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CLINICAL AND RADIOLOGICAL EVALUATION OF TRACHEAL LESIONS

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ABSTRACT

Background: Tracheal lesions arise from diverse causes including trauma, tumors, and congenital abnormalities. Accurate diagnosis is essential for appropriate management. **Methods and Materials:** This retrospective study was conducted at Al-Mouwasat University Hospital, Damascus, between 2022 and 2024. It included 282 patients with clinically or radiologically suspected tracheal lesions, all undergoing CT imaging. Data were collected from hospital records across pulmonology, thoracic surgery, and radiology departments. **Results:** Males represented 66% of cases, mostly aged 30–50 years (61.9%). The most common lesion was tracheal stenosis (39.6%), with trauma-related tracheomalacia as the leading subtype (59.4%). Gunshot wounds and penetrating neck injuries were major trauma causes. Tracheal tumors included squamous cell carcinoma (20%) and small cell carcinoma (30%). CT imaging proved superior to plain radiographs in lesion detection. Post-COVID-19 tracheal changes were observed in 45 patients, including stenosis and wall thickening. **Conclusion:** Multimodal clinical and radiological evaluation, particularly using CT, is critical for precise characterization of tracheal lesions. This ensures better treatment planning and outcomes.

KEYWORDS: Tracheal stenosis, Computed tomography, Tracheal tumors, Trauma.

INTRODUCTION

The trachea is a fundamental component of the respiratory system, serving as the central airway that conducts air from the larynx to the bronchi and lungs. Its integrity and function are essential for effective ventilation. Structurally, the tracheal wall is composed of cartilaginous rings that provide rigidity while maintaining the flexibility required for respiratory movements and body mobility. Tracheal lesions, whether stenotic, benign or malignant neoplastic, traumatic, or inflammatory, can significantly compromise the airway, potentially leading to partial or complete obstruction and life-threatening consequences that necessitate prompt and accurate evaluation.[1,2]

Clinical assessment begins with a comprehensive medical history and a physical examination focused on respiratory symptoms, including persistent cough, hoarseness, dyspnea, and wheezing. Bronchoscopic techniques play a pivotal role in diagnosis by allowing direct visualization of the tracheal mucosa, assessment of the extent of pathology, and acquisition of tissue biopsies for histopathological evaluation.[2,3]

Radiologically, computed tomography (CT) is the cornerstone for assessing tracheal lesions, offering high-resolution three-dimensional imaging that accurately defines lesion size, location, and impact on adjacent structures. Magnetic resonance imaging (MRI) may be used adjunctively, particularly when soft tissue characterization is required. Although conventional radiography (X-ray) remains a preliminary tool, its sensitivity for detailed tracheal evaluation is limited.[3,4]

The integration of clinical, bronchoscopic, and radiological modalities enables a comprehensive and accurate diagnosis of tracheal lesions. This multidisciplinary approach facilitates tailored therapeutic strategies—whether conservative or surgical—thereby improving patient outcomes and minimizing complications associated with tracheal pathology.[1,5]

METHODS AND MATERIALS

This retrospective observational study was conducted at Al-Mouwasat University Hospital in Damascus, Syria, over a two-year period from January 2022 to December 2024. The study aimed to clinically and radiologically evaluate tracheal lesions using hospital-based case data.

All patient records and imaging studies were reviewed from three specialized departments: The Department of Pulmonology, the Department of Thoracic Surgery, and

the Department of Radiology. The study cohort consisted of 282 patients who were diagnosed with or suspected to have tracheal lesions and underwent imaging evaluation during the study period.

Inclusion Criteria

Patients were included if they had a documented clinical diagnosis or suspicion of a tracheal lesion and underwent radiological follow-up using computed tomography (CT). The availability of CT imaging was a prerequisite for inclusion to ensure the presence of objective radiological evaluation of the airway pathology.

Exclusion Criteria

Patients with insufficient radiological data or those who were not followed up with CT imaging were excluded from the study, even if their diagnosis was clinically suspected. Cases with only endoscopic evaluation and no CT follow-up were also excluded.

Data Collection

Data were retrospectively extracted from patient files, radiological reports, and digital archiving systems. Demographic data (age, sex), clinical symptoms (e.g., dyspnea, cough, stridor), suspected diagnosis, imaging modality used, and final radiological interpretation were collected. Special attention was given to the location, type, and extent of the tracheal lesion, as well as associated findings in adjacent structures such as lymphadenopathy or lung changes.

The total number of included cases was 282, with each case being analyzed for clinical presentation and correlated with imaging findings. The study did not involve direct patient contact and relied exclusively on hospital records and imaging databases.

Ethical Approval

The study protocol was reviewed and approved by the Ethical Committee at Al-Mouwasat University Hospital, Damascus. Permission was granted to access archived patient data and imaging studies under approval number 289/Mo/2025. All data were handled confidentially and anonymized prior to analysis, in accordance with institutional and international ethical standards for retrospective medical research.

Statistical Analysis

Only descriptive statistics were used for data analysis. Continuous variables such as age were expressed as means and standard deviations (SD), while categorical variables such as sex, presenting symptoms, lesion location, and lesion type were presented as frequencies and percentages. No inferential statistical tests were applied. Data were organized and analyzed using Microsoft Excel 2019 and SPSS software version 26 (IBM Corp., Armonk, NY).

RESULTS

The total number of patients included in this study was 282, with males accounting for 66% and females 34%. In terms of age distribution among patients with tracheal stenosis, the age group between 30 and 50 years represented the largest proportion at 61.9%, followed by the 50 to 70 age group at 28.6%, and the 10 to 30 age group at only 4.7%. Clinical evaluations of tracheal lesions revealed that descriptive tracheal stenosis was the most common diagnosis, comprising 39.6% of cases, followed by tracheal tumors at 29.7%, traumatic tracheal injuries at 19.8%, and congenital anomalies and malformations at 9.9%. Regarding the types of tracheal stenosis, tracheomalacia secondary to traumatic lesions and cartilage fractures was the most prevalent at 59.4%, followed by primary tracheomalacia at 24.8%, post-intubation stenosis in 9.9%, and mild stenosis following minor trauma at 4.9%. As for the causes of tracheal trauma, gunshot wounds (war-related injuries) were the most frequent at 38.6%, followed by penetrating neck wounds at 35.6%, washing line strangulation at 29.7%, road traffic accidents at 12.9%, hanging or strangulation injuries at 5.9%, and unknown causes at 2.9%. Among these tracheal traumas, 85% were blunt traumas, while 14.8% were penetrating injuries. Radiologic assessment using CT imaging showed lesions due to tracheal intubation in 14.9%, infectious lesions in 19.8%, hemorrhagic lesions in 14.9%, and radiologically confirmed traumatic lesions in 19.8%. Combined tracheobronchial injuries were documented in varying proportions: isolated tracheal injuries in 28%, injuries involving the right middle bronchus in 8.7%, the right bronchus alone in 30%, avulsion of the main bronchus of the right lobe in 8%, the medial portion of the bronchial bifurcation in 13%, avulsion of the upper right lobar bronchus in 28.5%, and injury to the left main bronchus in 13%. Regarding tracheal tumors diagnosed by CT and confirmed histologically post-surgery, squamous cell carcinoma (SCC) accounted for 20%, adenoid cystic carcinoma (ACC) 15%, non-small cell carcinoma 10%, small cell carcinoma 30%, and unclassified carcinomas 30%. Tracheal stenosis was graded into four degrees: Grade I (up to 50% luminal narrowing) was observed in 60% of cases, Grade II (51–70%) in 13%, Grade III (71–90%) in 25%, and Grade IV (complete obstruction) in 2%. Anatomically, stenosis was located in the upper third of the trachea in 13%, the middle third in 25%, and at the tracheobronchial junction in 62%. CT scan imaging of tumoral lesions showed irregular narrowing in 25% of cases, regular narrowing in 13%, polypoid lesions in 40%, and intraluminal wall-adherent lesions in 22%. Contrast enhancement was seen in 65% of tumoral lesions, while 35% were non-enhancing. Simple radiographs detected only 45% of tumoral lesions, whereas all were confirmed by CT imaging. Review of patient files identified 45 patients with a history of COVID-19 who presented with tracheal lesions. Among them, simple stenosis was seen in 33.3%, multifocal stenosis in 17.8%, focal wall thickening in 31.1%, diffuse wall thickening in 13.3%, focal tracheal wall

calcifications in 33.3%, diffuse calcifications in 33.3%, tracheal diameter dilation in 33.3%, and multiple combined lesions in 26.7% of patients. Regarding lesion localization relative to the tracheal wall, 30% were adherent to the anterior wall (plaque-like), 22% to the lateral walls, 15% showed nodular thickening along the entire trachea, 8% were attached to cartilaginous rings, and 10% were distributed in both anterior and posterior walls. Tumor-mimicking tracheal lesions were also observed, including irregular nodular lesions sparing the posterior tracheal wall in 40%, amyloidosis in 4%, fungal infections in 6%, nonspecific nodular thickening in 14%, and relapsing polychondritis in 46%. Histopathological follow-up of tracheal nodules revealed hematomas in 15%, lipomas in 25%, leiomyomas in 25%, carcinoid tumors in 10%, papillomas in 20%, and metastases in 5%. Regarding multiple tracheal nodules, 65% were mucous nodules, 15% were papillomas, 15% were metastatic, and 5% were tuberculous. A gender-based analysis of stenosis grades showed that Grade I stenosis was more prevalent in females (59.5%) compared to males (26.2%), whereas Grade III stenosis was more common in males (71.4%) compared to females (30%). Grade II stenosis was noted in 10.3% of females and 2.3% of males.

DISCUSSION

This retrospective study included 282 patients, with a male predominance of 66% and females comprising 34%. The most commonly affected age group was between 30 and 50 years (61.9%), which is consistent with previous studies reporting a higher incidence of tracheal stenosis among middle-aged individuals, especially in post-intubation and traumatic cases.[6]

Regarding etiology, traumatic tracheal lesions due to gunshot wounds (38.6%) and penetrating neck injuries (35.6%) represented the leading causes. These findings align with global literature, which confirms that cervical tracheal trauma is more frequent than thoracic trauma, particularly in settings involving military or civilian violence.[7]

Tracheomalacia was identified in 25% of the cohort, with 59.4% of these cases following blunt or penetrating trauma leading to cartilage fractures. This is in accordance with international reports indicating that acquired tracheomalacia can occur in up to 10–23% of patients undergoing CT imaging for chronic airway symptoms.[8]

CT imaging played a pivotal role in lesion detection, especially for hemorrhagic (14.8%) and post-intubation-related injuries. The superiority of CT over plain chest radiography is well-documented, particularly in the evaluation of soft tissue and cartilaginous structures of the trachea.[9]

Tracheal tumors diagnosed included squamous cell carcinoma (SCC, 20%), adenoid cystic carcinoma (ACC, 15%), small-cell carcinoma (30%), non-small cell carcinoma (10%), and unclassified tumors (25%). CT enhancement was noted in 65% of tumors, which is consistent with prior studies indicating that tracheal malignancies often present as contrast-enhancing lesions with variable morphologic patterns.[10]

Tracheal stenosis severity varied across patients: Grade I stenosis (≤50% luminal narrowing) accounted for 60%, Grade II (51–70%) for 13%, Grade III (71–90%) for 25%, and Grade IV (complete obstruction) for 2%. These proportions show some variation compared to post-COVID studies, where Grade I stenosis has been reported in up to 71% of cases[11], reflecting differing underlying causes and tissue response.

Among patients with a history of COVID-19 infection (45 cases), a range of tracheal abnormalities were documented, including mild focal stenosis (33.3%), multifocal stenosis (17.7%), focal wall thickening (31.1%), diffuse thickening (13.3%), focal and diffuse calcifications (33.3%), and tracheal dilation (33.3%). These findings support emerging evidence that COVID-19 may predispose to structural tracheal damage, either through direct viral mechanisms or prolonged mechanical ventilation.[12]

Morphologically, CT features of tracheal tumors included polypoid lesions (40%), irregular narrowing (25%), wall-adherent intraluminal masses (22%), and smooth narrowing (13%). These appearances reflect a spectrum of benign and malignant etiologies as described in recent imaging literature.[13]

Interestingly, 45% of tracheal tumors were identifiable on plain radiographs, but CT was necessary for definitive diagnosis in 100% of cases. This confirms the essential role of CT imaging in comprehensive tracheal lesion evaluation.[14]

Tracheal lesions mimicking neoplasms were also identified, including nodular tracheal wall thickening in amyloidosis (4 cases), fungal infections (6 cases), non-specific nodular thickening (14 cases), and relapsing polychondritis (46 cases). These findings echo global reports that such mimics can delay diagnosis and necessitate histopathological confirmation.[15]

Histologic follow-up of tracheal nodules showed hematomas (15%), lipomas (25%), leiomyomas (25%), carcinoid tumors (10%), papillomas (20%), and metastatic lesions (5%). The prevalence of benign tumors such as lipomas and papillomas was comparable to similar reports in surgical pathology literature.[16]

CONCLUSION

This study included 282 cases, with 66% males and 34% females, most patients aged between 30-50 years. Tracheal lesions varied among congenital abnormalities, descriptive stenoses, tumors, and trauma caused by

multiple factors including war injuries and traffic accidents. The most common stenosis was located at the bronchial bifurcation level (62%), with varying degrees of airway obstruction, where grade one (up to 50%) was the most frequent. Computed tomography showed high effectiveness in diagnosing all lesions compared to plain radiographs. Tracheal changes related to previous COVID-19 infection were also observed. The results highlight the necessity of a thorough multimodal evaluation to accurately determine lesion type and severity for appropriate treatment planning.

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Conflict of Interest

The authors affirm that there are no actual or potential conflicts of interest associated with this research.

Data Availability

The datasets generated and analyzed during this study are not publicly available due to institutional confidentiality policies but may be obtained from the corresponding author upon reasonable and approved request.

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