Procedure for assessment of the mammary gland electrical impedance images.

M. Korotkova[1], A. Karpov[2]

[1]Clinical Hospital №9, Yaroslavl, Russia
[2]SIM-Technika, Russia.

Abstract- **We analyzed more than 2000 electroimpedance images of the mammary gland in norm and with pathology. The research was carried out utilizing the electrical impedance computer tomograph «MEIK»® (current 0.5 mA, frequency 50 kHz). The following particularities of the electrical impedance image were established. In the norm the electrical impedance image reflected a regular anatomic structure of a mammary gland and the index of the mean electrical conductivity corresponded to the age norm. In case of pathology either changes of the anatomic structure of a mammary gland or changes of its mean electrical conductivity index were observed. Thus, estimation of the electroimpedance image should include both a visual analysis of the image as well as quantitative. The visual estimation of the electroimpedance image includes analysis of the following details: the mammary gland contour (presence of deformations, infiltration); the mammary gland anatomy (changes of anatomy, displacement of internal structures, perifocal infiltration); the lacteal sinus zone (visualization, dilatation); local changes of electrical conductivity (presence of hypo- or hyperimpedance areas). The quantitative analysis includes the following particulars: an index of mean electrical conductivity and a histogram of electrical conductivity distribution; comparison of histograms with a norm; an index of mean electrical conductivity of the area in question. The article is illustrated with electroimpedance mammograms and tables.**

Keywords- **impedance, breast, image.**

I. Introduction

Image assessment is an important part of a diagnostic process. In modern methods of diagnostics, based on images (MRI, CT, X-ray, US) a visual method of the image assessment is used (1). The visual assessment is based on knowledge of the anatomical particularities of the organ under consideration. The method of electroim-pedance mammography has been used in the clinic for several years.

There are several ways of obtaining the electrical impedance mammograms (2, 3). But no criteria for a universal assessment of electroimpedance images of the mammary gland have been developed. Application of assessment of the mammary gland images in practical activity would make it possible to reduce to minimum the percentage of unidentified diseases of the mammary gland.

II. Materials and methods

The aim of the research was to work out a procedure for assessment of electroimpedance images of the mammary gland. The research was carried out with the help of the electrical impedance computer mammograph "MEIK" (current frequency 50 kHz, current strength 0,5 mA). The researchers examined and interpreted 2125 electroimpedance images of normal and diseased mammary glands. The electrical impedance images comprised the following nosologies: norm - 1749, breast cancer – 53, cyst – 76, mastitis – 15, fibro-cystous disease – 232.

III. Results

The research proved that in some diseases, for instance, mastitis, visual assessment of the image was sufficient. In case of other diseases, for instance, fibro-cyctous disease, it is necessary to perform a quantitative analysis. In the rest of the case, for instance, cancer, it is essential to resort to both types of assessments. Hence, the technique for assessment of the electroimpedance images should combine a visual as

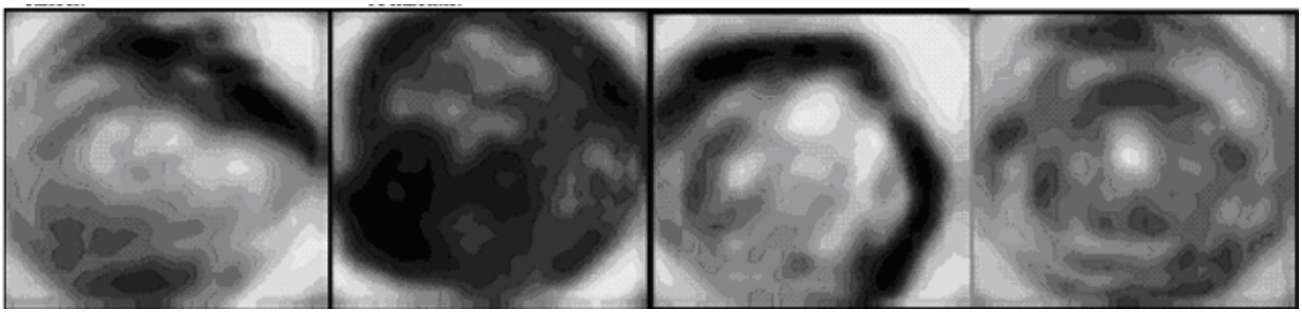

Fig. 1 Deformity of the breast contour in form of retraction at 1-2 o'clock registered in case of cancer.

Fig. 2 Deformity of the breast contour in form of swelling at 7-8 o'clock, registered in case of mastitis.

Fig. 3 Hyperimpedance of the breast contour in cancer (left image) as compared with the healthy breast contour (right image).

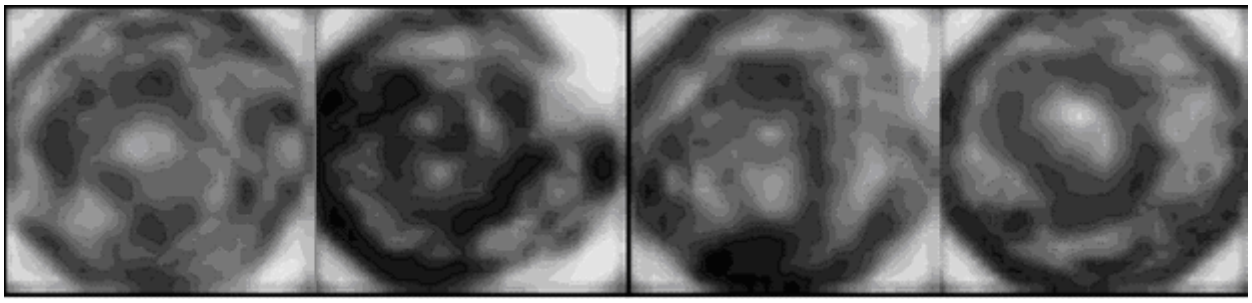

Fig. 4 Changes of the breast anatomy during cancer (left image) as compared with the healthy breast anatomy (right image)

Fig. 5 Displacement of the breast inner structures during cancer (left image) as compared with the healthy breast anatomy (right image).

well as a quantitative analysis.

Visual assessment of the electroimpedance image comprises the following elements: the mammary gland contour, the mammary gland anatomy, local changes of electroconductivity, the lacteal sinus zone.

The visual assessment of the electroimpedance image of the mammary gland should start from examination of the contour of the mammary gland. As a rule, the breast contour of an impedance structure is even without deformity. During extensional processes in the mammary gland it might feature the following particularities: a) the contour deformity in form of retraction (fig. 1) or swelling (fig. 2); b) hyperimpedance of the contour (fig. 3).

Assessment of the breast anatomy is the next element in the procedure. In the norm images of the breast should have the type of anatomic structure that corresponds to the age norm without displacement of inner structures. In a diseased breast its anatomy changes (fig. 4), and in case of extensive processes and cicatricial changes a displacement of inner structures takes place (fig. 5).

Local changes of electrical conductivity in the zone of lacteal sinus, never to be found in the norm, is one of the most important elements of assessment. In case of various diseases of the mammary gland a researcher might encounter with a hyperimpedance areas with the electroconductivity index < 0,20, typical for mastitis (fig. 6) as well as with a hypoimpedance areas with the index of electrical conductivity >0,95, typical for cancer (fig. 7). In addition, in case of cancer the scanning might reveal a hyperimpedance contour, infiltration zone around the lesion zone (fig. 8).

The zone of the lacteal sinus is the last element in the visual assessment. Depending on the menstrual and physiological cycles it can be observed in the retro-nipple area in form of a hyperimpedance zone (fig.9) or in form of hypoimpedance areas (fig. 10, 11).

Quantitative assessment of the electroimpedance image comprises computation of the following parameters: mean electrical conductivity index, histogram of electrical conductivity distribution, comparison with the norm.

The index of mean electroconductivity and the histogram of electroconductivity distribution are one of the key characteristics used for assessment of the electroimpedance image (fig. 12).

Comparison of the electroconductivity distribution histograms of the left and the right breasts are the next element of the quantitative assessment. In the norm the electroconductivity distribution histograms of the left and the right breasts practically coincide. In diseases a displacement of the affected breast histogram takes place (fig.13).

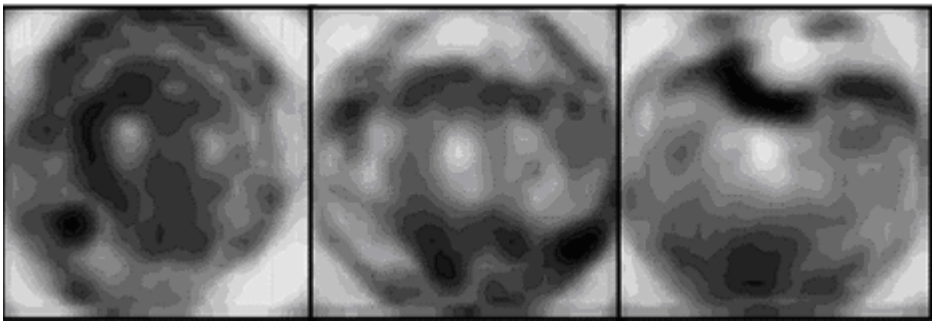

Fig. 6 Local changes of electroconductivity in form of a hyperimpedance focus at 7 o' clock during mastitis.

Fig. 7 Local changes of electroconductivity in form of a hypoimpedance focus during cancer at 12 o'clock.

Fig. 8 Local changes of electroconductivity in form of a hypoimpedance focus at 1 o'clock with a hyperimpedance contour during cancer .

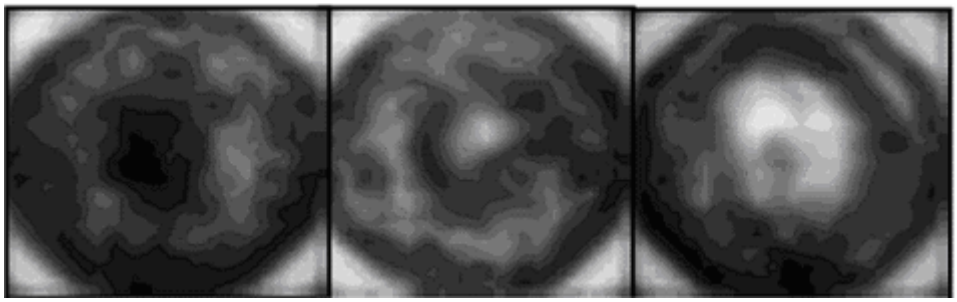

Fig. 9 Hyperimpedance area in the lacteal sinus zone in the 2nd phase of the cycle.

Fig. 10 Hypoimpedance area in the lacteal sinus zone in the 1st phase of the cycle.

Fig. 11 The lacteal sinus zone dilatation during lactation.

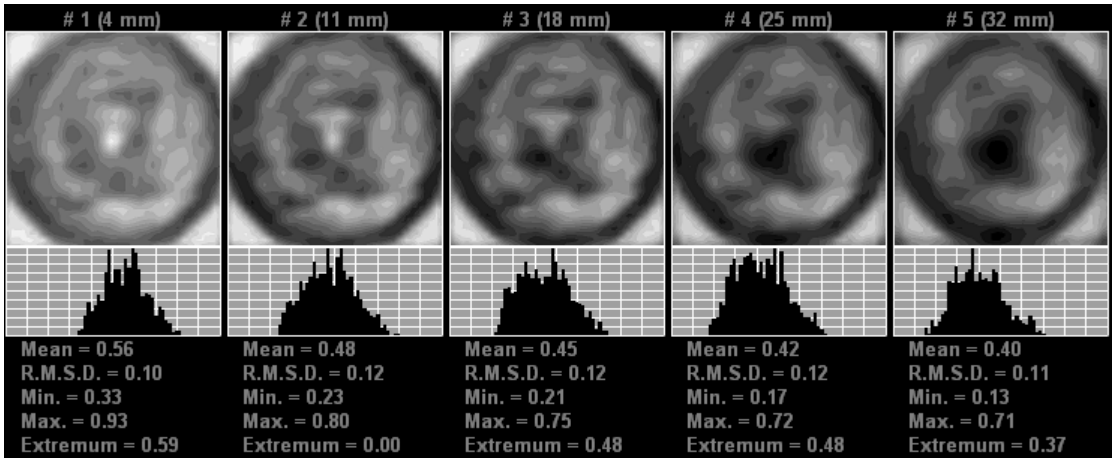

Fig. 12 Index of mean electroconductivity and histogram of electroconductivity distribution at 5 scanning planes.

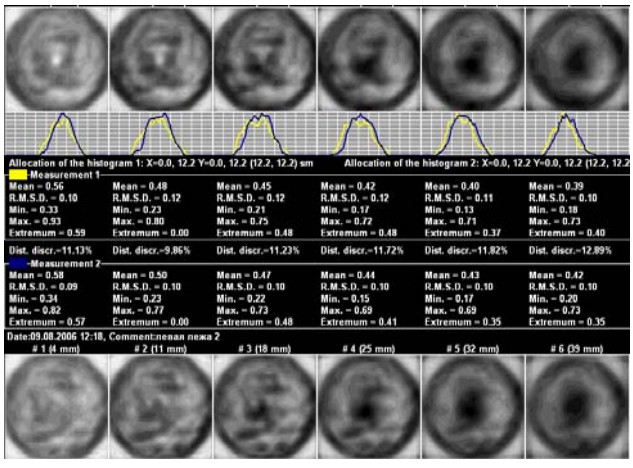

Fig. 13 Comparison of the electroconductivity distribution histograms of the left and the right breasts

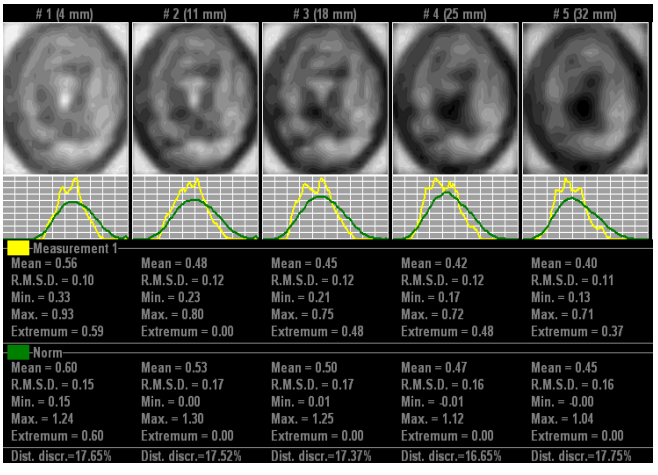

Fig. 14 Comparison of the electroconductivity distribution histograms of the breasts with the norm.

Comparison the mean electroconductivity of the breast under examination with the norm is a final element of the quantitative assessment. In absence of pathologies the electroconductivity distribution histograms of the breasts and the norm display no significant difference. In case of a disease a displacement of the affected breast histogram is revealed (fig. 14).

IV. Conclusions

We made available first experience, based on examination and interpretation of a large number of images of the mammary gland in the norm and during various diseases. The recommended assessment criteria of the images establish a uniform approach to diagnostics and helps doctors to understand better the existing pathology.

V. References

1. Rinck P. (1993) Magnetic Resonance in Medicine. European Magnetic Resonance Forum
2. Hartov A. et al. Electrical Impedance Tomography in breast cancer screening. (2006) Proc. of 7th biomedical applications of electrical impedance tomography, 130
3. Zhen Chen et al. (2006) Research for breast cancer detection based multy-frequency EIS measurement, 131

Address of the corresponding author:

Author: M. Korotkova
Institute: Clinical hospital №9
Street Tutaevskoe
City Yaroslavl
Country Russia
Email Sim-tech@Net76.ru