Vocal Range in the Speech of Users of Low-Dose Oral Contraceptives

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Summary: Objective. The study aimed to investigate the vocal range of oral contraceptive (OC) users aged between 20 and 30 years.

Study Design. This is a cross-sectional study.

Methods. Forty-eight women aged 20–30 years who used low-dose OCs and 24 age-matched women who did not use oral monophasic contraceptives (w/oOC) were enrolled. Acoustic analysis was performed using the *Motor Speech Profile* program, Model 4341 (Kay Elemetrics Corp). Data were analyzed using generalized estimating equation.

Results. In the w/oOC group, the highest vocal tones in the sentence uttered using exclamatory intonation were similar in the follicular phases of two cycles (F1: 289 ± 46 Hz; F2: 284 ± 61 Hz). In the luteal phase of the first cycle, the vocal tones were lower, whereas in the second cycle they were higher than the tones in both follicular phases (L1: 274 ± 42 Hz; L2: 291 ± 62 Hz) ($P = 0.056$). In the highest vocal tones of the same sentence uttered using exclamatory intonation, the OC group showed lower tones (284 ± 53 Hz) than the w/oOC group (298 ± 44 Hz) ($P = 0.048$). In the lowest vocal tones of utterances of joy, the OC group showed higher values (180 ± 39 Hz) than the w/oOC group (169 ± 44 Hz) ($P = 0.024$). The close proximity of the highest to the lowest values of utterances of joy in the OC group (321 ± 59 Hz and 180 ± 39 Hz), when related to the w/oOC group (338 ± 65 Hz and 169 ± 44 Hz), suggests a reduced vocal modulation.

Conclusions. The present findings demonstrate that the use of low-dose OCs influences the vocal range of women during menacme.

Key Words: Menacme–Menstrual cycles–Oral contraceptives–Vocal range–Sound records.

INTRODUCTION

Speakers integrate linguistic and intentional contents with intonation and speech rhythm to communicate more clearly. Vocal variation can be employed to express different meanings, such as in interrogative and exclamatory sentences. Vocal variety, including resonance and pace, can also signal the prosodic features of languages, which are perceived through synchrony between intonation and rhythm.[1–3]

The cortical, subcortical, and neuromuscular integration allows coordinated movements among the respiratory system, laryngopharyngeal tract, and oral or nasal tract in speech.[4–6] Linguistic prosodic features, such as interrogative and exclamatory utterances, are attributed to higher cortical activity in the left hemisphere, whereas emotional intonations, such as sadness and happiness, are generated from the cortical processes in the right hemisphere. Speakers verbalize these intonations in a synchronized manner among voice variation (human sound waves), resonance (amplification and damping of the vocal sound waves), and speech articulation (opening and closing movements of the vocal tract that are required to produce vowel and consonant sounds).[1,3,7]

These vocal sounds can be correlated with acoustic properties. Therefore, vocal volume or intensity (loud-soft) is measured in decibels (dB) and corresponds to the amplitude of the laryngeal wave resulting from the interaction of subglottic airway pressure, amount of expiratory airflow, and glottal resistance. Voice frequency or vocal tone (low-high) provides information on the number of vibrations of the vocal folds per second and is measured in Hertz (Hz). The same applies to the harmonics, which are almost perfect multiples of the fundamental vocal tone, and to the formants, which arise from phonoarticulatory movements. In addition, the length of time taken by the glottal wave to complete a cycle corresponds to sound duration and is measured in milliseconds (ms) and segments per second (/s).[7–10]

Sex, age, habits and lifestyle, vocal effort, diseases, and medication use can change the phonoarticulatory characteristics.[11–16] Women are more vulnerable to vocal problems than men, and the risk is increased in professions that use voice as an occupational instrument, such as teachers and singers.

The effects of sexual hormones have been associated with memory, cognition, spatial skills, fine motor control of the speech, verbal fluency, social and communicative functions, and sensorimotor integration.[17–19] Fluctuations in ovarian hormones can change the sensory and motor processes of the larynx.[15,20,21]

The interaction of the hypothalamic-pituitary-ovarian axis with the genital tract during the reproductive years (menacme) is responsible for the occurrence of menstrual cycles at intervals of about 4 weeks. The length of time required for follicular maturation (variable) and the functional duration of the corpus luteum determine the menstrual cycle duration and menstruation cyclicity. Ovulation occurs between the follicular and luteal phases and, if fertilization does not occur, the functional layer of the endometrium is shed (menstruation).[20,21]

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Oral contraceptives (OCs) containing estrogen and progesterone can be used to inhibit ovulation and avoid pregnancy during menacme. They are also used in the treatment of premenstrual tension syndrome or premenstrual dysphoric disorder, acne, hyperandrogenism, increased menstrual bleeding, and primary dysmenorrhea, among other disorders.[22]

The relationships between voice and hormones have been studied. During menacme, increased nasal resonance has been detected during ovulation,[23,24] and vocal changes have been found to occur in the premenstrual phase.[10,25,26] OC use has also been associated with vocal stability,[27,28] changes in verbal fluency and memory, fine motor control, and speech perception, among other processes.[19] Pregnant women have shown reduced phonation time.[29–31] A reduction in the fundamental vocal tone and in vocal range has been observed during premenopause,[32] whereas vocal virilization has been observed during postmenopause.[33,34]

Acoustic analyses can capture the audible results of complex phonoarticulatory activity. Therefore, the aim of the present study was to investigate the vocal range of users of low-dose OCs based on speech settings situations produced in an acoustic laboratory in order to preserve expressive spontaneity speech.[1]

Currently, OCs are widely used by women during menacme. Yet little is known about their influence on phonoarticulatory aspects, especially in regard to hormone dosage. Whereas phonoarticulatory aspects play an important role in human communications, the aim of the present study was to investigate the vocal range of users of monophasic low-dose OCs based on speech settings situations produced in an acoustic laboratory in order to preserve expressive spontaneity speech.[1]

MATERIALS AND METHODS

Study design

A cross-sectional study was performed.

Population and sample

This study was approved by the Research Ethics Committee of the Research and Graduate Studies Group of Hospital de Clínicas de Porto Alegre (#03–230). This study is ethically and methodologically adequate according to the Guidelines and Regulatory Standards of Research Involving Human Subjects (Resolution 466/2012 of the Brazilian National Health Council).

Seventy-two women of reproductive age who had never been pregnant were invited to participate in the study at the gynecology outpatient clinic of the Hospital de Clínicas de Porto Alegre. Participants were native speakers of Brazilian Portuguese, nonsmokers, and had no vocal training in speech or singing. None of the participants were under hormone therapy or had any organic, neurologic, cognitive, or emotional limitations. Of these, 24 had regular menstrual cycles and had not been using hormonal drugs and contraceptives for more than 3 months. The other 48 women had been using OCs for 3 months or longer. Participants signed an informed consent form and completed a questionnaire about their vocal and gynecological history. Participants were then divided into two groups: women using low-dose oral monophasic contraceptives (containing estrogen 0.03, 0.02, or 0.015 mg), or the OC group; and women not using oral monophasic contraceptives, or the w/oOC group.

Data collection was performed as follows: (1) The noise level of the recording room was measured for 15 seconds to exclude possible interferences from environmental noise on verbal records. (2) The participants were asked to read aloud the sentence “Irei a Gramado nas férias de inverno” (I’m going to go Gramado over winter break”) in six variations, which consisted of neutral, exclamatory, and interrogative (prosodic) intonations, as well as expressing sadness, joy, and anger (emotional intonations), in order to record the speakers’ abilities regarding variations of higher frequency and lower frequency. This sentence refers to a local tourist spot. Participants were instructed to produce the desired intonation intended as in previous studies.[26] The speech sample of this sentence using neutral intonation demonstrated the mean time of syllable voicing and pausing. These pauses correspond to emissions of less than 30 dB of intensity, which are considered inaudible by the acoustic software for usual speech situations. (3) Five repetitions of verbal diadochokinesia /pataka/ were recorded to investigate the minimum vocal intensity and maximum vocal intensity.

Measurements were recorded during the follicular phase (days 5–8) and the luteal phase (days 18–23) for women with regular menstrual cycles, and were repeated in two menstrual cycles. The measurements for women using OCs were performed after the third day they had started a new pill pack.

Procedures were similar to previous work from our group.[25] Briefly, speech samples were recorded using the Sony MZR70-S1 Minidisc Recorder (Sony Corporation, Tokyo, Japan), a Shure 16A microphone (Shure Incorporated, Evanston, IL), and the Sony Recordable MiniDisc–74 Minutes (Sony Corporation). This cardioid, unidirectional, polar-pattern microphone had a frequency response of between 50 and 15,000 Hz. In the range between 500 and 8000 Hz, the variation was less than 4 dB, with a peak between 6000 and 7000 Hz for high-fidelity recording. The microphone was placed 10 cm from the mouth of the participants, who remained standing during the recording to facilitate their verbal emission processes. The emissions were trained whenever training was requested by the participants to avoid interference of individual differences, such as professional activity. The records were repeated until analyzable patterns were achieved according to the recorder sensor. Continuous analysis of the results was performed using the *Motor Speech Profile* program, Model 4341, coupled with the *Computer Speech Laboratory* software (Kay Elemetrics Corp, Lincoln Park, NJ).

Statistical analysis was performed using the *Statistical Package for the SPSS* (Chicago, IL, USA), version 18.0 for Windows. The final analysis was performed using generalized estimating equations considering differences of 30% between the variables for a beta error of 0.10, effect size of 1, and significance level of 0.05.

RESULTS

The participants’ mean age was 24 years (w/oOC group: 283 ± 29 months; OC group: 295 ± 32 months). Most participants were students (w/oOC: 88%; OC: 77%); they were college students or had already graduated from college (w/oOC: 92%; OC: 83%).