

Investigating the Relationship between Sexual Hormones and Female Western Classical Singing

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Abstract

There has not always been an awareness of the relationship between sexual hormonal concentrations and quality of the singing voice in the Western Classical singing world. Despite evidence for this connection existing since the 3rd century B.C., there are still controversies and lack of information about this area, especially regarding the effects on the female western classical singing voice. The aim of this paper is to shed light on the importance of undertaking further research in this field. Therefore, a revision of previous research, exploring the extent to which sexual hormonal concentrations can contribute to the well-being of a singer's voice and career, from both psychological and biological points of view, will be presented. Additionally, further investigation in the field of hormonal related medication and its effects on singing voice quality will be undertaken.

Introduction

It is estimated that malfunctions of the endocrine system are responsible for 15% of voice disorders. For example, hypothyroidism is often responsible for a husky “broken-pot” voice, and minor thyroid dysfunction can also cause mild dysphonia and a sensation of “having a veil over the voice” (Brodnitz, 1971; Sataloff, 1987). However, prominent changes in the quality of the voice occur mostly when there are changes in the concentrations of sexual hormones. During the life span, the voice undergoes changes related to a person's sexual

hormonal concentrations, and women are notably affected by these hormonal fluctuations more than men. The male voice changes in the early and later stages of sexual development, puberty and andropause; however, the female voice is affected across her life span, and during the reproductive years in particular this effect can be cyclical. Therefore, and bearing in mind the complexity of the female sexual endocrinology system, this article focuses on changes in female classical singing voices related to the hormonal variations that are responsible for women's menstrual cycles.

Historical contextualisation

Nowadays, it is known that the human larynx is a “hormonal target organ” (Abitbol, Abitbol & Abitbol, 1999). However, the acceptance of this concept by the Western classical singing world has been a long and difficult process which still raises some controversy.

The first written evidence of a strong connection between sexual hormones and voice quality dates back to the 3rd century B.C., when castration was reported as a way of preserving a boy's high vocal range for singing purposes beyond puberty. Experiments with castration spread to all of Europe during the 8th and 9th centuries, especially to Spain and to Italy, and by the 16th century, the Church became the greatest promoter of the *Castrato* voice.

A *Castrato* had a crystalline timbre and an exceptional range, and his voice was extremely powerful (Weiss, 1950). *Castrati* developed a reputation as skilful singers, able to sing the majority of operatic roles of their time, despite the fact that, they were originally vocally altered in order to sing sacred music in churches. Their voice characteristics were a consequence of a paediatric laryngeal structure, vibrating in a female register, but having the breathing power and resonance of a man (Abitbol, Abitbol & Abitbol, 1999).

Another source of evidence that demonstrates the interference of sexual hormonal levels on voice quality has been obtained from pubertal vocal studies. During puberty a set of bodily transformations occur. The increase in the activity of the adrenal cortex and gonads is responsible not only for transformations in both male and female reproductive systems, but for significant changes in the larynx, especially for boys (Gelder, 1974). Vocal changes during puberty are a result of a fast increase in the size of the larynx: there is a rapid and disproportional change in the thyroid cartilage, and thus vocal fold length, which happens approximately between the ages of 12 to 13 years of age (Titze, 1993). Physically, there is an increase in breathing capacity as a consequence of an enlargement of the neck and chest. The lengthening of the neck allows the descent of the larynx, which is more significant for boys and especially in deeper voices (Cooksey, Beckett & Wiseman, 1984). Following these transformations, voice becomes a sexual secondary characteristic, which means that the gender of a person is likely to be detected by his/her vocal pitch (Abitbol, Abitbol & Abitbol, 1999).

A third and important source of evidence for the hormonal-vocal relationship has been the singers' subjective reports of their experiences. Classically trained female singers have complained about vocal alterations over several days before the onset of menses (Frale, 1961). These reports have often been taken into account by Eastern European opera houses, where "respect days" were written into contracts (three days in which the singer can refrain from singing during vocal premenstrual tension) in order to avoid negative effects on the quality of her voice (Lacina, 1968). However, Eastern and Western Europe is divided in its opinion as to whether singers should refrain from singing during the premenstrual and menstrual phases of the cycle. In Western Europe, female operatic singers may have professional engagements regardless of which phase of the menstrual cycle they are in.

One aim of this paper, therefore, is to increase awareness of the relationship between sexual hormones and quality of classical singing voice and the potential vocal problems related to it. To achieve this, an overview of previous research and the investigative approaches employed will be discussed, followed by an assessment of the psychological and physiological effects of sexual hormonal variations on Western classical singers' performances. Finally, there is a discussion on how further research in this area could help to improve the care of the professional voice at all levels.

Summary of key research

Several previous studies have been concerned with the effects of cyclical hormonal variations during the menstrual cycle on the quality of the female voice; however, findings amongst these studies are inconsistent. Whilst there is little consensus in one group of studies in demonstrating a clear link between the menstrual cycle and vocal aberrations, another group of studies provides evidence that supports such a link. For example, Frable (1961) reported the complaints of three female voice users, all non-trained singers, who mentioned symptoms of hoarseness, vocal breaks, loss of control, decrease in pitch and huskiness of the voice during the premenstrual period of the menstrual cycle. However, the results of laryngoscopic examinations undertaken at several times during the menstrual cycle showed normal larynxes (Frable, 1961).

Silverman and Zimmer (1978) analysed the spectrograms of three sustained vowels from 20 undergraduate students at ovulation and premenstruation. From their investigation, they concluded that hoarseness is not a symptom of premenstruation, since there were no significant changes between ovulation and premenstruation (Silverman & Zimmer, 1978).

Flach, Schwickardi and Simon (1968) studied the voices of 187 singing students during their menstrual cycle, in order to assess whether vocal changes were observed; however, no direct correlation between voice changes and menstruation was found (Flach, Schwickardi & Simon, 1968). Wilson and Purvis (1980) compared the range and fundamental frequency of the voice of ten singing students. They analysed the production of a sustained vowel, /a/, and the highest and lowest notes of the singers' ranges, at three specific points of the menstrual cycle: two days before the onset of menses, and on days 14 and 21 of the menstrual cycle. The results of this study did not show significant acoustical changes between the three recorded times; however, seven singers perceived negative changes in the quality of their voices during menstruation and premenstruation. Their reports included comments such as: "cloudiness of the voice", loss of brilliance, loss of flexibility, changes in timbre towards a darker and hoarse colour (Wilson & Purvis, 1980). Brown and Hollien (1981) reported the results of a study undertaken by Coleman and Hyler (1981 as personal communication) who recorded three young women with untrained voices reading a standard passage everyday of one menstrual cycle. The research questions were concerned with changes on the fundamental frequency of untrained female voices during the menstrual cycle and its comparison with the fundamental frequency of the trained female voice. The results did not indicate any significant differences (Brown & Hollien, 1981).

On the other hand, studies have shown a direct relationship between certain phases of the menstrual cycle and voice changes. Lacina (1968) highlighted the existence of premenstrual and menstrual vocal symptoms by studying 42 opera singers in the National Opera House in Prague. During the phases of the menstrual cycle, some singers commonly reported loss of high notes and uncertainty of pitch. A laryngeal examination showed vocal haemorrhage and a small oedema. With vocal rest and small dosages of prednisolone the voice

was restored, but these singers were advised not to sing during the premenstrual phase of their menstrual cycle. In the face of the gravity of these symptoms, Lacina (1968) advised avoiding severe strenuous use of the vocal folds during these times of the menstrual cycle.

Brodnitz (1971) presented the case of a young opera singer who lost her voice every month during premenstruation. Laryngoscopies were performed and revealed small mucous membrane haemorrhages premenstrually. Also hormonal analysis showed low levels of luteinising hormone (LH). If the singer did not sing at all during this phase of her ovarian cycle, vocal problems were reported as being avoided (Brodnitz, 1971). Whitehead, Kohler and Schlueter (1974) reported that the vocal quality of some singers could be affected some days before and during menstruation. They studied the effects of the menstrual cycle on the harmonic and non-harmonic portions of sung vowels in twelve adult females during one menstrual cycle. Spectrographic analysis was performed and the results indicated that there was an increase in non-periodic components in the vowel spectra during premenstruation (Brown & Hollien, 1982).

Bearing in mind the severity of the vocal symptoms reported in some case studies, Gelder (1974) considered vocal aberrations during premenstruation and menstruation as a discrete diagnosis, *Laryngopathia Menstrualis*. According to this author, this cyclical dysfunction of the voice could be seen more frequently in singers, since they demand more from their vocal mechanism. The vocal symptoms could include dull, colourless, raucous voice, and hoarseness, as consequences of oedema or even haemorrhages in the vocal folds. The tension of the vocal folds was reduced, resulting in a husky voice. Gelder strongly advised singers not to perform during these phases of the menstrual cycle, since vocal haemorrhages could cause an irreversible damage of the tissues involved in phonation (Gelder, *ibid*). Isenberg, Brown and Rothman (1983) included in their study additional physiological

measures, particularly body weight and body temperature. They chose a population of singers with irregular menstrual cycle or amenorrhea, since, according to them, this population is the most affected by vocal problems, such as a “crack” in the voice; breathiness and weakness in a given area that persists even after several years of vocal training; inability to phonate on given pitches; tonal “stops”; and lack of flexibility. During their experiment, these authors found that singers who had an increase in body temperature had an increase in their speaking fundamental frequency. On this basis, they suggested that a fluctuation in hormone levels and the fundamental frequency of the speaking voice might have a direct relationship, since release of progesterone following ovulation induces a rise in basal body temperature in the second half of the menstrual cycle. Additionally, measurements of serum testosterone were made, since this hormone can have masculinising effects on the female voice. The authors concluded that women with menstrual problems had higher levels of testosterone when compared to the group of singers who had regular menstrual cycles (Isenberg, Brown & Rothman, 1983).

Abramson *et al.* (1984) distributed a questionnaire to 120 trained singers concerning their own perception of the quality of their voices across their menstrual cycles. Their results showed that changes in a singer’s voice during the menstrual cycle might be a result of elevated oestrogen levels rather than drops in the levels of oestrogens, since some of their responses highlighted vocal changes during the ovulatory phase of the cycle, i.e. when levels of oestrogens are high (Abramson *et al.* 1984). Brown and Rothman (1985) added a new technique for studying the quality of the voice through the menstrual cycle. They used an index of hoarseness based on a relation between the levels of harmonics versus the levels of noise (H/N ratio), and they also analysed a jitter factor. These two measurements provide a more accurate view of the acoustical characteristics of the voice, where “noise” can be understood as the non-periodic components of the vowel spectra. They compared a group of non-singers, elementary school teachers, with a group of college students studying vocal

music, during the day prior to menses, one day in early menses and one day out of premenstrual and menstrual influence. Their results suggested significant differences in these parameters for the three recorded times. When the H/N ratio decreased, indicating greater “noise” in the vocal signal, the jitter values increased (H/N ratio decreased and jitter levels became higher). This phenomenon occurred during clear and premenstrual moments, when compared with menses, results that the authors did not expect. There was more noise when sustaining the three vowels /i/, /a/ and /u/ softly, which was the most difficult to control. The authors did not find significant differences during menstruation for values of fundamental frequency (F_0). F_0 was higher when sustaining the three vowels loudly when compared with soft and conversational levels. The authors reached the conclusion that although teachers and singers showed similar results, the latter demonstrated more voice control and less overall aperiodicity in the voice signal than the former, suggesting that singers may be more capable of overcoming premenstrual vocal problems than non singers.

Wicklund *et al.* (1988) compared the longitudinal effects of the menstrual cycle on perturbation, phonatory range and mean fundamental frequency of singers and non-singers with regular menstrual cycles. They analysed a spoken text, the ‘Rainbow Passage’ (Fairbanks, 1940), and three sustained vowels /a/, /i/ and /u/, during pre, peri and postmenstrual phases of the menstrual cycle. They also analysed diaries of the menstrual cycle (menstruation was day one), which embraced questions such as: perception of energy levels, emotions, and irritability and hoarseness. Generally, the results showed higher F_0 for singers than for non-singers, which was expected. In the same way, singers were more aware of vocal aberrations and were more sensitive to them, looking to care for their voices. Differences in both singers and non-singers F_0 were found for the different recorded periods. Singers showed lower F_0 premenstrually, higher F_0 during the menstrual period and even higher F_0

postmenstrually. These results correspond with earlier theories of fluid retention in the vocal folds during the premenstrual and menstrual phases of the cycle (and fluid retention relates to increased mass in the vocal fold tissue and lower vocal pitch). On the other hand, non-singers showed higher F_0 during premenstruation. This could be evidence of their increased effort to compensate for physiological changes. Non-singers might increase the adductory forces to maintain a normal sound during premenstruation. This hypothesis of an increase in adductory forces was supported by an increase in the levels of loudness (Wicklund *et al.*, 1988).

Abitbol *et al.* (1989) carried out an investigation aimed at assessing the prevalence of premenstrual hoarseness and whether changes in voice quality accompanied biological and/or hormonal changes during the premenstrual phase of the cycle. The subjects sang 'Frère Jacques' on three successive starting notes. The recordings were made at ovulation (scheduled 14-15 days following onset of menses), and for one to three days before the onset of menses, during two successive cycles. Each subject's experimental behaviour was videotaped and dynamic vocal exploration (DVE) was performed. DVE offers three kinds of data, all synchronised: acoustic, visual and glottographic. Vocal range, vocal quality and vocal intensity were recorded and analysed by later audition. Visually, they investigated the mobility of arytenoids, vocal mass and the appearance of the epithelium during singing, all evaluated with videostroboscopy. A rigid laryngeal telescope was used to magnify the capillaries after the exercises to assess oedema in detail and look for possible signs of muscle fatigue. Electrolaryngography enabled the action and the impedance of the vocal folds to be reviewed during phonation. This was a major piece of research which confirmed that hormonal levels influence the woman's voice. The researchers also established that there were hormonal receptors in the larynx; oestrogen target cells were found in the larynx, as well as androgen and steroid receptors in human pharyngolaryngeal mucosa and epithelium.

Furthermore, these authors found a similarity between vocal fold and cervical epitheliums as an outcome of performing a vocal fold smear and a cervical smear test. These observations could help to explain why large numbers of singers had premenstrual symptoms such as hoarseness and vocal fatigue.

More recently, Abitbol, Abitbol and Abitbol (1999) undertook a systematic study on the effects of the menstrual cycle on voice quality in 97 vocal professionals, at ovulation and in the premenstrual phase, during three consecutive menstrual cycles. They performed video recordings of vocal fold anatomy and a laryngeal chrono-kinetic study. Spectrographic vocal analyses were also performed. The participants sang 'Frère Jacques' to test the agility of their voices; they also sang staccato notes on the /i/ vowel to allow the assessment of mobility and suppleness of the left and right cricoarytenoid joints. The vibrations of the vocal fold mucosa during phonation were analysed in slow motion using stroboscopy. The results of this study indicated: (i) swelling of the vocal folds, with thickened mucous membrane and loss of capacity of distension during the premenstrual phase of the cycle for the 97 patients analysed; (ii) 71 patients showed dilatation of microvarices in the vocal folds, submucosal vocal fold haematoma and vocal fatigue; (iii) 59 subjects presented a decrease in muscular tone, diminished power of contraction of the vocal muscles, decreased range and vocal fold nodules. Results suggested that during the premenstrual and menstrual periods the laryngeal mucous is thicker, leading to a frequent throat clearing and a decrease in the levels of hydration of the free edges of the vocal folds, so vocal lubrication is reduced (Abitbol , Abitbol, & Abitbol 1999).

The studies described above are significant and we believe that they are sufficiently compelling to support the concept of "respect days" in female singers' contracts. Nowadays,

performers, voice educators, voice scientists, medical doctors and behavioural therapist work in a close relationship, so they need to be aware of these recent systematic studies.

Physiological and psychological effects of sexual hormonal variations

Having considered the research presented above, it seems that there is evidence to support the proposition that negative vocal symptoms are related to premenstrual and menstrual phases of the menstrual cycle. Therefore, the physiological and psychological evidence for this assumption will now be explored.

From a physiological and endocrinological point of view, there are several possible explanations for the effects of variations across the menstrual cycle on the quality of the voice.

According to the pioneer of the study of vocal behaviour across the menstrual cycle, Frable (1961), there is a strong influence of levels of oestrogen on the state of the ground substance. Drawing on the work of Schiff and Burn (1961), Frable (1961), Owen (1975) and Dalton (1977) suggested that the decreasing levels of oestrogens just before and during the menstrual phase of the menstrual cycle cause water retention in the vocal tissue, and that this physiological change would account for vocal aberrations. Pressman and Kelerman (1970) explained that vocal changes during the premenstrual and menstrual phases of the menstrual cycle were as a result of an increase of blood supply to the vocal folds, due to an increase of thyroid gland activity. Vocal hoarseness would be therefore the most common vocal symptom at these phases of the menstrual cycle. Isenberg, Brown, and Rothman (1983) claimed that the cause for vocal changes during the menstrual cycle was not the actual dropping in the levels of oestrogens before menstruation, but the inconstancy of hormonal levels during the whole menstrual cycle. They also hypothesised that changes in testosterone

levels might also account for vocal changes across the menstrual cycle, thus these changes should be closely monitored.

Abramson et al. (1984) also argued that for a female singer it is much more difficult to overcome constant physiological changes in the larynx in response to constant changing levels of oestrogen, than with a more prolonged change during a particular moment of her menstrual cycle. Higgins and Saxman (1989) maintained that the inconstancy of the sexual hormonal levels across the menstrual cycle would interfere with the laryngeal neuromotor movement and sensory thresholds, so voice production would be affected. More recently, Abitbol, Abitbol and Abitbol (1999) studied the effects of oestrogens and progesterone on the vocal folds. They claimed that oestrogens cause an increase on the secretion of the glandular cells above and below the vocal folds' edges. This increases mucous production both before ovulation and when the levels of oestrogen fall before menses. These modifications in the mucosa of the vocal folds may lead to minor changes in the voice, and these are enhanced by progesterone production. When progesterone is secreted, major changes in vocal quality occur due to the fact that this hormone increases the viscosity and acidity of the secretions of the glandular cells, but decreases their volume, causing a relative dryness. The dryness of the vocal folds, the increase in the acidity level, the reduced tonicity of the laryngeal muscles, oedema of the vocal folds and venous dilatation of the microvarices all combine and result in a premenstrual voice syndrome. They also found (besides the fluctuations in hormonal levels) that cyclical changes in the mucosa of the vocal folds are similar to those occurring in the cervix of the uterus, since both tissues are physiologically and structurally similar. The squamous ectocervical mucosa has three layers: the lamina propria, and the chorion, which can be divided into basal and parabasal membranes. During the first part of the cycle, the junction between these three layers of cells is larger than during the second half of the cycle,

leading to the conclusion that the volume of intracellular space in the cervical mucosa is hormone dependent. The endocervix is also hormone dependent. It is ciliated and has serous and mucous glands. Oestrogens produce a thin mucous and progesterone leads to a thick mucous. According to these authors, both tissues have a hormonal sensitive intracellular space, so that oedema caused by a thicker mucous during the luteal phase of the menstrual cycle (i.e. the last phase of the menstrual cycle) may cause changes in vocal quality, such as decreased flexibility, loss of high notes and breathy voice.

Alongside the understanding of physiological vocal changes that cause premenstrual and menstrual vocal distress, it is important to recognise the psychological impact of this in singers' performances. A singer is always aware of the next performance, and being obliged to sing when there is vocal distress can be very soul-destroying. The reports of singers constitute the clearest currently available evidence for an association between certain phases of the menstrual cycle and vocal difficulties. To understand better the degree of vocal distress that singers feel during the menstrual cycle, we report data gathered from face-to-face semi-structured interviews we undertook with five professional female singers (age range between 34-48 years, all in normal menstruating cycles) living in the U.K. For reasons of confidentiality, the five singers will be identified by the pseudonyms of Anna, Beatrice, Catherine, Danielle and Eva. These qualitative inquiries encouraged the exploration of singers' perceptions, feelings and understandings of their voices regarding their hormonal background, and the first reports concern the singers' perceptions of their voices during the premenstrual and menstrual phases of the menstrual cycle,

“When I do my daily practice I feel tired, either the day before or the first day of the period. But the biggest thing I notice, which always happens and which always has

happened to me, is that my voice is much heavier. The day before and the first day is like lifting a sack of potatoes. It's probably the only way to describe it. Every exercise is like lifting a sack of potatoes. The voice is very heavy and I find that it is like the sack is on my back. The pianissimos are also affected. For instance, in the cadenza of "Lucia di Lammermoor", there is a very high section that is all in high B flat, C and D pianissimo; this is very high in the voice, and it is right near the passaggio which is not good to sing - the passaggio and pianissimo. During my period, at times it just doesn't work, and I have just to accept that maybe on these days it's just not going to work." [Anna]

"I feel dragged down, so that the problems are more in the lower parts of the body. It is like there is dissociation between the several parts of my body. With menstrual pain, there is so much the feeling of being dragged down that there is no more connection."

[Beatrice]

It seems evident from the above reports that singers are aware of a strong relationship between vocal tiredness, sensation of heavier voice, loss of pianissimo effects on high notes and loss of vocal support during premenstrual and menstrual phases of the menstrual cycle.

One of the reasons to explain why singers agree to sing in such demanding and potentially professionally dangerous conditions might be because they do not recognise these symptoms as being associated with their menstrual cycles. Because of the personal nature of these issues, they might not have been discussed at a professional level. Beatrice and Catherine had the opinion that consciousness about this phenomenon among the "world of classical female singers" might be the only way to overcome possible long time vocal injuries associated with hormonal imbalances.

“I never had discussed these matters with other colleagues.” [Beatrice]

“Singers are more or less aware of this relationship between the hormonal cycle and the quality of the voice, but I think they are not conscious of it. It’s like all kinds of things; it needs to be brought into attention. (...) I think if I had recognised the biological things much sooner, I might have done some thing about it.” [Catherine]

At this point of the interviews, a discussion emerged about whether there should be ‘respect days’. The interviewees were aware that vocal damage could occur at premenstrual and menstrual phases of the menstrual cycle, and that “respect days” exist in certain European countries.

“As a singer, I don’t know whether “respect days” should exist in England. I don’t know whether the menstrual cycle affects a large number of singers in England. As far as I can see, I think colleagues of mine tend to have the opinion that they just have to get on with it and put it down to a bad day. If it is a performance day, then it is tough. The performance might not be so good, but it is just part of life, there is no other way around it. I suppose that the fact that other countries have “respect days” is a question of temperament of people, and culture. Other European countries might have more respect and there is still more respect for this kind of profession. The average working singer cannot refuse to sing, and the average company would not be prepared for the expense and the bother of putting in another singer, just because she is having maybe a slightly not so good performance. I think they would not be that bothered, but if you

have the clout, if you have a big reputation, people would listen to what you would say.

Yes, I think that is perhaps why it is more prevalent in other countries in Europe.

People in positions that have much more to say and are more outspoken about what they want, achieve conditions that they are prepared to work in.” [Danielle]

“My singing teacher actually experienced a haemorrhage during her menstruation, in one menstrual cycle, because her vocal folds were very swollen. One of my friends is a Russian soprano, and when she sang back home, she didn’t have to sing during the premenstrual phase of her menstrual cycle. It was in her contract that during the days before her period she was not booked to do an opera, and every concert and every opera for her was arranged that way. In England they are not aware of all the problems that female singers have during their cycles, and it can be very soul destroying. They do need to know because it’s not that you want to cancel anything, it’s just that the voice is not there and you can’t change your body”. [Anna]

In these interviews, these singers showed how concerned they feel about their voices, and that they are always thinking about how their voices will be in their next performance. It is urgent to bring out these issues for a broader discussion, so a consensus could be reached for all (European) countries about the importance and practice of “respect days”.

Further research

This article is focused on the physiological and psychological effects of the menstrual cycle on the female operatic singers and singing voices. However, in the field of endocrinology and hormonal related medication applied to vocal quality, there is still great

scope for research. Hormones have been used as therapy for many years; however, they have frequently been used without knowledge of their side effects on the voice. Earlier research concerning female synthetic sexual hormones and voice quality suggested a predominance of adverse effects of oral contraception on singers' voices. Gelder (1974) enhanced the study by Zilstorff (1965) in which the author reported the case of two Denmark sopranos who showed deeper voices after taking an oral contraceptive pill (OCP) Enovid®. The natural pitch of their voices recovered after stopping the use of the OCP (Gelder, 1974).

Additionally, Brodnitz (1971) described symptoms of hoarseness and loss of high notes in a 19-year-old singing student who took an OCP containing norethyodrel mestranol (synthetic progestogen) for two months, and for three opera singers who were prescribed with this OCP for longer periods of time. For both cases, the above mentioned vocal symptoms stopped after cessation of this contraceptive method (Brodnitz, 1971). Dordain (1972) recorded the extemporaneous speaking voice, the projected speaking voice and the highest and lowest notes in the vocal ranges of: singers who were not taking any kind of oral contraception, singers who were taking an OCP, and singers who were using mechanical contraception. The results identified a decrease in the vocal range in professional singers who took an OCP, even over a brief period of time (Dordain, 1972). Other studies have also found OCPs containing 19-norsteroid have a negative effect on the voice (Damsté, 1967; Pattie *et al.*, 1998; Davies & Jahn, 1999; Baker, 1999). The authors hypothesised a swelling of the vocal folds under the influence of synthetic progestogens; however, an increased mass of the vocal folds could not be demonstrated. Another OCP, Ovosiston®, containing 2mg Chlormadione acetate and 0.1 mg mestranol, was also associated with virilisation of the voice (Wendler *et al.*, 1995).

Regarding the observations obtained from the above mentioned studies, during the later 1960s and 1970s professional voice users who were taking an OCP were advised to avoid it, or undertake regular phoniatic examinations by ear, nose and throat (ENT) surgeons. In the 1980s, as a consequence of the pharmacological evolution of the OCP, in which hormonal dosages were decreased and other active ingredients were used, there was a reduction of complaints of vocal changes.

On the other hand, recent studies have been unable to find any effects of OCP use in voice quality. In a study by Wendler (1995), the effects of 2 different OCPs on voice quality were assessed: Diane-35[®] (0.035mg ethinylestradiol and 2mg cyproterone) and Microgynon[®] (0.03 ethinylestradiol and 0.15mg levonorgestrel). The study assessed the mean speaking frequency, pitch range, voice range profile and sound quality coefficient for women who were non singers, aged between 18 and 35 years old, during 13 cycles. Phoniatic observations were done between the 10th and 14th days of the 3rd, 6th and 12th cycles. Perceptual, laryngological and acoustical observations of the quality of the voice and the state of the vocal folds were performed. Perceptual observations were based on singers' reports of vocal changes, such as complaints about vocal fatigue, sensation of lump in the throat, need to clear throat, unpleasant sensations in the throat, hoarseness and changes in the speaking range. Laryngological examinations were made by an ENT surgeon. And finally, acoustical observations assessing the speaking frequency and the voice quality before and 20 minutes after voice production, were performed by a panel of five phoniaticians and speech pathologists, who assessed three different voice categories: 1 – hoarseness (total impression of the noise), 2 - roughness (noise component based on irregularities in the vocal cord vibration); 3 - breathiness (noise component based on turbulence resulting from insufficient closure of the glottis). These three categories were quantified in a scale between 0 = not present, 1= slight, 2 = moderate and 3 =

severe; recordings of pitch range (in Hz) and dynamic range (in dB) were made from the softest to the loudest voice intensities over the entire pitch range, from the lowest to the highest tones using vowels /a/, /e/, /i/ and /u/.

The subjective reports of the singers did not show any vocal symptoms related to this medication such as: vocal fatigue, feeling of lump in the throat, feeling a need to clear the throat, unpleasant sensation in the throat, hoarseness, and changes in speaking range. Also from the observations done by the ENT surgeon, no significant alterations were noticed; however, a slight increase loosening of the vocal mucosa and greater irregularities and incomplete closure of the glottis could be observed in some of the participants taking Microgynon[®]. Regarding the several acoustic parameters that were studied, there were no alterations noticed in the mean speaking frequency or reported changes in the quality of the sound. Additionally, the vocal ranges did not show significant alterations, although an increase of one octave above could be observed in the 12th cycle. Therefore, this research did not find a connection between negative vocal changes and the intake of an OCP. There were no alterations in the acoustic characteristics of the voice or in the quality of the voice. These findings lead us to believe that, with the pharmacological evolution of the new OCPs, side effects on the voice have been reduced. However, the authors still advise monitoring of professional voice users who take OCPs (Wendler *et al.*, 1995).

Other authors have proposed that an OCP might help singers to overcome vocal aberrations connected with the menstrual cycle. In a study by Isenberg, Brown and Rothman (1983) the authors tested the effects of an oral contraceptive pill, Ortho-Novum[®], on the singing voice. They chose five singers who had irregular menstrual cycles and previous problems of vocal symptoms connected with the menstrual cycle and they recorded their speaking voice reading the “Rainbow Passage” (Fairbanks, 1940) and singing a high and a low

note during two cycles. At the end of the experiment, which was completed by three singers, their results suggested that the OCP stabilised the body temperature and the speaking fundamental frequency was raised to a higher pitch. From their findings, they proposed that an OCP may help singers who had serious hormonal imbalances to stabilise their voices (Isenberg, Brown, & Rothman, 1983).

A similar idea was proposed by Amir, Kishon-Rabin and Muchnik (2002). They compared a group of non-singers, five who were taking an OCP and five who were not, over a period of approximately 40 days, sustaining two vowels /i/ and /a/ for five seconds. Acoustic parameters such as fundamental frequency (F_0), jitter, amplitude, shimmer, and harmonic-to-noise ratio (HNR) were assessed. The results suggested that there were significant differences in shimmer and jitter values between the two groups of women. Women taking an OCP showed lower perturbation values and smaller variance - parameters associated with healthier voices - during the menstrual cycle. Furthermore, fundamental frequencies were higher for those who were not OCP users. This study supported the hypothesis that the OCP might stabilise the vocal quality across the menstrual cycle (Amir, Kishon-Rabin, & Muchnik, 2002).

The literature on the use of OCP is too scant for definitive conclusions concerning the effects of the OCP on the quality of the classical singing voice to be drawn. Some studies support the idea that an OCP might decrease the fundamental frequency and range of the voice, mainly using older "First generation" OCPs, initially used in early 1960s. Lower amount of synthetic hormones with the same contraceptive effectiveness are currently used in new OCPs, so fewer side effects are expected. Other studies support the hypothesis that ovulatory inhibitors like the OCP might reduce certain singers' vocal difficulties connected with hormonal fluctuation during the menstrual cycle, although the majority of studies concern

only the speaking voice. Those studies which looked at the singing voice were not performed under a situation analogous to performance of repertoire. Given that a high percentage of young singers use this contraceptive method during their training and early career, it is important to investigate the effects of OCPs on their performance.

To contribute to further research in this area, we are currently undertaking a systematic investigation on the effects of a third generation OCP on the female operatic singing voice, in collaboration with Professor William Ledger, Professor David Howard and Dr. Georgina Jones. This ongoing study is a double blind randomized placebo controlled trial involving ten healthy operatic singers who are taking a placebo and a third generation OCP - Yasmin[®] each during three consecutive menstrual cycles. Acoustic measurements of vocal fold vibrations during the performance of a Lied, a French melody, and one operatic aria from each singer's repertoire are measured using an electrolaryngograph. Blood samples are collected at the end of each recording session, to measure levels of oestrogen, progesterone, testosterone, LH and FSH. The recording sessions and blood collections are performed for each part of the study (at the third month of use of Placebo and third month of use of Yasmin[®]) at three different phases of the menstrual cycle: at the second day of menstruation, and during follicular (around the 10th day of the menstrual cycle) and luteal (around the 25th day of the menstrual cycle) phases of the menstrual cycle. Through this fieldwork, we hope to advance research in this area, to extend our understanding and to provide information that is likely to be of great concern to the female singer.

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