



ELSEVIER

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

## Trauma Case Reports

journal homepage: [www.elsevier.com/locate/ocr](http://www.elsevier.com/locate/ocr)

# Traumatic thyrohyoid membrane rupture with hyolaryngeal separation due to strangulation injury<sup>☆</sup>

Anna Lawrence<sup>a,\*</sup>, Shannon Kraft<sup>b</sup>

<sup>a</sup> Otolaryngology Resident Year 4, The University of Kansas Medical Center, Department of Otolaryngology-Head & Neck Surgery, Otolaryngology - MS 3010, 3901 Rainbow Blvd., Kansas City, KS 66160, United States of America

<sup>b</sup> University of Kansas, United States of America

## ARTICLE INFO

## Keywords:

Laryngeal trauma  
Strangulation  
Suicide  
Hanging  
Tracheostomy  
Hyolaryngeal separation

## ABSTRACT

**Background:** Cervical injuries due to hanging have a high mortality rate. Survivors may present for care with subtle symptoms that belie potentially life-threatening injuries to vital structures of the neck.

**Case report:** We report a case of a 39-year-old male admitted to the Intensive Care Unit following attempted self-strangulation. Alert and clinically stable, his primary symptoms were pain and voice changes. His external exam was remarkable only for a cervical ligature mark and subcutaneous emphysema on palpation. CT imaging demonstrated disruption of the infrahyoid strap muscles and displacement of the hyoid and epiglottis superiorly. Subsequent flexible laryngoscopy by the Otolaryngology-Head & Neck Surgery (OTO-HNS) team revealed avulsion of the epiglottis from the thyroid cartilage and disruption of the aryepiglottic folds/false cord mucosa, resulting in an open wound into the soft tissues of the anterior neck. The airway was secured in the operating room via fiberoptic nasotracheal intubation. A tracheostomy was performed. Neck exploration revealed transection of the anterior strap muscles and thyrohyoid membrane. The wound was repaired in layers via a modified thyrohyoidopexy. At one-month follow-up, the patient was successfully decannulated and tolerating a regular diet.

**Conclusion:** Evaluation and management of head and neck trauma requires a systematic approach and thorough evaluation, as potentially life-threatening injuries can present subtly. Swift establishment of safe airway, when needed, and prompt repair of laryngeal injuries is essential to optimal functional recovery.

## Introduction

Hanging is a highly lethal method of suicide resulting in death in 84.5 % of attempts, second in mortality only to acts involving firearms (89.7 %) [1]. Of those who do not succumb to their injuries in the field, over 30 % will result in a mortality prior to leaving the hospital and 10 % will suffer severe functional disabilities in speech, swallow and motion [2].

Injury patterns related to hanging have largely been derived from autopsy reports. Injury to the sternocleidomastoid muscle (typically hematoma) is the most common finding (54 %). Injury to the hyolaryngeal complex occurs in 35–45 % of patients, with

<sup>☆</sup> This has not been presented at any meeting.

\* Corresponding author.

E-mail address: [alawrence3@kumc.edu](mailto:alawrence3@kumc.edu) (A. Lawrence).

<https://doi.org/10.1016/j.tcr.2024.101085>

Accepted 28 July 2024

Available online 5 August 2024

2352-6440/Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

hyoid fracture occurring in approximately 21 % and laryngeal fracture in about 17 % [3]. Vascular injuries are common, with carotid artery dissection noted in approximately 16 % of fatal hangings [4]. For those few survivors that undergo radiographic assessment, almost 40 % have some kind of hyolaryngeal injury [5] and approximately 2 % have evidence of carotid artery dissection [3].

Hyolaryngeal separation is a rare pattern of injury among survivors of attempted hanging, with only one previously reported case [6]. We present a case of hyolaryngeal separation in which distraction of the separated hyoid and larynx and co-existing cervical spine injuries required a unique approach to repair via thyrohyoidopexy with epiglottopexy.

### Case report

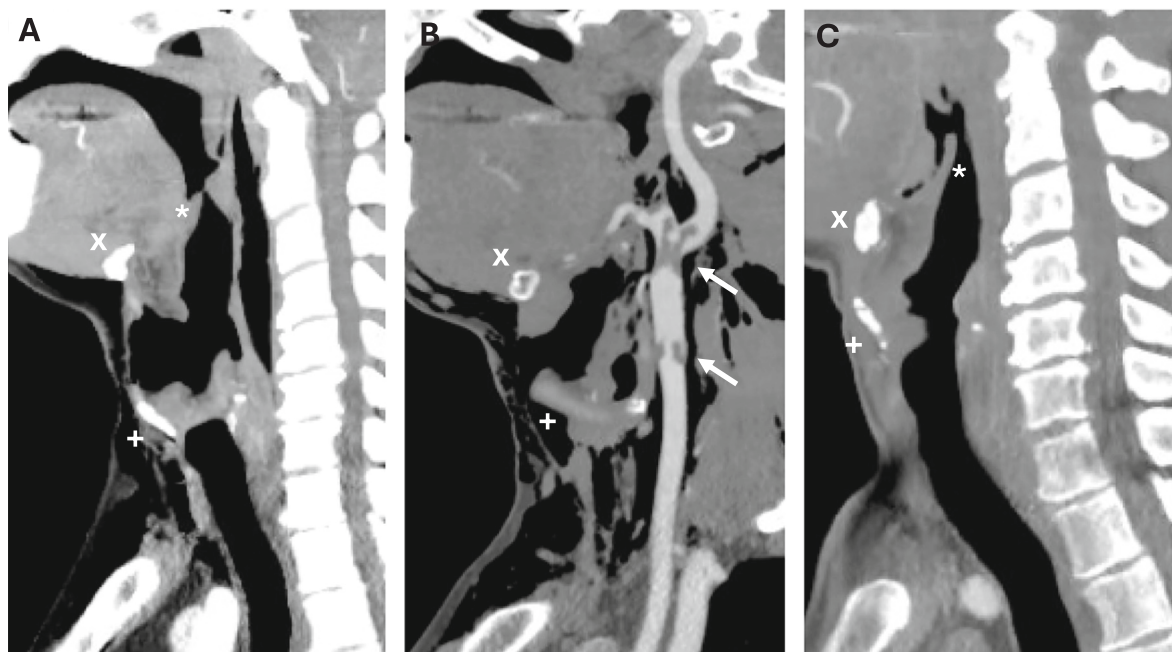
A 39-year-old male presented to a tertiary care center following attempted hanging one hour prior. By EMS report, he was found on the ground coughing blood next to a tree with a suspended wire noose. On presentation, he was alert and oriented. He reported difficulty projecting his voice but denied dyspnea. Physical exam revealed a ligature mark along the anterior neck at the level of the thyroid cartilage. The thyroid notch could be palpated, but other cervical landmarks were obscured by subcutaneous emphysema.

CT angiography revealed intimal injuries with thrombus (AAST Grades III-V) of the bilateral common carotid, left external carotid and bilateral vertebral arteries. A displaced transverse process fracture at C4 was noted. There was extensive subcutaneous emphysema with pneumomediastinum. On closer inspection, the infrahyoid strap muscles were disrupted, with distraction of the hyoid bone and epiglottis superiorly and the thyroid cartilage inferiorly (Fig. 1a and b). MRI demonstrated a partial tear of the nuchal ligament, requiring ongoing spine immobilization.

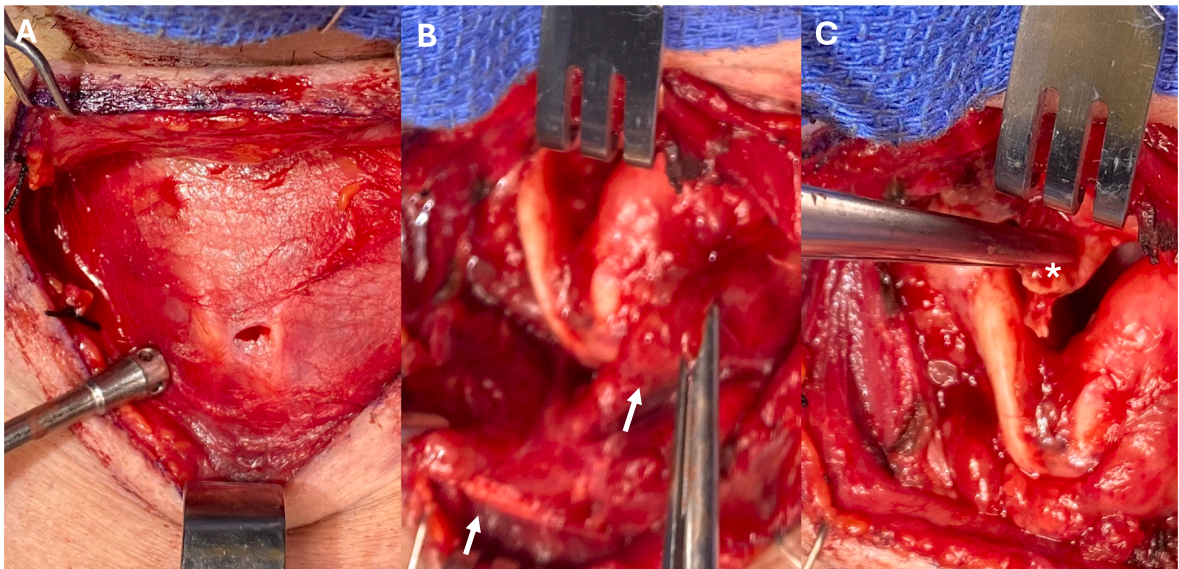
The OTO-HNS service was consulted to evaluate the patient's airway. Flexible laryngoscopy demonstrated mobile cords bilaterally with mild laryngeal edema. The epiglottis appeared to be detached from the laryngeal cartilage and the mucosa of the aryepiglottic folds/false cords was disrupted.

Shortly after initial evaluation by OTO-HNS, the patient was taken to the operating room (OR) for a controlled awake nasotracheal intubation. He was stable from an airway standpoint and due to the extent of his laryngeal mucosal lacerations, we felt the safest option was to transfer him to the OR for definitive airway management under direct visualization the night of his arrival. On hospital day two, the patient underwent tracheostomy, laryngoscopy, esophagoscopy, and repair of the hyolaryngeal injury. After raising flaps, a small defect was noted over the thyroid notch in the investing layer of the deep cervical fascia (Fig. 2a) which, when opened, revealed a large soft tissue defect extending into the supraglottic airway (Fig. 2b). The sternohyoid, thyrohyoid and omohyoid muscles had ruptured 1–2 cm below their insertion on the hyoid. The thyrohyoid membrane was completely disrupted, as was the mucosa of the false cords and aryepiglottic folds. The epiglottis was detached from the thyroid cartilage (Fig. 2c) and was distracted superiorly with the hyoid by the unopposed forces of the suprahyoid musculature.

Due to co-existing cervical spine injuries, the neck had to remain in a neutral position. An Allis clamp was used to retract the hyoid



**Fig. 1.** (A). Pre-operative CTA imaging. The hyoid (x) and epiglottis (\*) are retracted superiorly while the thyroid cartilage (arrow) is distracted inferiorly. The deep investing layer of the cervical fascia is seen anteriorly between the separated straps and thyrohyoid membrane. (B). Oblique view pre-operative view. In addition to the distracted hyoid (x) and thyroid cartilage, injury thrombus in the common carotid and carotid bulb are seen (arrows). (C). Reconstructed larynx with hyoid (x), epiglottis (\*) and thyroid cartilage in normal position.

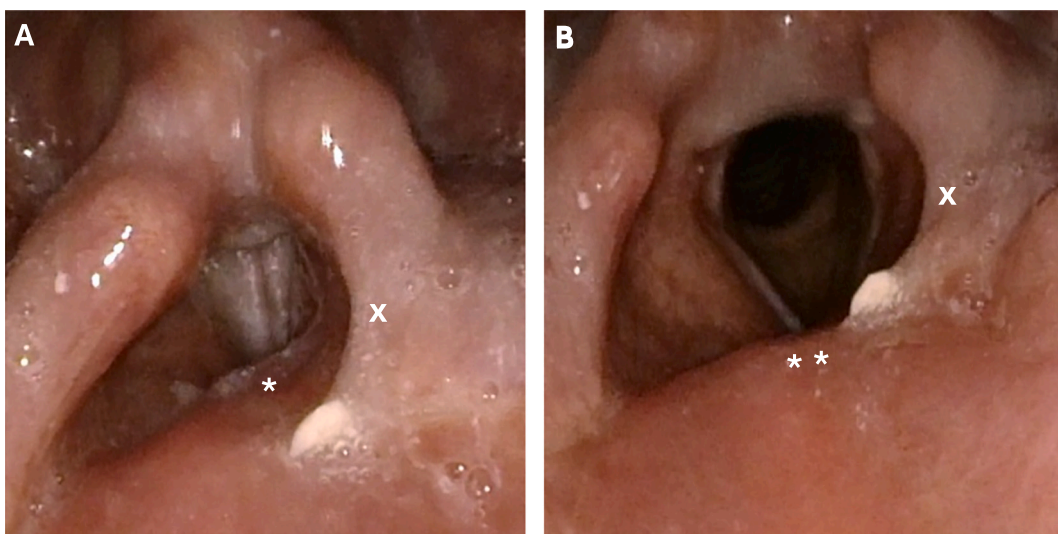


**Fig. 2.** Intraoperative images depicting (A) a small defect in superficial layer of the deep cervical fascia, (B), the disrupted thyrohyoid membrane and strap muscles (arrows) resulting in opening into the supraglottic airway at the level of the thyroid notch, and (C) the avulsed epiglottis (\*).

inferiorly and a single hook to pull the larynx/trachea superiorly. The laryngeal mucosa was repaired first with interrupted 4–0 vicryl suture. To keep tension off the wound, a modified thyrohyoidopexy with epiglottopexy was performed. 20-gauge needle was passed through the anterior thyroid cartilage under visualization with a flexible bronchoscope to ensure adequate distance above the anterior commissure before passing the midline suture. On the airway side, the suture was then passed through the petiole of the epiglottis. The inferior arm of four additional 2–0 vicryl sutures were passed through the superior thyroid ala (2 sutures each side). The superior arm of each suture was then passed around the hyoid. These tension sutures were secured, holding the hyoid and thyroid cartilages in close approximation. The ruptured ends of the strap musculature were reapproximated, penrose drains were placed, and the incision was closed in a layered fashion.

The patient had a gastrostomy tube placed. He was started on heparin for carotid thrombus and continued one week of intravenous Unasyn. The first tracheostomy change was performed on post-operative day (POD) 7 once resolution of airway edema was confirmed with flexible laryngoscopy. A video swallow study on POD 14 revealed mild-moderate oropharyngeal dysphagia which was minimized with swallow strategies. He was decannulated on POD 17 and discharged the following day.

At follow up, the patient was no longer in a c-collar. He was tolerating a regular diet. His voice was slightly hoarse, considered a



**Fig. 3.** One-month post-operative laryngoscopy. (A). Adducted vocal folds foreshortened left aryepiglottic fold (x) and inferiorly displaced epiglottis (\*). (B). Abducted cords with widely patent subglottic airway after decannulation.



grade one for roughness on the GRBAS scale (grade, rough, breathy, asthenia, strain), but he was able to communicate without limitation. Laryngoscopy demonstrated a well healed larynx with mobile cords, shortening of left aryepiglottic folds and inferior displacement of the epiglottis. (Fig. 1c). Follow up CTA neck to evaluate his carotid injury demonstrated resolution of cervical air with a patent/intact airway (Fig. 3).

## Discussion

Understanding the mechanism of injury in head and neck trauma helps direct a systematic approach to evaluation and treatment, potentially reducing mortality and long-term morbidity. Hanging or ligature strangulation is a particularly lethal method of injury. Minimal compression forces are required to occlude the cervical venous system (2 kg) and airway (3.2 kg) and cause asphyxiation [7].

Intramuscular hematoma, vascular injury and hyolaryngeal trauma are common with hanging. Muscle rupture and hyolaryngeal has rarely been reported. Autopsies in two reported cases suggest that muscle rupture occurs due to protracted, high pressure muscle elongation under ischemic conditions long after the victim has expired [8]. In the one instance of hyolaryngeal separation in a survivor reported, the patient also sustained a depressed laryngeal fracture [6]. Ultimately, it is difficult to apply sufficient force applied over short enough time to sustain these injuries and avoid asphyxiation. One possible explanation for our patient's injury pattern may be the use of a wire noose. A narrower ligature might be able to exert more force per unit area, causing more localized damage with rapid application [9]. In this case, the wire implement generated enough force to injure but broke under the patient's weight prior to asphyxiation.

Pre-operative CT imaging proved to be immensely helpful in this case. At the time, there were no reports of hyolaryngeal separation in blunt trauma, but there were reports describing a similar injury pattern in penetrating trauma in which a technique used in sleep surgery was used to repair the defect [10]. Using that as an exemplar, we performed a modified version of thyrohyoidopexy with epiglottopexy. The pexy facilitated repositioning of the superiorly distracted hyoid (unopposed forces of the suprahyoid muscles) and the larynx (inferior pull by the sternothyroid muscle) in close approximation, thereby reducing tension on the mucosal repair of the supraglottic larynx.

## Conclusion

Evaluation and management of head and neck trauma requires a systematic approach. Swift establishment of safe airway, when needed, and prompt repair of laryngeal injuries is essential to optimal functional recovery. In this rare case of hyolaryngeal separation, a modified surgery adapted from the sleep literature allowed for successful repair of the injury and eventual recovery of voice, swallow and airway function.

## CRedit authorship contribution statement

**Anna Lawrence:** Writing – review & editing, Writing – original draft, Project administration. **Shannon Kraft:** Writing – review & editing, Writing – original draft, Supervision.

## Declaration of competing interest

The authors have no financial or personal disclosures related to the submitted work.  
There was no use of artificial intelligence in the development of this manuscript.

## References

- [1] Z. Cai, A. Junus, Q. Chang, P.S.F. Yip, The lethality of suicide methods: a systematic review and meta-analysis, *J Affective Disorders* 300 (2022) 121–129.
- [2] M.J. Martin, J. Weng, D. Demetriades, A. Salim, Patterns of injury and functional outcome after hanging: analysis of the National Trauma Data Bank, *Am. J. Surg.* 190 (6) (2005) 836–840, <https://doi.org/10.1016/j.amjsurg.2005.05.051>.
- [3] B.R. Sharma, D. Harish, A. Sharma, S. Sharma, H. Singh, Injuries to neck structures in deaths due to constriction of neck, with a special reference to hanging, *J. Forensic Leg. Med.* 15 (5) (2008) 298–305, <https://doi.org/10.1016/j.jflm.2007.12.002>.
- [4] Hejna P. Amussat's sign in hanging—A prospective autopsy study. *J. Forensic Sci.* 2011;56(1):132–135. doi:<https://doi.org/10.1111/j.1556-4029.2010.01548.x>.
- [5] W. Fukumoto, H. Mitani, Y. Kuno, et al., Incidence and factor analysis of laryngo/hyoid fractures in hanging individuals-computed tomography study, *Eur. Radiol.* 31 (10) (2021) 7827–7833, <https://doi.org/10.1007/s00330-021-07932-8>.
- [6] H.W. Katolo, J.A. Bass, J.A. McGilligan, P. Bowles, *BMJ Case Rep.* 16 (2023) e255563, <https://doi.org/10.1136/bcr-2023-255563>.
- [7] C. Polson, *The Essentials of Forensic Medicine*, Pergamon, 1985.
- [8] A.S. Advenier, L. de la Grandmaison, Traumatic rupture of deep neck structures in hanging: two case reports, *Am. J. Forensic Med. Pathol.* 35 (3) (2014) 189–192.
- [9] H. Maxeiner, Hidden laryngeal injuries in strangulation: how to detect and interpret the findings, *J. Forensic Sci.* 43 (1998) 784–791.
- [10] D. Noh, K.H. Yeo, H.M. Cho, C.Y. Park, Thyrohyoid membrane transection caused by a stab injury, *Trauma Case Rep.* 12 (2017) 31–33, <https://doi.org/10.1016/j.tcr.2017.10.013>.