



Original Article

# Clinical Symptoms, Endoscopic and Stroboscopic Imaging in Patients with Laryngeal Fungal Infection in Relation to Fungal Identification Result

Ngo Thi Linh Trang, Dao Dinh Thi, Nguyen Tuan Son \*

*VNU University of Medicine and Pharmacy, 144 Xuan Thuy, Cau Giay, Hanoi, Vietnam*

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**Abstract:** This paper aims to describe the similarities and differences in fungal laryngitis' clinical characteristics, endoscopic, and stroboscopic imaging between patients with positive and non-positive fungal identification results. The study enrolled 48 patients diagnosed with fungal laryngitis by the Endoscopy Department in the National ENT Hospital of Vietnam from August 2019 to March 2020. The study results show that the patients in both groups had dysphonia (100%), with insignificant difference in the severity. However, the patients in the Positive group were more likely to go to hospital right in the first month of the symptom (55%), whereas the patients in the Non-positive group usually waited for more than 3 months (57.1%), ( $p < 0.05$ ). In endoscopic imaging, fungal pseudomembrane could be found mainly on the vocal cords in both groups, with instances spreading to the subglottis (15%) and trachea (5%) in the Positive group ( $p < 0.05$ ). The tissue layer of the patients in the Positive group was mostly inflamed, meanwhile the patients in the Non-positive group were more prone to swelling tissue (67.9%), ( $p < 0.05$ ). In stroboscopic imaging, the difference was minimal. The patients in the Positive group were more likely to lose the mucosal wave formation (60%) than in the Non-positive group (46.4%). There were also insignificant differences in the mucosal wave's characteristics: asymmetry (50% in the Positive group; 66.7% in Non-positive group), diverse periodicity (50% in the Positive group; 33.3% in the Non-positive group). The paper concludes that there were differences between the two groups of patients and the clinical, endoscopic and stroboscopic findings, fungal identification should be further implemented for definitive diagnosis in patients with fungal laryngitis.

**Keywords:** Fungal laryngitis, dysphonia, endoscopic imaging, stroboscopic imaging, fungal identification.

\* Corresponding author.

*E-mail address:* [tuansonent@gmail.com](mailto:tuansonent@gmail.com)

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## 1. Introduction

Laryngeal fungal infection, or fungal laryngitis, is a rare disease describing the inflammation of the larynx caused by fungi, an organism group often found in the environment [1,2]. In Vietnam, *Aspergillus fumigatus* and *Candida albicans* are the most common pathogenic fungi [3,4]. Multiple determinants are causing increased incidences of fungal diseases, such as geo-ecological characteristics and risk factors. HIV/AIDS pandemic, tuberculosis, chronic obstructive pulmonary disease and cancer are the major drivers of fungal infections [5].

Fungal laryngitis results in the presentation of a few symptoms, notably prolonged hoarseness of the voice (dysphonia), coughing and foreign body sensation [6]. Its clinical presentations are generic symptoms found in most disorders of the larynx. Before, fungal laryngitis was often mistaken for chronic laryngitis (30,76%), cancer (28,85%) [3]. Moreover, there were misdiagnoses where another disorder was mistaken for fungal laryngitis (13,3%) [3]. Delays in diagnosis contribute to prolonged, inadequate treatments, causing a decrease in the patients' quality of life. Even after correct diagnosis of fungal laryngitis, only Itraconazole treatment is used, lasting 5 – 7 weeks [3,6] instead of targeting the specific pathogenic fungi.

According to the surveys by the Asian Fungal Working Group (AFWG), conventional microscopy and fungal culture remain the mainstay of diagnosis for countries with limited resources [7]. However, in Vietnam, fungal culture and identification was not an option for definitive diagnosis in Otolaryngology. The definitive means of fungal laryngitis' diagnosis were the clinical assessment, biopsy, pathology, and most importantly, direct microscopy, which only provided positive – negative results. By implementing fungal culture and identification as one of the definitive diagnosis methods with other conventional methods, the chance of misdiagnosis will be minimized, and it will provide the ground for individualized fungal

treatment. However, due to limited amount of fungal specimen in patients with fungal laryngitis, direct microscopy is prioritized as the mainstay of definitive diagnosis. Comparing the clinical and paraclinical characteristics of the patients between two groups of positive and non-positive fungal identification results will provide a better understanding of its impression in fungal diagnosis.

Assessing the practical needs, we carried out the research: “Clinical symptoms, endoscopic imaging and stroboscopic imaging in patients with Laryngeal fungal infection” with 2 objectives:

- i) To describe the clinical characteristics, endoscopic, and stroboscopic imaging in patients with fungal laryngitis.
- ii) To describe similarities and differences of clinical characteristics, endoscopic and stroboscopic imaging between patients with positive and non-positive fungal identification result.

## 2. Methodology

The cross-sectional study prospectively enrolled 48 patients diagnosed with fungal laryngitis by the Endoscopy Department in National ENT Hospital of Vietnam from August 2019 to March 2020.

### 2.1. Participants

#### 2.1.1. Inclusion criteria

All chosen patients must fulfill the inclusion criteria, including patients with clear fungal laryngitis diagnoses using direct microscopy, with endoscopic imaging and stroboscopic imaging test results, and have given full consent to participate in the study.

#### 2.2.2. Exclusion criteria

All patients with unclear fungal laryngitis diagnoses, patients with laryngeal cancer diagnosis, patients with diagnoses of fungal laryngitis but did neither endoscopic nor stroboscopic imaging, and patients who refused to participate in the study would be excluded from the study.

### 2.2.3. Variables

For the analysis, all studied patients were diagnosed with fungal laryngitis using direct microscopy as the definitive diagnosis.

### 2.2. Dependent variables

For the analysis, one dependent variable was examined: Fungal identification results – which are divided into 2 groups: Positive and Non-positive group for the second objective. Positive group includes all patients with positive fungal culture and identification results and the pathogenic fungal species. Meanwhile, Non-positive group includes all other instances, either their fungal culture and identification tests returned negative, or they weren't able to conduct the laboratory test at all.

#### 2.2.1. Independent variables

We describe clinical symptoms and paraclinical symptoms using following variables: Firstly, we record the general demographic characteristics: gender, age, living places, and occupation. Age is divided into age groups (under 20, 20 to 29, 30 to 39, 40 to 49, and above 50); living places has 2 categories: urban and rural areas using the Vietnamese administrative system; occupation has 3 categories: agricultural work, labor work and office work. The studied medical history and habits include: pneumonia, hepatitis B and smoking (coded (1) if positive, (0) if negative). Secondly, we record the studied patients' clinical symptoms: dysphonia, coughing, foreign body sensation, fever, and dyspnea. Dysphonia is described in severity, with 4 categories (mild, moderate, severe and aphonia) and duration, with 3 categories (less than 1 month, 1 to 3 months and more than 3 months). Thirdly, we record the studied patients' paraclinical characteristics: Endoscopic imaging, Stroboscopic imaging and Fungal identification. Endoscopic imaging focuses on pseudomembrane characteristics – the amount of pseudomembrane found in endoscopy (thick, thin and patchy), epithelium layer characteristics (inflamed, swollen and ulcerated), pseudomembrane placement on the vocal cords,

subglottis and trachea. Stroboscopic imaging describes general characteristics of the vocal cords: adduction – abduction movement, closing phase of the vocal cords, mucosal wave and laryngospasm. Mucosal wave's characteristics is further described in 4 categories: frequency of the mucosal wave, symmetry, adduction posture and periodicity. Fungal identification is described as identification result, and pathogenic fungal species, which is divided into 2 categories: *Aspergillus fumigatus* and *Candida albicans*.

#### 2.2.2. Statistical data analysis

After all the studied patients' relevant information has been recorded and checked for accuracy, data analysis will be performed using SPSS Statistics 20. Univariate analysis will be applied to present descriptive data in the form of exact number and percentage.

## 3. Result

### 3.1. Clinical and paraclinical symptoms

#### 3.1.1. Clinical symptoms

Dysphonia is the most important symptom and is the main reason for patients to see a specialized physician. Although all of the *studied* patients have dysphonia (100%), the severity and duration vary with each patient. The severity of dysphonia development has four levels: Mild, moderate, severe before completely lose the voice (aphonia). Two-third of the patients suffer from mild to moderate level of dysphonia (66.7%), only one-third of the studied patients have a severe level of dysphonia (33.3%). Moreover, the studied patients are more likely to wait out until the symptom worsens, usually more than 3 months (43,8%), and only one-third of the patients visit the doctor within 1 month, most of whom suffer from severe dysphonia. Aphonia is the most severe characteristics of dysphonia. The patient suffers from completely loss of voice. The chance of developing in patients' pre-admission are fairly low, with the prevalence of 29,2%, however,

they almost always visit the hospital within 1 week of development (92,8%). Other notable symptoms include coughing (64,6%) and foreign body sensation (50,0%). Dyspnea and fever are equally rarely seen in the studied patients (2,1%).

### 3.2. Endoscopic imaging

#### 3.2.1. Fungal pseudomembrane characteristics

The fungal pseudomembrane is usually white, or whitish-grey. The pseudomembrane is more likely to be growing thick (56,3%) covering all over the vocal cords; while in some instances, the pseudomembrane can be a thin layer (29,2%) or a patchy, barely visible layer (14,6%), covering only a small part of the surface.

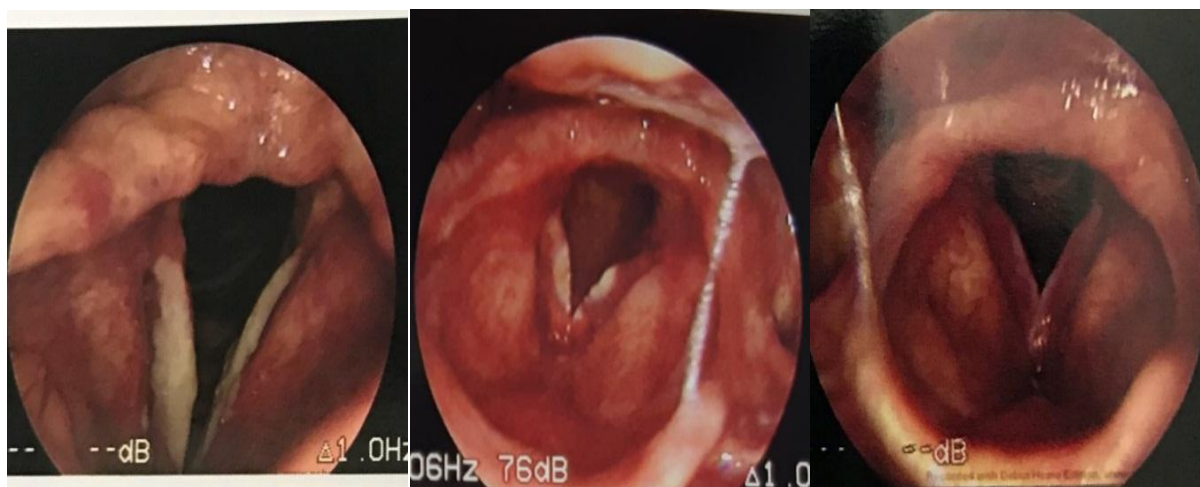


Figure 1. Different pseudomembrane characteristics seen on endoscopic imaging.

#### 3.2.2. Tissue layer characteristics

Inflammation of the tissue layer is the most common characteristics (62,5%) of the samples. Swelling can be seen in more than half of the study patients (56,3%). Shallow ulceration only takes up less than one fourth of the studied patients (22,9%).

#### 3.2.3. Placement of the fungal pseudomembrane

All of the patients have pseudomembrane on the vocal cords; however, it is mostly seen bilaterally (85,4%), and rarely on just one side of the vocal cord (14,6%). Other than the vocal folds, the pseudomembrane can spread to the epithelium layer of the subglottis (6,3%), even down to the trachea (2,1%).

#### 3.2.4. Other abnormalities on Endoscopic imaging

The most common disorder detected in patients with fungal laryngitis is oropharyngitis (68,8%), while rhinopharyngitis is rarely seen (4,2%).

### 3.3. Stroboscopic imaging

All patient has normal adduct-abduct movement of the vocal cords (100%). However, the mucosal wave formation is only found in less than half of the patients (47,9%). The vocal cords, most of the time, close incompletely during the closing phase (87,5%). There is a low chance of laryngospasm being seen on stroboscopic imaging (6,3%).

3.3.1. Mucosal wave's characteristics

Most of the patients have decreased mucosal wave's frequency (91,3%). Moreover, patients with fungal laryngitis are more likely to have asymmetrical wave (60,9%). Patients with fungal laryngitis can also have non-isometric adduction posture of the vocal cords (47%) and diverse periodicity (39,1%).

3.4. Fungal identification

Fungal identification test doesn't have a high success rate (41,7%). The rest either had their laboratory test returned negative, or they weren't able to do the test. One of the main reasons is the insufficient amount of pseudomembrane for specimen extraction.

Table 1. Fungal identification results in studied patients

|                       | number of patients (n=48) | percentage (%) |
|-----------------------|---------------------------|----------------|
| Fungal identification |                           |                |
| Non-positive          | 28                        | 58,3           |
| Positive              | 20                        | 41,7           |

To compare clinical and paraclinical traits, we separate the studied patients into two groups: (1) The patients with positive results and (2) with non-positive results in fungal identification,

portrayed by Table 1. Group (1) includes the studied patients who have positive results in fungal identification, with 20 (41,67%) out of 48 patients in total. Group (2) includes the rest of the patients, with 28 (58,33%) out of 48 patients in total.

3.5. Comparison between 2 groups: Positive and Non-positive group

3.5.1. Clinical symptoms

According to table 2, the Positive group experience more severe dysphonia, with moderate and severe dysphonia shares the same rate (45%), with only 10% of the studied patients in the positive group have mild dysphonia. Instead, the Non-positive group are more likely to experience moderate dysphonia (53,6%), followed by severe and mild dysphonia, with the prevalence of 25% and 21,4% respectively (p>.05). Aphonia are similarly seen between both groups, with 25% and 32,1% respectively (p>.05). The patients in the Positive group are more likely to visit the hospital earlier, with 55% go to the hospital right in the first month of symptom development. However, the difference in the Non-positive group is clear, more than half (57,1%) will go to the hospital after 3 months, and only 17,9% visit the doctor within 1 month of symptom development (p<.05).

Table 2. Comparison between 2 groups: Dysphonia severity and duration

|                  | Positive (n=20) |      | Non-positive (n=28) |      | p-value |
|------------------|-----------------|------|---------------------|------|---------|
|                  | N               | %    | N                   | %    |         |
| <b>Dysphonia</b> |                 |      |                     |      |         |
| Mild             | 2               | 10,0 | 6                   | 21,4 | 0,29    |
| Moderate         | 9               | 45,0 | 15                  | 53,6 |         |
| Severe           | 9               | 45,0 | 7                   | 25,0 |         |
| <b>Duration</b>  |                 |      |                     |      |         |
| < 1 month        | 11              | 55,0 | 5                   | 17,9 | 0,02    |
| 1 – 3 months     | 4               | 20,0 | 7                   | 25,0 |         |
| > 3 months       | 5               | 25,0 | 16                  | 57,1 |         |
| <b>Aphonia</b>   |                 |      |                     |      |         |
| No               | 15              | 75,0 | 19                  | 67,9 | 0,59    |
| Yes              | 5               | 25,0 | 9                   | 32,1 |         |

3.5.2. Endoscopic imaging characteristics

Pseudomembrane characteristics

In the Positive group, two third of patients have a thicker, paste-like pseudomembrane layer, one fourth of them have a thinner layer,

meanwhile there is only 10% of them have patchy, friable pseudomembrane. On the other hand, in the Non-positive group, exactly half of them have a thicker pseudomembrane, the other half have either a thin or a patchy layer ( $p>.05$ ).

Fungal pseudomembrane placement

Table 3. Comparison between 2 groups: Fungal pseudomembrane placement

|             | Positive (n=20) |      | Non-positive (n=28) |      | p-value |
|-------------|-----------------|------|---------------------|------|---------|
|             | N               | %    | N                   | %    |         |
| Vocal cords |                 |      |                     |      |         |
| One side    | 1               | 5,0  | 6                   | 21,4 | 0,11    |
| Both sides  | 19              | 95,0 | 22                  | 78,6 |         |
| Subglottis  |                 |      |                     |      |         |
| Yes         | 3               | 15,0 | 0                   | 0    | 0,03    |
| No          | 17              | 85,0 | 28                  | 100  |         |
| Trachea     |                 |      |                     |      |         |
| Yes         | 1               | 5,0  | 0                   | 0    | 0,23    |
| No          | 19              | 95,0 | 28                  | 100  |         |

The pseudomembrane placements are 100% on the vocal cords. The prevalence of the pseudomembrane covering the vocal cords bilaterally in the Positive group and its counterpart are 95% and 78,4% respectively ( $p>.05$ ). However, in the positive group, the pseudomembrane spreads to the subglottis (15%) ( $p<.05$ ), the trachea (5%), and none in the Non-positive group.

Tissue layer characteristics

We have found patients in Positive group mostly have inflammation of the tissue layer under the pseudomembrane (85%), meanwhile less than half of patients in Non-positive group

(46,4%) have this characteristic ( $p<.05$ ). However, Non-positive group are more prone to swelling tissue, edema, especially the vocal cords (67,9%) than Positive group (40%) ( $p\le.05$ ). Endoscopic imaging has shown images of shallow, ulcerated tissue found under the pseudomembrane in both groups with similar prevalence (25,0% and 21,4% respectively) ( $p>.05$ ).

Other disorders detected

7,1% of patients in Non-positive group have rhinopharyngitis, opposite to none in the Positive group. On the other hand, oropharyngitis is more commonly seen in both groups, with the similar prevalence (70,0% and 67,9% respectively).

Table 4. Comparison between 2 groups: Tissue layer under fungal pseudomembrane

|           | Positive (n=20) |      | Non-positive (n=28) |      | p-value |
|-----------|-----------------|------|---------------------|------|---------|
|           | N               | %    | N                   | %    |         |
| Inflamed  |                 |      |                     |      |         |
| Yes       | 17              | 85,0 | 13                  | 46,4 | 0,03    |
| No        | 3               | 15,0 | 15                  | 53,6 |         |
| Swollen   |                 |      |                     |      |         |
| Yes       | 8               | 40,0 | 19                  | 67,9 | 0,05    |
| No        | 12              | 60,0 | 9                   | 32,1 |         |
| Ulcerated |                 |      |                     |      |         |
| Yes       | 5               | 25,0 | 6                   | 21,4 | 0,77    |
| No        | 15              | 75,0 | 22                  | 78,6 |         |

### 3.5.3. Stroboscopic imaging characteristics

#### General characteristics

Overall, the patients are more likely to lose the mucosal wave (60%) in the Positive group than in the Non-positive group (53,6%) ( $p>.05$ ). 80% of the patients have abnormalities in the

closing phase of the vocal cords in the Positive group, and 92.9% of the patients in the Non-positive group (92,9%) ( $p>.05$ ). There is a low chance of laryngospasm showing up on stroboscopic imaging, more often in the Positive group (10%) than the Non-positive positive group (3,6%).

Table 5. Comparison between two groups: Mucosal wave's characteristics

|                           | Positive (n=8) |      | Non-positive (n=15) |      | p-value |
|---------------------------|----------------|------|---------------------|------|---------|
|                           | N              | %    | N                   | %    |         |
| Mucosal wave              |                |      |                     |      |         |
| Frequency of mucosal wave |                |      |                     |      |         |
| Normal                    | 0              | 0,0  | 2                   | 13,3 | 0,28    |
| Decreased                 | 8              | 100  | 13                  | 86,7 |         |
| Symmetry                  |                |      |                     |      |         |
| Asymmetrical              | 4              | 50,0 | 10                  | 66,7 | 0,43    |
| Symmetrical               | 4              | 50,0 | 5                   | 33,3 |         |
| Adduction posture         |                |      |                     |      |         |
| Isometric                 | 5              | 62,5 | 7                   | 46,7 | 0,46    |
| Non-isometric             | 3              | 37,5 | 8                   | 53,3 |         |
| Periodicity               |                |      |                     |      |         |
| Consistent                | 4              | 50,0 | 10                  | 66,7 | 0,43    |
| Diverse                   | 4              | 50,0 | 5                   | 33,3 |         |

Comparing the mucosal wave's characteristics between the patients in the two group, most patients have lower frequency (91,3%). In the Positive group, all of the patients have lower frequency than normal, while in the Non-positive group, there are 13,3% of patients have normal frequency ( $p>.05$ ). Meanwhile, the symmetry of the vocal cords of the patients in two groups is insignificantly different. The number of asymmetrical vocal cords takes up half (50%) in the Positive group, but two-third in the Non-Positive group (66,7%). This is the same for the periodicity between two groups ( $p>.05$ ). For adduction posture, the patients in the Positive group have more isometric adduction posture than the Non-positive group, with a prevalence of 62,5% and 46,7% respectively ( $p>.05$ ).

## 4. Discussion

### 4.1. Clinical symptoms, endoscopic imaging and stroboscopic imaging characteristics

#### 4.1.1. Clinical symptoms

The main reason for hospital admission in patients with fungal laryngitis is dysphonia. All of the patients in the study have dysphonia, which fits exactly with other studies in Vietnam and worldwide [3-5]. There are levels of dysphonia: mild, moderate and severe before aphonia. Two third of the patients suffer from mild to moderate level of dysphonia, with little to noticeable changes in voice. This sometimes is the only symptom, and it has very little negative impact on their daily life. Thus, it is very likely that most patients would ignore, wait

out, or self-treat the symptom with home remedies or generic medication, until dysphonia worsens, or other symptoms start to develop. Aphonia is the most severe characteristics of dysphonia. The patient suffers from completely loss of voice. Patients who developed aphonia will visit the hospital right within the first week (92,8%). Other symptoms include coughing (64,6%), foreign body sensation (50%). Our study shares a similar finding with previous studies, with coughing ranging from 56% to 61%, and foreign body sensation ranging from 39% to 58,1%. Patients mostly experience dry, intermittent cough. The severity of the symptoms depends on the severity of fungal laryngitis, and the amount of fungal pseudomembrane on their vocal cords. Dyspnea and fever are rarely seen (2,1%), Thai recorded no case with fever [4], while Luong found 10,58% of the studied patients had fever before admitting to the hospital [3].

#### 4.1.2. Endoscopic imaging

The amount of biofilm seen on endoscopic imaging can differ, but it is more likely to be growing thick (56,3%), instead of being a thin, patchy layer. The fungal biofilm occurs most notably on the true vocal folds. Our study came back with 100% of patients having fungal biofilm on their vocal cords, mostly on both sides (85,4%), similar to other studies of the same field [3, 4]. This also explains dysphonia experienced by 100% of the studied patients. Other than the vocal folds, the biofilm can be found on the epithelium layer of the subglottis (6,3%), with one instance spreading down to the trachea (2,1%). While Luong recorded bigger spreads of pseudomembrane adjacent to the vocal cords like the false vocal cords (13,46%), epiglottis (9,62%) [3], no previous studies have found the pseudomembrane spreading down to the trachea before [3,4].

In all of the studied patients, inflammation of the tissue layer is the most common, seen in 62,5% of the sample. The foremost characteristic of the damaged tissue layer is the increase of the blood flow, causing erythema. Swelling is the result of inflammation, with exceeding fluid in

the tissue layer. Swelling can be seen in more than half of the study patients, with the prevalence of 56,3%. Shallow ulceration is in 22,9% of the studied patients. Usually, the ulceration can only be seen after pseudomembrane extraction, especially in patients with a thick layer of pseudomembrane covering the tissues. Our result fits with Luong [3] and her study on fungal laryngitis, with a similar result of 22% having shallow ulceration. However, her study concluded to have found necrotic tissues in 28% of the patients, whereas we could not record any case of bleeding or necrotic tissue layer under the pseudomembrane.

#### 4.1.3. Stroboscopic imaging

All of the studied patients have normal vocal cords' mobility. Some studies have shown marked stiffness in the vocal cords pre-fungal treatment [8]. However, the mucosal wave formation is more likely to be lost (52,1%). In studied patients, most of them have a thick layer of pseudomembrane covering some parts or all of the surface of the vocal cords, so the fungal pseudomembrane can alter its structure, causing abnormalities – in this case, the complete loss of the mucosal wave. Some patients retain the mucosal wave however, the characteristics vary. Most patients have a lower frequency (91,3%). Three out of five patients with mucosal wave have asymmetrical movements of the vocal cord (60,9%). Only 39,1% remains symmetrical. The number of studied patients with isometric adduction posture and non-isometric adduction posture is almost the same, with 52,2% and 47,8% respectively. Three out of five patients with mucosal wave still have a consistent periodicity (60,9%), and only two out of five have recorded a diverse periodicity.

### 4.2. Clinical, paraclinical characteristics comparison between 2 groups: Positive and Non-positive

#### 4.2.1. Fungal identification

Fungal identification still has a less than half positive rate (41,7%). Two identified pathogenic



fungi in the study are *Aspergillus fumigatus* (90%) and *Candida albicans* (10%).

#### 4.2.2. Clinical symptoms

**Severity:** Between two groups, the Positive group experience more severe dysphonia, with moderate and severe dysphonia shares the same rate (45%). Contrary, the Non-positive group are more likely to experience moderate dysphonia (53,6%), followed by severe and mild dysphonia, with the prevalence of 25% and 21,4% respectively. The amount of fungal pseudomembrane can explain this difference in severity, however, it is clinically insignificant ( $p>.05$ ).

**Duration:** Between two groups, the Positive group are more likely to go to the hospital earlier, with 55% go to the hospital right in the first month of symptom development. However, more than half (57,1%) of the patients in the Non-positive will go to the hospital after 3 months ( $p<.05$ ). The severity of dysphonia directly contributes to this difference in duration.

#### 4.2.3. Endoscopic imaging

Overall, there are slight differences in the characteristics of the fungal pseudomembrane. In the Positive group, two-third of patients have a thicker, paste-like pseudomembrane layer, one fourth of them have a thinner layer, meanwhile, there is only 10% of them have patchy, friable pseudomembrane. On the other hand, in the Non-positive group, exactly half of them have a thicker pseudomembrane, the other half have either a thin or a patchy layer ( $p>.05$ ). All of the patients have the pseudomembrane on their vocal cords, but only the patients in the Positive group have fungal pseudomembrane spreading to the subglottis (15%) ( $p<.05$ ) and the trachea (5%). The amount of fungal pseudomembrane directly affects the physiology of the vocal cords, causing dysphonia in 100% of the patients, and the placement explains why there are more cases of severe dysphonia in the Positive group than in the Non-positive group.

We have found patients in Positive group mostly have inflammation of the tissue layer

under the biofilm (85%), meanwhile less than half of patients in Non-positive group (46,4%) have this characteristic ( $p<.05$ ). However, Non-positive group are more prone to swelling tissue, edema, especially the vocal cords (67,9%) than Positive group (40%) ( $p\le.05$ ). Endoscopic imaging has shown images of shallow, ulcerated tissue found under the biofilm in both groups with a similar prevalence.

#### 4.2.4. Stroboscopic imaging

The mucosal wave is an important characteristic in laryngeal stroboscopic imaging. The patients are less likely to retain the mucosal wave (40%) in the Positive group, meanwhile more than half of the Non-positive group still have it (53,6%) ( $p>.05$ ). This study found some differences in the mucosal wave's stroboscopic characteristics of the two groups. The alteration of the fungal pseudomembrane on the vocal cords affects its physiology, but due to the prolonged effects of the pathogenic fungi on patients in both groups, the differences were clinically insignificant ( $p>.05$ ).

## 5. Conclusion

Within 6 months, from August 2019 to February 2020, a total of 48 patients was studied, all of them were diagnosed with fungal laryngitis using direct microscopy:

All patients have dysphonia (100%). Other symptoms include coughing (64,6%), foreign body sensation (50%). Dyspnea and fever are rarely seen (2,1%).

### 5.1. Endoscopic imaging

The fungal pseudomembrane is usually a white, whitish grey, thick layer (56,3%) covering the vocal cords (100%), more likely to cover both sides (85,4%). It can spread down to the subglottis (6,3%) and the trachea (2,1%). The epithelium layer under the fungal pseudomembrane are inflamed (62,5%), swollen (56,3%) and ulcerated (22,9%). The patients with fungal laryngitis have a high prevalence of contracting oropharyngitis (68,6%).

## 5.2. Stroboscopic imaging

The vocal cords still retain their mobility (100%). The mucosal wave formation can still be seen (47,9%), albeit with abnormalities, such as lower frequency (91,3%), asymmetrical movement of the vocal cords (60,9%), non-isometric adduction posture (47,8%), diverse periodicity (39,1%). The vocal cords fail to completely close in the closing phase of the glottal cycle (87,5%), and laryngospasm can be detected on videostroboscopy (6,3%).

## 5.3. Fungal identification

Fungal culture and identification should be implemented as one of the definitive diagnostic methods of fungal laryngitis, despite having a less than half positive rate (41,7%). Two identified pathogenic fungi are *Aspergillus fumigatus* (90%) and *Candida albicans* (10%).

## 5.4. Clinical, paraclinical characteristics comparison between 2 groups: Positive and Non-positive

### 5.4.1. Clinical symptoms

The patients in two group experience somewhat similar severity of dysphonia. The patients in Positive group will visit the hospital right in the first month (55,0%), three times higher than in the Non-positive group (17,9%).

### 5.4.2. Paraclinical characteristics.

#### Endoscopic imaging.

The patients in two group have similar pseudomembrane characteristics with different pseudomembrane placement. The pseudomembrane spreads down to subglottis (15%) ( $p < .05$ ) and trachea (5%) in the Positive group. The tissue layer under the pseudomembrane of the studied patients in Positive group are more likely to be inflamed, erythema (85%) than the Non-positive group (46,4%). The patients in the Non-positive group are more prone to swelling (67,9%) ( $p < .05$ ).

#### Stroboscopic imaging.

There are similarities and differences in stroboscopic imaging between two groups. In

both groups, the patients have a high chance of abnormalities in the closing phase of the vocal cords, with a prevalence of 80% and 92.9%; a similar symmetry, and a similar periodicity of the mucosal wave. However, the patients are more likely to lose the mucosal wave (60%) in the Positive group than in the Non-positive group (46.4%). The patients are more likely to have isometric adduction posture in the Positive group (62.5%) than in the Non-positive group (46.7%). Some of the patients in the Non-positive group still have a normal vocal cords' amplitude (13.3%) ( $p > .05$ ).

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