Use of electrical impedance tomography for the diagnosis of precancerous diseases and cancer of the cervix

O.V. Trokhanova[1], Y.A. Chijova[1], V.A. Cherepenin[2], A.V. Korjenevsky[2], T. S. Tuykin[2]

[1] Yaroslavl State Medical Academy, Yaroslavl, Russia, trokhanove@yandex.ru
[2] Institute of Radioengineering and Electronics of the RAS, Moscow, Russia

Abstract: The paper describes possibility of EIT diagnostics of precancerous diseases and cancer of the cervix. The data were obtained through EIT system GIT (gynaecological impedance tomograph) [1].

1 Introduction

Cervical cancer is one of the most frequent types of cancer. The disease is increasingly recorded in young women and is characterized by high mortality. Cervical cancer kills 290 000 women per year, which equals to 789 women per day or a woman per 2 minutes, all over the world.

There is a generally accepted classification of precursors of cervical cancer, which is based on the depth of lesions stratified squamous epithelium:
-cervical intraepithelial neoplasia grade 1 (CIN1) defeats a third of the thickness of stratified squamous epithelium;
-cervical intraepithelial neoplasia grade 2 (CIN2) captures 2/3 of the thickness of stratified squamous epithelium;
-cervical intraepithelial neoplasia grade 3 (CIN3) corrupts the whole layer of stratified squamous epithelium.

Intraepithelial lesions usually are associated with human papillomavirus (HPV) and it is considered as forerunner of cancer.

The purpose of the study is to identify opportunities of electrical impedance tomography in the diagnosis of precursors and cervical cancer.

2 Methods

The data were obtained through EIT system GIT [1] with 48 electrodes organized in non-orthogonal matrix. The external diameter of a vaginal probe is 33 mm. Images were reconstructed by a weighted 3D back-projection along equipotential sphere algorithm [2] extended by Delaine interpolation [1]. The result of GIT visualization is three slices at a depth of 2, 5 and 8 mm for 10 kHz and 50 kHz simultaneously in a real time mode (a shot per seconds). On a slice the conductivity value is presented in relative units (relative to average conductivity), that helps to calculate average value over a region and get numerical criteria of diagnostics, not only visual estimation of pictures.

The report presents main results (see table 1) of a comprehensive examination of the neck of the womb of 186 women from 19 to 70 years: 63 - without cervical pathology, 50 - with low-grade squamouse intraepithelial lesion (LSIL) CIN1, 46 – with high-grade squamouse intraepithelial lesion (HSIL) CIN2 and CIN3, 11 - cervical cancer stage 1, 16 - cervical cancer stages 2-3.

We used the following methods of diagnosis: history taking, a visual examination on the uterine speculum, liquid oncocitology, extended colposcopy, target biopsy of cervix, electrical impedance tomography of the neck of the womb.

3 Conclusions

According the preliminary results, the conductivity of cervical tissue is almost the same for intact and LSIL cases while it is slightly different from the HSIL case and is significantly different from cancer cases (see table 1). That allows us to hope that electrical impedance tomography will help: to detect precursors of cervical cancer before visual changes of cervical surface; to distinguish diseases (CIN1, CIN2, CIN3, cancer, inflammation); to control effectiveness of treatment and to detect changes associated with HPV.

References

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Table 1: Conductivity is given in arbitrary units at frequency 50 kHz. MC is menstrual cycle; n is quantity of patients in a group. Transformation area is the border between two types of epitheliums (squamous and columnar) on cervix.

Cervix pathology, MC phase and patient quantity		Age before 30		Age after 30	
		2mm	Transformation area	2mm	Transformation area
Norm	1 phase of MC n = 63	0.92±0.06	1.08±0.1	0.95±0.06	1.02±0.06
	2 phase of MC n = 63	0.95±0.06	1.02±0.06	0.99±0.07	1.06±0.08
LSIL	1 phase of MC n = 50	0.91±0.04	1.0±0.04	0.96±0.02	1.07±0.04
	2 phase of MC n = 50	0.94±0.03	1.07±0.06	0.98±0.01	1.1±0.03
HSIL	1 phase of MC n = 46	0.96±0.02	1.07±0.01	1.01±0.07	1.1±0.09
	2 phase of MC n = 46	0.99±0.1	1.13±0.09	1.09±0.08	1.14±0.01
Cancer stage 1	1 phase of MC n = 11	No data	No data	1.03±0.03	1.18±0.04
	2 phase of MC n = 11	No data	No data	1.03±0.03	1.18±0.04
Cancer stage 2-3	1 phase of MC n = 16	0.65±0.01	Not applicable	0.79±0.1	Not applicable
	2 phase of MC n = 16	0.65±0.01	Not applicable	0.79±0.1	Not applicable

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Systems and Computer Engineering
Carleton University, 1125 Colonel By Drive
Ottawa, Ontario, K1S 5B6, Canada
adler@sce.carleton.ca
+1 (613) 520-2600

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