

THE PHYSIOLOGY OF THE MENSTRUAL CYCLE AND HOW IT AFFECTS VOCAL
PRODUCTION

Kayleigh Sprouse

MUSC 496: Vocal Pedagogy

April 27th, 2022

As singers continue to step more into the modern era, more conversations that embrace inclusivity, equality, and allyship have risen up and have been addressed by many. These conversations have allowed for many issues that have been in the vocalist community to be resolved, or at least be put on such a path. However, one conversation that many hesitate to fully approach and regard as legitimate is the affect of the menstrual cycle on the singing voice. Many singers carry on throughout their cycle as though nothing has changed, and attempt to produce the same sounds they would normally produce when in a different stage of their cycle. For the overall health and well being for many singers around the globe, it is essential to understand the changes that the vocal cords and the body undergo during the cycle so as to find ways to adapt and prepare.

When studying the affects of the menstrual cycle on the voice, there are three main hormones of interest which heavily impact the voice: estrogen, progesterone, and testosterone. Estrogen is responsible for health and growth of female reproductive organs. The hormone increases vaginal moisture and generates a watery, thin, and stretchable mucus. When estrogen reduces, it causes dryness and when there is an excessive amount, it causes fluid retention. Estrogen is also influenced by progesterone, which influences optimal energy, sleep, clarity, and concentration/memory. Progesterone balances the effects of estrogen and is referred to as the relaxing hormone. The hormone builds the uterine lining, increases swelling, and has dehydrating effects on mucosa, thus making the mucus thicker and more opaque. Progesterone also causes an increase in basal temperature and disappears at menopause. Testosterone's main function is to maintain muscle mass and bone strength, well-being, and energy. Increased

testosterone in women can cause the fundamental frequency of the voice to decrease and can have thickening and drying effects on the mucosa.¹

Now that the three main hormones have been established, it is important to observe to detailed physiology of the menstrual cycle. The purpose lies in what many refer to as the period, which are regular cyclic changes that are regarded as periodic preparation for pregnancy and fertilization. Periodic vaginal bleeding occurs with the shedding of uterine mucosa. When looking at the timeline, it is an average 28 days from the start of one menstrual period to the start of the next. Cycles begin at puberty around ages 10-16 and ends at menopause, around 51 years. Overall, it is important to remember that hormones are secreted in a negative and positive manner to control the menstrual cycle.²

When puberty begins, hormone secretion begins in the hypothalamus portion of the brain where gonadotropin-releasing (GnRH) hormone, the hormone which controls reproductive activity, is secreted. This secretion signals to the anterior pituitary, which secretes growth hormones, to secrete follicle hormone (FSH), and hormone which regulates the development, growth, pubertal maturation, and reproductive processes, and luteinizing hormone (LH), a hormone which triggers ovulation and development of the corpus luteum in females. In the ovarian follicle, theca cells, a group of endocrine cells in the ovary made up of connective tissue surrounding the follicle, and granulosa cells, the cells responsible for hormone production, are found. LH stimulates theca cells in order to produce progesterone by activating the enzyme, cholesterol desmolase. Once that is secreted, the hormone goes to the nearby testosterone by activating the enzyme aromatase. As levels of 17-beta-estradiol/progesterone increase based on

¹ Steinhauer, Kimberly. "The Effect of Hormonal changes on voice quality," *The Voice*, vol. 20 (2015): 1-3

² Jeanmonod, Rebecca. "Physiology, Menstrual Cycle," *NCBI Bookshelf* (2021).

the phases on the menstrual cycle, there is negative feedback to the anterior pituitary to lower the levels of FSH and LH, the levels of 17-beta-estradiol, and progesterone produced.³

Now it is understood how the menstrual cycle is started in regards to the heavy hormone involvement. The actual cycle itself is separated into four phases: menstruation, the follicular phase, ovulation, and the luteal phase. The Follicular Phase, also known as the Proliferative Phase, occurs from day one to day 14. This timeline is based on the average 28 days of the full cycle. The length of this cycle affects the length of the menstrual cycle. The main hormone active is estrogen, also known as 17-beta-estradiol. The increase in estrogen occurs by the upregulation of the FSH receptors within the follicle at the beginning of the cycle. Estrogen provides negative feedback to the anterior pituitary as this phase nears its end. The purpose of the Follicular phase is the overall growth of the endometrial layer of the uterus. It also creates an environment that is prepped for sperm entry by creating channels within the cervix. These steps also prep the follicle for ovulation.⁴

Ovulation occurs 14 days before menses. In a typical 28-day cycle, ovulation occurs on day 14. At the end of the follicular phase, estrogen levels are high due to follicle maturation and increased production of the hormone. Estrogen provides positive feedback for FSH and LH production. This action occurs once the critical levels of estrogen have been reached, and in response, 200 picograms per milliliter of plasma is released. These high levels of FSH and LH create what is known as the LH surge. As result, the mature follicle breaks, and an oocyte is released. The changes to the cervix as initiated during the follicular phase further increases,

³ Jeanmonod, Rebecca. "Physiology, Menstrual Cycle," *NCBI Bookshelf* (2021).

⁴ Jeanmonod, Rebecca. "Physiology, Menstrual Cycle," *NCBI Bookshelf* (2021).

allowing for increased, watery cervical mucous to better accommodate the possible sperm. Estrogen levels then fall at end of ovulation.⁵

The second definite phase of the menstrual cycle is The Luteal Phase, or the Secretary Phase. This occurs from day 14-day 28 of the typical cycle. Progesterone stimulated by LH is dominantly active and works to prep the corpus luteum and the endometrium for possible fertilized ovum implantation. As this luteal phase ends, the progesterone provides negative feedback to the anterior pituitary to decrease FSH and LH levels and estrogen and progesterone levels. The corpus luteum, a temporary endocrine structure in the ovaries, ruptures to produce estrogen and progesterone, which is predominant at the end of the phase due to the negative feedback system. During this cycle, progesterone decreases and thickens the cervical mucous making it non-elastic since the fertilization period passed, and sperm entry is no longer a priority.⁶

Menses, the bleeding portion of the cycle, is considered day 0 to day 5 of the next menstrual cycle. However, sometimes ovulation fails to occur during the menstrual cycle and this is known as anovulatory cycles. These are common for the first 12-18 months after menarche (occurrence of the first menstrual cycle) and again before the onset of menopause. When ovulation does not occur, usually no corpus luteum is found and the effect of progesterone on the endometrium is absent.⁷

Now that the detailed physiology of the menstrual cycle is understood, the affects of the cycle of the voice is now ready to be reviewed. The larynx and the surrounding vocal tract

⁵ Jeanmonod, Rebecca. "Physiology, Menstrual Cycle," *NCBI Bookshelf* (2021).

⁶ Jeanmonod, Rebecca. "Physiology, Menstrual Cycle," *NCBI Bookshelf* (2021).

⁷ Jeanmonod, Rebecca. "Physiology, Menstrual Cycle," *NCBI Bookshelf* (2021).

tissues are affected by cyclic changes in hormone levels. Many have observed this to be a solidified fact due to the observation that the vocal tract and endometrium show similar cytology. Furthermore, estrogen and progesterone receptor expressions have been identified in laryngeal tissues.⁸ Because of these relations, the larynx is seen as a hormonal target organ since there are numerous affects on vocal fold structure, tissue integrity, and function. Menstruation, stress, polycystic ovarian syndrome, pregnancy, birth control, thyroid disease, diabetes, and endocrine disorders are all results of such dramatic changes in the body.⁹ The larynx is also extremely susceptible to sex hormones such as androgens, progesterone, and estrogen. Smears of the larynx and the cervix stained for estrogen throughout the menstrual cycle were indistinguishable with microscopy. Both have estrogen, progesterone, and androgen receptors.¹⁰ Overall, puberty, menopause, pregnancy, pre menstruation, hormone replacement therapy, and hormonal contraceptives impact vocal production and acoustics.¹¹

“Layngopathia premenstrualis” is the scientific term for a result of physiologic, anatomic, and psychologic alterations secondary to endocrine changes. The physiologic correlations to the

⁸ Pipitone, R. “The Unique Impact of Menstruation on the Female Voice: Implications for the Evolution of Menstrual Cycle Cues,” *Ethology: international journal of behavioural biology*, 2011.

⁹ Steinhauer, Kimberly. “The Effect of Hormonal changes on voice quality,” *The Voice*, vol. 20 (2015): 1-3

¹⁰ Kadakai, Sameep. “Hormones and the Voice,” *The Voice*, vol. 20 (2015): 4-6.

¹¹ Pipitone, R. “The Unique Impact of Menstruation on the Female Voice: Implications for the Evolution of Menstrual Cycle Cues,” *Ethology: international journal of behavioural biology*, 2011.

perceived voice changes are related to the drop in estrogen levels on or about day 21 in the menstrual cycle.¹² As the estrogen level declines during premenstrual period, laryngeal tissue begins to absorb water, causing the folds to swell. At the same time, there is an increase in the blood supply to the vocal folds because of the greater thyroid gland activity, Increased water and blood supply means the folds have greater mass.¹³ Premenstrual voice syndrome, or dysphonia premenstrualis, is caused by an increased incidence of submucosal hemorrhage during the period before menstruation.¹⁴

The beginning of the menstrual cycle, the follicular phase, is marked by increased amounts of estrogen and lower levels of progesterone.¹⁵ The dramatic estrogen level alteration cause laryngeal water retention, edema or intersitial tissues, and venous dilation.¹⁶ It causes vocal fold swelling and increased blood flow to the structures. Polysaccharides in the vocal folds break down and bind water more readily, furthering the fluid buildup in the vocal folds. The vessels in the nasal passages also dilate, resulting in changes in patency and the singer's perception of their voice. The always fluctuating hormonal environment can cause an increase in reflux symptoms

¹² Ouyuong, Laishyang. "Effects of Resonance Voice Therapy on Hormone-Related Vocal

Disorders in Professional Singers: A Pilot Study," *Clinical Medical Insights: Ear, nose, and throat*, vol. 11 (2018): 1-7

¹³ Doscher, Barbara. *The Functional Unity of the Singing Voice*. United Kingdom: Scarecrow Press, 1994.

¹⁴ Kadakai, Sameep. "Hormones and the Voice," *The Voice*, vol. 20 (2015): 4-6.

¹⁵ Kadakai, Sameep. "Hormones and the Voice," *The Voice*, vol. 20 (2015): 4-6.

¹⁶ Ouyuong, Laishyang. "Effects of Resonance Voice Therapy on Hormone-Related Vocal Disorders in Professional Singers: A Pilot Study,"

by slowing gastric motility.¹⁷ Increased estrogen levels during the late follicular phase result in thickening of the laryngeal mucosa and increased mucus production, while increased progesterone levels during the luteal phase result in drying of the laryngeal mucosa.¹⁸

In the second half of the cycle, during the luteal phase, progesterone levels increases over estrogen. The resulting premenstrual syndrome (PMS) makes singing higher notes more difficult.¹⁹ As estrogen levels begin to decrease, laryngeal tissues begin to absorb water, causing mucosal edema, vascular congestion, and increased vocal fold mass, which can cause a loss of high notes, vocal instability, fatigue, uncertainty of pitch, decreased vocal efficiency, and reduced vocal power and flexibility.²⁰ The heightened progesterone during this phase promotes sloughing of the laryngeal epithelium and works against proliferation. The hormones makes the glandular secretions more viscous, leading to a decrease in vibratory efficiency and possibly increased cell damage.²¹ Possible changes in phonation include hoarseness, breathiness, and reduction in range, especially at the top of the voice.²²

¹⁷ Kadakai, Sameep. "Hormones and the Voice," *The Voice*, vol. 20 (2015): 4-6.

¹⁸ Banai, Irena. "Voice in different phases of menstrual cycle among naturally cycling women and users of hormonal contraceptives," <https://doi.org/10.1371/journal.pone.0183462>, Jagiellonian University, 2017.

¹⁹ Kadakai, Sameep. "Hormones and the Voice," *The Voice*, vol. 20 (2015): 4-6.

²⁰ Ouyuong, Laishyang. "Effects of Resonance Voice Therapy on Hormone-Related Vocal Disorders in Professional Singers: A Pilot Study,"

²¹ Kadakai, Sameep. "Hormones and the Voice," *The Voice*, vol. 20 (2015): 4-6.

²² Doscher, Barbara. *The Functional Unity of the Singing Voice*. United Kingdom: Scarecrow Press, 1994.

During menopause, the levels of estrogen and progesterone fall completely.²³ For postmenopausal female singers, their estrogen and progesterone fluctuation diminishes significantly and singers have experience permanent physiologic changes in the vocal folds which are attributed to alterations in hormonal status. Voices typically drop in fundamental frequency because the ovary secretes little to no estrogen but continues to secrete androgen. Progesterone decreases in volume, causing vocal fold swelling by increasing viscosity and acidity levels of glandular laryngeal cells, whereas estrogen increases glandular cell secretion and has a hypertrophic effect on laryngeal mucus.²⁴ During menopause, the laryngeal tissues are affected and result in muscular and mucosal atrophy, fluid retention and swelling of the vocal folds, and increased viscosity of the mucosa. Vocal discomfort is described as dryness, throat clearing, lower fundamental frequency, reduced frequency range, reduced intensity, and increased roughness and hoarseness.²⁵

Though it is now understood how the voice changes, the question remains: why? Many scientists have looked into the evolutionary purpose for the changes in voice during the menstrual cycle and have studied it to see if there is any correlation between the phases and the voice's production. As stated earlier, receptors for sex hormones have been found on the vocal folds, which suggests a link between hormone levels and vocal fold function. From here, a theory can be formed. Some say that the cords adapt with the cycle with the purpose of finding an

²³ Kadakai, Sameep. "Hormones and the Voice," *The Voice*, vol. 20 (2015): 4-6.

²⁴ Ouyuong, Laishyang. "Effects of Resonance Voice Therapy on Hormone-Related Vocal Disorders in Professional Singers: A Pilot Study,"

²⁵ Steinhauer, Kimberly. "The Effect of Hormonal changes on voice quality," *The Voice*, vol. 20 (2015): 1-3

adequate partner. Estrogen levels peak in the late follicular phase, which corresponds to the period of highest conception probability, while progesterone levels peak in the luteal phase. In certain studies, which will soon be discussed, attractiveness ratings of women's voices varied across the menstrual cycle, with higher ratings being found for voices recorded in the fertile phase. Sex hormones might be the mechanism underlying voice changes across the menstrual cycle.²⁶

Numerous studies have been worked through to understand why the voice changes. Bryant and Haselton found increases in voice pitch in fertile period. Tatar backed up these findings by discovering that voice pitch was higher in follicular than in luteal phase, but did not differ from pitch recorded in the menstrual phase. Findings recorded a decrease in voice following fertile phase. Other acoustice characteristics are involved in how other perceive the voice like pitch variability: less monotone and stable. In order to come about such findings, researchers collected voice samples. Voice recordings were obtained in the menstrual, late follicular, and luteal phases from 62 women with regular menstrual cycles and who had not taken hormonal contraceptives or any other kind of hormonal therapy, and 21 women using monophasic hormonal contraceptives who had been using these for at least 3 months prior to study. In order to create consistent material, the women were instructed to speak on a prolonged vowel sequence.²⁷ Other researchers took a more different, more upfront approach. One group of

²⁶ Banai, Irena. "Voice in different phases of menstrual cycle among naturally cycling women and users of hormonal contraceptives," <https://doi.org/10.1371/journal.pone.0183462>, Jagiellonian University, 2017.

²⁷ Banai, Irena. "Voice in different phases of menstrual cycle among naturally cycling women and users of hormonal contraceptives," <https://doi.org/10.1371/journal.pone.0183462>,

researchers gathered a group of women to anonymously speak to heterosexual men. The men had to determine if they thought the woman was on her period, and if he thought her voice was attractive. Though the results were not across the board consistent, results showed that many of the men found the female's voice to be more "attractive" during the fertile stages of menstruation.²⁸

Many researchers who understand how and why the change occurs then want to see a change. The singer should not have to simply sing through such a harsh and dramatic change without any help or alterations of any kind. One group of researchers sought to understand if voice therapy would help the vocalist build up core skills in order to navigate their way through the vocal changes from the monthly fluctuation of hormones. They experimented with resonant voice therapy, or RVT, which aids in a healthy resonant phonation, and cervical thoracic therapy, which focuses on the more physical side of phonation.²⁹

The researchers used RVT in healthy female singers during the premenstrual phase and in postmenopausal singers to improve vocal quality and to evaluate which therapy will allow singers to improve vocal performance regardless of changes in hormonal status. They gathered a group of 20 female singers, 10 of which were premenopausal and 10 of which were postmenopausal, and all were older than 18. All subjects were professional singers giving

Jagiellonian University, 2017.

²⁸ Pipitone, R. "The Unique Impact of Menstruation on the Female Voice: Implications for the Evolution of Menstrual Cycle Cues," *Ethology: international journal of behavioural biology*, 2011.

²⁹ Ouyuong, Laishyang. "Effects of Resonance Voice Therapy on Hormone-Related Vocal Disorders in Professional Singers: A Pilot Study,"

performances more than 3 times a week, had regular cycles, not pregnant, no vocal issues, and had no history of surgery in neck/larynx. Half of the group received RVT the other half received cervical thoracic-focused therapy.³⁰

The researchers modified RVT curriculum for the singers. They were required to exercise 3 times a day for 5 minutes each time with assigned warmups. The singer was to sit with upright shoulders relaxed, breath out first, then inhaled, and then hold. While holding their breath, the subjects said “mum-mum-mum-mum” on the top of their breath. They would do slow, slow-fast, and quiet-projected “mum” for 5 times. After warm-ups was stretching. The subject was to glide their phonation from the lowest note to the highest note on the word “whoop” 5 times, then they would glide from a comfortable high note to the lowest note on the word “boom” 5 times. With cervical-thoracic focused therapy, the subjects were instructed to perform suboccipital stretch, pectoral stretch, neck flexor strength, and neck extender strength exercise in sequence, and each stretch was held for 30 seconds according to the protocols provided. For subjects in the premenopausal group, the posttherapy data collection occurred during their consecutive premenstrual phases of the menstrual cycle or days 25-27 of the menstrual phase. The first day of menses is defined as day 1 when the estrogen level decreases and vocal cords have the most severe edema and dysfunction. For women in the postmenopausal group, subjects were examined at the time of voice evaluation without considering their menstruation status.³¹

³⁰ Ouyuong, Laishyang. “Effects of Resonance Voice Therapy on Hormone-Related Vocal Disorders in Professional Singers: A Pilot Study,”

³¹ Ouyuong, Laishyang. “Effects of Resonance Voice Therapy on Hormone-Related Vocal Disorders in Professional Singers: A Pilot Study,”

In order to view the changes as they were occurring, subjects were to get a scope in order to have the vocal cords looked at. This information would allow the researchers to have both physical and auditory proof of change from the therapy. In the end, it was found that RVT has positive effects on female singers' voice quality, speaking flexibility, phonation effort, and functional communications.³²

With everything gained from this analysis and research, it is still important to note that there is still so much that scientists and vocalists do not know. In order to make a fully make change in regards to how vocalists are treated during menstruation, more solidified research needs to continue to be done. In the meantime, vocalists can take part in the findings that have been released, such as the resonant phonation therapy. Not only will this strengthen core techniques in the vocalist, but it will also allow the vocalist to become even more aware of the changes which occur in their voice so they can better prepare.

³² Ouyuong, Laishyang. "Effects of Resonance Voice Therapy on Hormone-Related Vocal Disorders in Professional Singers: A Pilot Study,"

Bibliography

- Ouyuong, Laishyang. "Effects of Resonance Voice Therapy on Hormone-Related Vocal Disorders in Professional Singers: A Pilot Study," *Clinical Medical Insights: Ear, nose, and throat*, vol. 11 (2018): 1-7
- Banai, Irena. "Voice in different phases of menstrual cycle among naturally cycling women and users of hormonal contraceptives," <https://doi.org/10.1371/journal.pone.0183462>, Jagiellonian University, 2017.
- Steinhauer, Kimberly. "The Effect of Hormonal changes on voice quality," *The Voice*, vol. 20 (2015): 1-3
- Kadakai, Sameep. "Hormones and the Voice," *The Voice*, vol. 20 (2015): 4-6.
- Pipitone, R. "The Unique Impact of Menstruation on the Female Voice: Implications for the Evolution of Menstrual Cycle Cues," *Ethology: international journal of behavioural biology*, 2011.
- Jeanmonod, Rebecca. "Physiology, Menstrual Cycle," *NCBI Bookshelf* (2021).
- Doscher, Barbara. *The Functional Unity of the Singing Voice*. United Kingdom: Scarecrow Press, 1994.