

## Electric impedance measurements in inferior limbs of the pregnant. Preliminary results.

M. Korotkova \*, A. Karpov \*, V. Cherepenin \*\*, A. Korjnevsky \*\*

\*Clinical Hospital \* 9, Yaroslavl, Russia

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

We were unable to discover the relevant data on use of the electric impedance tomography for studying an arterial, venous and tissual blood flow in the inferior limbs of the pregnant in the available literature.

**Material and methods.** We have carried out a series of electroimpedance measurements on the inferior limbs of healthy pregnant women at various periods of pregnancy (6-21 weeks.). Fourteen pregnant women were subjected to the examination and measurements. We utilized the sixteen-electrode, single-frequency (8 kHz, 0,5 ma) single-channel electroimpedance tomograph, capable of obtaining the static image, developed in the Research Institute of Radioengineering and Electronics of Russian Academy of Sciences. The top third part of the left and the right shin were subjected to the inferior limb computer scanning, with the pregnant reclining on the left side and standing. In order to carry out the measurements steel round electrodes 6 mm in diameter were used; they were fixed around the shin of the pregnant woman with the help of a rubber belt at a distance of 10 cm below the tuberous part of the shinbone (tibia).

### Results.

**The electroimpedance image of a shin.** The image of the shin on the electroimpedance tomograms, carried out in a grey scale, possesses non-uniform character depending on the tissue's electroconductivity. The light parts of the tomogram correspond to the areas with high electroconductivity, typical for vascular fascicle. These are so-called hypoimpedance areas. The dark parts of the tomogram correspond to the areas with low electroconductivity typical for bone tissue. These are so-called hyperimpedance areas. The grey colour areas of various intensity correspond to the areas with moderate electroconductivity typical for muscular tissue.

**Quality evaluation of the image.** When the same pregnant woman was subjected

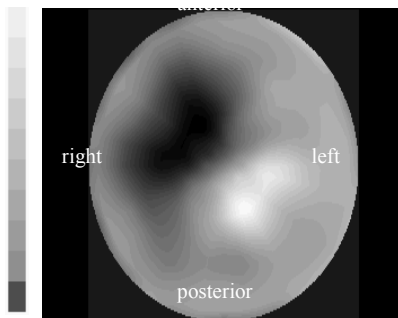


Fig. 1 Electroimpedance tomo-gramme left shin in a position lying on the left side

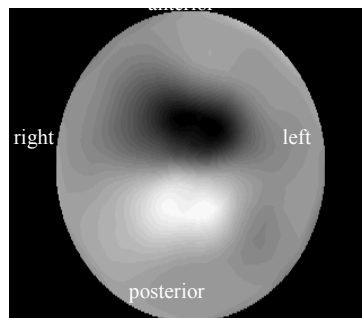


Figure 2 Electroimpedance tomo-gramme left shin same patient through 3 weeks.

to the electroimpedance measurements at various periods of pregnancy, the results proved to be precise. Anatomico-topographical particularities of the electroimpedance images of the examined area, brought to light after repeated examination of the same person, differ neither visually nor numerically (fig. 1, 2).

Reproducibility was determined by the results of

the measurements at various conditions - in recumbent positions on the left side as

well as standing. Anatomico-topographical particularities of the electroimpedance images of the examined area did not change (fig. 3, 4).

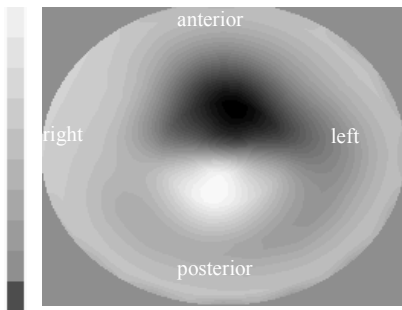


Fig. 3. Electroimpedance tomogramme left shin in a position lying on the left side

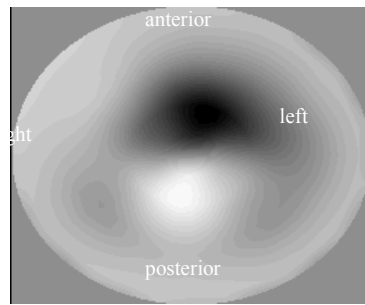


Fig. 4. Electroimpedance tomogramme left shin the same patient in a position standing.

In order to confirm accuracy of the measurements we compared the electroimpedance tomograms, obtained from the top third of the shin, with the corresponding anatomic cuts. The comparison of the electroimpedance tomograms and anatomic drawings proves that the basic anatomic formations (bones, vascular fascicle, muscles) are visualized distinctly. The obtained tomograms confirmed anatomico-topographical interrelation of various tissues (fig. 5, 6).

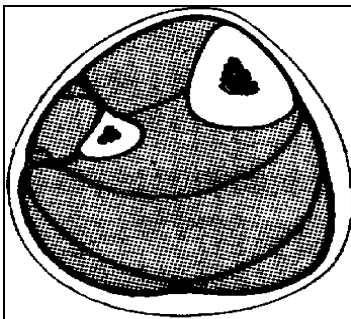


Fig. 5. An anatomic shear in the upper third shin.

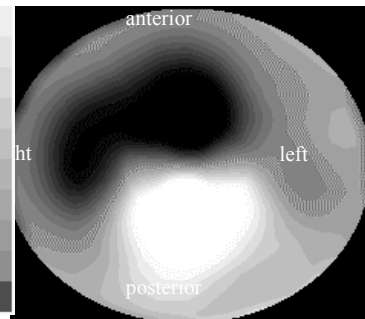


Fig. 6. Electroimpedance tomogramme of the upper third shin.

### The quantitative analysis.

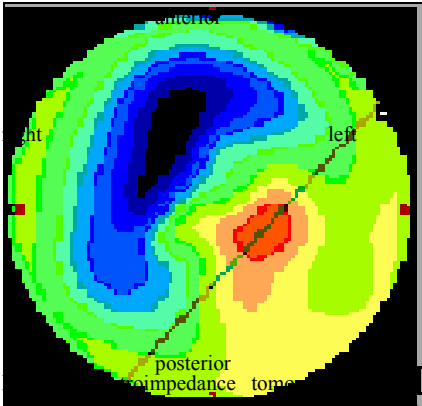
**Table 1.** Electroconductivity in vascular and extravascular zones shin.

		lying				standing			
		Vascular zones	Extravascular zones 1	Extravascular zones 2	Extravascular zones 3	Vascular zones	Extravascular zones 1	Extravascular zones 2	Extravascular zones 3
Left shin	M	1,116	0,751	0,772	0,624	1,544	1,066	1,061	0,977
	$\sigma$	0,44	0,38	0,38	0,29	1,19	0,81	0,795	0,81
Right shin	M	1,605*	1,217*	1,201*	1,045*	1,726	1,262	1,269	1,049
	$\sigma$	0,665	0,5	0,5	0,5	0,818	0,74	0,71	0,72

\* -  $p < 0,05$

The data analysis revealed that electroconductivity (v, conventional units) in vascular and extravascular zones between the right and the left shin in normal limbs significantly differs only in a recumbent position on the left side (the left shin -  $V_{reclining} = 1,116$ ;  $std_{reclining} = 0,44$ ; the right shin -  $V_{reclining} = 1,605$ ;  $std_{reclining} = 0,665$ ;  $p < 0,05$ ). In standing position validity of distinctions disappears ( $p > 0,05$ ). During comparison of electroconductivity in vascular and extravascular zones of the same shin in a recumbent and standing positions in normal limbs, reliable distinctions were not received, though the tendency of increasing electroconductivity was observed (the left shin -  $std_{reclining} = 1,116$ ;  $std_{reclining} = 0,44$ ;  $vst_{standing} = 1,544$ ;  $vst_{standing} = 1,19$ ;  $p > 0,05$ ; the right shin -  $std_{reclining} = 1,605$ ;  $vst_{reclining} = 0,665$ ;  $vst_{standing} = 1,726$ ;  $vst_{standing} = 0,818$ ;  $p > 0,05$ ). During comparison of electroconductivity of vascular and

extravascular zones of the same shin in a recumbent as well as standing position in normal limbs, authentic distinctions were discovered only in the recumbent position. For assessment of the shin tissue conditions it is worthwhile to use «the electroimpedance shin profile» suggested by us. Calculation of the tissues electroconductivity is carried out along the line, which connects the opposite edges the shin and passes through a vascular fascicle (fig. 7, diagram 1).



shin. A line of account of an "electroimpedance profile".

