Analysis of Blood Pressure Patterns: Effects on Assessment of Atherosclerosis

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Abstract: A statistical regression model is proposed to assess the early Atherosclerosis. Several new parameters are defined from blood pressure patterns being measured from the left arm brachial artery and in comparison with the parameters of ECG spectrum. The analysis result is realized that the QT value could be modulated with the AS state of the subjects.

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Introduction

Atherosclerosis (AS) is the pathological basis for many cardiovascular and cerebrovascular diseases, especially the most important cause of ischemic cardiovascular disease. The main disease related to AS leading to the death is coronary heart disease and stroke. From 1960s, in the developed countries, coronary heart disease has become the most important cause of death **[1]**. At present, the epidemiological characteristic of cardiovascular disease has been as similar with the western developed countries in China. The only difference is that ischemic cardiovascular disease has become to be epidemic in China **[2-3]**. AS generally includes several irreparable risk factors, such as age, sex, and heredity; however, there are also some repairable risk factors such as dyslipidemia, hypertension, sedentary, smoking, and diabetes. AS can occur in the first ten years without any clinical symptoms, so in the past a long time, many researches have been dedicated to focus of their attention on AS and related angina, myocardium Infarction, stroke and other fatal problems before early detection of atherosclerosis for treatment.

Atherosclerosis is the main pathological process of the plaque formation on vascular wall. When cholesterol and other substances are accumulated to a sufficient extent, the vascular endometrial cells induce mononuclear cells into macrophages to swallow the blood vessels. The fat between the walls accumulates in the cells and promote macrophages to be foam cells. The most typical atherosclerotic lesion is the "atherosclerotic" component on the vessel wall containing large amounts of lipid and necrotic foam cells. Atherosclerosis can accumulate on the the aorta, heart of the coronary artery, cerebral artery, renal artery, etc. **[4]**. In certain circumstances, atherosclerotic plaque rupture and thrombosis resulting in stenosis to occlusion affecting the blood supply to the related organs.

Since the process of atherosclerosis is very complex involving the organization, cell and molecular level of multiple links, scientists have tried a lot of clinical and experimental studies of atherosclerosis pathophysiology for the last several decades, but there are still no good predictors of atherosclerosis models and techniques **[5]**. The development of an effective predictor for atherosclerosis is the major topic in current epidemiological study. Establishing a reliable model of atherosclerosis for the detection of AS etiology, pathogenesis and prevention and control is also expected **[6]**.

Method

In this study, the approval of local IRB clinical trial, 18 subjects including 8 suspected AS patients in experimental group and 10 normal subjects in contrary group with ECG test results were participated into the program. Blood pressure pattern (BPP) clinical analysis was performed to compare with the results of ECG diagnosis. Cross sectional statistical model was proposed to assess the disease state of the patients in Henan Provincial People's Hospital (in China, Henan Province).

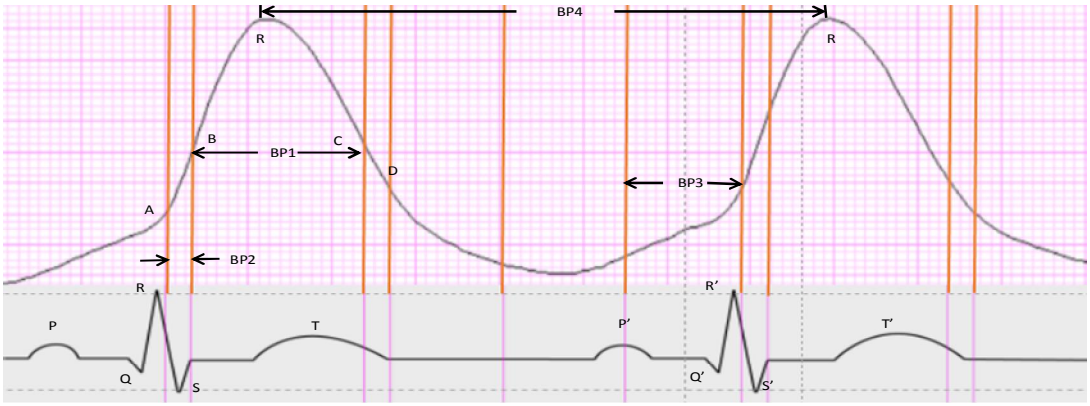

Figure 1 Definitions of the parameters for BPP and ECG pattern

Table 1. Cardiac cycle time durations for BPP and ECG patterns (10^{-3}second)

ID	BPP1	BPP2	BPP3	BPP4	PR	QRS	QT	QTC	HR	DSE	Diagnosis
29	181	14	151	961	162	142	428	447	923	1	AS suspect
34	391	9	142	879	210	106	404	433	870	1	AS suspect
35	185	13	143	871	178	84	412	437	896	1	AS suspect
38	103	64	167	1012	262	120	456	479	909	1	AS suspect
41	257	15	134	855	146	142	418	436	923	1	AS suspect
70	346	9	170	1036	156	86	392	389	1017	1	AS suspect
72	138	13	119	732	160	88	386	431	811	1	AS suspect
280	100	33	132	807	142	78	386	428	822	1	AS suspect
19	194	34	111	684	154	86	398	457	759	0	Normal
23	97	61	125	781	156	96	390	412	909	0	Normal
24	88	28	120	728	166	94	364	411	789	0	Normal
25	92	19	103	631	132	78	356	416	741	0	Normal
27	221	52	136	826	158	78	380	399	909	0	Normal
28	75	63	130	790	162	90	386	434	789	0	Normal
31	104	16	113	685	158	82	346	415	698	0	Normal
37	137	8	113	690	196	86	370	421	779	0	Normal
42	53	63	103	628	120	80	342	430	632	0	Normal
43	62	76	119	728	168	82	384	438	769	0	Normal

In this study, BP1 is defined as the life time duration of the first corresponding wave with the third high frequency in the BPP power spectrum. BP2 is defined as the life time duration of the corresponding wave with the second high frequency in the BPP power spectrum. BP3 is defined as the time duration of the corresponding wave with the highest frequency in the power spectrum of BPP in two consecutive cycles. BP4 are defined as the time interval between two peaks. In ECG spectrum, PR Interval is measured from beginning of P to beginning of QRS in the frontal plane. QRS duration is measured of the duration of QRS complex in frontal plane. QT Interval is measured from beginning of QRS to end of T wave in the frontal plane. QTC is the corrected QT interval, in which QT/ sq-root RR in seconds (upper limit for QTc = 0.45 sec). HR means heart rate and DSE means the disease state, 0 is normal, 1 is abnormal.

Results

The BPP and ECG parameters are selected and listed in the Figure 1 and Table 1. The correlation coefficients of the parameters are listed in Table 2. We realized that the correlation coefficient has been modulated with the AS state of the subjects. The disease states were assessed from ECG by professionals. ROC and AUC (area under curve) are used to evaluate the strength of predictors selected. Clinical result shows ROC-AUC evaluation for QT is over 90 percent accuracy for this study. The path coefficients, 0.628 were calculated to recognize the BPP parameter as the cause of AS with the dependent variable for ECG. A regression model is proposed for AS assessment. The path coefficients are listed as beta value in Table 3. Further study for the modulation of the model is under preparation for publication.

Discussions

For preoperative AS patients, the QT value of ECG was basically abnormal **[7]**. However, we can also observe the BPP parameters instead in earlier time. The model that we proposed in this study can

determine the disease state through BPP parameters.

As regression equation is presented as QT=0.8×BPP2 + 393, we can easily check the parameter to realize how risk the patient is in the early state of As. When the cardiovascular contains a factor that affects the heart contraction caused by AS, the BPP can be revealed is a good finding in Epidemiological study.

Table 2. Correlation matrix for parameters of ECG and BPP

		BPP1	BPP2	BPP3	BPP4	QRS	PR	QT	QTC	HR
Correlation Coefficient	BPP1	1.000	-.630	.235	.278	.069	-.063	-.234	-.562	.502
	BPP2	-.630	1.000	.335	.274	.105	.660	.628	.713	-.134
	BPP3	.235	.335	1.000	.984	.148	.480	.516	.018	.810
	BPP4	.278	.274	.984	1.000	.299	.429	.564	.037	.852
	QRS	.069	.105	.148	.299	1.000	.165	.685	.493	.280
	PR	-.063	.660	.480	.429	.165	1.000	.711	.678	.027
	QT	-.234	.628	.516	.564	.685	.711	1.000	.810	.284
	QTC	-.562	.713	.018	.037	.493	.678	.810	1.000	-.331
	HR	.502	-.134	.810	.852	.280	.027	.284	-.331	1.000

Table 3. The Regression Model AS-1 correlates the predictor BPP2 and dependent QT

Model		R	R square	Adjust R Square	Std. Error of Estimate	Sig.
AS-1	Dependent QT	0.628	0.395	0.294	20.133	0.047

Model		Unstandardized coefficients		Standardized coefficients	t	sig
		B	Std. Error	Beta		
AS-1	Constant	393.164	11.190	0.628	35.136	0.000
	Predictor: BPP2	0.800	0.404		1.979	0.047

Table 4. Area Under the Curve AUC: Predicted probability of Variable QT

Area	Std. Error	Asymptotic Sig.	Asymptotic 95% Confidence Interval	
			Lower bound	Upper bound
.925	.060	.003	.807	1.000

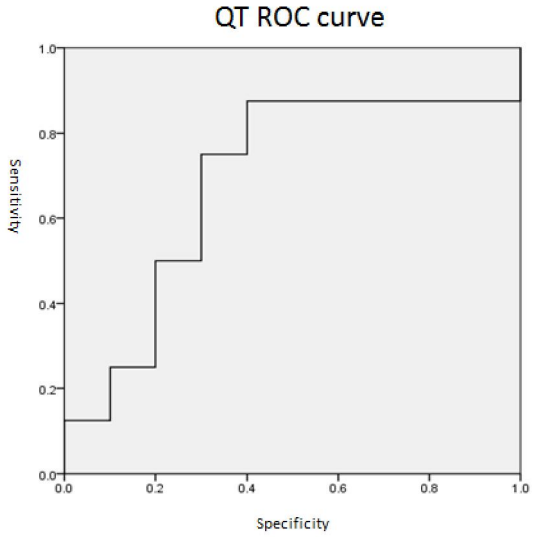

Figure 2. ROC curve for QT assessment

Conclusions

By using of our proposed model to identify AS state is a new technology which can be quickly applied to health examination. Since BPP is based on brachial artery pulse signals characterized by the closure and open states of the valves, AS disease states associated with myocardium can be recognized through the BPP parameters as health concern reference. At present, many studies have confirmed that AS can be recognized in BPP analysis **[8-9]**. Although using of brachial artery BPP as indicators for the assessment of AS is still in doubts, the AS related to the relevant parameters of BPP at large-scale population and clinic research has been on the way. Measurement of brachial artery BPP is simple, invasive and valued for the assessment of AS at first screen for patients in clinic.

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