NONINVASIVE DIAGNOSIS OF BLOOD VESSEL DISEASES RELATED TO VISCO ELASTIC DETERIORATION OF BLOOD VESSEL WALL

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Abstract
The algorithm of noninvasive diagnosing blood vessel diseases was established by detecting the acceleration response of blood vessel wall under pulsatile conditions, which estimates visco elasticity of blood vessel wall characterized by our proposed parameter of I^*. This method and theory were shown to be used to predict coronary artery disease by the clinical research. Furthermore, this method was applied to detect non-invasively the existence of aneurysm based on chaos theory. Review of these research are discussed in this study.

Introduction

Myocardial infraction, coronary artery disease and aneurysm rupture are those with high risk mortality after occurrence of these events. Therefore, it is very important to detect these diseases before these onsets by preventive medicine. These blood vessel diseases are caused by a mechanical deterioration of blood vessel wall such as atherosclerosis and by a morphology change of blood vessel wall such as aneurysm. Author's group have found out that the deterioration of blood vessel wall is caused by decrease in the pulsatile amplitude of blood pressure (increase in minimum blood pressue) and by the increase process of mean blood pressure [1]. This means that the mechanical property of blood vessel wall is sensitive to the creep effect, which results in visco elastic deterioration of blood vessel wall [2]. Furthermore, we found that a characteristic disturbance is caused in the pulsatile motion of blood vessel wall due to the occurrence of an aneurysm [3]. We have established the theory and the equipment of the noninvasive diganonosis of these diseases. In this study, these results are discussed. Clinical measurements were approved by the ethics committee of the Graduate School of Medicine, The University of Tokyo and by that of Tohoku University Hospital respectively. Informed consent was obtained from all participants prior to performing any measurements.

1. Results

2.1 The effect of various pulsatile pressure conditions on the deterioration of blood vessel wall

We have conducted the invitro pulsatile pressure tests of blood vessel of canine using the originately designed machine. From these experiments, the regular pulsatile condition was found not to cause the deterioration of blood vessel wall [1]. On the other hand, high mean stress (high minimum pressure) and creep conditions were found to cause inelastic deformation of blood vessel wall, that is deterioration on the strength of blood vessel wall. Especially, the pulsatile condition with increasing process of mean pressure was found to cause typical inelastic deformation of blood vessel wall [1]. Therefore, the deterioration on the strength of blood vessel wall is caused by the time dependent pressure condition [2].

2.2. The proposal of the noninvasive diagnostic method of deterioration of blood vessel wall such as atherosclerosis and aneurysm

The index of quantitative estimating the progressive degree of visco elasticity of blood vessel wall, that is, I*parameter, was proposed [4]. This parameter can obtain the quantitative progressive degree of viscoelasticity of blood vessel wall (deterioration of blood vessel wall) by noninvasive measurement of the accelerated response of pulsatile motion of blood vessel wall using supersonic Doppler ultrasound and it is related to diagnose the progressive degee of atheresclelosis [3,4]. Furthermore, for the case of

existence of aneurysm, a characteristic disturbance in the wave form of pulsatile motion of blood vessel wall was also found out, that is, the two phase wave form [3]. Including this characteristic disturbance, the analysis of entropy on the trajectory of pulsatile motion of blood vessel wall was conducted. In addition to the diagnosis of the progressive degree of atherosclerosis derived by I*, the method of simultaneous diagnosis of the existence of aneurysm by the entropy of the trajectory was proposed. The results of clinical measurement of the progressive degree of atherosclerosis by I*and the existence of aneurysm by the entropy,S were shown in Fig.1[3].These results are obtained non invasively within 15seconds. Furthermore, the diagnosis of the aneurysm, by dividing frequencies that compose the frequency of the pulsatile velocity of blood vessel wall into low and high regions and conducting attractor analyses of the trajectory of pulsatile blood vessel wall, the possibility of accurate selective detection of blood vessel diseases such as mechanical deterioration of blood vessel wall (low frequency region) and morphological change of blood vessel wall that are aneurysm (high frequency region) was indicated [5].This method is clinically shown to be used to predict coronary artery disease [6] and will be used to predict the existence of thoracic aortic aneurysm [5,7]

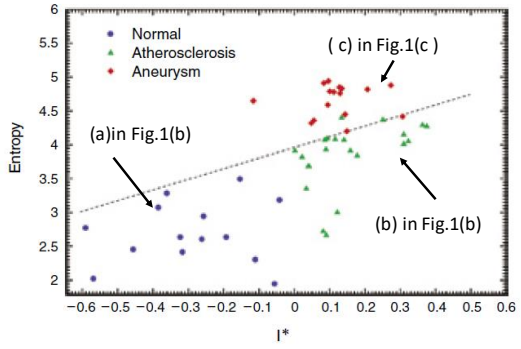

Fig.1 (a) Two dimensional representation of coronary artery disease and aneurysm obtained by this method

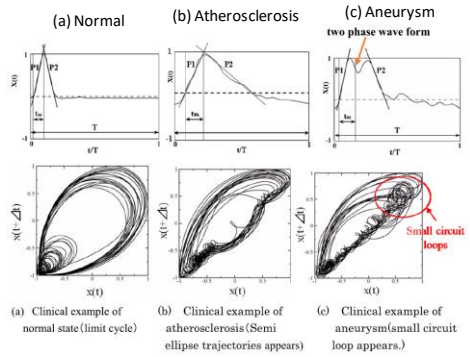

Fig.1(b) The pulsatile waveform of blood vessel wall and its trajectoriy based on the attractor analysis for normal, atherosclerosis and aneurysm

3.Conclusions

The theory of diagnostic method of progressive degree of atherosclerosis and aneutrysmwas proposed and its clinical application was discussed.

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