REPORT

CNR Short Term Mobility Program 2014

Visiting Researcher: Prof. Ivaylo Hristov, Institute of Biophysics and Biomedical Engineering – Bulgarian Academy of Science, BAS, Sofia, Bulgaria
Proponent: Giovanni Bortolan, ISIB-CNR , Padova, Italy
Host Institution: Institute of Biomedical Engineering, ISIB-CNR, Padova, Italy

Title of the project: ECG analysis of dialyzed patients by temporal-frequency techniques.

Objectives. Hemodialysis is the most common method used to treat advanced and permanent kidney failure. It removes wastes and extra fluid from the blood, restoring a proper balance of electrolytes. This procedure causes drastic changes in the electrical activity of the heart which can be observed by electrocardiographic (ECG) analysis. The purpose of the project is to analyze the individual changes of the ECG and to correlate these changes to the general clinical condition of the patient (degree and duration of the kidney disease) and to the specific clinical parameters measured during the procedure

Materials and methods. We studied 58 patients, age 59±13 years, 52% males, with renal disease duration 9.7±6.7 years and haemodialysis duration 5.2±4.4 years. Digital ECGs (1-minute duration, 12-standatd leads, 500 Hz sampling rate) were recorded before and after haemodialysis session. Serum electrolytes (potassium-K, sodium-Na, phosphorus-Ph and calcium-Ca), urea and creatinine levels were evaluated before and after haemodialysis. Percentage change of the above mentioned parameters during haemodialysis was estimated. The ECG recordings were collected at the National Heart Hospital in Sofia.
Two kinds of studies have been considered.
1. Vectorcardiographic leads (VCG) were derived from ECG data, and the 3-D changes of the QRS- and T- loops (area and magnitude), caused by hemodialysis were quantified and analyzed.

Results: QRS loop areas increased significantly after haemodialysis (typical examples are shown in the Figure), while the T loop areas did not change significantly. Maximal QRS vector increased significantly, maximal T vector decreased significantly, and QRS-T angle remained relatively the same see the Table.

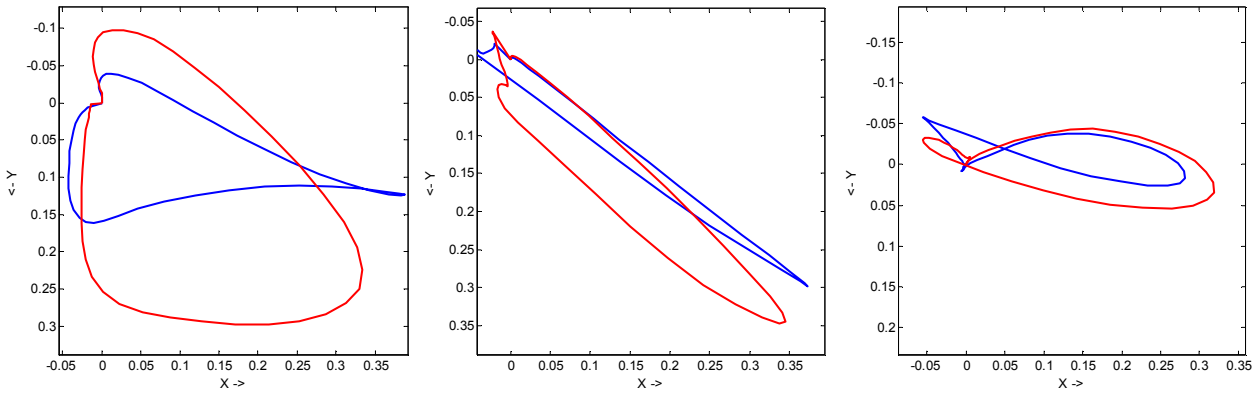

Figure. Typical examples of QRS loops before (blue trace) and after (red trace) haemodialysis

Table. VCG parameters change during hemodialysis (HD)

Parameter	Baseline	After HD	Significance
QRS area (mV^2/1000)	34.9 ± 34.8	50.4 ± 47.3	$p < 0.001$
T wave area (mV^2/1000)	1.9 ± 2.3	1.6 ± 1.7	ns
Max QRS vector (mV)	0.48 ± 0.2	0.54 ± 0.22	$p < 0.001$
Max T wave vector (mV)	0.14 ± 0.05	0.12 ± 0.05	$p < 0.001$
QRS-T angle	55 ± 39.7	55.7 ± 43.5	ns

Materials and results of the above study were prepared for a publication

2. Episodes of T-wave and QRS complex alternans in hemodialysis patients were detected. The detection was based on finding the morphology changes of odds-and-evens heart cycles by Principal Component Analysis. A thorough analysis of the alternans changes is under development, and some preliminary results show decrease of the QRS alternans (i.e. improvement of the cardiac function) after hemodialysis.
The material and the results obtained during the stay will be used for international publications.

Padova, October, 31, 2014 Giovanni Bortolan Ivaylo Hristov