

Robert T. Sataloff, MD, DMA, Associate Editor

The Effect of Hormones on the Voice

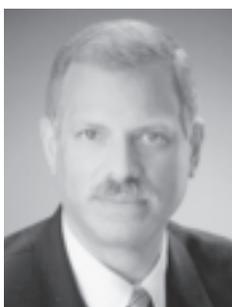
Sameep Kadakia, Dave Carlson, and Robert T. Sataloff



Sameep Kadakia



Dave Carlson



Robert T. Sataloff

THE HORMONAL ENVIRONMENT OF THE BODY has major effects on the sound quality of the voice. It is important for singers and teachers to be familiar with the body's major hormones and their effect on vocal fold function.

The anatomy of the vocal apparatus is subject to changes based on the environment both inside and outside the body. For the purposes of this discussion, we will concentrate on the endocrine system, the glands that secrete hormones that control bodily function. The voice is exquisitely sensitive to changes in the hormonal milieu. Although there are numerous hormones in the body, evidence has shown direct effects of the sex hormones and thyroid hormones particularly on the voice.

The larynx is extremely responsive to sex hormones—androgens, progesterone, and estrogen. Abitbol et al. demonstrated that smears of the larynx and the cervix stained for estrogen throughout the menstrual cycle were indistinguishable with microscopy.¹ Both types of tissues have been shown to have estrogen, progesterone, and androgen receptors.² Thus, the menstrual cycle and pubertal development both have an affect on the female larynx. In males, increased levels of testosterone and DHT during puberty are responsible for the increase in size of the laryngeal cartilages. This increase is accompanied by increased bulk of the laryngeal muscles and ligaments, leading to a drop of about one octave in the pitch of the voice. As the larynx changes in the growing male, the voice breaks occasionally as an adjustment reaction to the changing background.³

Females mature in response to increased amounts of progesterone and estrogen. While androgens are present, their effect is not as noticeable till after menopause. During puberty, the female voice does not undergo as drastic a change as the male voice. Sex hormones allow for a decrease in basal pitch of one third of an octave.⁴ However, the female voice does undergo cyclic changes with the menstrual cycle. The beginning of the menstrual cycle, the follicular phase, is marked by increased amounts of estrogen and markedly lower levels of progesterone. This combination of hormones is responsible for causing vocal fold edema and increased blood flow to the structures. Polysaccharides in the vocal folds break down and bind water more readily, furthering the fluid build up in the vocal folds.⁵ The vessels in the nasal passages also dilate, resulting in changes in patency and the singer's perception of her voice. Additionally, the hormonal environment can cause an increase in reflux symptoms by slowing gastric motility. In the second half of the menstrual cycle, the luteal phase, progesterone levels increase to a greater degree

than estrogen levels. Progesterone promotes sloughing of the laryngeal epithelium and works against proliferation. It also makes the glandular secretions more viscous, leading to a decrease in vibratory efficiency and possibly increased cell damage.⁶ These changes are responsible for changes in the voice during the menstrual cycle.

The period prior to menses also is marked by numerous symptoms, the most common of which is the difficulty of singing higher notes.⁷ The premenstrual syndrome (PMS) is a constellation of symptoms such as irritability, breast tenderness, increased reflux, anxiety, and edema that occur due to the high estrogen levels. Along with PMS, there are a number of voice changes that also may occur, an entity known as premenstrual voice syndrome, or *dysphonia premenstrualis*. The changes responsible for the entity known as *dysphonia premenstrualis* remain unknown but may be caused by some of the previously mentioned mechanisms along with an increase in acid reflux. One of the possible causes could be related to the increased incidence of submucosal hemorrhage during the period before menstruation.⁸ Due to the increased estrogen levels, there is also more edema during the premenstrual period because fluid flows from the inside of the cells and capillaries to outside. This edema may also be responsible for some of the voice changes noted prior to menses. This dysphonia may alter vocal efficiency and clarity in about one-third of singers. The presence of abdominal cramps during the menstrual cycle also can impair efficient phonation by interfering with support.

The most drastic changes in the female voice occur during menopause, when the levels of estrogen and progesterone fall. In the period immediately after the start of menopause, the level of FSH and LH is very high, continuing to cause ovarian androgen production. Usually, these ovarian steroids are converted to estrogen, especially in women with more peripheral fat stores. Women have excessive peripheral fat prior to menopause, allowing more conversion of androgens to estrogen, preserving the effects of estrogen on the body. Some women however, have less ability to do so and have relatively higher levels of androgen as a result.⁹ Androgens deepen the voice and cause irreversible changes.¹⁰

Along with hormonal changes after menopause, effects of aging also become evident after menopause. Laryngeal muscles decrease in size, cartilages harden

and eventually may ossify, vocal folds become thicker, and collagenous fibers decrease in quantity leading to an overall stiffening of the vocal apparatus. The changes of aging may be difficult to distinguish from potentially treatable hormonal changes caused by menopause.¹¹

Oral contraceptives, estrogen, and/or progesterone preparations used to combat the uncomfortable changes associated with menopause and menstruation, have been used to treat the voice changes, as well. Their use has found varying results in women, and more data still must be collected on the subject. However, if used, preparations should be titrated according to the patient's hormone levels.¹² Although androgens have been shown to increase libido, their use is relatively contraindicated due to the permanent masculinizing effects on the female voice.

Thyroid hormones are also known to cause voice disturbances.¹³ In normal physiology, the hypothalamus releases a thyrotropin-releasing hormone (TRH), a molecule that stimulates the anterior pituitary gland to release a thyroid-stimulating hormone (TSH). The TSH in turn stimulates the thyroid gland to produce T4 and T3, of which T3 is the more biologically active hormone. Thyroid hormones serve to increase the rate of metabolic functions in the body. When patients have hypothyroidism (low thyroid function), hoarseness and loss of range are common complaints. The mechanism is not known for certain, but it is believed to be related to increased levels of polysaccharides in the vocal folds, leading to increased fluid retention and vocal fold thickening.¹⁴ This thickening is similar to the mechanism by which sex hormones act on the female vocal folds. The vocal fold thickening causes a decreased vibratory capacity and hence a lower frequency production and a sensation of insufficiency. Hyperthyroidism (high thyroid function) also can cause hoarseness, usually when it is severe.¹⁵ The supplementation of thyroid hormone is usually sufficient to control hypothyroid symptoms, and the use of antithyroid medications like propylthiuracil can usually help control symptoms of hyperthyroidism.

The effect of pituitary gland hormones on voice also has been studied. The pituitary gland is involved in the release of growth hormone (GH), prolactin, vasopressin, adrenocorticotrophic hormone (ACTH), thyroid stimulating hormone (TSH), follicle stimulating hormone (FSH), luteinizing hormone (LH), and oxytocin. It is

more common for singers to have problems associated with overproduction than underproduction. Patients suffering from increased prolactin levels from a prolactin secreting adenoma may suffer from symptoms of *dysphonia premenstrualis* since prolactin suppresses luteinizing hormone (LH), the surge of which leads to ovulation. Men typically do not have changes in pitch, but they may complain of a decrease in intensity and range.¹⁶ Decreased levels of FSH and testosterone also may make the male voice less powerful.

Some patients may have increased growth hormone release (GH), causing the syndrome of acromegaly. Excess GH causes thickening of the laryngeal cartilages, as well as the thickening of the vocal folds themselves, leading to a drop in voice frequency.¹⁷ Also, people with excess GH who go on to develop acromegaly may be prone to arytenoid cartilage dislocation.¹⁸

Patients who suffer from increased levels of ACTH may be subjected to irreversible virilization of the voice. Because of the propensity of these people to develop insulin intolerance, they also are prone to the effects of diabetes on their voices. Diabetes is known to cause xerostomia (dry mouth) and neuropathy. The neuropathy may lead to weakening of the phonation muscles and loss of control, while the xerostomia may cause difficulty in phonation by decreasing lubrication.¹⁹ Diabetes can also cause hearing loss, another imperative skill a singer would suffer from the loss of. Diabetic patients must be encouraged to keep a strict watch over their medication regimen and diet.

It is clear that the human voice is susceptible to hormonal changes, daily and throughout life. From puberty to senescence, the vocal apparatus is undergoing numerous changes, some of which are quite different in males and females. Through an understanding of these mechanisms, treatment can be optimized to control symptoms and allow individuals to carry their normal voice use. Singing teachers should be familiar with these issues and should not hesitate to refer students for evaluation when hormone problems are suspected.

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Sameep Kadakia, MD is a surgical resident at Beth Israel Medical Center, serving as part of New York Eye and Ear’s ENT program. Originally from Tennessee, he spent a large part of his childhood growing up in Iowa, New York, and New Jersey. Undergraduate and medical degrees both were attained at Drexel University. Under the tutelage and mentorship of Dr. Robert Sataloff, Kadakia became interested in otolaryngology, and he looks forward to his continued ENT training.

David Carlson, D.O. is a senior resident in otolaryngology at Philadelphia College of Osteopathic Medicine in collaboration with Drexel University College of Medicine. Following residency, he will complete a fellowship in rhinology/skull case surgery in Boston, Massachusetts.

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