

Diagnosis of Voice Disorders

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Abstract

In diagnosing voice disorders, a description is obtained of the patient's chief complaints, present illness, degree and quality of hoarseness, past history, occupation, and voice-related daily habits or social background. Useful in this are two simple-to-perform examinations that do not require special instruments: auditory-perceptual evaluation using the GRBAS (Grade, Roughness, Breathiness, Asthenia, Strain) scale and measurement of the maximum phonation time (MPT).

Conditions which cause hoarseness include vocal cord polyps, vocal cord nodules, recurrent nerve paralysis, and laryngeal cancer. In cases where the degree of hoarseness is high or does not improve in two or more weeks, the patient is referred to a physician specializing in ear, nose, and throat disorders. Many laryngeal disorders can be easily diagnosed through observation of the larynx using indirect laryngoscopy or laryngeal endoscopy.

Cases which call for particular care include those in which the patient's chief complaint is breathy hoarseness and they have been treated by a general practitioner but in actual fact the patient has recurrent nerve paralysis caused by thyroid cancer; and those in which the patient has a high degree of hoarseness and is being treated for bronchial asthma when in fact they have laryngeal cancer.

In the case that a patient has a muffled voice and is complaining of a sore throat and respiratory discomfort, there is a possibility that the patient has an acute epiglottitis, a peritonsillar abscess, or another airway stenosis and s/he is referred immediately to a hospital where there are full-time physicians specializing in ear, nose, and throat disorders.

Key words Voice disorders, Diagnosis, Laryngeal endoscopy, Hoarseness

Introduction

The generation of vocal sounds is generally referred to as “phonation,” while the action of generating word sounds is referred to as “speech” or “articulation.” The organs involved in phonation and/or speech are the oral cavity, nasal cavity, pharynx, larynx, trachea, bronchus, lungs, thorax, and diaphragm; these multiple organs work in a coordinated manner to perform complex integrated movements.

In the phonation mechanism, in response to a command to vocalize from the cerebral cortex, the respiratory muscles contract and expiratory flow from the lungs is moved upwards towards the trachea and larynx as a power source, while at

the same time both vocal cords are adducted through the recurrent laryngeal nerve, closing the glottis. The expiratory flow raises the subglottal pressure, causing the vocal cords to vibrate and generate sound, which passes through the vocal tract (which acts as a resonance chamber) to produce vocal sound. Consonants and vowels are articulated, becoming speech, and are generated continuously to produce spoken words. If any part of these phonation control or motion mechanisms becomes impaired, a voice disorder occurs.¹

The clinical state of voice disorders can be classified from phonation mechanisms as follows: 1) glottal closure disorder; 2) affected vocal cord stiffness; 3) vocal cord asymmetry; 4) respiration/resonance chamber disorder; and 5) psy-

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Table 1 Points for taking medical histories

1) Chief complaints (hoarseness, abnormal voice pitch, abnormal voice strength, wavering voice, etc.)
2) Present illness (acute/chronic, time since onset of symptoms, treatment history, etc.)
3) Contributing factors (voice misuse, operations, external injuries, common cold, hormone therapy, stress, etc.)
4) Complications (heartburn, acid reflux, laryngopharynx pain, respiratory difficulties, miswallowing, etc.)
5) Past history (neurological disorders, psychological disorders, endocrine disorders, etc.)
6) Occupation (teacher, singer, bus tour guide, announcer, sports instructor, nursery teacher, Buddhist monk, restaurant employee, service industry employee, etc.) and/or hobbies (<i>yokyoku</i> or <i>karaoke</i> singing)
7) Oral medication (psychotropic drugs, hormonal drugs, ACE inhibitory drugs)
8) Lifestyle habits (smoking history, drinking history, etc.)
9) Drug allergies

[Extracted and modified from the Japan Society of Logopedics and Phoniatrics (editor).]

chological factors. Of these, 1) to 3) are abnormalities in the shape and motility of the larynx and are the main causes of voice disorders. When examining patients who are complaining of voice disorders, first of all they are asked about their main complaints, medical history, degree and quality of hoarseness, past history, occupation, and daily lifestyle habits and social background related to phonation, and possible causes of the voice disorder are estimated. A physician who is a voice specialist can estimate the patient's condition just by listening to their voice. Furthermore, performing indirect laryngoscope or laryngeal endoscopy enables the diagnosis of many laryngeal disorders.

Initial responses to patients by general practitioners differ according to whether the disorder they have is benign or malignant, acute or chronic. Although it is thought that patients with benign disorders such as acute corditis vocalis with a common cold are in many cases initially treated at internal medicine clinics, in cases where there is a high degree of hoarseness and the hoarseness has not improved in two weeks or more, the patient is referred to a physician specializing in ear, nose, and throat disorders. Loosely examining a patient without looking at the larynx can result in malignancies such as laryngeal cancer and thyroid cancer being overlooked. Of course, patients with acute epiglottitis or other airway stenotic disorders should be referred to a specialist physician urgently.

Diagnosis of General Practitioners for Voice Disorders

Taking the patient's medical history

With regard to the patient's chief complaints, they are asked about how phonation has been impaired. It is important to obtain a present illness including the time since onset of the symptoms and treatment at other hospitals. With regard to contributory factors, the patient is asked about voice misuse, past operations on the larynx, and past operations for which the patient was under general anesthesia. If the patient has experienced symptoms of heartburn, acid reflux, or reflux esophagitis in the past, the possibility of laryngeal granuloma can be considered.² If the patient complains of respiratory difficulties, there is the possibility of airway stenosis and the patient is referred to a specialist.

With regard to occupation, all of the occupations shown in **Table 1** misuse the voice and vocal cord nodules are easily formed in cases with vocal abuse. Dysphonia plicae ventricularis can be observed amongst Buddhist monks. For restaurant and service industry employees, smoking, drinking, and karaoke singing also exert an effect, with vocal cord polyps and polypoid vocal cords occurring more commonly. Points for taking medical histories are summarized in **Table 1**.

Inspection and palpation

With regard to inspection of the oral cavity and

oropharynx, the clinical features of acute inflammation, such as mucosal reddening or adhesion of purulent mucus, are observed. With regard to palpation of the neck, for acute disorders the presence/absence and location of tenderness is checked, and for cases in which a malignant disorder is suspected, special attention is paid to cervical lymphadenopathy and thyroid tumors.

Maximum phonation time

For maximum phonation time (MPT), the maximum length of time a patient can vocalize after taking a deep breath is measured. In general, 10 seconds or less is abnormal, and 5 seconds or less interferes with daily living. Disorders which shorten MPT include recurrent nerve paralysis and vocal cord atrophy.

Auditory-perceptual evaluation of hoarseness

An auditory-perceptual evaluation method for hoarseness is the GRBAS scale of the Japan Society of Logopedics and Phoniatics, which gives scores of 0, 1, 2, or 3 for the Grade of hoarseness; Roughness, Breathiness, Asthenia, and Strain, where 0 is normal, 1 is a slight degree, 2 is a medium degree, and 3 is a high degree.

Rough hoarseness is a rasping, rattling sounding voice that can be heard mainly in disorders such as vocal cord polyps, polypoid vocal cords, and laryngeal cancer. Breathiness is a whispery voice that can be heard in such disorders as recurrent nerve paralysis, vocal cord nodules, laryngeal cancer, acute corditis vocalis, and vocal cord atrophy. Asthenic hoarseness is a small, weak voice which is heard in such disorders as psychosomatic aphonia and myasthenia gravis. Strained hoarseness is produced with the throat constricted; this condition occurs in such disorders as spasmodic voice disorders and laryngeal cancer.

In addition, disorders in which the voice becomes muffled include peritonsillar abscess and acute epiglottitis; these are potentially lethal disorders which cause airway stenosis and must not be overlooked.

Specialist Otorhinolaryngological Tests and Diagnosis for Voice Disorder

1) Laryngeal endoscopy and indirect laryngoscopy

Laryngeal endoscopy and indirect laryngoscopy

are the most useful tests, and looking at the larynx makes the diagnosis of many laryngeal disorders possible. Stroboscopy is an examination in which vocal cord vibrations are observed and is useful in detecting minute pathological lesions in vocal cords.

2) Tests related to voice pitch and strength

Voice pitch measures speaking fundamental frequency (SFF) and vocal range. Voice strength measures the sound pressure level at comfortable phonation as well as at the maximum and minimum strengths of phonation.

Voice profile tests and other examinations are available.

3) Aerodynamic tests

Aerodynamic tests include measurement of MPT, average airflow rate during phonation, and larynx efficiency.

4) Acoustic analysis tests

These are tests which enable quantitative evaluation and include parameters such as pitch period perturbation, amplitude perturbation, and laryngeal noise components as well as spectrograms.

5) Auditory-perceptual evaluation

The GRBAS scale is the main tool used in auditory-perceptual evaluation, which physicians and speech pathologists use to subjectively assess the degree and quality of hoarseness. There is also a voice handicap index which patients use to subjectively evaluate social and lifestyle limitations (functional aspects), voice and larynx condition (physical aspects), and what the patient is feeling (emotional aspects).³

Conditions Which Cause Voice Disorders

Main diseases

The “Japan Medical Association Continuing Medical Education Curriculum 2009”, lists the chief complaints of “hoarseness” patients with regard to concrete responses to clinical problems for each symptom. The patient should be referred to a specialist physician, if the hoarseness does not improve in disorders (1) or (2) below, urgently in the case of disorder (3) and swiftly in the case of disorders (4) or (5).

(1) Vocal cord polyps

These are the most common organic disorders of the larynx which cause voice disorders. A common site for polyps is from the front third to the center of the membranous portion of the vocal cord, and in many cases the sides are asymmetri-

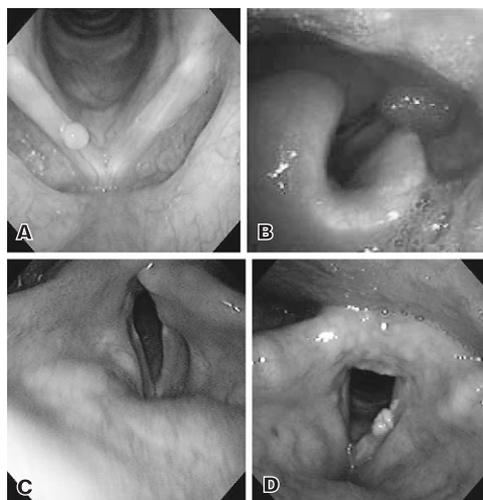


Fig. 1 Main conditions which cause voice disorder

- A: Right vocal cord polyp
- B: Acute epiglottitis
- C: Left recurrent nerve paralysis
- D: Laryngeal cancer of the left glottis

[Extracted and modified from the Japan Society of Logopedics and Phoniatrics (editor).¹]

cal, regardless if the polyp occurs on one side or both sides of the vocal cords (**Fig. 1A**). Polyps are thought to be caused by submucosal bleeding of the vocal cords, and contributing factors include voice misuse and smoking. With regard to hoarseness, in many cases the patient is found to have rough hoarseness or breathy hoarseness. At our institution, the abovementioned specialized tests are carried out and vocal sound before and after treatment is evaluated.⁴

(2) Acute corditis vocalis

The larynx becomes inflamed due to a common cold, etc., causing the voice to become whispery and hoarse, in some cases the patient's voice becomes aphonic. There is diffuse reddening and swelling of both vocal cords, and histologically this is regarded as being caused by inflammatory cell invasion of the superficial lamina propria, edema, and vasodilatation. Due to the rapid swelling of the vocal cords, the mucosa is extended excessively, reducing its mobility; mucosal waves are diminished, with asymmetrical vocal cord vibrations.

(3) Acute epiglottitis

Even when symptoms of acute inflammation such as pharyngeal pain or fever causing a muffled voice are observed, examination of the

oral cavity may overlook the inflammation finding, making it extremely important that the larynx also be examined. This is a potentially lethal disorder that causes airway stenosis and must not be overlooked (**Fig. 1B**).

This disorder is frequently observed in men in the prime of their lives; it can easily cause medical disputes as the disease progresses quickly with the patient dyspnea, resulting in hypoxic encephalopathy or death.

(4) Recurrent nerve paralysis

After leaving the ambiguous nucleus of the medulla oblongata as the vagus nerve, the recurrent nerve, which controls the movement of the vocal cords, travels a long distance before reaching the larynx, and may become paralyzed due to damage sustained along its various parts. In many cases this is caused by neck or chest disorders, and it may also be caused by tumors such as thyroid cancer, esophageal cancer, and lung cancer; lymph node metastasis, aortic aneurysm, and complications of surgeries performed to cure these; infectious diseases such as viruses; and tracheal intubation. It may also be caused by idiopathic and intracranial/skull base diseases. Symptoms for unilateral recurrent nerve paralysis include hoarseness and misswallowing, while bilateral paralysis causes airway stenosis with respiratory difficulties. The position in which the vocal cords are fixed determines the status of glottal closure and the degree of hoarseness also changes depending on vocal cord position. (**Fig. 1C**). Although strictly speaking these differ, terms such as laryngeal paralysis, vocal cord paralysis, and vocal cord fixation are also used.

(5) Laryngeal cancer

Laryngeal cancer is divided into supraglottic, glottic, and subglottic types. The glottic type is the most common, and when the cancer invades the mucosal lamina propria and muscle layer of the vocal cords, it impairs vocal cord vibration, causing hoarseness (**Fig. 1D**). In the supraglottic and subglottic types, patients are slow to become aware of the hoarseness and detection of the cancer is slower than that for the glottic type. When the cancer invades the cricoarytenoid articulation, the vocal cord becomes fixed, developing incomplete glottal closure, causing air leak and breathy hoarseness during vocalization.

Other disorders

Disorders (1) to (11) below should all be referred

to specialist physicians if the hoarseness does not improve.

(1) Vocal cord nodules

Nodules appear from the front third to the center of the membranous portion of the vocal cords, usually on both sides. They are thought to be caused by mechanical stimulation, and while soft in the early stages of growth, they grow increasingly hard, fibrous, and large if heavy voice usage or other voice misuse continues. This condition occurs commonly amongst school age boys and adult women, but often heals spontaneously in the case of children.

(2) Polypoid vocal cords (Reinke's edema)

In this condition, the superficial lamina propria swells into polyps or an edematous state over vertically the entire membranous portion of the vocal cords, usually on both sides. These are thought to be caused by pathological lesions generated by impaired absorption and leakage of serum components from blood vessels due to impairment of blood circulation in the vocal cords mucosa. Smoking is a highly contributory factor and voice misuse is also thought to play a part in causing this condition, which is common amongst middle-aged to elderly women with a history of smoking. In serious cases, the condition leads to airway stenosis with respiratory difficulty.

(3) Vocal cord atrophy

In vocal cord atrophy, the free edge of the vocal cord mutates into an arch shape as bowing, developing incomplete glottal closure. Symptoms include breathy hoarseness, inability to produce loud sounds, vocalization quickly tires the patient. This condition is common amongst elderly men.

(4) Sulcus vocalis

There is sulcus running front-to-back along vertically the entire membranous portion of the vocal cords near the free edge of the vocal cord, and impairment of vocal cord vibration causes breathy hoarseness. This condition commonly occurs on both vocal cords.

(5) Laryngeal granuloma

This condition is an inflammatory granulation tissue that occurs commonly in the vocal process. It is thought to be connected to tracheal intubation, coughing, and gastroesophageal reflux disease, and can be treated and improved with proton pump inhibitor (PPI) and digestive tract motor-activating drugs.²

(6) Functional aphonia

In many cases, this condition is psychosomatic; it is common amongst women aged between puberty and age 40 and causes a high degree of breathy hoarseness, whispery voice, and aphonia during intentional vocalization, such as in conversations. Glottal closure is insufficient, and because aspirated air flows out of the glottal gap, the vocal cords do not vibrate. Although no voiced sound is produced during vocalization, a voiced sound is often produced when the patients cries, laughs, or coughs.

(7) Spasmodic dysphonia

In this condition, the voice stops and starts intermittently; it is thought to be a form of dystonia. Almost all cases are adducted and are thought to be caused by excessive contraction of the thyroarytenoid muscle, making glottal closure too strong and interfering normal vocalization.⁵

(8) Dysphonia plicae ventricularis

False vocal cords swell up for various reasons, covering the vocal cords and vibrate due to contact between both false vocal cords. The enlarged false vocal cords either come in contact with the vocal cords, interfering with their vibration, or do not come in contact with the vocal cords but raise the supraglottal pressure, which also affects vocal cord vibration. This condition is observed commonly amongst elderly men, and when it occurs on only one side of the vocal cords is thought to be related to asymmetry of the thyroid cartilage. With regard to occupation, this condition is observed frequently amongst Buddhist monks.

(9) Hypotonic voice disorders

These conditions produce a very weak, faint voice. If the airflow rate decreases due to vocalization muscle fatigue caused by psychosomatic factors, voice misuse, and/or respiratory organ disease, subglottal pressure does not rise, causing asthenic hoarseness. These conditions occur in neurological/muscular disorders such as myasthenia gravis and muscular dystrophy.

(10) Mutational voice disorders

When the physiological voice-breaking process is impaired, a mutational voice disorder occurs. In the case of males, the voice's pitch may be too high and a reverse voice change may occur.

(11) Essential tremor

This is referred to as voice tremor and is characterized by the voice's regular trembling (4–8 times/second). It is observed in the regular opening movement of the vocal cords, up-and-down

movement of the larynx, and trembling of the diaphragm and rectus abdominis muscle.

Conclusion

This paper discussed the diagnosis of voice disorders. In summary, when patients come to the hospital complaining of voice disorders, a description is obtained of the patient's chief complaints, current medical history, degree and quality of hoarseness, past history, occupation, and voice-related life style habits or social background. Useful in this are two simple-to-perform tests which do not require special instruments: the auditory-perceptual evaluation (the GRBAS scale) and measurement of the MPT. The main conditions which cause hoarseness are vocal cord polyps, vocal cord nodules, recurrent nerve paralysis, and laryngeal cancer. In cases where the degree of hoarseness is high or does not improve in two or more weeks, the patient is referred to a physician specializing in ear, nose,

and throat diseases. Many laryngeal diseases can be easily diagnosed through observation of the larynx using indirect laryngoscopy or laryngeal endoscopy.

Cases which may easily cause medical disputes and call for particular care include hoarseness. The cases have been treated by a general practitioner but in actual fact the patient has recurrent nerve paralysis caused by thyroid cancer, and those in which the patient has a high degree of hoarseness and is being treated for bronchial asthma when in fact the patient has laryngeal cancer.

Moreover, in the case that a patient has a muffled voice and is complaining of a sore throat and respiratory discomfort, there is a possibility that the patient has an acute epiglottitis, a peritonsillar abscess, or another airway stenosis and s/he is referred urgently to a hospital where there are full-time physicians specializing in ear, nose, and throat diseases.

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