



Noninvasive Approaches to Supraglottic and Vocal Cord Dysfunction

Yunus Emre Tunçdemir and Kamil Cintan

Introduction

Ventilation is of vital importance to human beings. Ventilation is defined as the delivery of the outside air to the alveoli and the discharge of the alveolar air to the outside through the respiratory tract. Thus, oxygenation of the cells and elimination of carbon dioxide from the body are provided. The respiratory system begins with the nose and mouth and ends with the alveoli [1].

The larynx is a very important anatomical component of this system. Pathologies of the larynx may present with various clinical manifestations, such as congenital anomaly obstruction. These pathologies can cause very different clinical presentations like hoarseness, odynophagia, and even death [2].

In case of moderate to severe respiratory failure, some medical intervention may be required. This intervention can be invasive and noninvasive. The noninvasive method is to provide ventilation support without endotracheal intubation [3]. In noninvasive approaches, supportive ventilation is usually provided with a mask or similar device [4].

Mechanical ventilators have become an integral part of noninvasive interventions. In recent years, further progress has been made with different complex modes of microprocessor mechanical ventilators. Some modes of advanced mechanical ventilators are also used in noninvasive approaches.

Y. E. Tunçdemir (✉)

Anesthesiology and Reanimation Clinic, The Ministry of Health, Ankara Training and Research Hospital, Ankara, Turkey

K. Cintan

Anesthesiology and Reanimation Clinic, Bitlis Tatvan State Hospital, Bitlis, Turkey

Supraglottic and Vocal Cord Pathologies

- Congenital anomalies
- Laryngeal acute infections
- Chronic infections
- Inflammatory diseases causing laryngeal involvement
- Laryngeal malignancies
- Vocal cord paralysis

Congenital Anomalies

The upper airway extends from the nasal opening to the subglottis. Different congenital anomalies may occur along the tract which may cause anatomical or functional obstruction. Laryngomalacia, vocal cord paralysis, and subglottic stenosis are the most common congenital anomalies. Laryngomalacia is the most common congenital laryngeal anomaly. Inspiratory stridor usually develops 2 weeks after birth and resolves by 18 months of age.

Most cases can be managed with mindful nutrition support. Clinically severe cases require surgical intervention. Bilateral vocal cord paralysis is usually idiopathic. In severe cases, endotracheal intubation and tracheostomy may be required. Congenital subglottic stenosis is the third most common laryngeal anomaly. It is defined as a diameter less than 4 mm in a premature baby. It is the most common laryngeal anomaly requiring tracheotomy [5].

Laryngeal Acute Infections

Acute Laryngotracheobronchitis

Laryngotracheobronchitis is inflammation of the larynx, trachea, and bronchi. Usually, viruses are responsible for the etiology. Although it is more common in children, it can rarely be seen in adults [6–8]. On physical examination, the vocal cords are edematous, and intense purulent secretions can be seen in the larynx and trachea. Hoarseness and dyspnea are the main symptoms [9]. In treatment, oxygen support, hydration, and if necessary epinephrine can be given. Dexamethasone can be used in persistent acute respiratory failure. If secondary bacterial infection is suspected, antibiotics should be added to the treatment. Intubation may be required in 1% of patients [10].

Acute Epiglottitis

Acute epiglottitis, also known as acute supraglottitis, is a life-threatening mortal disease due to the risk of laryngospasm and irreversible loss of the airway. There is edema due to inflammation in the epiglottis. Mortality is higher in adults than in children. The most common causative agent is *Haemophilus influenzae* type b. Fever, dysphonia, odynophagia, dysphagia, and dyspnea are the most common

symptoms [11]. The patient should be hospitalized, and antibiotherapy, hydration, and anti-inflammatory treatment should be applied. If the airway is obstructed, non-invasive or invasive airway relief-opening maneuvers should be tried depending on the severity of the disease [12].

Laryngeal Diphtheria

Diphtheria caused by *Corynebacterium diphtheriae* is an extremely rare disease due to the widespread use of the diphtheria vaccine. It is characterized by gray membranes that may bleed when lifted. The presence of membranes in the larynx can lead to acute airway obstruction. Penicillin group antibiotics and antitoxins are used in treatment [13].

Chronic Infections

Laryngeal Tuberculosis

Laryngeal tuberculosis is rare. It may be primary laryngeal tuberculosis or secondary to pulmonary tuberculosis. Patients usually present with symptoms such as hoarseness, dysphagia, fever, or localized pain [14]. Laryngeal tuberculosis commonly involves the supraglottic region. It may cause severe dyspnea depending on the extent of the lesions. Long-term antituberculosis treatment is required [15].

Laryngeal Syphilis

Syphilis is a sexually transmitted disease caused by *Treponema pallidum*. Laryngeal syphilis is rare. Granulomatous diseases such as tuberculosis, sarcoidosis, and laryngeal carcinoma take place in differential diagnoses [16]. Syphilis causes ulcers, nodules, and erythematous plaques in the larynx. In untreated cases, it can lead to complications such as laryngeal scarring and chronic chondritis, which can cause airway obstruction. High-dose penicillin is used in treatment [17].

Laryngeal Leprae

Leprae caused by *Mycobacterium leprae* is a disease that classically affects the skin and peripheral nerves. Involvement of the testis, eye, lymph node, liver, spleen, bone, bone marrow, muscle, and larynx is rare. Laryngeal involvement presents with cough, hoarseness, shortness of breath, and rarely life-threatening airway obstruction. It causes erythematous and edematous nodular lesions. Especially epiglottis and glottis are affected. Long-term dapsone and rifampicin treatment is used [18, 19].

Laryngeal Fungal Infections

Primary fungal laryngitis is extremely rare [20]. Symptoms are usually nonspecific. Fungal laryngitis is often confused with leukoplakia and other granulomatous lesions of the larynx [21]. Clinical conditions such as long-term antibiotic use, inhaled steroid use, and laryngopharyngeal reflux may predispose to fungal infections of the larynx. It may present with hoarseness, odynophagia, and dyspnea due

to laryngeal edema and granulations. Fungal laryngitis often mimics granulomatous disease, gastroesophageal reflux disease, and malignant lesions [22]. The most commonly isolated fungi are *Candida*, *Aspergillus*, *Cryptococcus*, *Histoplasma capsulatum*, and *Blastomyces dermatitidis*. Mucosal ulcers, intense edema, and inflammation are seen in tissue. If untreated, it can cause mortal airway obstruction [23].

Prompt treatment and appropriate precautions prevent the morbidity of fungal laryngitis. Laryngeal fungal infection is treated with antifungal drugs and the elimination of risk factors [24]. Fluconazole, itraconazole, ketoconazole, topical nystatin, or intravenous amphotericin B is used for the primary treatment of fungal laryngitis [25].

Inflammatory Diseases Causing Laryngeal Involvement

Rheumatoid Arthritis

Rheumatoid arthritis is a common autoimmune disease affecting 3% of the adult population and 35 per 100,000 of the pediatric population [26, 27]. It is a devastating systemic disease that affects all joints in the body. The course of the disease is characterized by remissions and exacerbations. It is characterized by the formation of both articular and extra-articular lesions, especially small joints [28, 29].

On laryngoscopic examination, arytenoids are edematous and hyperemic. In the chronic phase, mucosal thickening and arytenoid fixation can be seen [30]. Although it can be asymptomatic, symptoms such as odynophagia, dysphagia, changes in voice quality, side ear pain, dyspnea, and stridor can also be seen [31].

Amyloidosis

Amyloidosis includes a heterogeneous group of diseases characterized by the accumulation of amyloid protein in various organs. Extracellular accumulation of amyloid leads to organ damage and failure [32]. Larynx involvement is rare. Vocal cords are most commonly involved. Hoarseness and stridor are the most common symptoms [33].

Systemic Lupus Erythematosus

Systemic lupus erythematosus (SLE) is an autoimmune collagen vascular disease that causes widespread damage to many organs. Few studies have been reported on the laryngeal involvement of SLE [34]. Laryngeal involvement in systemic lupus erythematosus (SLE) can range from mild ulcerations to airway obstruction due to edema, to vocal cord paralysis to necrotizing vasculitis [35]. If it causes a limitation of movement in the vocal cords, respiratory distress may occur. High-dose steroids are the main treatment [36].

Sarcoidosis

Sarcoidosis is common in young women. The most frequently involved organs are lungs, hilar-mediastinal lymph nodes, and the liver. It is also a chronic

granulomatous disease that tends to involve the eyes, skin, bones, and nervous system. Laryngeal sarcoidosis is rare. It can cause hoarseness, dysphagia, dyspnea, and life-threatening airway obstruction [37]. Corticosteroids are helpful in treatment. Rarely, a tracheotomy may be required due to severe dyspnea [38].

Laryngeal Malignancies

Laryngeal cancers account for one-third of head and neck cancers. It is an important cause of morbidity and mortality [39]. Laryngeal cancers can develop from any of the epithelial and non-epithelial structures of the larynx. Squamous cell carcinoma is the most common histological variant and accounts for 85–95% of all malignant tumors of the larynx [40]. Verrucous carcinoma, adenoid cystic carcinoma, or sarcomas may occur less frequently. Larynx cancers may originate from potentially malignant leukoplakia or erythroplakia [41]. It is more common in men older than 40 years. Male predominance has been considered to be associated with increased exposure to risk factors. Although the etiology is unknown, it is considered it could be strongly associated with frequent exposure of the larynx mucosa to a wide variety of ingested and inhaled exogenous carcinogenic agents. Smoking and alcohol consumption are the two most important risk factors for the development of laryngeal squamous cell carcinoma [42, 43].

Symptoms may differ according to the localization of the lesion. Dysphagia in supraglottic laryngeal cancers, hoarseness in glottic cancers, and shortness of breath in subglottic cancers are the main symptoms. Also, there may be symptoms such as odynophagia, ear pain, and swelling in the neck [44].

In early-stage disease, treatment with surgery or radiation monotherapy is highly curative. However, advanced laryngeal cancer has a poor prognosis and requires multimodal treatment. Speech rehabilitation methods have been developed for patients requiring laryngectomy [39].

Bilateral Vocal Cord Paralysis

The vocal cords have two functions: phonation and protection of the lower airways by the glottis. Symptoms vary depending on the underlying etiology of bilateral vocal cord paralysis and the position of the vocal cords. Management of the disease depends on the underlying etiology and vocal cord position [45].

Benninger et al. estimated that etiologically, bilateral vocal cord paralysis cases can be attributed to surgical trauma in 44%, malignancies in 17%, secondary to endotracheal intubation in 15%, neurological disease in 12%, and idiopathic causes in 12% [46]. Although surgical intervention is indicated in patients with bilateral vocal cord paralysis, treatment of the underlying etiology is essential. Corticosteroids are effective in sarcoidosis, polychondritis, and Wegener's granulomatosis. Regulation of glucose is mandatory to prevent neuropathy development in patients with diabetes mellitus. Reflux treatment is usually recommended during the

recovery period to minimize unwanted stimulation of the larynx. More than 50% of children will spontaneously improve their symptoms in the first 12 months of life [47].

If the patient has increased respiratory effort or significant stridor, surgical intervention may be required to improve the airway, even if spontaneous recovery is expected. Depending on the course of the prognosis, a reversible procedure such as botulinum toxin injection or tracheostomy should be performed. If minimal or no improvement is expected, laryngeal surgery may be considered to decannulate the patient [48].

In glottic and supraglottic dysfunctions, regardless of the etiology, the patient may present with acute respiratory failure. In this case, noninvasive approaches can be used.

Noninvasive Approaches

Acute Oxygen Therapy

Oxygen is widely available in the hospital and nonhospital medical institutions. It can be lifesaving when used correctly and on time. But it should never be forgotten that it is a drug. The use of oxygen should be decided by the clinician, because oxygen has adverse effects like any other drug [49]. The most common indication for oxygen therapy is hypoxemia. The main goal is to correct hypoxia at the tissue level. Oxygen can be given by nasal cannula, simple oxygen mask, oxygen mask with reservoir, nasal or oropharyngeal catheter, tracheostomy mask, diffuser mask, or proportional gas distribution mask [50].

Venturi Mask

A Venturi mask provides a constant mixing of room air and oxygen. Thus, it allows the patient to breathe oxygen at a constant concentration. Gas flow in this mask is usually greater than the patient's inspiratory gas flow. Oxygen reaches the patient without being affected by the patient's respiratory rate and inspiratory airflow rate. It consists of a simple mask and different colored adapters that allow different amounts of oxygen to pass through. Different ratios of FIO_2 can be provided with these adapters [50].

High Flow Nasal Cannula (HFNC) Oxygen Therapy

High flow nasal cannula (HFNC) oxygen therapy is performed using an air/oxygen mixer, active humidifier, single heated tube, and nasal cannula. It is an application

that can deliver sufficiently heated and humidified medical gas at flows up to 60 L/min. Although few large randomized clinical trials have been conducted, particularly in adults, HFNC is being considered alternative respiratory support in critically ill patients. Several published reports have shown that HFNC reduces respiratory effort and tachypnea. However, exact indications for HFNC and criteria for initiation or discontinuation of therapy remain unclear. Despite these uncertainties, HFNC has emerged as an innovative and effective method for the early treatment of adults with various respiratory failures [51].

Newly published data suggest that HFNC should be used as a potentially superior alternative to conventional simple oxygen masks in patients with acute respiratory failure without hypercapnia [52].

Noninvasive Mechanical Ventilation Method

Noninvasive mechanical ventilation (NIMV) is an application of external ventilation without intubating a patient. It is increasingly used in acute and chronic respiratory failure. NIMV provides ventilation support to the patient through the upper airway with a mask or similar device [4]. Noninvasive mechanical ventilation is an effective ventilation practice that is frequently used.

Face masks are gold standard equipment for NIMV. Nasal or mouth ventilation can be done with masks of different sizes [53].

Mechanical ventilators provide ventilation with bilevel positive airway pressure (BIPAP) modes that can determine inspiratory/expiratory pressure levels and continuous positive airway pressure (CPAP) [54].

NIMV should primarily be considered as an alternative to avoiding endotracheal intubation. The use of NIMV as an alternative to tracheal intubation in patients with acute respiratory failure has increased in recent years [4]. As a result of the studies, the noninvasive approach is as effective as the invasive approach, and if there are no contraindications, NIMV should be applied first to all patients presenting with acute respiratory failure [55, 56].

Conclusion

Pathologies that cause dysfunction in the glottis and supraglottis, which are important components of the larynx, were discussed. The etiology of these pathologies may have different causes such as congenital anomalies and paralysis. Patients may present with different clinical symptoms.

It was discussed which noninvasive interventions can be used in order to ensure airway safety in dysfunctions that cause moderate to severe respiratory failure. The types of noninvasive interventions used to ensure airway safety in dysfunctions leading moderate to severe respiratory failure were discussed.

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