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CASE REPORT

Reconstruction of complete tracheal transection with cardiopulmonary bypass support following bull horn injury in neck during coronavirus disease 19 pandemic lockdown

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Abstract

A 22-year-old male had complete tracheal transection 2.5 cm above the carina with distal end retracted into the mediastinum. This was accidental bullhorn injury to the trachea in the lower cervical region, which posed arduous challenge of "cannot intubate" situation, necessitating percutaneous femoro-femoral cardiopulmonary bypass for surgical reconstruction, during coronavirus disease 19 (COVID-19) pandemic lockdown.

Keywords Tracheal transection · Bull-horn injury · Cardiopulmonary bypass · COVID-19 pandemic

Introduction

Complete tracheal transection following blunt and penetrating injury of the neck is an exceedingly rare life-threatening injury, which may result in death on the spot due to asphyxia. Few patients who may reach the hospital can survive with timely, skilful management of airways and subsequent prompt surgical repair [1]. We describe here successful management of a case of bullhorn injury to the trachea leading to complete tracheal transection, 2.5 cm above the carina with the distal end retracted into the mediastinum with review of literature.

Case report

A 22-year-old man presented to the emergency department on 25 May 2020 with severe breathing difficulty, following collision with a bull resulting in neck injury from the horn, while on a bicycle. He was conscious, moving all limbs and had a heart rate of 120 beats/min, blood pressure 110/70 mm of Hg, respiratory rate 32/min and oxygen saturation 80% on room air and 94% with oxygen supplementation. There was approximately a 6 cm × 4 cm horizontal lacerated wound in the anterior neck region, 2 cm above the suprasternal notch, without active bleeding. The proximal end of the transected trachea was visualised in the wound, but distal end retracted into the thorax and could not be seen (Fig. 1a,c). The patient was breathing through the wound in the neck and was not able to phonate. Surgical emphysema was present around the neck and chest. Emergency computed tomography (CT) was performed which revealed complete tracheal transection with a defect of 3.9 cm in the cervical and superior mediastinum, 2.5 cm proximal to the carina. There was bilateral pneumothorax and surgical emphysema in the neck and chest wall, without injury of the oesophagus and nearby vessels (Fig. 2a, b). Virtual bronchoscopy confirmed complete tracheal transection, showing distinct proximal and retracted intrathoracic distal tracheal ends (Fig. 2c).

The case was discussed among team of otorhinolaryngologist, anaesthesiologist, pulmonologist and cardiothoracic surgeon. First, immediate priority was to achieve secure airways for ventilation and induction of general anaesthesia for reconstruction of the trachea. Neither tracheostomy nor orotracheal/bronchoscopic-guided intubation seemed safe as

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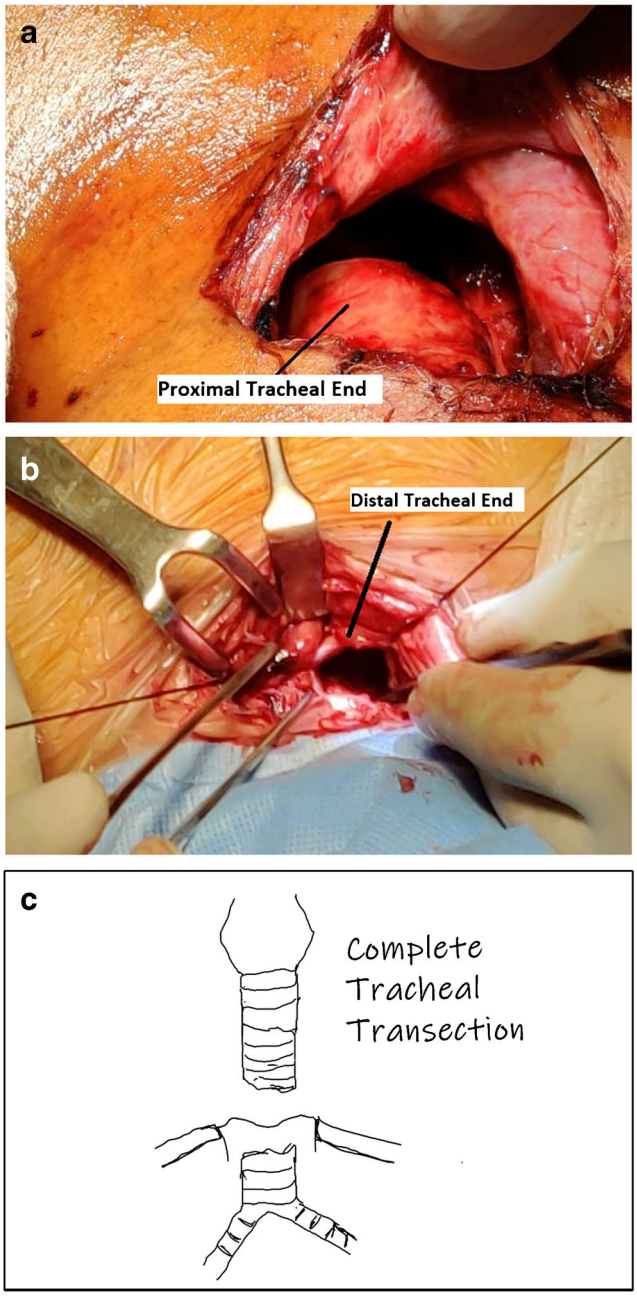

Fig. 1 **a** Photograph showing complete tracheal transection—only the proximal end seen. **b** Intraoperative photograph showing the distal tracheal end after pulling up by silk stay sutures. **c** Sketch diagram showing complete transection of the trachea

the lower tracheal end retracted into the mediastinum and was obscure to inspection or palpation. Hence, the consensus opinion was in favour of emergency tracheal reconstructive surgery under percutaneous femoro-femoral cardiopulmonary bypass (CPB), as the patient was maintaining spontaneous ventilation through the wound. Percutaneous right femoral arterial and venous cannulation was done under local anaesthesia and partial CPB support was achieved, which maintained oxygenation and haemodynamics. Then, the patient

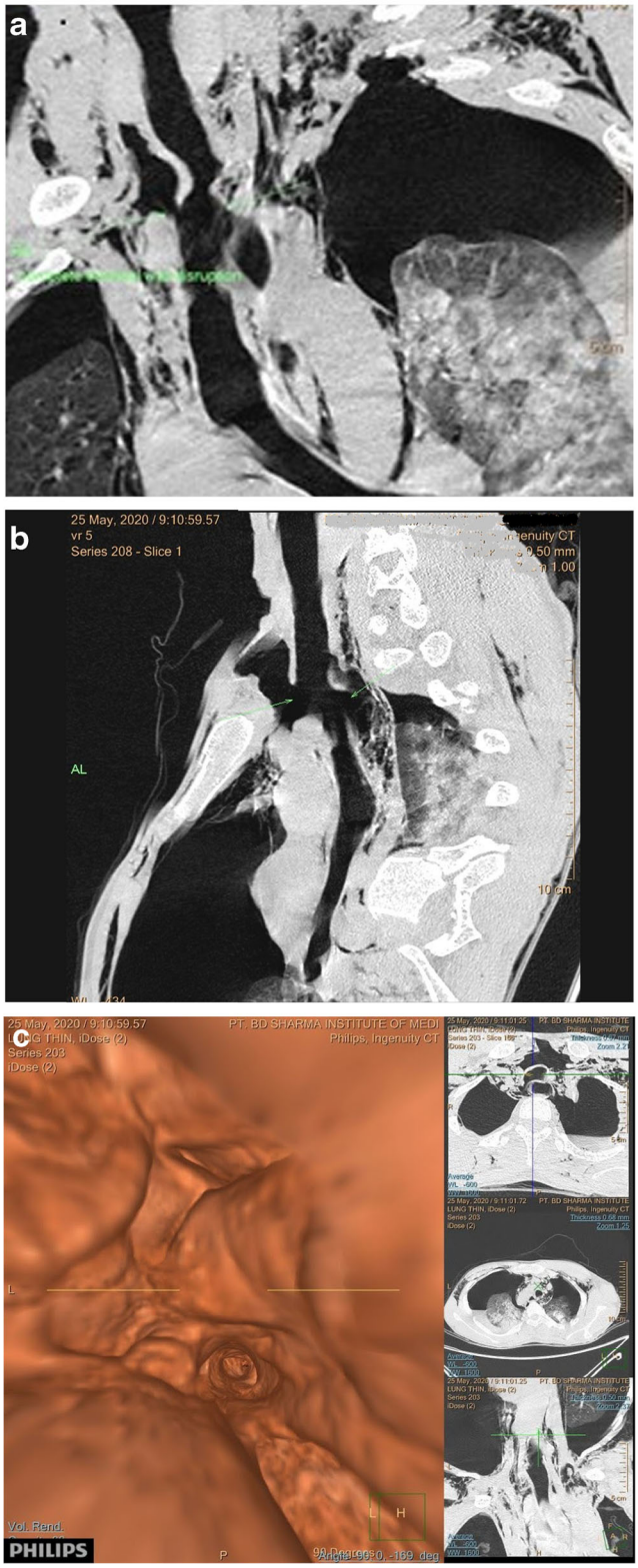

Fig. 2 Preoperative CT: **a** Coronal view—complete tracheal transection with bilateral pneumothorax. **b** Sagittal view—complete transection of the trachea, distal end 2.5 cm from the carina. **c** Virtual bronchoscopy—complete tracheal transection with ragged membranous part continuity with defect of 3.9 cm in the cartilaginous part

was given intravenous fentanyl and midazolam. The neck wound was explored, and the retracted end of the distal trachea was identified deep in the mediastinum. The lower end of the trachea was pulled up by two no. 1 stay silk sutures at the edges (Fig. 1b). Both ends of the trachea were freshened by excluding a small longitudinal tear of the lower end. Interrupted 4–0 Vicryl sutures (Ethicon, Cincinnati, OH) were passed through the proximal and distal ends from the posterior to anterior aspect. To prevent crisscrossing of sutures, small sponges were placed over each suture as an innovative manoeuvre made by a scrub nurse. Before tying the sutures, the endotracheal tube was inserted and positioned just above the site of anastomosis under vision. The interrupted sutures were tied from anterior to posterior after flexing the neck to felicitate approximation of both ends, avoiding tension on sutures. At this juncture, the patient was weaned off from bypass after resuming ventilation through the endotracheal tube. Air leak test was conducted by blowing the lungs, with deflated cuff of the endotracheal tube and closure of the nose and mouth, with water in the surgical field, which showed gross air leak. Anastomosis was examined, but there was no obvious leak. Chest tubes were placed in both pleural spaces as there was bilateral pneumothorax. When air got removed from the pleural spaces, air leak diminished. There was a communication from the neck wound to both pleural spaces, which falsified air leak. The above described procedure was done through the primary neck wound without requiring sternotomy. After wound closure, two no. 5 polyester sutures were applied in the skin between the chin and sternal regions, to keep the neck flexed. The patient was extubated on the table and shifted to intensive care unit with stable haemodynamics. Postoperatively, the patient was haemodynamically stable and maintained oxygen saturation on room air. The patient was able to speak after 3 hours. Postoperatively, serial chest X-ray was done to monitor the resolution of bilateral pneumothorax. The left and right chest tubes were removed on postoperative days 3 and 7 respectively. CT chest and neck with virtual bronchoscopy was done in postoperative period, which showed no discontinuity in the trachea (Fig. 3a, b, c). Polyester chin sutures were removed on the 10th postoperative day. The patient was discharged on postoperative day 13 and he is asymptomatic after 3 months of follow-up.

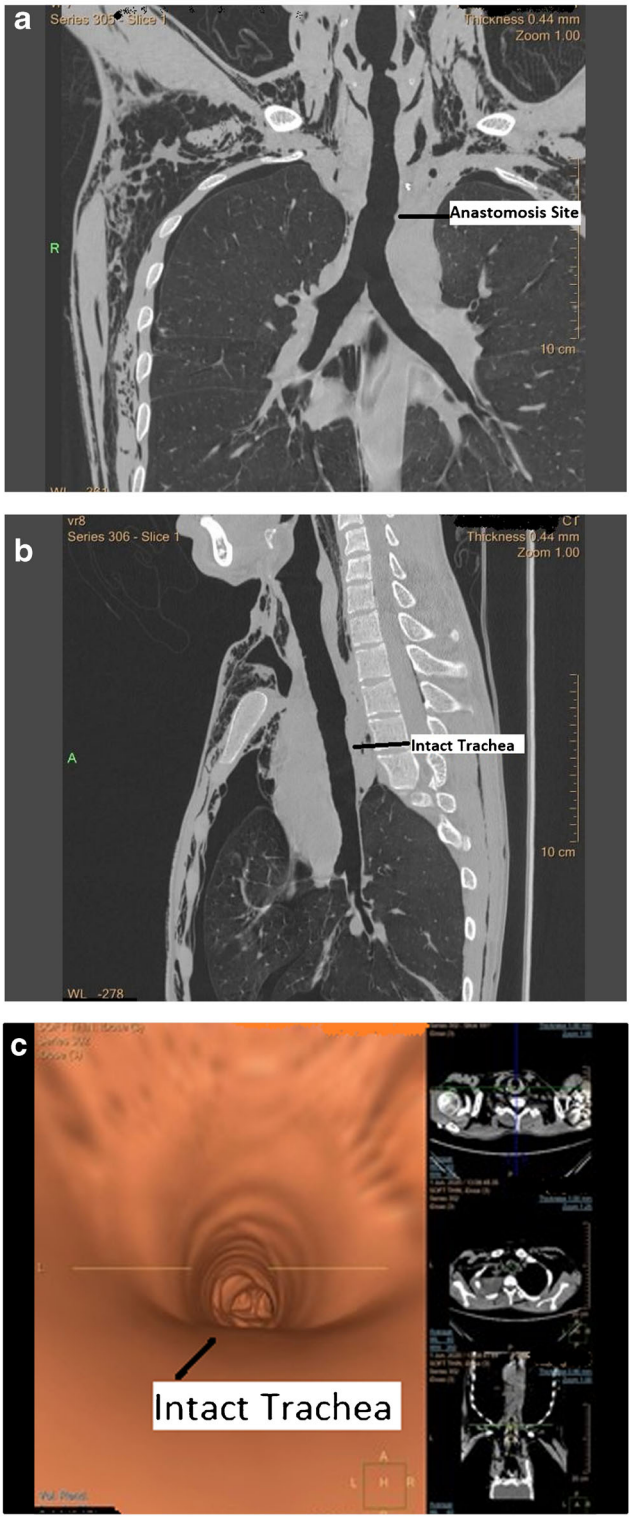

Fig. 3 Postoperative CT: **a** Coronal view and **b** sagittal view—complete trachea without any narrowing. **c** Virtual bronchoscopy showing the intact trachea up to the carina

Discussion

The incidence of tracheobronchial injury with chest and neck trauma is 0.5 to 2%. These injuries are usually associated with injuries of other surrounding structures like the oesophagus, major vessels and spinal cord and result in fatal outcome [1].

Isolated complete tracheal transection is quite rare and has been described as few case reports, or as a part of cumulative description of major airways injury, being only one or two cases [2]. There are several mechanisms involved in traumatic tracheal injuries. The first is the "explosive rupture", where, after the chest is crushed, there is a quick rise of the pressure in

the airway while the glottis is reflexively closed. Once the pressure exceeds the elasticity of the tissues, they explode. The second mechanism involves the development of shearing forces at fixed points of the airway (the cricoid cartilage and carina) due to its movement during sudden deceleration. The third one occurs when the chest is compressed along its anterior-posterior axis. As the lungs remain fixed to the chest wall, because of the negative pressure existing between them and the parietal pleura, and the compression pulls them apart, excessive tensile forces may lacerate the airway at the level of the carina [3].

A majority (75–80%) of complete tracheal transection injuries occur within 2.5 cm from the carina, where the third mechanism, as explained above, plays a major role [1, 3].

Stray cattle, especially bulls and cows, frequently roam on streets and roads in India, who usually hit people by their horn leading to various types of injuries [4]. Bull horn injuries of the trachea are extremely rare and there is only one case report in literature [5]. To the best of our knowledge, in literature, this is the 2nd case of successful management of complete tracheal transection due to bullhorn injury and the first one during the COVID-19 pandemic. Dyspnoea, tachypnoea, respiratory distress, pneumothorax, Hamman's sign and aphonia are typical clinical findings, which are present in a majority of these patients [2, 3]. In the case reported here, the patient had all these typical clinical features. The mechanism of bullhorn tracheal injury involves both blunt (third mechanism as mentioned above) and penetrating elements.

Directly visible tracheal injury and air coming out from wound in neck were diagnostic of complete tracheal disruption injury in this patient. CT is essential to confirm the extent of disrupted trachea and any collateral injury to adjacent structures. Virtual bronchoscopy is a novel technique, which comprises a computer-generated volumetric reconstruction of the tracheobronchial tree based on multiplanar reconstruction (MPR)/three-dimensional (3D) images obtained during multi-slice CT imaging of the airway. The technique simulates the findings at conventional bronchoscopy, and therefore is a valid alternative of bronchoscopy [6]. In our patient, CT images and virtual bronchoscopy defined complete tracheal transection, 2.5 cm above the carina, and guided us in planning the reconstruction of the trachea through an already existing neck wound.

The foremost concern for successful treatment of complete tracheal transection is airway management.

Neither tracheostomy nor orotracheal/bronchoscopy-guided intubation seemed safe in the case under reference, as the lower tracheal end retracted into the mediastinum and was obscure to inspection or palpation. Blind passage of endotracheal/tracheostomy tube may have disintegrated the tracheal laceration and/or created false passage of the tube and may have proved fatal due to asphyxia [7]. Hence, the consensus opinion was in favour of emergency tracheal reconstructive surgery under percutaneous femoro-femoral CPB, as the patient was maintaining spontaneous ventilation through the wound. There also seemed an element of fear psychosis of transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) among the team members, as a reason to avoid bronchoscopic intubation, as reverse transcriptase polymerase chain reaction (RT-PCR) test report was not available in time [8]; however, it turned out negative the next day. Conventional tube thoracostomy for relieving bilateral pneumothorax was also deferred in this patient, before achieving secure physiological ventilation, as he was maintaining spontaneous ventilation through the neck wound. It could have adversely affected the respiratory mechanics, by way of preferential air escape through chest tubes, as the neck wound was communicating with bilateral pleural spaces. This premise was based on hypothetical assumption and needs to be verified by further studies.

In complex situations of "no tube, no ventilation" scenarios, cardiopulmonary bypass/extracorporeal membrane oxygenation (ECMO) has been used to maintain normal physiological ventilation due to non-passage of endotracheal tube during planned tracheal repair for stricture or tumour. However, there are only few reports advocating their use in trauma patients. Potential bleeding complication following heparinisation for CPB has been feared, but it is not a reality as effect of heparin is completely reversed with protamine. Moreover, the presence of endotracheal tube in the surgical field may obstruct conduct of tracheal anastomosis, while its absence during CPB makes it easy, smooth and fast [9]. We encountered no significant bleeding intra-/postoperatively and the surgical procedure was uneventful. We used the standard technique of tracheal anastomosis described by Mathisen [10] with interrupted 4–0 Vicryl (Ethicon, Cincinnati, OH) sutures, by passing the sutures from posterior to anterior and tying in reverse order to prevent entanglement of sutures. He has described fixation of sutures on the drapes to prevent crisscrossing, but we found that with excessive traction, while fixing on drapes, sutures may cut through the tracheal wall, especially from the membranous posterior part. To prevent crisscrossing of anterior with posterior sutures, small sponges were placed over each suture as an innovative manoeuvre made by the scrub nurse.

In tracheal reconstructive surgery for tracheal stenosis, air leak check is recommended on completion of anastomosis by positive pressure ventilation with deflated balloon of endotracheal tube and closure of the nose and mouth [10]. This manoeuvre in instant case demonstrated significant air escape, while on inspection of anastomosis, there was no visible hole around it putting the surgical team in a dilemma of taking addition sutures without visible gaping. However, patience at this stage paved the way ahead, as the suspected air leak was found false, as this air disappeared on relieving pneumothorax by tube thoracostomy. In fact, it was air escaping from

the pleural cavities, communicating with the neck wound, and it was a new learning point in tracheal reconstruction following intrathoracic complete tracheal transection.

On-table extubation is preferred in patients undergoing tracheal reconstructive surgery [10]. However, delayed extubation in case of tracheal reconstruction under CPB has been a preferred approach [9]. But in this case, there was shorter CPB time of 30 min; hence, the patient was extubated on table and there was no adverse post-operative respiratory event.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval Not applicable.

Informed consent Informed consent was obtained from the patient for publishing this case report.

Research involving human and animal rights This article does not contain any studies with animals performed by any of the authors. The study has been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

References

1. Johnson SB. Tracheobronchial injury. Semin Thorac Cardiovasc Surg. 2008;20:52–7.
2. Prokakis C, Koletsis EN, Dedeilias P, Fligou F, Filos K, Dougenis D. Airway trauma: a review on epidemiology, mechanisms of injury, diagnosis and treatment. J Cardiothorac Surg. 2014;9:117.
3. Kiser AC, O'Brien SM, Detterbeck FC. Blunt tracheobronchial injuries: treatment and outcomes. Ann Thorac Surg. 2001;71:2059–65.
4. Maheshwari A, Raikwar RS, Dubey S. Bull horn injuries-rural problem in urban India. Sch J App Med Sci. 2015;3:3043–7.
5. Khan MM, Ahmed SM, Shakeel M, Hasan A, Singh SP, Siddiqi MM. Complication following primary repair of a penetrating bull horn injury to the trachea. J Emerg Trauma Shock. 2008;1:123–5.
6. Horton KM, Horton MR, Fishman EK. Advanced visualization of airways with 64-MDCT: 3D mapping and virtual bronchoscopy. AJR Am J Roentgenol. 2007;189:1387–96.
7. Baumgartner FJ, Ayres B, Theuer C. Danger of false intubation after traumatic tracheal transection. Ann Thorac Surg. 1997;63:227–8.
8. Yadava OP. COVID 19: are there lessons? Indian J Thorac Cardiovasc Surg. 2020;36:433–5.
9. Carretta A, Ciriaco P, Bandiera A, et al. Veno-venous extracorporeal membrane oxygenation in the surgical management of post-traumatic intrathoracic tracheal transection. J Thorac Dis. 2018;10:7045–51.
10. Mathisen DJ. Tracheal resection and reconstruction. How I teach it. Ann Thorac Surg. 2017;103:1043–8.