ELECTRICAL IMPEDANCE ANATOMY OF THE MAMMARY GLAND

A. Karpov *, O.Trokhanova **, V. Cherepenin *, A. Korjenevsky *****

*Clinical Hospital * 9, Yaroslavl, Russia

** Yaroslavl State Medical Academy, Russia

*** Institute of Radio-Engineering and Electronics of Russian Academy of Sciences, Russia

The living organism is not only the generator of bioelectricity, but also the passive conductor of the electric current occurring in the organism or applied from the outside. Each segment and each organ has its own electric characteristics (table 2). These characteristics, in their turn, are determined by the electric properties of the tissues, which form and surround the organs, as well as electric properties of intravascular and extravascular liquid.

Table 2. Specific resistance values of various tissue of mammals (cit. by V.S. Shinkarenko and co-authors. Application of an impedance tomography for detection of the latent forms of pathology during routine examination of population, Bulletin of Russian Academy of Medical Science, 1997, 4, pages 52-56)

Tissue	***Specific resistance,*** Ohm m	***Conditions of measurements***
Spinal liquid	0,65	
Blood	1,5	50 %
Liver	3,5	Perfused in vivo of a dog
Skeletal muscle	1,25 18,0	Along fibres Across fibres
Neural tissue ▪ Grey substance ▪ White substance	5,8 2,84 6,82	Average results for rabbits, cows and pigs
Lung	7,2-23,6	A range of values at inhalation and exhalation for rabbits
Fatty tissue	27,2	Average results for various kinds of animals
Bone	166,0	Recently obtain bovine bone

The mammary gland is a complex alveolar-tubular gland and consists of 15-25 lobules, which are surrounded with a fatty tissue. The tissue of the mammary gland is penetrated with fibrous septa. From the point of view of electric impedance, the tissues of the mammary gland possess a considerable variety.

Just as the liver, the pancreas and the prostate gland, the mammary gland belongs to glandular organs with excretory function. They have different histological structure and secretory function. However, at the same time it is possible to single out one common feature, which unites them: all glands have similar macroanatomy. In a macro anatomic structure of these glands, it is possible to define the following common structures: *a capsule, a connective-tissue skeleton, a parenchyma, a pouch for accumulation of a secret*.

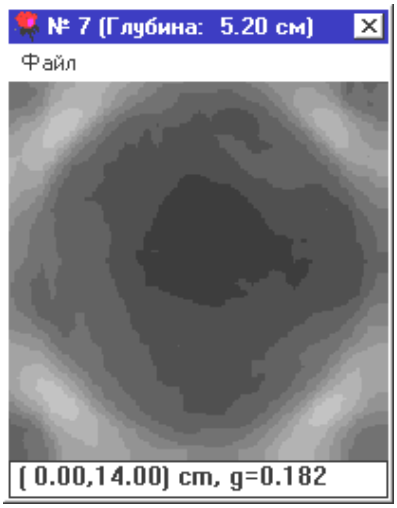

Fig. 1. Electroimpedance mammo-gram, 7th scanning plane, depth 5,20 cm. Retro mammary fatty tissue.

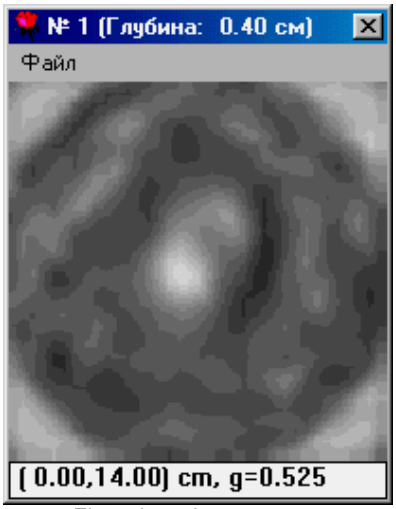

Fig. 2. Electroimpedance mammo-gram, 1st scanning plane, depth 0,40 cm.

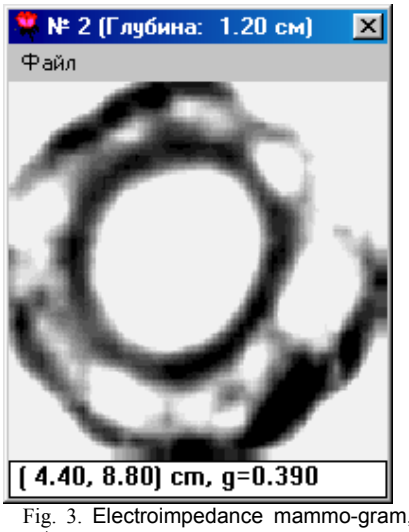

Fig. 3. Electroimpedance mammo-gram, 2nd scanning plane, depth 1,20 cm.

The macro anatomic structures become most evident during maximal functional activity of the organ. For the mammary gland, such period is the period of lactation.

Capsule. The mammary gland capsule is formed by a leaf of superficial fascia and subcutaneous fat, enclosing the gland from various directions. Between the fascia capsule of the gland and the breast fascia there is retro mammary tissue and areola tissue. Figure 1 shows the electroimpedance mammogram, registered at the depth of 5,2 cm in the area of retro mammary tissue. Retro mammary tissue, having high electric impedance, is represented as hyperimpedance homogeneous irregular-shaped formation, with electroconductivity not exceeding 0,2 conventional units, located in the centre of the mammogram. Fatty tissue envelopes the body of the mammary gland (capsula adiposa mammae). The front leaf of the capsule loses its integrity in retroareolar areas where terminal parts of the lacteal duct pass. Figure 2 shows the electroimpedance mammogram, obtained from the 1st plane of scanning. The fatty tissue at periphery of the mammary gland and of the retromammillary areas, having high impedance, is represented as hyperimpedance areas with electroconductivity not exceeding 0,3 conventional units and resembling a circle.

Carcass. The mammary gland is enveloped by a connective-tissue capsule from which septa lead into the gland thickness. The septa, which are made of soft delicate fibrillary tissue and glandular elements spaced between them, possess high electric impedance. Figure 3 shows the electroimpedance mammogram, where with the help of contrast study the areas with low electroconductivity are set off. The septa, forming connective-tissue carcass of the mammary gland, are represented as hyperimpedance areas with electroconductivity of 0,3-0,4 conventional units that spread radially from the centre. The adipose capsule is clearly seen, as hyperimpedance areas with electroconductivity not exceeding 0,3 conventional units, in the periphery of the mammary gland and in the retroareolar areas.

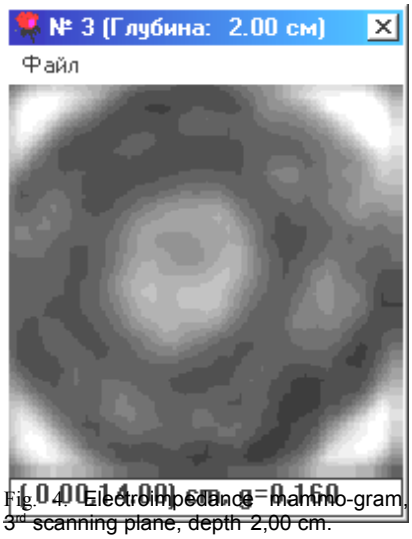

Fig. 4. Electroimpedance mammo-gram, 3rd scanning plane, depth 2,00 cm.

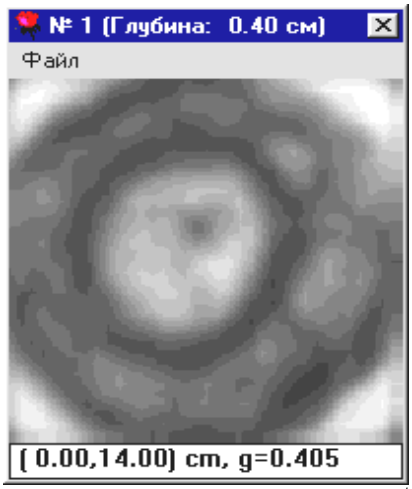

Fig. 5. Electroimpedance mammo-gram, 1st scanning plane, depth 0,40 cm.

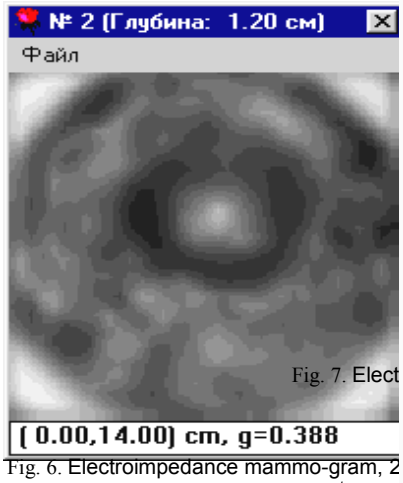

Fig. 6. Electroimpedance mammo-gram, 2 scanning plane, depth 1,20 cm, 1st phas of the menstrual cycle.

Parenchyma. The mammary gland comprises parenchyma (parenchyma gl. mammariae) and connective-tissue stroma (stroma gl. mammariae). Parenchyma of the mammary gland consists of alveolar-tubular glands, collected in fine lobules, which in their turn form lobes. Figures 4, 5 show the electroimpedance mammograms, in which alveolar-tubular glands are represented as hyperimpedance areas with electroconductivity 0,3 – 0.7 conventional units, located between septa.

The pouch for secret accumulation. The mammary gland lobe consists of a multitude of lobules, formed by repeatedly branching lacteal ducts and separated from each other by connecting tissue. Each lobe has a main excretory duct, which opens on the external surface the nipple. Before approaching the nipple the ducts expand and form a lacteal sinus (sinus lactiferi) in which the secret and the milk, having a low electric impedance and being formed in alveoluses, are collected,. There are about 15 – 25 lacteal sinuses of this kind in the in retro-nipple areas. Figures 5 shows the electroimpedance mammogram of the lactating mammal gland. The zone of the lactic sinus is represented as an extensive hyperimpedance area with electroconductivity of 0.7 conventional units, located in the centre of the mammogram.

The described above anatomic characteristics of the mammary gland (fig. 7) structure, but only less pronounced, can be found on electroimpedance mammograms of women who belong to different age group during various physiological periods (fig. 6). The knowledge of electroimpedance anatomy of the mammary gland facilitates understanding of the physiological and pathological processes taking place in the mammary gland.

Fig. 7. Elect pedance mammograms at various scanning planes, from 7th to 1st. from left to right and from top-down