Houas *et al.*
The Egyptian Journal of Otolaryngology (2023) 39:166
https://doi.org/10.1186/s43163-023-00527-8

The Egyptian Journal of Otolaryngology

ORIGINAL ARTICLE Open Access

Post-intubation laryngotracheal stenosis: clinical presentation and management approaches

Jihene Houas[1*], Monia Ghammam[1], Heyfa Belhadj-Miled[1], Mouna Bellakhdher[1], Malika El Omri[1], Meherzi Abir[1], Kermani Wassim[1] and Mohamed Abdelkefi[1]

Abstract

Introduction Addressing acquired laryngotracheal stenosis presents a complex healthcare dilemma.

Results We present a case series of 48 acquired post-intubation laryngotracheal stenosis cases managed within our Department of ENT Surgery at Farhat Hached Tunisia. Diagnosis relied on imaging and endoscopic findings. Among these cases, 28 exhibited tracheal stenosis, with 60% falling into grade 2–3 severity. Management approaches included sole endoscopic dilation for 17 patients, surgical intervention for 19 patients, and T-tube placement for 10 patients.

Conclusions The management of laryngotracheal stenosis poses a challenge for ENT surgeons. Prevention is paramount, encompassing various measures such as employing high-volume, high tracheostomy, and extended intubation practices.

Keywords Laryngotracheal stenosis, Post-intubation, Surgery, Endoscopy

Background

Laryngotracheal stenosis (LTS) refers to a fibrotic condition characterized by narrowing of the upper airway at the level of the larynx or trachea [1]. While commonly found in the larynx or proximal trachea, it can also manifest further down the airway. LTS presents a considerable challenge for otolaryngology specialists [2]. While in children, it may be either acquired or congenital, in adults and adolescents, it is predominantly acquired [1, 3]. Etiological factors include trauma, chronic inflammatory diseases, neoplasms, and collagen vascular diseases. LTS management remains intricate for otolaryngologists, encompassing endoscopic procedures, open laryngotracheal resection with anastomosis, and laryngotracheal reconstruction [4, 5].

This study aims to present the experience of Tunisian ENT surgeons in managing a series of acquired LTS cases, shedding light on current diagnostic methods and therapeutic approaches for acquired LTS.

Methods

A retrospective analysis was conducted at the ENT Department of Farhat Hached University Hospital, spanning from 1994 to 2020. The study encompassed patients with a history of prolonged intubation [7–31 days] or tracheostomy, who presented with symptoms of dyspnea or stridor. Cases involving congenital or tumoral stenosis, as well as those with incomplete medical records, were excluded. The study enrolled a total of 48 patients diagnosed with acquired laryngotracheal stenosis.

Diagnostic evaluation for LTS consisted of fiberoptic laryngoscopy followed by direct laryngoscopy and

*Correspondence:
Jihene Houas
jihene.haouas@gmail.com
[1] ENT Department and Cervical Surgery Farhat Hached Hospital, Medicine University, Sousse, Tunisia

bronchoscopy. In cases of severe LTS, a CT scan of the larynx and trachea was performed. The severity of stenosis was assessed using the Myer-Cotton classification, which categorizes obstruction as grade 1 (up to 50% obstruction), grade 2 (51–70% obstruction), grade 3 (71–99% obstruction), and grade 4 (no detectable lumen). All patients underwent routine blood investigations. Treatment approaches included endoscopic tracheal dilations for stenosis, open surgical resection with end-to-end anastomosis, and definitive tracheostomy.

Results

Throughout the study duration, a total of 48 patients were incorporated into the analysis, consisting of 36 males and 12 females. The average age of the cohort was 24 years, with the youngest patient being 19 years old and the oldest patient being 65 years old.

Endotracheal intubation was incriminated in all patients. The most common indications of intubation were trauma and complications of acute or chronic diseases (Table 1).

Table 1 The reasons for intubation

Reasons of intubation	Number	Percentage (%)
Traumatic	29	60.42
Diabetic coma	2	4.17
Chronic obstructive pulmonary disease	2	4.17
Meningitis	3	6.25
Status epilepticus	4	8.33
Suicide attempt	2	4.17
Acute abdomen	3	6.25
Brain tumor	3	6.25
Total	48	100%

Out of the total, 22 patients (66%) exhibited a history of extended intubation, while 16 patients (34%) had a history of both prolonged intubation and tracheostomy. The average duration of intubation was 14 days. Initial assessment was conducted using rigid tracheoscopy and bronchoscopy, with a CT scan performed in 34 patients.

In terms of the stenosis location, 28 cases (58%) were identified as tracheal stenosis, while 20 cases (42%) involved subglottic stenosis. Notably, none of the cases exhibited supraglottic stenosis. The average length of the stenotic segment was approximately 2.3 cm, with 64% of cases showing a segment length of up to 1 cm. The stenosis pattern was concentric and hourglass-shaped in 46 patients, while 2 patients exhibited an eccentric narrowing (Fig. 1).

VRT: volume rendering technique

The degree of stenosis displayed a range of 10% to 90%, with an average of 56%. Stenosis severity was categorized as grade 1 (40%), grade 2 (35%), and grade 3 (25%) based on the Meyer-Cotton classification. No cases fell under grade 4.

Ten patients (20.83%) had undergone tracheostomy before their presentation, while six additional patients required emergency tracheostomies in our department. A substantial majority, 42 patients (87.5%), underwent endoscopic interventions. The period from symptom onset to endoscopic intervention varied between 1 and 21 months.

Direct laryngoscopy and rigid bronchoscopy were performed to evaluate the characteristics of the stenotic segment, revealing a fibrotic nature in 19 patients

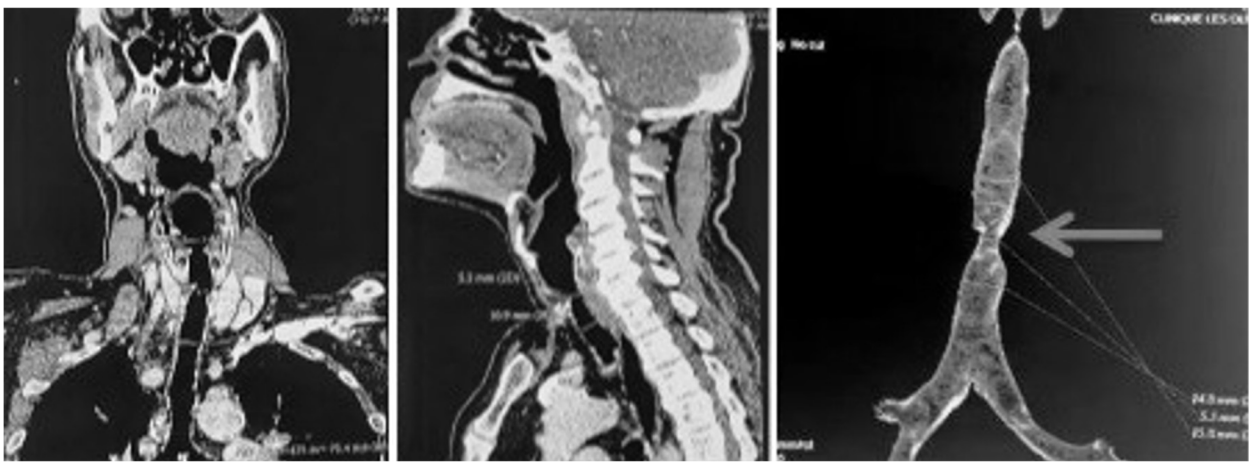

Fig. 1 CT Scan showing a case of post-intubation tracheal stenosis: coronal (**A**), sagittal (**B**) and VRT images show a focal short segment concentric narrowing of the tracheal wall giving an "hourglass" configuration (arrow)

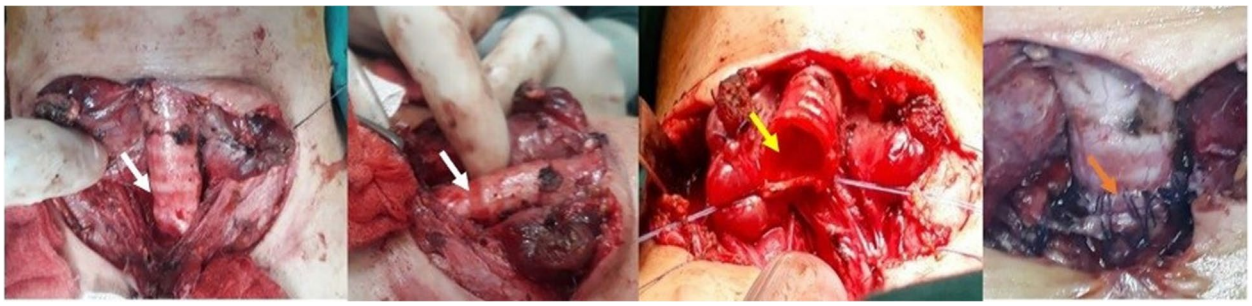

Fig. 2 A preoperative view: the thyroid isthmus is divided and ligated. The anterior trachea is exposed and the stenotic cervical tracheal segment is exposed (white arrow) and then resected (yellow arrow) with end-to-end anastomosis (orange-yellow)

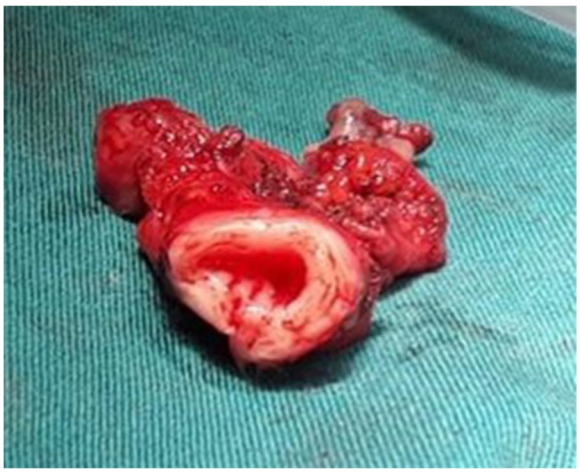

Fig. 3 Image of the resected segment of the trachea showing a concentric LTS

(39.58%), inflammatory attributes in 21 patients (43.75%), and mixed features in 2 cases (4.17%).

In total, 17 patients (35.41%) underwent successful curative endoscopic dilatation, while others received alternative treatments. Among these, 15 underwent additional surgical procedures, and 10 had a T-tube insertion. Multiple endoscopic dilatations were required, with an average of 4 sessions (range 1 to 19).

T-tube placement was implemented in 10 patients (20.8%), with tube retention spanning 6 to 24 months (mean 15 months). Successful decannulation was accomplished in 9 patients (90%), with one patient unable to undergo the procedure.

Surgical intervention was conducted in 19 cases, involving laryngotracheal resection with end-to-end anastomosis. The procedures included crico-tracheal anastomosis in 6 instances and tracheal anastomosis in 13 cases (Figs. 2 and 3).

A cervical approach was employed for the surgical procedure in all patients, without any instances of open laryngotracheal reconstruction. The mean count of resected rings totaled 4 (ranging from 3 to 6 rings).

Table 2 Table illustrating postoperative complications in our study

Complications	Number
Skin excoriation	2
T tube blockage	5
Granulomas	2
Death	0

Several complications emerged within our study cohort (Table 2).

Two patients (4.16%) experienced skin excoriation, while tube blockage due to crust formation occurred in 5 patients (10.41%). Additionally, granulomas resulting from foreign body reactions were identified in 2 patients (4.16%), and one case reported restenosis. No fatalities were recorded during the course of this retrospective study. The average duration of follow-up was 3 years, with a ± 6 months.

Discussion

Laryngotracheal stenosis (LTS) encompasses the narrowing of the upper airway involving both the laryngeal and tracheal segments [1, 4]. This condition, whether partial or complete, presents intricate configurations and has seen an increase in incidence. Acquired cases predominantly stem from patients admitted to intensive care units necessitating extended endotracheal intubation and tracheostomy [6, 7]. Key sites of stenosis typically include the endotracheal tube cuff region and tracheostomy site [5]. Although prolonged intubation stands as the primary cause, other etiologies should be explored, ranging from infectious to neoplastic to autoimmune origins [1, 5, 8, 9]. Despite the life-saving nature of intubation and tracheostomy, their cautious employment is advised [5, 8].

The elevated pressure from the endotracheal tube balloon induces LTS by triggering mucosal ischemia. Subsequent tracheal wall necrosis leads to tissue scarring and stenosis. It is often advised to maintain the balloon pressure within a range of 20 to 30 cmH2O (centimeters of water) to minimize the risk of complications. Symptoms of airway compromise ensue [5, 9]. Initial symptoms, including voice alterations, stridor, cough, and dyspnea, often develop after a period of asymptomatic incubation, with varying duration [4, 9].

For managing LTS, meticulous clinical and endoscopic evaluations are essential. Diagnostic protocols encompass imaging and endoscopic assessments [10]. Conventional endoscopy serves as the gold standard for LTS characterization, although its efficacy might decline with tight strictures [11]. Common imaging findings include localized tracheal wall narrowing that imparts a characteristic hourglass shape [10, 11]. CT scans provide data on stenosis grade, number, length, and distance from vocal cords [3, 10, 11]. CT virtual bronchoscopy is a valuable tool for assessing the trachea and bronchi. It is a non-invasive imaging technique that uses computed tomography (CT) data to create three-dimensional visualizations of the inside of the airways [3, 10, 11].

Grading systems for LTS abound, with the widely accepted Myer-Cotton grading system being internationally recognized [4, 10]. It quantifies stenosis percentage based on air leak relative to the endotracheal tube size, dividing subglottic airway stenosis into four grades.

Management options aim to restore optimal airway function [12–14]. The chosen method hinges on patient factors and procedure benefits. Endoscopic interventions encompass mechanical dilation, cold steel or CO2 laser excision, balloon dilation, mitomycin C application, conducted via flexible or rigid bronchoscopy [7, 13, 15–17]. This approach suits grade I or II LTS with a stenotic segment < 1 cm, but proves less effective for circumferential scarring, longer stenotic segments, or cartilage loss (e.g., tracheomalacia), and is favored for high anesthetic risk patients [18, 19].

Surgical interventions cater to patients in good general condition, executed post-resolution of edema and inflammation to ensure optimal anastomotic outcomes [13, 14, 20]. Tracheal resection with end-to-end anastomosis is ideal for localized cervical tracheal stenosis, with tension-free anastomosis crucial for preventing detachment [20, 21]. Crico-tracheal resection with end-to-end anastomosis boasts moderate success, though anastomotic release risk raises uncertainty [20, 22]. In cases of anastomotic site re-stenosis post-surgery, endoscopic procedures may optimize final results [20, 22, 23].

Conclusion

Management of laryngotracheal stenosis is a challenging problem that demands a multidisciplinary approach. The appropriate treatment option should be discussed depending on the pathology, the location and the length of the stenotic segment, the experience of the medical staff, and the general condition of the patient. Prevention is essential and multiple precautions should be considered like the use of high volume, high tracheostomy, and prolonged intubation.

Acknowledgements
Not applicable.

Authors' contributions
JH, MG: data analysis and interpretation and final approval of the version to be published. HB: analysis and interpretation of the data and drafting of the article. ME, MA: data collection. MB, KW, MA: critical revision of the article. All authors read and approved the final manuscript.

Funding
None.

Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the Faculty of Medicine of Sousse's Ethics Committee. Date of approval: 14-12-2022. Committee's notice number 153 (Ref: CEFMS 153/2022).

Consent for publication
Written informed consent for the publication obtained from the participants.

Competing interests
The authors declare that they have no competing interests.

Received: 9 August 2023 Accepted: 21 September 2023
Published online: 03 November 2023

References
1. Gelbard A, Francis DO, Sandulache VC, Simmons JC, Donovan DT, Ongkasuwan J (2015) Causes and consequences of adult laryngotracheal stenosis. Laryngoscope 125(5):1137–1143
2. Yin LX, Padula WV, Gadkaree S, Motz K, Rahman S, Predmore Z et al (2019) Health care costs and cost-effectiveness in laryngotracheal stenosis. Otolaryngol-Head Neck Surg Off J Am Acad Otolaryngol-Head Neck Surg 160(4):679–686
3. McDaniel LS, Poynot WJ, Gonthier KA, Dunham ME, Crosby ATW (2018) Image-based 3-dimensional characterization of laryngotracheal stenosis in children. OTO Open 2(1):2473974X17753583
4. Smith MM, Cotton RT (2018) Diagnosis and management of laryngotracheal stenosis. Expert Rev Respir Med 12(8):709–717
5. Lorenz RR (2003) Adult laryngotracheal stenosis: etiology and surgical management. Curr Opin Otolaryngol Head Neck Surg 11(6):467–472
6. Wright CD, Li S, Geller AD, Lanuti M, Gaissert HA, Muniappan A et al (2019) Postintubation tracheal stenosis: management and results 1993 to 2017. Ann Thorac Surg 108(5):1471–1477

7. Jung Y-R, Taek Jeong J, Kyu Lee M, Kim S-H, Joong Yong S, Jeong Lee S et al (2016) Recurred post-intubation tracheal stenosis treated with bronchoscopic cryotherapy. Intern Med Tokyo Jpn 55(22):3331–3335
8. Koshkareva Y, Gaughan JP, Soliman AMS (2007) Risk factors for adult laryngotracheal stenosis: a review of 74 cases. Ann Otol Rhinol Laryngol 116(3):206–210
9. Rosow DE, Barbarite E (2016) Review of adult laryngotracheal stenosis: pathogenesis, management, and outcomes. Curr Opin Otolaryngol Head Neck Surg 24(6):489–493
10. Morshed K, Trojanowska A, Szymański M, Trojanowski P, Szymańska A, Smoleń A et al (2011) Evaluation of tracheal stenosis: comparison between computed tomography virtual tracheobronchoscopy with multiplanar reformatting, flexible tracheofiberoscopy and intra-operative findings. Eur Arch Otorhinolaryngol 268(4):591–597
11. Jugpal TS, Garg A, Sethi GR, Daga MK, Kumar J (2015) Multi-detector computed tomography imaging of large airway pathology: a pictorial review. World J Radiol 7(12):459–474
12. Nair S, Nilakantan A, Sood A, Gupta A, Gupta A (2016) Challenges in the management of laryngeal stenosis. Indian J Otolaryngol Head Neck Surg Off Publ Assoc Otolaryngol India 68(3):294–299
13. Vorasubin N, Vira D, Jamal N, Chhetri DK (2014) Airway management and endoscopic treatment of subglottic and tracheal stenosis: the laryngeal mask airway technique. Ann Otol Rhinol Laryngol 123(4):293–298
14. Ansari A, Thomas A (2018) Multimodality surgical approach in management of laryngotracheal stenosis. Case Rep Otolaryngol 2018:4583726
15. Cataneo DC, Ximenes AMG, Cataneo AJM (2018) Mitomycin C in the endoscopic treatment of tracheal stenosis: a prospective cohort study. J Bras Pneumol Publicacao Of Soc Bras Pneumol E Tisilogia 44(6):486–490
16. Filiz A, Ulualp SO (2014) Long-term outcomes of balloon dilation for acquired subglottic stenosis in children. Case Rep Otolaryngol 2014:304593
17. Dhillon VK, Akst LM, Best SR, Hillel AT (2018) Voice outcomes in laryngotracheal stenosis: impact of the montgomery T-tube. Clin Surg 3:1855
18. Yafit D, Cavel O, Ungar OJ, Wasserzug O, Oestreicher-Kedem Y, Shklovsky-Kordi A et al (2018) Rigid dilatation of pediatric laryngotracheal stenosis as an adequate alternative to balloon dilatation. Eur Arch Oto-Rhino-Laryngol Off J Eur Fed Oto-Rhino-Laryngol Soc EUFOS Affil Ger Soc Oto-Rhino-Laryngol - Head Neck Surg 275(10):2529–2533
19. Nikolovski N, Kopacheva-Barsova G, Pejkovska A (2019) Laryngotracheal stenosis: a retrospective analysis of their aetiology, diagnose and treatment. Open Access Maced J Med Sci 7(10):1649–1656
20. Timman ST, Schoemaker C, Li WWL, Marres HAM, Honings J, Morshuis WJ et al (2018) Functional outcome after (laryngo)tracheal resection and reconstruction for acquired benign (laryngo)tracheal stenosis. Ann Cardiothorac Surg 7(2):227–236
21. Mathisen DJ (2017) Tracheal resection and reconstruction: how i teach it. Ann Thorac Surg 103(4):1043–1048
22. Carpenter PS, Pierce JL, Smith ME (2018) Outcomes after cricotracheal resection for idiopathic subglottic stenosis. Laryngoscope 128(10):2268–2272
23. Maurizi G, Vanni C, Rendina EA, Ciccone AM, Ibrahim M, Andreetti C et al (2021) Surgery for laryngotracheal stenosis: Improved results. J Thorac Cardiovasc Surg 161(3):845–852

Publisher's Note