lacerations >4 cm, a depth of laceration corresponding to 3A or 3B disruption, or in patients who are clinically deteriorating.^{2,E6-E9} The application of adult bronchoscopic techniques to pediatric diseases has led to the use of tracheal stents to manage injuries that historically required surgery.^{5,E10,E11} This patient's full-thickness, level 3A injury and worsening subcutaneous emphysema met traditional criteria for open surgical repair, yet a multidisciplinary approach allowed for a less-invasive intervention.

Temporary tracheal stents are effective by spanning the entire defect, inducing an inflammatory response, and

promoting tissue granulation, which leads to defect closure.² However, potential risks include airway obstruction from mucus accumulation or stent migration, and the need for frequent bronchoscopy. In the acute setting, signs of stent failure include stent migration, respiratory distress, and inadequate granulation and defect closure. Successful treatment is indicated by appropriate position on chest radiography and appropriate healing on bronchoscopic examination.

Early multidisciplinary coordination enabled a tailored treatment plan leading to an excellent outcome. This approach may not be feasible at centers with limited experience in advanced bronchoscopic techniques. Multidisciplinary evaluation and appropriate patient selection are essential to identify patients that will benefit from endotracheal stent placement.

Conflict of Interest Statement

The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

References

1. Schneider T, Volz K, Dienemann H, Hoffmann H. Incidence and treatment modalities of tracheobronchial injuries in Germany. *Interact Cardiovasc Thorac Surg*. 2009;8(5):571-576. <https://doi.org/10.1510/icvts.2008.196790>
2. Grewal HS, Dangayach NS, Ahmad U, Ghosh S, Gildea T, Mehta AC. Treatment of tracheobronchial injuries: a contemporary review. *Chest*. 2019;155(3):595-604. <https://doi.org/10.1016/j.chest.2018.07.018>
3. Serio P, Fainardi V, Coletta R, et al. Conservative management of posterior tracheal wall injury by endoscopic stent placement in children: preliminary data of three cases. *Int J Pediatr Otorhinolaryngol*. 2022;159. <https://doi.org/10.1016/j.ijporl.2022.111214>
4. Cardillo G, Carbone L, Carleo F, et al. Tracheal lacerations after endotracheal intubation: a proposed morphological classification to guide non-surgical treatment. *Eur J Cardio Thorac Surg*. 2010;37(3):581-587. <https://doi.org/10.1016/j.ejcts.2009.07.034>
5. Tazi-Mezalek R, Musani AI, Laroumagne S, et al. Airway stenting in the management of iatrogenic tracheal injuries: 10-Year experience. *Respirology*. 2016;21(8):1452-1458. <https://doi.org/10.1111/resp.12853>

E-References

- E1. Geltner C, Likar R, Hausegger K, Rauter M. Management of postintubational tracheal injury by endoscopic stent placement: case report and review of the literature. *Thorac Cardiovasc Surg Rep*. 2016;05(01):8-12. <https://doi.org/10.1055/s-0035-1570376>
- E2. Han C, Kim SH, Park SJ, Kim GH. Successful management of blunt tracheal injury by endotracheal-stent placement. *Asian J Surg*. 2023;46(3):1341-1342. <https://doi.org/10.1016/j.asjsur.2022.08.104>
- E3. Dominguez E, De La Torre C, Sánchez AV, et al. Severe tracheobronchial injuries: our experience. *Eur J Pediatr Surg*. 2015;25(1):71-76. <https://doi.org/10.1055/s-0034-1386642>
- E4. Wood JW, Thornton B, Brown CS, McLevy JD, Thompson JW. Traumatic tracheal injury in children: a case series supporting conservative management. *Int J Pediatr Otorhinolaryngol*. 2015;79(5):716-720. <https://doi.org/10.1016/j.ijporl.2015.02.025>
- E5. Markus-Rodden MM, Bojko T, Hauck LC. Traumatic tracheal laceration in a pediatric patient medically managed with high-frequency oscillatory ventilation. *Pediatr Emerg Care*. 2008;24(4):236-237. <https://doi.org/10.1097/PEC.0b013e31816b7b70>
- E6. Passera E, Orlandi R, Calderoni M, et al. Post-intubation iatrogenic tracheobronchial injuries: the state of art. *Front Surg*. 2023;10:1125997. <https://doi.org/10.3389/fsurg.2023.1125997>
- E7. Miñambres E, Burón J, Ballesteros MA, Llorca J, Muñoz P, González-Castro A. Tracheal rupture after endotracheal intubation: a literature systematic review. *Eur J Cardio Thorac Surg*. 2009;35(6):1056-1062. <https://doi.org/10.1016/j.ejcts.2009.01.053>
- E8. Gabor S, Renner H, Pinter H, et al. Indications for surgery in tracheobronchial ruptures. *Eur J Cardio Thorac Surg*. 2001;20(2):399-404. [https://doi.org/10.1016/s1010-7940\(01\)00798-9](https://doi.org/10.1016/s1010-7940(01)00798-9)
- E9. Koletsis E, Prokakis C, Baltayiannis N, Apostolakis E, Chatzimichalis A, Dougenis D. Surgical decision making in tracheobronchial injuries on the basis of clinical evidences and the injury's anatomical setting: a retrospective analysis. *Injury*. 2012;43(9):1437-1441. <https://doi.org/10.1016/j.injury.2010.08.038>
- E10. Yamamoto S, Endo S, Endo T, Mitsuda S. Successful silicon stent for life-threatening tracheal wall laceration. *Ann Thorac Cardiovasc Surg*. 2013;19(1):49-51. <https://doi.org/10.5761/atcs.cr.11.01768>
- E11. Lee BE, Korst RJ. Successful treatment of an iatrogenic tracheal laceration with a temporary polyurethane-coated nitinol stent. *Ann Thorac Surg*. 2016;102(1):e11-e12. <https://doi.org/10.1016/j.athoracsur.2015.12.030>