Acoustic Analysis of Female Voice during Menstruation cycle with reference to   Assamese Language

Mousmita Devi, Laba Thakuria, Purnendu Acharjee. Pran Hari Talukdar.
devimausmita@yahoo.co.in,thakurialaba@gmail.com,pbacharyaa@gmail.com, phtassam@gmail.com.
Department of Instrumentation and USIC
Gauhati University

Abstract-Human voice is the medium through which one can communicate and share ideas and thoughts. It also provides a rich source of information about an object and its attributes such as body size, developmental stability and emotional state[4].Recently number of studies said that female voice characteristics changes across the menstrual cycle. The purpose of this paper is to analyse and provide information about the effects of the acoustic variations during a menstrual cycle. Besides, the paper also obtains certain statistical acoustic variables during the menstrual cycle like Mean Fundamental frequency, Jitter, Shimmer, Amplitude Variation, degree of voice break, Noise to Harmonic Ratio etc. The objective of this study was to examine if there is a change in vocal quality of female during different phases of menstruation cycle viz. menstrual, follicular, ovulatory, Luteal, and premenstrual when subject's language is Assamese Language.

Key words: Assamese language**,** acoustic, hormone, menstrual cycle, phoneme, voice, vocal, woman.

1. INTRODUCTION

Menstrual cycle is the cycle of changes that occurs in the uterus and ovary for the purpose of sexual reproduction. It is essential for the production of eggs and for the preparation of the uterus for pregnancy. The menstrual cycle occurs only in fertile female humans and other female primates.

In humans, the length of a menstrual cycle varies greatly among women (ranging from 25 to 35 days), with 28 days designated as the average length. Each cycle can be divided into three phases based on events in the ovary (ovarian cycle) or in the uterus (uterine cycle). The ovarian cycle consists of the follicular phase, ovulation, and luteal phase whereas the uterine cycle is divided into menstruation, proliferative phase, and secretory phase. Both cycles are controlled by the endocrine system and the normal hormonal changes.

1.1 Why Assamese Language As a Refence Language?

The Assamese or Asamyia (IPA:[x mija]) is a major language in the North-Eastern part of India with its own unique identity. Its origins root back to the Indo-European family of languages. It is also related to the Indo-Iranian subfamily. This class can be subdivided into three groups of languages: the Dardic (or Pisacha), the Indic (or Indo-Aryan), and the Iranian. Assamese is the easternmost member of this New Indo-Aryan (NIA) subfamily spoken mainly in the Brahmaputra Valley of Assam. Assamese is, therefore, a composite language into which words of both Indo-Aryan and Indo-Chinese origins have made their way. Besides, other Pre-Aryan and non-Aryan influences are discernible not only in loan-words but also in print of grammar, syntax, and pronunciation. The Indo-Chinese group of languages is a large family divided into different sub-sections. Fig.1 depicts the evolution of Assamese language.
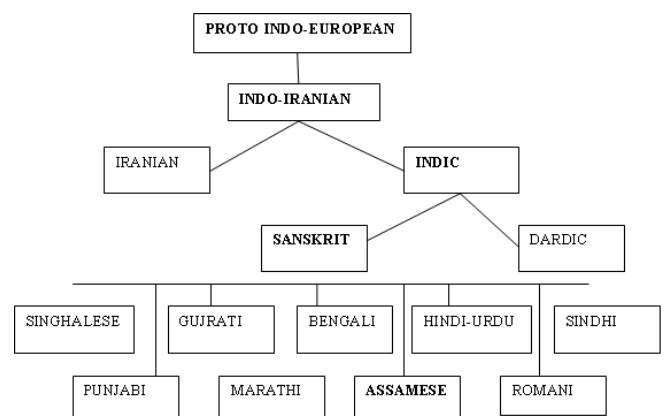

Fig: Proto Indo-European Family Tree

Assamese language has some unique phonetic properties in their phonemes. There is other phonological uniqueness of Assamese pronunciation which shows minor variations when spoken by people from different regions of the state. This makes Assamese speech unique and hence requires an extensive study to develop a speech recognition and synthesis system in Assamese.

1.2 Phonological structure of Assamese Language

The ASSAMESE phonemic inventory consists of eight vowels, ten diphthongs, twenty-one consonants and two semi vowels [7]. The ASSAMESE vowels and consonants are shown in the tables below.

Table 1: Vowels in ASSAMESE.

	Front	Central	Back
Close	i		u û
Half-close	e ê		o ô
Half-open	ɛ		ɔ
Open		A	

There are twenty-three consonant sounds including two semi-vowels in Assamese Language.

Table 4: Consonants in ASSAMESE

Nature of Articulation	Bi-labial	Alveolar	Palatal	Velar	Glottal
Plosive	p b	T d		K g	
	pʰ bʱ	tʰ dʱ		kʰ gʱ	
Fricative		s z		x	ɦ
Nasal	M	n		ŋ	
Lateral		l			
Rolled		r ɭ			
Semi Vowel	w		J		

The purpose of this study was to examine the factors that may affect women's voice. And also this study includes the acoustic analysis of voice change during different phases of the menstrual cycle with reference to assamese phonemes. The paper describes how menstrual cycle correlate with women's voice. The objective of this paper is to study an acoustic mode of assamese voice during the menstrual cycle. A significant correlation was found between the level of progesterone hormone and the characteristics of the voice.

2. METHODOLOGY

To test the above mentioned hypothesis, two major assessments were done: (i) the age of all the subjects were between 20 to 25, (ii) a set of audio recorded female voice samples from 10 subjects were used during various phases of menstrual cycles to examine the relationship between the female voice and premenstrual vocal symptoms throughout the menstrual cycle.

2.1 Subjects

Ten females between 20 and 25 years of age participated in the study. All subjects had no history of smoking, no complaints of premenstrual dysphonia, and were not professional voice users. All subjects were evaluated three times within one month or one menstrual cycle to obtain acoustic measurements. [6] Recordings were taken during different phases of the menstrual cycle.

2.2 Recording Procedure

The entire ten subjects were asked to record the words of Assamese language, which were selected for contain almost all the syllable templates. The recording was done in a quiet room with a noise cancelling microphone using the recording facilities of a typical multimedia computer system. The boundaries of syllable were marked according to the pronunciation of the team. The voice was recorded and processed on Audacity and Cool Edit Pro. The equipment used in recording was a microphone with a frequency response of 48000 Hz with a 16 bit sound card and high quality speakers.

2.3 Data Collection

According to Subject's number of days in their menstrual cycle they were divided into three groups[1].

1. For those with a 32 day cycle recordings were acquired on days 2 (menstrual phase), 8 (follicular

phase), 16 (ovulatory phase), 24 (luteal phase), and 32 (premenstrual phase) following the start date of menses.

2. For those on a 28 day cycle recordings were acquired on days 2 (menstrual phase), 7 (follicular phase), 14 (ovulatory phase), 21 (luteal phase) and 28 (premenstrual phase).

3. For those with a 26 day cycle recordings were acquired on days 2 (menstrual phase), 6 (follicular phase), 13 (ovulatory phase), 18 (luteal phase), and 26 (premenstrual phase) following the start date of menses.

A total of 50 audio recordings were acquired for analysis. Each session was audio recorded in a quiet room using a microphone connected directly to a computer operating voice analysis software to capture the audio signal. Subjects were positioned approximately 8 to 10 inches from the microphone while reading aloud the following stimulus sentence: "মই ভাত খাম" (mai bhaat khaam). The stimulus sentence is a connected speech pattern allowing for optimal changes in statistical analysis of acoustic variable [1].

3.STATISTICAL ANALYSIS OF SPEECH SAMPLES

Once the audio signal was captured a speech analysis software generated means for 8 voice parameters. These are the following eight parameters were statistically analyzed for significance: mean fundamental frequency, jitter, and shimmer. The sampling rate for analysis was set at 48.0 kHz. Table 1 notes the three measured parameters with the specific data results for each of the five phases of menstrual periods.

	follicular	Ovulatory	luteal	Premenstrual	Menstrual
mean fundamental frequency	208 (+/-3)	210 (+/-2)	212 (+/-3)	213 (+/-4)	207 (+/-2)

F0 max	245 (+/-4)	250 (+/-2)	253 (+/-3)	254 (+/-3)	246 (+/-5)
F0 min	184 (+/-2)	185 (+/-3)	186 (+/-2)	186 (+/-4)	185 (+/-2)
Jitter	3.0 (+/-2)	3.2 (+/-4)	3.1 (+/-4)	3.3 (+/-3)	3.2 (+/-2)
Shimmer	5.7 (+/-2)	5.9 (+/-4)	6.0 (+/-2)	6.2 (+/-3)	5.7 (+/-3)

Table 3 Statistical Analysis of Acoustic Variables During Menstrual Cycle Phases

4.RESULT AND DISCUSSION

The purpose of this paper is to analyse and provide information about the effects of the acoustic variations during a menstrual cycle. Ten female object between the age of 20 to 25 years participated in recording. Evaluations were completed for five phases of the menstrual cycle: menstrual, follicular, ovulatory, Luteal, and premenstrual under the condition

1) Menstrual phase, has minimal levels of estrogen and progesterone,
2) Ovulation phase, has a peak in estrogen and minimal levels of progesterone, and
3) Premenstrual phase, has both estrogen and progesterone levels are peaked.

Hormonal fluctuation during female mensuration cycle has a significant role in acoustic measurement when the reference language is taken as Assamese. But the differences are very negligible. The prime changes occur in the acoustic variables during premenstrual phase to the Menstrual phase. Although the differences are so negligible.

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