Trauma Case Reports 42 (2022) 100711

Contents lists available at ScienceDirect

Trauma Case Reports

journal homepage: www.elsevier.com/locate/tcr

Robotic repair of traumatic bronchial disruption: A minimally invasive and multi-disciplinary approach to a complex constellation of injuries

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ARTICLE INFO

Keywords:
Bronchial injury
Robotic thoracoscopy
Liver laceration
Innominate artery pseudoaneurysm

ABSTRACT

Bronchial disruption is a catastrophic consequence of blunt thoracic trauma with high pre-hospital lethality. This injury is classically managed through a large thoracotomy incision to facilitate adequate exposure for open repair. Here, we describe a case of complete bronchus intermedius disruption following a motor vehicle accident that was repaired via robotic thoracoscopy. The patient sustained multi-system trauma, including a grade III liver laceration, an innominate artery pseudoaneurysm, and femoral condyle fracture, all of which required systematic intervention and multi-disciplinary coordination to best facilitate this patient's care. This patient recovered well from his multiple injuries and was discharged after an uneventful post-operative course.

Introduction

Bronchial disruption is a life-threatening complication of blunt thoracic trauma. Bronchial disruptions are associated with concomitant injuries to the cervical and thoracic regions, and there is little available data to guide treatment due to their high pre-hospital lethality [1]. Bronchial injuries are classically repaired through large posterolateral thoracotomy incisions, though theoretically, with the advancement of robotic thoracoscopic techniques, robotic bronchial repair is feasible [2,3]. Here, we describe a case of traumatic airway disruption following motor vehicle accident in a patient without classical presenting symptoms and with potentially lethal concomitant injuries. This constellation of injuries required a meticulous, multidisciplinary care plan that culminated in robotic bronchus repair.

Case summary

The patient is a 23-year-old male involved in a motor vehicle accident. He was combative with hemodynamic instability upon

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https://doi.org/10.1016/j.tcr.2022.100711
Accepted 2 October 2022
Available online 4 October 2022

arrival to an outlying facility, prompting intubation to secure his airway and to facilitate further workup. The patient was transferred to our level I trauma center with multiple injuries, including facial fractures, open right femoral condyle fracture, right sided rib fractures, small right pneumothorax with pigtail thoracostomy in place, grade III liver laceration without hemoperitoneum, pneumomediastinum, and questionable pseudoaneurysm of the innominate artery (see Figs. 1, 2, and 3). He was hemodynamically stable with a heart rate of 104, blood pressure of 143/78, and 100 % oxygen saturation on 40 % fraction of inspired oxygen. Radial pulses were intact bilaterally, and no subcutaneous emphysema or chest tube air leak was present. No further pertinent findings were discovered on primary or secondary survey.

A chest radiograph was obtained to confirm endotracheal tube and chest tube positioning, which demonstrated irregular aneurysmal dilation of the right bronchus intermedius (see Fig. 4). Cross-sectional imaging from the outside hospital was reviewed, demonstrating pneumomediastinum near the associated irregularity on his admission radiograph (see Fig. 2). Given these findings, we performed bronchoscopy to assess for bronchial disruption. There were bloody secretions within the proximal airway, and just distal to the origin of the right upper lobe bronchus, the bronchus intermedius was completely transected with associated mediastinal hematoma (see Fig. 4). We obtained cardiothoracic surgery consultation, and after a multidisciplinary discussion between trauma surgery, cardiothoracic surgery, and vascular surgery regarding sequential management of the patient's injuries and operating room capabilities, the patient was transferred to our associated elective surgery facility for cardiothoracic-specific anesthesia and hybrid endovascular suite access.

Following transfer, the patient underwent aortic arch arteriography to characterize his innominate artery pseudoaneurysm, which was small with an adynamic dissection flap without signs of impending rupture (see Fig. 3). This lesion did not require intervention. The patient's hemoglobin declined on serial hemograms following admission; though there was no hepatic extravasation or hemoperitoneum on his pre-hospital imaging, mesenteric angiography was performed, which demonstrated a focal irregularity in Couinaud segment 7 that was prophylactically embolized (see Fig. 1).

Next, the patient's airway disruption was addressed. Given the patient's clinical stability, the anatomic location of injury, and the surgeon's experience in robotic mediastinal dissection, the patient was a candidate for a robotic thoracoscopic approach. His airway was exchanged for a double-lumen endotracheal tube, and pre-operative bronchoscopy confirmed the site of the injury in the proximal right bronchus intermedius. The patient was placed in the left lateral decubitus position, and the robot was docked with two 8 mm ports and a 12 mm port. The inferior pulmonary ligament was divided up to the inferior pulmonary vein to facilitate anteromedial retraction. The mediastinal structures, including the azygous vein and esophagus, were identified and dissected superiorly until the phlegmon was visible. This phlegmon was opened, and while the distal bronchial stump was mobile, the proximal stump was stationary. The upper and lower stumps were reapproximated using running polydioxanone suture in a tension-free manner. A leak test was performed and was negative. The trocar sites were closed, and a 24 French channel drain was left in the right hemithorax. The patient tolerated single lung ventilation throughout the operation. A post-surgical chest radiograph confirmed lung re-expansion.

The patient was successfully extubated on post-operative day 1, and his chest tube was discontinued two days later. The patient was then transferred back to our level I trauma center for management of his femoral condyle fracture. Following this, his activity restrictions were liberalized, and he was ultimately discharged from our facility on hospital day twelve with ongoing physical therapy and rehabilitation.

Discussion

Bronchial disruption is a rare but lethal phenomenon that should remain high on the differential in the injured patient with chest

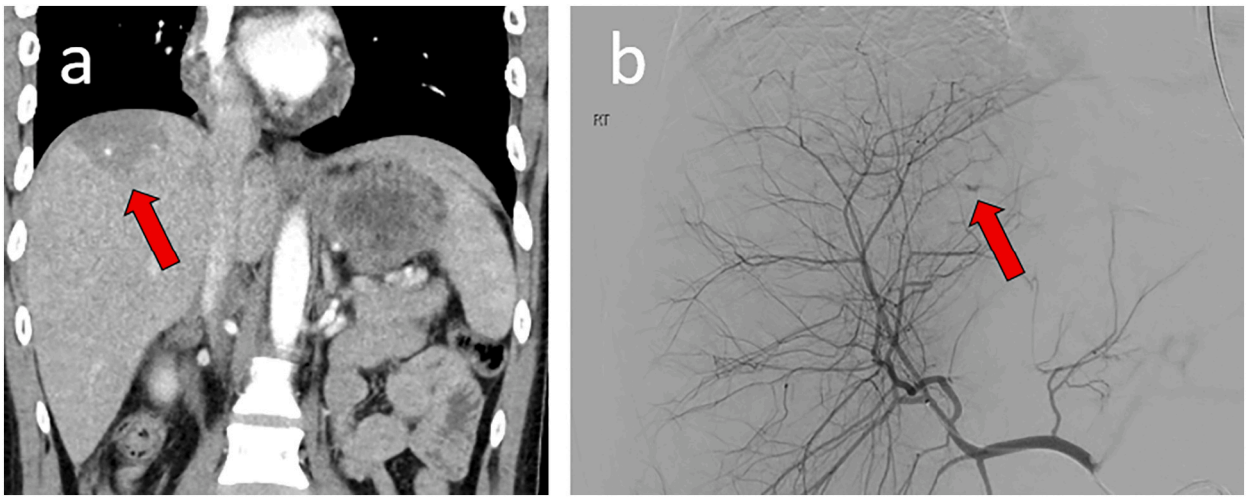

Fig. 1. AAST grade III liver laceration (a) in segment 7 with possible extravasation. Hepatic angiogram demonstrated focal irregularities without extravasation (b). Prophylactic gel-foam embolization performed.

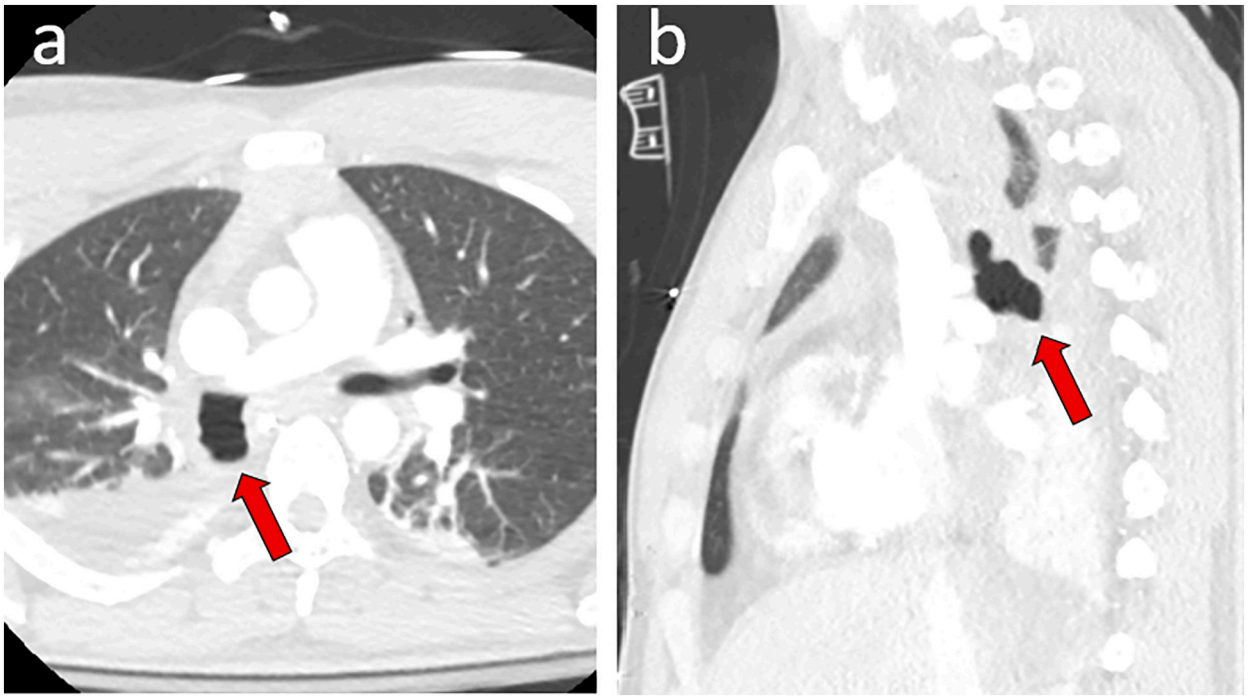

Fig. 2. Axial (a) and sagittal (b) views of suspected right bronchus intermedius disruption on admission CT chest. Consolidation and non-aeration of right lower lobe secondary to bloody secretions within airway. Note the absence of classical sequelae, such as subcutaneous emphysema and large-volume pneumothorax.

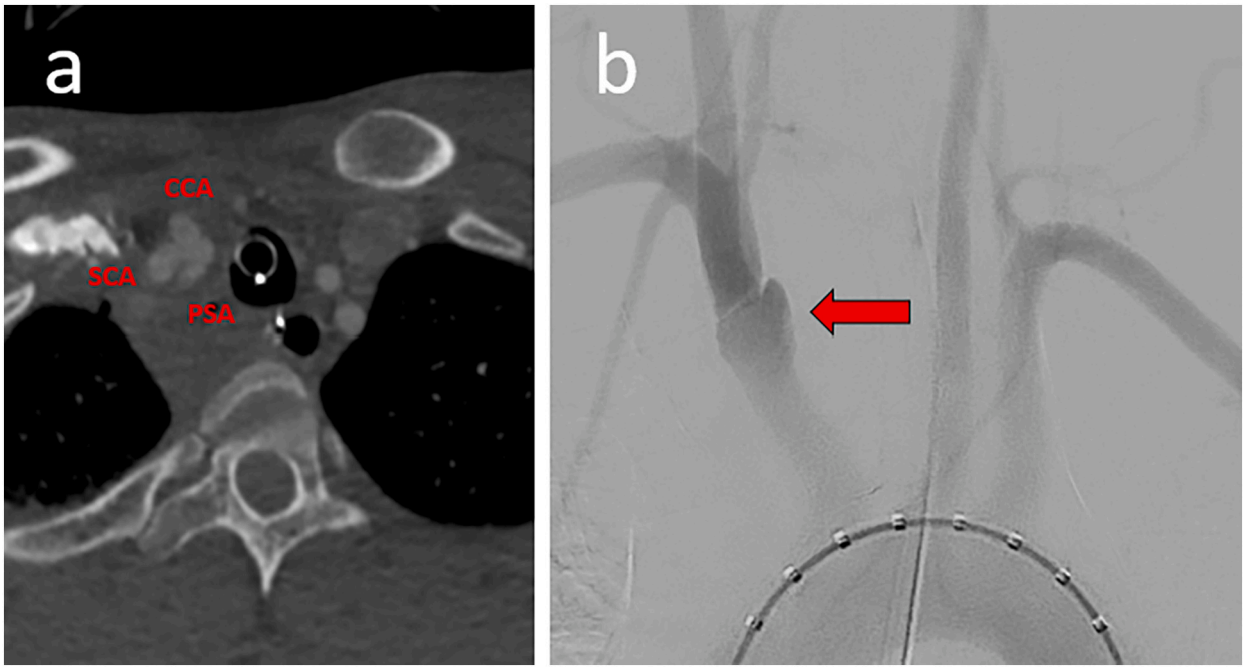

Fig. 3. Pre-hospital CTA chest (a) demonstrating innominate artery pseudoaneurysm (PSA) with posterior hematoma in relation to origins of common carotid (CCA) and subclavian (SCA) arteries. Aortogram (b) re-demonstrating innominate artery pseudoaneurysm without extravasation.

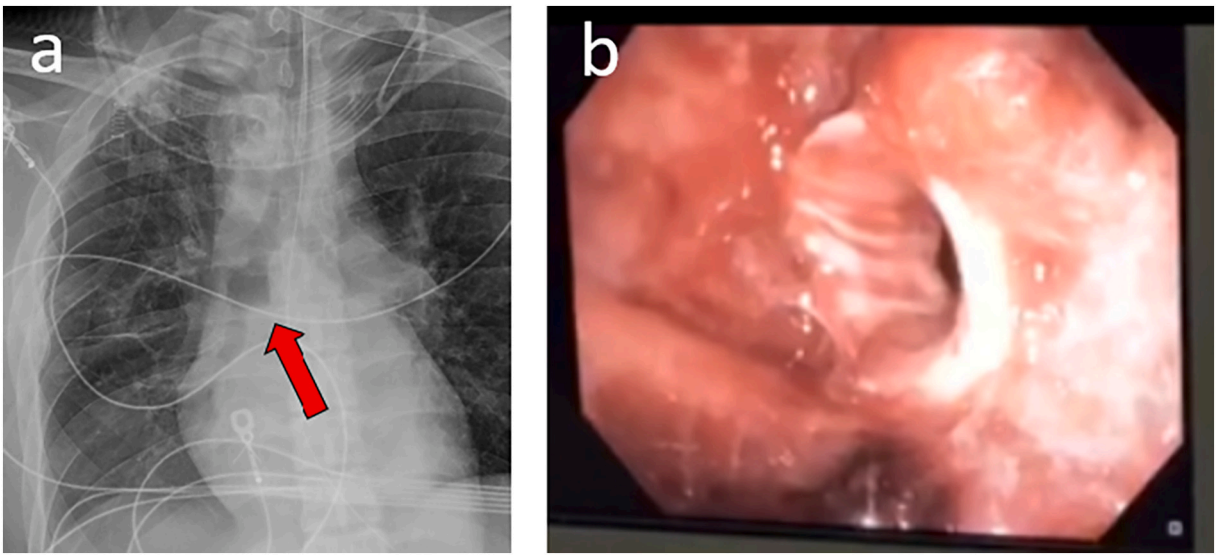

Fig. 4. (a) Aneurysmal dilation of the right bronchus intermedius concerning for airway disruption, which was confirmed by bedside flexible bronchoscopy (b). Note the mediastinal hematoma and circumferential disruption of the proximal bronchus intermedius.

wall trauma. Several symptoms are classically present, including respiratory distress, hemoptysis, subcutaneous emphysema, pneumothorax, and pneumomediastinum [4]. Though several hallmark symptoms were present on arrival, the airway injury was rather insidious, as the patient was on minimal ventilatory support with a trace right pneumothorax without persistent air leakage from his chest tube. Without high-quality cross-sectional imaging, we would have certainly under-appreciated the severity of airway injury in this patient. Furthermore, while the patient had severe multi-system trauma with associated hepatic, vascular, and orthopedic injuries, we were fortunate that management of these injuries was concise and straightforward, allowing all providers to focus on the patient's bronchial transection within 24 h post-hospitalization.

Initial management of tracheobronchial injuries should adhere to Advanced Trauma Life Support (ATLS) protocols and algorithms. If tracheobronchial injury is suspected, flexible bronchoscopy should be performed, which remains the gold standard for diagnosis of these injuries [5]. If proximal airway trauma is suspected, such as in the setting of a tracheal injury, utilization of simple rapid sequence intubation will likely prove futile and fatal, given the unrecognized distortion at the level of the injury. Endobronchial fiberoptic intubation over a flexible bronchoscope is widely accepted as the preferred method of airway establishment in these critically ill patients. Furthermore, in patients with bronchial injury presenting with hypoxemia, shunting, or hemoptysis, once an airway has been established, clinicians may have to perform intentional single lung ventilation until the injury can be surgically addressed. Given the complexities of airway management in these patients, the American Society of Anesthesiologists has developed a comprehensive algorithm for airway management in patients suspected to have tracheobronchial injuries [6].

Complete bronchial disruption is a diagnosis that almost universally requires surgical intervention, though there is little data comparing various surgical techniques or timing [3]. Mainstem disruption is classically exposed through right or left posterolateral thoracotomy, depending on the laterality of injury. As robotic thoracoscopy becomes widely accepted, robotic bronchial injury repair should be considered in the appropriate clinical setting, such as in a stable patient at a high-volume thoracic surgery center. Given the pre-hospital lethality of airway disruption, it is likely impossible to obtain prospective data comparing the outcomes amongst open and minimally invasive techniques, though robotic thoracoscopy compares very favorably to traditional thoracoscopy and thoracotomy for non-trauma-related operations [7,8]. While we do not have long-term follow-up with this patient, the surgical team was satisfied that they had achieved a durable robotic repair, and we expect excellent long-term results for this patient.

Statement of informed consent

No patient identifiers were used in this report.

Funding

Funds were neither received nor expected in support of this manuscript.

Declaration of competing interest

The authors declare no competing interests.

Acknowledgements

We would like to acknowledge Ann Gaffney, M.D., and Patricia Thistlewaite, M.D., Ph.D., for their technical contributions in the management of this patient.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tcr.2022.100711.

References

[1] D.C. Cassada, M.P. Munyikwa, M.P. Moniz, R.A. Dieter, G.F. Schuchmann, B.L. Enderson, Acute injuries of the trachea and major bronchi: importance of early diagnosis, Ann. Thorac. Surg. 69 (5) (2000) 1563–1567, https://doi.org/10.1016/s0003-4975(00)01077-8.
[2] H.L.C. Wang, C.H. How, H.F. Lin, J.M. Lee, Traumatic left main bronchial rupture: delayed but successful outcome of robotic-assisted reconstruction, Respirol. Case Rep. 6 (1) (2018), e00278, https://doi.org/10.1002/rcr2.278.
[3] A.E. Balci, N. Eren, S. Eren, R. Ulkü, Surgical treatment of post-traumatic tracheobronchial injuries: 14-year experience, Eur. J. Cardio-Thorac. Surg. Off. J. Eur. Assoc. Cardio-Thorac. Surg. 22 (6) (2002) 984–989, https://doi.org/10.1016/s1010-7940(02)00591-2.
[4] R. Karmy-Jones, D.E. Wood, Traumatic injury to the trachea and bronchus, Thorac. Surg. Clin. 17 (1) (2007) 35–46, https://doi.org/10.1016/j.thorsurg.2007.03.005.
[5] C.P.W. Chu, P.P. Chen, Tracheobronchial injury secondary to blunt chest trauma: diagnosis and management, Anaesth. Intensive Care 30 (2) (2002) 145–152, https://doi.org/10.1177/0310057X0203000204.
[6] C.A. Hagberg, O. Kaslow, Difficult airway management algorithm in trauma updated by COTEP, ASA Newsl. 78 (9) (2014) 56–60.
[7] A. Emmert, C. Straube, J. Buentzel, C. Roever, Robotic versus thoracoscopic lung resection: a systematic review and meta-analysis, Medicine (Baltimore) 96 (35) (2017), e7633, https://doi.org/10.1097/MD.0000000000007633.
[8] R.M. Reddy, M.L. Gorrepati, D.S. Oh, S. Mehendale, M.F. Reed, Robotic-assisted versus thoracoscopic lobectomy outcomes from high-volume thoracic surgeons, Ann. Thorac. Surg. 106 (3) (2018) 902–908, https://doi.org/10.1016/j.athoracsur.2018.03.048.