ELECTRO-IMPEDANCE MAMMOGRAPHY TESTING AT SOME PHYSIOLOGICAL WOMAN'S PERIODS.

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Abstract Mammary gland, being an organ-target, alters at the background of such physiological events as menstrual circle, pregnancy, lactation, postmenopause. The aim of this work is to estimate the electro-impedance mammography possibilities for investigation of mammary glands' state among women with different hormonal status. 66 women-voluntaries from 20 to 60 years old were divided on 5 clinical groups: first and second menstrual circle phase, pregnancy, lactation and postmenopause correspondingly. 256-electrodes single (10MHz) frequency one-channel electro-impedance mammograph (Breast Cancer Detection Device, BCDD) developed by Institute of Radio-Engineering and Electronics, Russian Academy of Sciences was used for investigations. The breast scanning was made at seven scanning planes after every 8 mm up to 6 sm deep. The received mammograms analysis included: visual image evaluation (looking for hotbed symptoms, local conductivity definition); accepting general parameters of conductivity and its variability (mean value, standard deviation, maximum and minimum values). We used Student criteria to compare conductivity in defined clinical groups. We found out that electro-impedance mammograms got in different groups had clear visual distinctions and statistically significant differences in mammary glands' conductivity.

1. INTRODUCTION

During the last years the interest to mammology problems have raised. Medical diagnostics is oriented mainly on x-rays mammography and ultrasound investigations. The using of other methods (MR, termography, and radioisotopes) is limited by their expensiveness. The nowadays task is to find new effective method for early definition of mammary glands pathology differ by accessibility, safety and informativeness.

Today we can examine breast tissues with electro-impedance tomography (EIT). Later we fulfilled the work on breast cancer diagnostics with electro-impedance mammography (EIM) [3]. Mammary gland is the important part of woman's reproductive system and its tissues are the targets for active influence of sex steroid hormones of ovary, tropic hormones of hypophysis and indirectly of other endocrine glands. At the background of such physiological events as menstrual cycle, pregnancy, lactation and menopause mammary glands have an influence of sex hormones considering the secret variation.

In this work we decided to estimate the means of EIM in studying mammary glands of women with different hormones status.

2. MATERIALS AND METHODS.

57 women-voluntaries from 19 to 61 years old were investigated. They were divided on 5 clinical groups:
1 group – 12 women from 19 to 45 years old at the first menstrual cycle phase (from 1 to 10 day);
2 group – 12 women from 19 to 45 years old at the second menstrual cycle phase (from 16 to 28 day);
3 group – 14 women from 18 to 39 years at pregnancy (37-40 weeks);
4 group – 14 women from 18 to 39 years at lactation (3-5 days after labor);
5 group – 5 women from 47 to 61 years at postmenopause (more than 1 year).

Criterions for choosing woman-voluntaries for investigation were the following: absence of patient's complaints on mammary glands, absence of mammary glands diseases, normal 28-days menstrual cycle, absence of alarming somatic and gynaecological history, absence of pathological alterations at ultrasound investigation of mammary glands, no hormonal contraceptives taking.

256-electrodes single (10MHz) frequency one-channel electro-impedance mammograph (Breast Cancer Detection Device, BCDD) developed by Institute of Radio-Engineering and Electronics, Russian Academy of Sciences was used for investigations. The breast scanning was made in lying and standing positions at seven scanning planes after every 8 mm up to 6 sm deep. Mammary glands were preliminary treated with EKG gel or wet pads were applied. One patient investigation duration (electrodes application, mammogram registration, image treatment) was about 15-20 minutes.

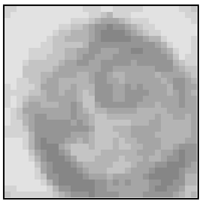
The received mammograms analysis included: visual image evaluation, accepting general parameters of conductivity and its variability (mean value, standard deviation, maximum and minimum values).

3. RESULTS.

Electro-impedance image presents the mammary glands conductivity in grey scale, change from dark to light correspond to change from low electric conductivity to high. For correct image estimation we compared mammograms got from the same scanning plane. We used Student criteria for computations.

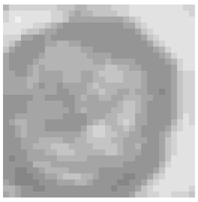
3.1. Electro-impedance image of mammary glands.

3.1.1. First menstrual cycle phase (1-10 days).



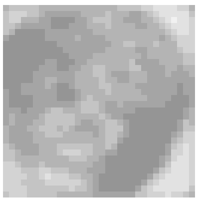
In the first phase of menstrual cycle there occurs cells proliferation in duct-lobe structure under the estrogens influence. EIM image of mammary gland in the first phase is characterised by smooth allocation of grey tones and absence of node symptomatic. “Mosaic” structure of images is explained by its complex anatomical composition.

3.1.2. Second menstrual cycle phase (16-28 days).



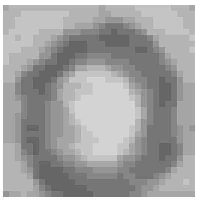
In the second phase because of estrogen receptors down-regulation in mammary gland epithelium under the influence of rising quantity of progesterone the gradual decreasing of cells proliferation begins, then follows evolution and differentiation of alveoli and secretory transformation of gland tissue. At the end of first phase the apoptosis takes place. EIM image f mammary gland in the second phase is also characterised by smooth allocation of grey tones and absence of node symptomatic, moreover there are much more light tones as compared with the first phase. Light tones presence can be explained by the increased quantity of secret or liquid in breast tissues because of changings in gland epithelium and hence the tissues conductivity increases.

3.1.3. Pregnancy (37-40 weeks.).



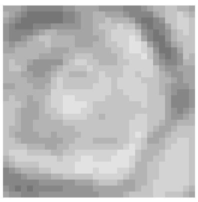
At pregnancy the combined influence of progesterone, prolactin and estrogens of placenta are accompanying the morpho-functional preparation for lactation. EIM image of mammary gland at the end of pregnancy is characterised by smooth allocation of grey tones and presence of light tones.

3.1.4. Lactation (3-5 days after labor).



At the end of pregnancy and during the first days after labor due to the abrupt decreasing of placenta’s estrogens level there is the prolactin peak ejection, which switches on the lactation mechanism. At lactation EIM image is characterised by dark tones distribution on periphery and contrast threshold to light tones in the centre. This reflects milk accumulation in main ducts and increasing of tissue conductivity.

3.1.4. Postmenopause (more than 1 year).



During postmenopause, when the level of estrogens and gestagens decrease, the replacement of tissue by fat starts. EIT image of mammary gland during menopause looks more light with contrast changings to dark tones. No node symptomatic presents.

3.2. Conductivity of mammary glands at different hormonal status.

For estimation of mammary gland tissue conductivity we used values got from the second scanning plane (1,2-2,0 sm. deep). Conductivity is presented in conventional units.
In table 1 we present mean values of mammary glands' conductivity in groups 1, 2, 3, 4 and 5 depending on patient's position during investigation.

Position	1 phase	2 phase	Pregnancy	Lactation	Postmenopause
Lying	0,83± 0,06	0,83± 0,06	0,83± 0,09	0,85± 0,07	0,92± 0,03
Standing	0,80± 0,07	0,80± 0,07	0,79± 0,08	0,80± 0,05	0,86± 0,06

Table.1 Conductivity of mammary glands depending on position during investigation (x±σ).

Conductivity of mammary glands in lying position appeared to be higher in all groups, however, statistically significant differences in conductivity values we did not find ($p>0,05$). Decreasing of mammary glands conductivity in standing position probably depends on hemo-dynamics changing with investigation position changing. In further computations we used conductivity values got from lying position.
In table 2 we present mean values of mammary glands' conductivity in groups 1, 2, 3, 4 and 5 depending on scanning side (right and left) and in group 4 additionally in consideration with breast-feeding.

Position	1 phase		2 phase		Pregnancy		Lactation		Postmenopause	
	left	right	left	right	left	right	left	right	left	right
Lying	0,83 ±0,06	0,82 ±0,06	0,83 ±0,05	0,83 ±0,06	0,84 ±0,05	0,82 ±0,06	0,88 ±0,07	0,82 ±0,05	0,92 ±0,03	0,91 ±0,03

Table.2 Conductivity of mammary glands depending on scanning side (x±σ).

Tissues' conductivity of left and right mammary glands in groups 1, 2, 3, 5 does not differ ($p>0,05$). In group 4 it is statistically significant ($t= 2,61$, $p<0,05$).
In table we present mean values of mammary glands' conductivity at different physiological woman's periods.

1 phase	2 phase	Pregnancy	Lactation	Postmenopause
0,83±0,06	0,83±0,06	0,83±0,09	0,88±0,07	0,92±0,03

Table.3 Mammary glands' conductivity at different physiological woman's periods. (x±σ).

We used Student criterion to compare mean conductivity in groups 1,2,3,4,5. We found no statistical differences in mammary glands' conductivity in groups 1, 2, 3 ($p>0,05$). It was found out that mean conductivity in groups 4 and 5 is higher than in groups 1,2. Differences in conductivity are statistically significant ($t_{1-4}=2,3$, $p<0,05$; $t_{2-4}=2,3$, $p<0,05$; $t_{1-5}=4,3$, $p<0,001$; $t_{2-5}=4,3$, $p<0,001$). Differences in conductivity in groups 4 and 5 are not statistically significant ($t = 1,69$; $p>0,05$).

3.3. Estimation of conductivity distribution.

We estimated modality and symmetry of distribution for analysis of conductivity distribution. We found (Table 4) that the frequency of uni-modal distribution is mostly typical for menopause (90%) and second phase of menstrual cycle (81,25%). Multi-modal distribution of conductivity is typical for pregnancy period (21,4%) and lactation (23,2%).

Conductivity distribution	1 phase	2 phase	Pregnancy	Lactation	Postmenopause
uni-modal	68,75%	81,25%	64,3%	58,9%	90%
bi-modal	18,75%	12,5%	14,3%	17,9%	10%
multi-modal	12,5%	6,25%	21,4%	23,2%	0%

Table 4 Conductivity distribution characteristics.

4. DISCUSSION.

Conductivity analysis showed that mean conductivity of mammary gland tissue of healthy woman in lying position is higher than in standing position. No statistical differences were found in conductivity of left and right mammary glands. EIM of lactating gland is noted by contrast transition to light tones in the centre of the image, which reflects milk accumulation in main ducts in the area behind the nipple. At 28-days menstrual cycle conductivity of mammary gland tissue of healthy woman in first and second phase does not differ. This fact can be explained by absence of structural and functional changes in mammary gland. High conductivity of mammary gland tissue at menopause is caused by involutive processes in woman's organism.

The got values of mammary glands' conductivity at different physiological periods permit to use them in future as norm and continue investigations of different mammary glands pathologies.

5. REFERENCES.

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