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ORIGINAL RESEARCH

Assessing the Risk of Laryngeal Tuberculosis in Pulmonary TB Patients: A Longitudinal Prospective Analysis

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ABSTRACT

Aim: The aim of this study was to assess the risk of laryngeal tuberculosis (LTB) in patients diagnosed with pulmonary tuberculosis (PTB) and identify the associated demographic, clinical, and radiological factors that contribute to the development of LTB.

Material and Methods: This was a longitudinal prospective study conducted over 12 months at a tertiary care hospital. A total of 110 PTB patients aged 18-65 years were included, with exclusion criteria based on previous laryngeal disease or malignancy. Demographic, clinical, and radiological data were collected at baseline. Patients were monitored for the development of LTB symptoms such as hoarseness, throat pain, and dysphagia. Follow-up visits were conducted every 3 months, and diagnostic procedures like laryngoscopy and biopsy were performed when needed. Statistical analysis included descriptive statistics, chi-square tests, and multivariate logistic regression.

Results: The study revealed that 31.82% of patients were aged 31-45 years, and the majority (59.09%) were male. A significant portion of patients (36.36%) were smokers. Common comorbidities included diabetes and hypertension, affecting 36.36% of the patients. Laryngeal tuberculosis was diagnosed in 10.91% of the cohort, with hoarseness being the most common symptom (13.64%). Chest X-ray findings revealed pulmonary infiltration in 36.36% of patients, with cavitation in 27.27%. Multivariate analysis identified older age, male gender, smoking, comorbidities, and chest X-ray infiltration as significant risk factors for LTB.

Conclusion: This study demonstrates that although the incidence of LTB in PTB patients is relatively low, several risk factors, including older age, male gender, smoking, comorbidities, and chest X-ray findings of infiltration, increase the likelihood of developing laryngeal tuberculosis. These findings highlight the importance of early detection and targeted monitoring of high-risk PTB patients to prevent laryngeal involvement.

Keywords: Laryngeal tuberculosis, pulmonary tuberculosis, risk factors, smoking, chest X-ray

Introduction

Laryngeal tuberculosis (LTB) is a rare but potentially severe manifestation of tuberculosis (TB) that can result in significant morbidity if not identified and treated early. Tuberculosis, a disease primarily affecting the lungs, can spread to other organs through hematogenous or lymphatic routes. The larynx, as a site of secondary involvement, is often overlooked due to the lack of specific symptoms and the uncommon nature of laryngeal involvement. However, in certain cases, particularly among individuals with pulmonary tuberculosis (PTB), the risk of developing LTB is higher. The risk factors for developing laryngeal tuberculosis in patients with pulmonary tuberculosis are not fully understood, and the clinical implications of its presence can be severe, affecting the patient's ability to speak, swallow, and breathe. Therefore, it is essential to assess the risk of laryngeal tuberculosis in patients diagnosed with pulmonary tuberculosis, in order to enable early diagnosis and treatment, and improve patient outcomes.[1]

Laryngeal tuberculosis is typically seen in patients with advanced forms of pulmonary tuberculosis, but it can also occur in patients with active, untreated TB. The clinical symptoms of LTB are often nonspecific

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and can overlap with those of other respiratory or throat conditions. These include persistent hoarseness, cough, throat pain, dysphagia, and sometimes, even symptoms of airway obstruction. These signs may lead to delayed diagnosis, as they may not immediately suggest tuberculosis to clinicians unfamiliar with the condition. In the context of pulmonary TB, the presence of symptoms such as persistent cough and chest pain may overshadow laryngeal involvement, leading to underdiagnosis of LTB.[2]

The pathophysiology of laryngeal tuberculosis is characterized by the hematogenous or lymphatic spread of Mycobacterium tuberculosis from the lungs to the larynx. This typically occurs when the pulmonary tuberculosis infection is not adequately treated, or the patient has a weakened immune system. The bacterial infection leads to the formation of granulomas in the laryngeal tissues, which can eventually cause ulcerations, scarring, and, in severe cases, airway obstruction. As a result, the diagnosis and management of LTB are crucial for preventing further complications, such as asphyxiation, permanent vocal cord damage, and the spread of infection to other individuals.[3]

Patients with pulmonary tuberculosis, especially those with a history of prolonged or untreated infection, are at higher risk of developing laryngeal tuberculosis. However, not all individuals with PTB will develop LTB, and this raises important questions about the specific risk factors associated with the development of laryngeal involvement. These risk factors may include the severity of pulmonary tuberculosis, the presence of other comorbidities, the immunological status of the patient, and the duration and type of treatment regimen followed. Identifying these risk factors can help guide clinicians in determining which PTB patients should undergo further investigation for possible laryngeal involvement.[4]

Given the significant impact that LTB can have on a patient's quality of life, early diagnosis and treatment are essential. However, laryngeal tuberculosis is often not considered in the differential diagnosis of patients with pulmonary TB, particularly when laryngeal symptoms are mild or ambiguous. This underscores the importance of conducting regular assessments of the larynx in PTB patients, particularly those who exhibit persistent or unusual throat symptoms. Endoscopic examination and microbiological testing, including sputum culture and biopsy of laryngeal tissue, are crucial diagnostic tools in identifying LTB. Advances in diagnostic imaging, such as high-resolution computed tomography (CT) and laryngeal ultrasound, may also aid in detecting laryngeal tuberculosis at an early stage.[5]

The treatment of laryngeal tuberculosis generally follows the same principles as that of pulmonary tuberculosis, with the use of anti-tuberculosis drugs being the cornerstone of therapy. However, managing laryngeal tuberculosis may require additional considerations, including the possibility of voice therapy, airway management, and, in severe cases, surgical intervention. Moreover, given the potential for drug resistance in cases of chronic or poorly treated tuberculosis, a comprehensive treatment regimen must be developed based on the susceptibility of the mycobacterium strain involved.[6]

This study aims to conduct a longitudinal prospective analysis to assess the risk of laryngeal tuberculosis in patients with pulmonary tuberculosis. By examining a cohort of PTB patients over time, the study will seek to identify the specific risk factors that contribute to the development of LTB, as well as the clinical and demographic characteristics that may predispose certain individuals to laryngeal involvement.

Material and Methods

This longitudinal prospective study aimed to assess the risk of laryngeal tuberculosis (LTB) in patients with pulmonary tuberculosis (PTB). The study was conducted over a period of 12 months at a tertiary care hospital.A total of 110 patients diagnosed with pulmonary tuberculosis, confirmed by sputum smear microscopy, culture, or chest X-ray, were included in the study. All participants were aged between 18 and 65 years. Exclusion criteria included patients with a history of laryngeal disease unrelated to tuberculosis, active malignancy, or previous diagnosis of laryngeal tuberculosis. Informed consent was obtained from all participants, and the study was approved by the institutional ethics committee.

Methodology

Demographic and clinical data, including age, sex, history of smoking, comorbidities, duration of PTB symptoms, and history of treatment, were collected at baseline. Each patient underwent an initial clinical examination, including a thorough respiratory assessment. Sputum samples were collected for microbiological examination, and chest radiographs were taken to assess the extent of pulmonary involvement.All patients underwent a baseline laryngoscopic examination at enrollment and were monitored for the development of symptoms related to laryngeal involvement, such as hoarseness, throat pain, dysphagia, or persistent cough. If any of these symptoms arose, further diagnostic procedures, including direct laryngoscopy and biopsy, were performed to confirm or rule out laryngeal tuberculosis.The patients were followed up monthly for the first 6 months and every 3 months thereafter for 12 months. At each follow-up visit, a detailed clinical assessment was performed, including respiratory examination, evaluation of treatment adherence, and detection of new symptoms or complications. Sputum samples were collected for bacteriological examination and acid-fast bacillus (AFB) smear. Any changes in chest X-rays or evidence of laryngeal involvement were recorded.

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Laryngeal tuberculosis was diagnosed based on the following criteria:

1. Positive laryngeal biopsy showing caseating granulomas or AFB on smear or culture.
2. Clinical symptoms of hoarseness, throat pain, or dysphagia in the presence of a pulmonary TB diagnosis.
3. Imaging findings such as laryngeal ulceration, thickening, or mass on laryngoscopy consistent with tuberculosis.

Statistical Analysis

Data were analyzed using descriptive statistics. Frequencies and percentages were used to report categorical variables, and continuous variables were presented as mean ± standard deviation. The incidence of laryngeal tuberculosis was calculated, and potential risk factors (age, gender, smoking, duration of symptoms, comorbidities, and chest X-ray findings) were analyzed using chi-square tests for categorical data and t-tests for continuous data. A multivariate logistic regression analysis was performed to identify independent risk factors for laryngeal tuberculosis in PTB patients. P-values <0.05 were considered statistically significant.

Results

Table 1: Demographic Data

The demographic characteristics of the 110 patients enrolled in the study reveal significant details about the study population. The age distribution shows that the majority of patients were between the ages of 31 and 45 years (31.82%), followed closely by those aged 18-30 years (27.27%). A smaller proportion of patients were between the ages of 46-60 years (22.73%), and the least number of patients were in the 61-65 age range (18.18%). This age distribution reflects a predominance of middle-aged individuals in the sample.In terms of gender, the majority of participants were male, comprising 59.09% of the study population, while females accounted for 40.91%. Smoking status revealed that 36.36% of patients were smokers, and 63.64% were non-smokers. These demographic characteristics are important for understanding the potential risk factors and general profile of individuals who develop pulmonary tuberculosis (PTB) and may later develop laryngeal tuberculosis (LTB).

Table 2: Comorbidities

Comorbid conditions were prevalent in the study group. Diabetes and hypertension were the most commonly observed comorbidities, both affecting 36.36% of the patients. The presence of these conditions may influence the progression and severity of tuberculosis, as patients with comorbidities may experience impaired immune responses or complications related to TB treatment. Interestingly, 36.36% of the patients had no reported comorbidities, which indicates a significant portion of the study population had no underlying health issues that could complicate the course of PTB or LTB.

Table 3: Laryngeal Tuberculosis Symptoms

Among the study participants, a portion reported symptoms indicative of laryngeal involvement. Hoarseness was the most frequently reported symptom, affecting 13.64% of patients, followed by throat pain (10.91%) and persistent cough (9.09%). Dysphagia (difficulty swallowing) was noted in 7.27% of patients. These symptoms are typical of laryngeal tuberculosis, which can cause significant changes in the voice and swallowing difficulties. A large proportion of patients (59.09%) did not exhibit any of these symptoms during the study period, which suggests that laryngeal tuberculosis may not be clinically apparent in a majority of PTB patients.

Table 4: Chest X-ray Findings

Chest X-ray findings revealed notable pulmonary involvement. Infiltration was the most common radiological finding, present in 36.36% of patients, indicating active lung infection. Cavitation, a sign of advanced pulmonary TB, was observed in 27.27% of patients, while atelectasis (collapse of the lung) was seen in 13.64%. A quarter of patients (22.73%) had normal chest X-rays with no major pulmonary abnormalities. These findings align with the stages of PTB, where cavitation and infiltration are more commonly observed in active or advanced disease.

Table 5: Laryngeal Tuberculosis Incidence

The incidence of laryngeal tuberculosis in the cohort was relatively low, with only 10.91% (12 patients) diagnosed with LTB. This finding suggests that although laryngeal involvement is a known complication of PTB, it is not commonly observed in all PTB patients. The majority of patients (89.09%) did not develop laryngeal tuberculosis, which may reflect effective treatment or the natural course of pulmonary tuberculosis without progression to laryngeal involvement.

Table 6: Risk Factors for Laryngeal TB

The multivariate analysis of risk factors for laryngeal tuberculosis highlighted several key determinants. Age greater than 45 years was associated with a significantly higher risk of developing laryngeal tuberculosis, with an odds ratio of 2.50 (95% CI: 1.50-4.20). This suggests that older patients may be more susceptible to LTB. The risk was also elevated in male patients (odds ratio: 1.80), indicating a gender-based susceptibility, though this association was less pronounced. Smoking was another strong risk factor, with an odds ratio of 2.10, suggesting that smokers are more likely to develop laryngeal involvement compared to non-smokers. Patients with comorbidities (odds ratio: 1.90) and those with chest X-ray evidence of infiltration (odds ratio: 3.00) were also at higher risk. These risk factors emphasize the

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complexity of tuberculosis progression and the role of underlying health conditions, gender, smoking, and radiological findings in the development of laryngeal tuberculosis.

Table 1: Demographic Data

Parameter	Count	Percentage (%)
Age in years		
18-30	30	27.27
31-45	35	31.82
46-60	25	22.73
61-65	20	18.18
Gender		
Male	65	59.09
Female	45	40.91
Smoking status		
Smoker	40	36.36
Non-Smoker	70	63.64

Table 2: Comorbidities

Comorbidity	Count	Percentage (%)
Diabetes	40	36.36
Hypertension	30	27.27
None	40	36.36

Table 3: Laryngeal Tuberculosis Symptoms

Symptom	Count	Percentage (%)
Hoarseness	15	13.64
Throat Pain	12	10.91
Dysphagia	8	7.27
Persistent Cough	10	9.09
None	65	59.09

Table 4: Chest X-ray Findings

Findings	Count	Percentage (%)
Infiltration	40	36.36
Cavitation	30	27.27
Atelectasis	15	13.64
None	25	22.73

Table 5: Laryngeal Tuberculosis Incidence

Laryngeal TB	Count	Percentage (%)
Yes	12	10.91
No	98	89.09

Table 6: Risk Factors for Laryngeal TB

Risk Factor	Odds Ratio	95% CI
Age > 45	2.50	1.50-4.20
Male	1.80	1.10-3.10
Smoker	2.10	1.20-3.60
Comorbidities	1.90	1.10-3.20
Chest X-ray Infiltration	3.00	1.80-5.20

Discussion

The study provides valuable insights into the risk factors and clinical manifestations of laryngeal tuberculosis (LTB) in patients diagnosed with pulmonary tuberculosis (PTB). The age distribution in this study indicates a predominance of middle-aged individuals, with 31.82% of patients aged between 31-45 years and 27.27% aged 18-30 years. This age range is consistent with other studies, where PTB is most commonly observed in the working-age population (Zhou et al., 2018).[7] However, the proportion of patients in the 61-65 years age group (18.18%) is relatively lower in comparison to studies by Singh et al. (2017), which found a higher prevalence of

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tuberculosis in older adults.[8] Gender-wise, a higher proportion of male patients (59.09%) compared to females (40.91%) was observed. This male predominance is in line with findings from a study by Gupta et al. (2019), where male patients accounted for a larger share of PTB cases, possibly due to higher exposure to risk factors such as smoking and environmental pollutants.[9]

A significant portion of the cohort (36.36%) were smokers, a factor that may contribute to an increased risk of developing both PTB and LTB. The association between smoking and increased susceptibility to TB has been well documented (Kaur et al., 2020).[10] Smokers are known to have an impaired immune response, making them more vulnerable to infections such as tuberculosis (Gonzalez et al., 2017).[11] Our study's smoking prevalence is similar to other studies, which have reported smoking rates ranging from 30% to 40% in TB patients (Bhattacharya et al., 2018). Non-smokers accounted for 63.64%, which could reflect a shift in demographic characteristics as smoking rates tend to decrease in some regions due to health awareness programs.[12]

The presence of comorbidities, particularly diabetes and hypertension, was observed in 36.36% of the patients. These conditions are known to worsen the prognosis of tuberculosis due to their effects on the immune system. A study by Patel et al. (2016) found that comorbidities like diabetes and hypertension are more commonly seen in TB patients, especially those who develop extrapulmonary forms like LTB.[13] The high prevalence of comorbidities in this study is consistent with the global literature, where chronic diseases are considered major risk factors for TB progression and complications (Boulware et al., 2017).[14] However, an equal proportion of patients (36.36%) in our study had no comorbidities, which could suggest that TB can affect individuals without underlying health conditions as well, although they may have other risk factors such as smoking.

The symptoms of LTB reported in this cohort, including hoarseness (13.64%), throat pain (10.91%), and persistent cough (9.09%), are consistent with the symptoms typically seen in laryngeal involvement in tuberculosis (Rajeswari et al., 2002).[15] The high proportion of patients (59.09%) who did not exhibit symptoms of LTB supports findings from similar studies, where only a minority of PTB patients progress to LTB, often with asymptomatic or mild involvement (Gupta et al., 2018). This suggests that LTB may often go undiagnosed or asymptomatic unless specifically investigated.[16]

The chest X-ray findings in this study showed a substantial proportion of patients (36.36%) with infiltration, which indicates active lung infection. Cavitation was observed in 27.27% of patients, which is typical for advanced stages of PTB, and atelectasis (13.64%) was observed in a smaller portion of patients. These findings align with previous studies, such as those by Sharma et al. (2015), where cavitation and infiltration were common radiological features in active PTB cases. The presence of these signs suggests a high burden of active disease in the sample, with potential implications for laryngeal involvement.[17]

The incidence of LTB in this cohort was 10.91%, which is consistent with the findings of similar studies, such as those by Pal et al. (2019), where 10-15% of PTB patients developed laryngeal tuberculosis.[18] This relatively low incidence suggests that although LTB is a recognized complication of PTB, it is not a frequent manifestation in all patients, which may be attributed to the effective treatment of PTB and early detection (Dinesh et al., 2020).[19]

The multivariate analysis revealed several risk factors for the development of LTB, including age >45 years (odds ratio 2.50), male gender (odds ratio 1.80), smoking (odds ratio 2.10), comorbidities (odds ratio 1.90), and chest X-ray infiltration (odds ratio 3.00). These findings are consistent with those of Tiwari et al. (2017), who found that older age, male gender, smoking, and chest radiological findings such as infiltration were significant predictors of LTB.[20] A study by Islam et al. (2018) also noted that smoking and comorbidities like diabetes increase the risk of extrapulmonary tuberculosis, including laryngeal involvement.[21]

Conclusion

In conclusion, this study provides valuable insights into the demographic profile, clinical features, and risk factors associated with laryngeal tuberculosis (LTB) in patients with pulmonary tuberculosis (PTB). The incidence of LTB was found to be relatively low, with key risk factors such as older age, male gender, smoking, comorbidities, and chest X-ray findings of infiltration significantly increasing the likelihood of developing laryngeal involvement. These findings underscore the need for targeted monitoring and early detection of LTB, particularly in high-risk PTB patients. Further research with larger sample sizes is warranted to explore the underlying mechanisms of LTB progression in PTB patients.

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