

# Voice

## Dysphonia and the Aging Voice

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The human voice is unique in the entire animal kingdom. The flexibility of the human voice allows us to portray our thoughts, emotions, joys, and fears. This extraordinary flexibility can be seen throughout life, beginning with the power of a baby's cry to the wonderful fullness and range of the world-class soprano or tenor. Each voice is unique and provides one of the signatures of the individual. The ancient Greeks felt that the voice was so important to a person's character that they thought that the voice actually originated in the heart.

These remarkable qualities of the voice are unfortunately not immune to the effects of human aging. It is rare that elite singers will continue to perform their most difficult roles even into their late 50s or 60s. As people enter their 80s and 90s, voices lose not only their range but also some of their strength and power, and male and female voices become less distinguishable.

This chapter will describe the multiple neurological, hormonal, and general effects of aging on the voice and also the opportunities that people have to allow their voices to remain strong and vibrant well into their senior years.

## Brief Anatomy and Physiology of the Voice

The production of the voice is a complex interaction among a number of different body systems. This discussion can be simplified by thinking of the voice as a musical instrument. For any instrument to produce sound, something must activate the sound (such as plucking a string on a guitar or blowing into a trumpet), something must vibrate (like the guitar string or the reed), and something must resonate (the body of the instrument). The lungs serve the role of the activator in human voice production. As one breathes in, negative pressure is produced that actually pulls air into the lungs. As we expire or exhale, that air serves as the source of power for setting up the vibration of the vocal folds.<sup>1</sup>

The vocal folds themselves serve as the vibrators, and it is the fine control of the movements of the vocal folds that allows for the flexibility of the speaking and singing voice. In the body, the face and sinuses and the chest serve as resonators, which give the voice its timbre or character.

In addition to these three important areas, other body parts and systems play important roles. Tension in the jaw or neck will reduce flexibility and increase the onset of fatigue. The voice is strongest when the body is in the upright position (not many opera roles allow the figure to recline) and musculo-skeletal problems can affect the best posture. In addition, the diaphragm and abdomen are important in the support of the voice, so abdominal conditions such as cramping or bowel disorder may have a negative impact on voice. The psychological system is

important in the confidence one has in his or her voice, as can be seen by the fluttering of the voice when a person is nervous or anxious. Finally, refined coordination of muscle movement and sensory control are adjusted by the neurological system.

### **Aging and Its Effects on the Larynx and Vocal Folds**

The larynx goes through a maturation process that begins early in life and continues with changes that occur throughout life, with the most dramatic changes occurring early in life through puberty. Over time, however, the cartilages of the larynx begin to calcify and become slightly more rigid. The joints that allow for three-dimensional movement of the vocal folds become stiffer and the bulk of muscle of the vocal folds diminishes.<sup>2</sup> These findings are not dissimilar to those that can be seen in other muscles and joints in the body. Often, the vocal folds become slightly bowed, which prevents tight vocal fold closure, and result in a somewhat more breathy voice with a reduction in the very upper portion of the range. This in turn requires tighter closure and tension

The vibration of the vocal folds requires that there be moisture on the vocal fold surface. As people age, there is a decrease in mucous and saliva secretions not only in the mouth but in the larynx as well.<sup>3</sup> Smooth vibration is reduced. It is important to maintain good hydration and this can be supplemented with products that thin the mucous such as Humabid® or Mucinex®. In general, the major changes that occur with the laryngeal structures

begin in the 60s in men and may begin just after menopause in women. Fortunately, these changes tend to occur over a long period of time, so most people are able to maintain a good voice well after the beginning of changes caused by aging, although this is often more difficult for the singing than the speaking voice. The hormonal effects on the larynx will be discussed in more detail later.

### **Neurological Changes of the Voice with Age**

The production of voice depends on a very sophisticated and integrated coordination of nerves of sensation to the larynx and nerves that control muscle movements. The nerves must also coordinate the activity of the lungs and resonating cavities. With aging, the speed of nerve transmission decreases and there is a reduction in coordination of muscular movement. Although in the absence of a true neurological disorder this does not play a major role, fine control of pitch and range may be affected. Specific neurological disorders increase in frequency with aging, but are still uncommon in comparison with the normal neurological changes that occur with the aging process. The most common specific voice disorder whose incidence increases with aging is voice tremor, which can occur independently (Primary Vocal Tremor) or with other diseases such as Parkinson's disease.<sup>4</sup> In addition, motion disturbances of the larynx such as neuromuscular paresis or paralysis, or joint movement problems, become more prevalent with ageing.<sup>5</sup> Early identification with a visit to an otolaryngologist (ear, nose and throat surgeon) may allow for either medications or voice training techniques

that can dramatically reduce the effects of the tremor on communication.

### **Gastrointestinal Disorders and Voice**

The most common and most important gastrointestinal disorder that can negatively affect the voice is reflux disease. Most people associate the term reflux with gastroesophageal reflux, which is a term used for acid leaving the stomach and regurgitates up the esophagus. When the reflux reaches the throat, however, it is more appropriately called laryngopharyngeal reflux (LPRD).<sup>6</sup> LPRD can result in a number of nonspecific symptoms such as hoarseness, chronic cough, or chronic irritation with a mucous-sticking sensation. People will frequently clear their throats or may suspect that this problem is related to sinus disease because of the mucous sensation. Although multiple or prolonged episodes of reflux are usually necessary to result in esophageal disease, intermittent and short-duration LPR can result in symptoms. Many patients with LPRD have no symptoms of heartburn.

Although reflux can occur at any age, it tends to increase as people age, particularly in the face of a hiatal hernia. In many senior patients with dysphonia, reflux may be playing an important role and therefore should at least be considered. LPRD may also be more difficult to treat than gastroesophageal reflux and may require a combination of diet and lifestyle modifications, histamine (H<sub>2</sub>) blockers, and proton pump inhibitors (such as Prilosec).

Other gastrointestinal or abdominal conditions may also have either a direct or indirect effect on the quality of the voice. Abdominal surgery, cramping, constipation, or diarrhea may all influence the ability of the abdomen and diaphragm to support the voice. In addition discomfort from some of these conditions may limit abdominal strength and support.

### **Respiratory Disorders**

As stated earlier, the initiation of sound and voice begins with inhalation and exhalation. Thoracic and pulmonary disorders may serve to limit vital capacity, which in turn will limit breath support and control necessary for efficient speaking and singing. Of particular note are restrictive pulmonary diseases such as Chronic Obstructive Pulmonary Disease (COPD), chronic bronchitis, and asthma. Appropriate prevention of controllable diseases such as COPD through early smoking cessation and early intervention for patients that develop these diseases will play a role in maintaining vocal strength and efficiency.

### **Hormonal Effects on the Aging Voice**

#### *Thyroid Hormones*

Besides these mechanical elements discussed above, the decrease or changes in hormones may play a major role in changes in voice with age.<sup>7</sup> As a person ages there may frequently be a drop in the secretion of thyroid hormones—hormones that generate energy for the muscle

s and that hydrate the organism. We often observe a decrease in thyroid hormone or hypothyroidism. The thyroid hormones should be controlled systematically in presbyphonia after menopause or andropause. Patients with a sluggish thyroid often require appropriate therapeutic treatment to get them out of their lethargy and feeling energetic again.

#### ***Progesterone Action on the Envelope of Neurons***

Progesterone is secreted by the ovaries and this was originally considered as a hormone involved only in reproductive functions. But Gago has demonstrated that it can be synthesized within the nervous system by neurons and glial cells.<sup>8</sup> The progesterone has promyelinating and neuroprotective effects. Moreover, it can be synthesized locally in the nervous system by neurons and glial cells and can thus be considered to be a "neurosteroid." It plays an astonishing role here. It activates the synthesis of the protective sheath of the neuron, the myelin sheath. The myelin sheath, a sort of protective sleeve that shields the nerve from all traumatic aggression and from differences in temperature, enables nervous impulses to be transmitted at a constant speed between the brain and its target organ. Nerves that have this myelin sheath conduct nervous impulses better and faster. As early as 1995, Ian Duncan of the University of Wisconsin lifted the veil on the action of progesterone on the brain, but not on its synthesis. The impact of this discovery has led to a better understanding of therapeutic approaches to treating neurological diseases or certain myopathies that alter the myelin sheath and therefore nerve conduction, such

as Lou Gehrig's disease or multiple sclerosis. It seems that progesterone significantly slows the evolution of these afflictions.

At menopause, the somewhat precipitous drop in progesterone results in a progressive slowing down of nerve conduction that's barely noticeable. This slowdown is caused by a relative lack of myelination of peripheral nerves and, as a result, the voice is less well controlled, particularly in singing.

#### ***Menopause Outcome***

During menopause, this cycle is progressively disrupted. But this menopause effect, which today is of interest to us all, has only relatively recently become topical.<sup>7</sup> In Greek civilization, four hundred years BCE, the menopausal woman didn't exist. She was an exception. The average life expectancy was 23 to 27 years of age. Menopause was still rare in the Middle Ages. Life expectancy was then 23 to 40 years. It was only in the nineteenth and twentieth centuries that menopause was common enough that consideration of its health implications began to be considered. Indeed, girls born in the 1980s can expect to live to the age of 92! Menopause now corresponds to practically half a woman's life. By the end of the twentieth century, France accounted for nearly 8.5 million menopausal women. The importance of the voice, the development of verbal communication, and interpersonal relationships all point to the essential problem that the voice and menopause are now beginning to pose.

### ***Why These Changes in a Woman's Voice at This Period of Her Life?***

During the perimenopause, ovarian activity strongly diminishes. Progesterone and estrogen levels are dramatically reduced. Similarly, the secretion of male hormones also drops off considerably. But their presence, now that they are no longer counterbalanced by feminine hormones, can sometimes cause the voice to become more masculine. Thus, the ovary becomes a simple endocrine gland with no reproductive function.

The menopausal phase normally lasts from the age of 47 to the age of 55. The impact that the sex hormones had on their various target organs disappears, not without consequences. However, these days, the administration of substitute hormones enables the unpleasant consequences of this lack of sex hormones to be delayed to an increasingly later age, saving many women from a trying experience that is both mentally and physically hard to accept. Our better understanding of endocrinology has provided therapies that may help some menopausal woman to have a better quality of life.

In some cases, hormone substitutes may be a contraindication. They are not recommended in cases of breast cancer, in patients with a high-risk family background, in certain cardiovascular pathologies, or in cholesterol-related afflictions. For this reason, a medical check-up is a prerequisite for women in their 50s considering their options.

Because estrogens are reduced, the receptors of sex hormones receive more androgens and become more receptive to them. As a result, the vocal cord mucous membrane thickens and exhibits a lack of tonicity and a deficiency of contour. The voice becomes deeper and more masculine. Meanwhile, the 60-year-old woman may develop symptoms such as increased hairiness, as an indirect consequence of androgens. A smear test of the cervix of the uterus indicates an atrophy of the epithelium. The same result is obtained from a smear test of the vocal cords: the parallelism is amazing

### ***Menopause and the Nervous System***

The neurological motor and sensation functions of the larynx are largely controlled by the vagus nerve. Its responsiveness is improved by estroprogesterone. Therefore, at menopause the radical drop in the secretion of estrogens and the complete halt in the secretion of progesterone induce slower nervous conduction from the brain to the larynx. As a result, vocal response slows down slightly, which can hamper rapid changes in frequencies when singing. Later, the vibrato (seven vibrations per second) cannot be maintained. The voice gradually gears down to the tremolo (four vibrations per second).

### ***Androgens Turn into Estrogens***

Since 1977, we know that in both men and women fat cells can turn androgens into estrogens. The relationship between obesity and a higher secretion of estrones

(estrogen derivatives) is also age related. It is higher in menopausal women. This is the work of a specific gene in our DNA (cytochrome 19 associated with P450 aromatase) that facilitates the transformation of androgen into estrogen in our adipose cells. Thus, the lower need for hormone substitutes of overweight woman is caused by the fact that her fat cells will transform her androgens into estrones. Meanwhile, the slim woman is more likely to need hormone substitute therapy, although the positive value of lower weight for many chronic diseases such as hypertension and diabetes would seem to be more important to most women.

With age, muscle mass also diminishes, adipose mass increases, and cells are redistributed differently about the body. Corticosteroids encourage the increase of fat cells. Therefore, menopause women need to be cautious about consuming them. A carefully considered hormone substitute therapy program, associated with vitamins and minerals, can bring considerable benefits to most females who have elite voice requirements, if their body can tolerate it. Many women thus treated are able to avoid developing a masculine voice as they age and are able to preserve a beautiful voice for significantly longer. It is impressive to see the sopranos who have kept the same tessitura until the age of 65.

### ***Men and Andropause***

The androgens secreted by the testicles have a direct effect on the voice. They certainly act on the bony tissues,

but also on the brain. Androgens increase blood flow in the organism and improve oxygenation and muscle performance and can produce some sense of euphoria. At the age of 70, andropause may appear. Blood analysis will diagnose the lack of androgens. If there is no contra indication such as cancer of the prostate, androgens treatment may be useful to recover the vocal folds shape, the tonicity of the resonators, and consequently a powerful voice with a satisfactory register.

### **The Paradox of the Aging Voice**

#### ***In Women***

As the menopausal woman advances in age, her new hormonal balance, with its absence of estrogens and its very mild secretion of testosterone due to the atrophy of her ovaries, is no longer able to sustain the tonicity and strength of the vocal cord muscles. What are the consequences of this? The two vocal cords atrophy progressively. The mucous membrane covering them becomes thinner and dehydrates.

Initially, the voice displays a narrower register, the higher harmonics are lost, and the voice is less powerful and tires faster. But a paradoxical effect sets in. Because the vocal cord has diminished in thickness and become finer, the voice, which had become a little deeper, now becomes higher, more delicate, sometimes even shrill. You often hear 80-year-olds speaking with a very high-pitched voice. One can thicken the vocal cords again by injecting

a substance into them, which may provide some reasonable timbre and vocal endurance.<sup>10</sup>

### *In Men*

After the age of 70, men can present the same vocal symptoms in the male climacteric. Yet the vocal structure in this case behaves like an athlete in all respects. As with women, hormone therapy is indicated in conjunction with specific nutrition hygiene, and voice therapy and training. Androgenic hormonal therapy is rarely advisable because of its danger for an altered prostate. For men, vocal training is the best guarantee of keeping a young voice. Regular practice and communication with others stimulates the voice and preserves its timbre.

### **When Should a Patient Be Seen by an Otolaryngologist?**

There are a number of different reasons for a referring physician to refer a patient to, or for that matter the patient themselves to consider being seen by, an otolaryngologist. Although dysphonia is rarely due to a worrisome cause such as a tumor or cancer, this diagnosis should be considered in someone with progressive hoarseness, particularly in a patient with a history of tobacco or alcohol use, or in the face of other symptoms such as progressive pain or discomfort, pain or difficulty swallowing, hemoptysis, or a neck mass. For intermittent hoarseness, or very gradual progression of dysphonia, in a patient that does not have the above more-worrisome history or symptoms, referral should be based in part on the level of concern of the patient and

their perceived degree of disability. In such cases it is probably best to have them seen and examined by an otolaryngologist to reassure the patient, confirm the diagnosis, and help in the coordination of treatment.

### **Treatment of the Disordered Aging Voice**

The approach to treatment of the dysphonic voice that may occur with aging requires thoughtful assessment so that the treatment can be focused on the most fundamental causes and individualized to the needs of the specific patient. There are three major avenues of treatment.<sup>11</sup> The first is to treat a specific etiology, such as reflux or a neurological disorder. These will be specific to the underlying problem. The second is general medical and environmental treatments. These include things like avoidance of smoke and irritants, hydration, humidification, and mucolytics. This might also include anti-inflammatory therapy and at times even a short course of systemic steroids. The last recourse is to have the patient evaluated and treated by a speech-language pathologist, preferably by an individual with a specific interest in voice disorders (voice pathologist). In many cases they can work with the patient to optimize their technique, voice use environment, and the quantity and volume of voice use. Many patients have dramatic improvements in the quality, strength, and durability of their voice after just a few sessions with a voice pathologist.

### Preserving a Youthful Voice: A Multifactorial Treatment

The key to preserving a youthful voice is to be serious about physical exercise,<sup>12</sup> hydration, lubrication of the vocal cords, dental hygiene, muscular activity, nutrition, vitamin and mineral supplements, possibly appropriate hormone therapy, and, often, anti reflux medication. The multiple potential etiologies of a voice problem in the aging patient may make specific identification and treatment difficult, because the disorder may be related to a number of different factors.

In general, people who are conscientious about their overall health will maintain good care of the health of their vocal cords. For the average person this should help to maintain a strong and vibrant voice. For the performer, they can most certainly retain an efficient vocal tessitura and timbre.

Hormonal treatment may be used. Thyroid testing may find a deficiency in thyroid hormones, more commonly found in women, which should be treated.<sup>13</sup>

Many patients who are unhappy with the quality of their voices may benefit from voice therapy. Some will prefer or add singing lessons and join a choir to strengthen their voices. This also allows them to belong to a team, to talk to others, and to routinely practice their voice. Some will require an acute treatment for arthrosis (anti-inflammatory medicine or injection of steroid in the crico

arytenoid joint), or injection of material in the bowing vocal cord. Dental care is important to maintain good oral hygiene and lubrication. In some cases respiratory therapy may be valuable in improving the breath support of the voice.

Alternative medicine with vitamins, minerals, and antioxidants may not only play an important role in overall health but also in vocal health. Lubrication of the vocal tract is critical to optimizing voice quality. This can be accomplished through hydration and at times the use of mucous thinning medications (mucolytics).

If people do not take proper care of themselves, the voice will age. The vocal register will narrow, the voice will weaken, and the timbre will lose color and become metallic. This may be partially avoided by adopting a regular and constant healthy lifestyle, by taking antioxidants, vitamin C and E, minerals such as magnesium, and by keeping up physical and intellectual activities.

In sum, the human voice is not immune to the effects of aging. Vocal quality and strength can be affected by a number of different conditions that increase in prevalence with age. The memory and the activity of the brain are indispensable to keep a good voice. As time goes by, the register becomes narrow, and the brain command is slower due to loss of neurons.<sup>14</sup> Training the voice and developing vocal memory are important in sustaining a strong voice with age. Fortunately, with appropriate diagnosis and environmental and hygienic interventions, specific medical treatments, and voice therapy, most people can maintain a functional, quality voice through all of their lives.



## Quiz



1. Which of the following generalizations about changes in voice with aging is true?

- a. Voice changes occur only at menopause in women.
- b. Laryngeal anatomic development is the same for men and women.
- c. Vocal fold bowing occurs infrequently with late voice aging.
- d. Modifications in voice may be due to a combination of neurological, muscular, and skeletal changes.
- e. Once a voice change occurs, there is little that can be done to improve voice quality.

2. Laryngopharyngeal reflux disease

- a. may be more difficult to treat than gastroesophageal reflux disease.
- b. decreases with age.
- c. is always associated with heartburn.
- d. will not cause any changes in voice.
- e. results in very specific symptoms.

3. Which of the following is not commonly associated with menopause?

- a. Masculinization of the voice
- b. Increased bulk of the vocal folds with increased vocal strength
- c. Decreased flexibility and range of the voice
- d. Reduced neuromuscular flexibility
- e. Increased adipose and changes in fat cell distribution

4. The treatment of a voice disorder in the aging patient

- a. is useless since voice change is inevitable.
- b. should focus more on the specific problem rather than general quality of life issues.
- c. is usually straightforward since the problem is often only from one cause.
- d. may be improved by the assessment and treatment from a voice pathologist.
- e. typically requires surgery.

5. Which of the following is an expected neurological change that occurs in relationship to the voice with aging?

- a. Specific and serious neurological disorders are the most common cause of a change in voice.
- b. Fine muscular coordination of vocal fold movement increases with age.
- c. Multiple neurological changes gradually occur which can reduce voice quality.
- d. Increased lubrication develops due to increased glandular secretion.
- e. Voice tremor is uncommon.

Answers:

- 1. d
- 2. a
- 3. b
- 4. d
- 5. c

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