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EVALUATION OF CORONARY ARTERY DISEASE IN ASYMPTOMATIC TYPE-2 DIABETICS: THE ROLE OF EXERCISE STRESS TESTING

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Abstract

Controlling micro vascular disease and coronary artery disease becomes significantly more challenging in those with type 2 diabetes. Examining the state of one's arteries on a regular basis is, thus, crucial. One of the most practical and inexpensive methods for monitoring changes in blood volume is the photoplethysmogram (PPG). In order to draw conclusions about the patient's health, doctors used one of the many applications of photoplethysmography (PPG), the second derivative photoplethysmogram (SDPPG). Instead of the SDPPG formal ageing index, also known as the SDPPG-AI, we shall utilise the SDPPG informal technique. When comparing the 23 patients with diabetes to the healthy people who served as controls, the researchers observed that the patients with diabetes had a higher index of vascular ageing.

Keywords: Type 2 Diabetes, Photoplethysmograph, SDPPG, Vascular Aging

I. INTRODUCTION

The metabolic condition known as diabetes mellitus, or simply diabetes, is characterised by insulin resistance and/or insufficient insulin synthesis. Diabetes is a common shorthand for diabetes mellitus. When diabetes goes untreated for a long time, it can cause tissue and blood vessel damage in vital organs like the kidneys, heart, muscles, and eyes. kinds 1 and 2 diabetes, or simply kinds 1 and 2, are the two most often diagnosed forms of the disease [1].

Younger people are more likely to be diagnosed with type 1 diabetes, which is related to genetics, whereas middle-aged adults are more likely to develop type 2 diabetes, which is related to lifestyle [2]. Younger persons are more likely to be diagnosed with type 1 diabetes. People tend to get diagnosed with type 1 diabetes at a younger age. The global health issue caused by the increasing incidence of type 2 diabetes is reaching epidemic proportions. Estimates for the prevalence of diabetes in the United States range from 7.4% in 1995 to 8.9% in 2025 [3]. Microvascular disease and the rapid worsening of coronary artery disease are both much more common in people

with type 2 diabetes [4]. Regular artery monitoring has the potential to become an efficient and fruitful method of lowering the danger of coronary artery disease (CAD).

The health of an artery system can be assessed with either invasive or noninvasive diagnostic techniques. Photoplethysmography (PPG) is an optical measurement technique that may detect changes in the microvascular bed of tissue blood volume without invasive treatments. PPG treatment is not limited to a certain area of the body. The finger's second derivative Single-diode PPGs are a relatively new innovation in the PPG industry. Techniques for the non-destructive study of pulse waves that have practical implications in the real world. Multiple research [5] have demonstrated the SDPPG's efficacy in estimating vascular age, which is correlated with arterial health. This allows for an in-depth evaluation of SDPPG's vascular health. We further investigate the link between age and diabetes. We hypothesise that this effort will hasten the vascular ageing that happens in people with diabetes.

II. METHODOLOGY

Subjects

The participants in the study spanned the full spectrum of diabetes duration, totaling twenty-three people. PPG is the name of a database that is managed by the UKM biomedical engineering research department. The database is used to store and retrieve information about patients. Participants were separated into three groups, based on their ages: those aged 40 to 44, those aged 45 to 49, and those aged 50 to 54. The severity of premature birth was measured by comparing the procedure to that of 34 healthy volunteers of the same age who smoked but did not have any other risk factors.

Data Processing

PPG signals were recorded using recording equipment that is available for purchase, and MATLAB, which was developed and is distributed by The MathWorks, Inc., was used to do offline analysis of the recorded data. The waveform of the SDPPG was altered for a number of subjects by utilising MATLAB, which was done in order to accomplish this. The PPG signal and the SDPPG that corresponds to it look like this, as can be seen in Figure 1.

The SDPPG is made up of the amplitudes of the first positive wave (wave a) as it rises from the baseline to its peak, the first negative wave (wave b), the re-uplosping wave (wave c), the late downsloping wave (wave d), and the diastolic positive wave (wave e). The form of the SDPPG wave can be determined by comparing the amplitudes of the b, c, d, and e waves to that of the a wave [5].

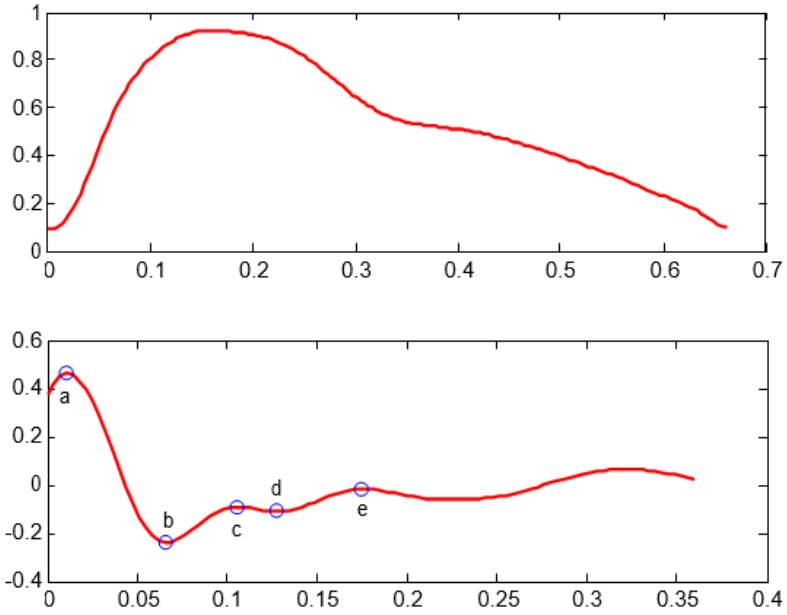

Figure 1: Finger Ppg and Its Second Derivative (Sdppg, Bottom) Waveforms After Normalisation

III. RESULTS AND DISCUSSION

The SDPPG ageing index can be calculated with the use of the following equation. The SDPPG waveforms all have a similar overall shape, but the slope of each period is entirely dependent by the condition of the subject's vessels [6]. This is notably true for the b wave and the e wave. This holds true for each and every one of the waveforms. The absence of these waves in the data that was collected is illustrated in Figure 2. Electrocardiograms taken from the vast majority of diabetic patients reveal the presence of recognisable a, b, and e waves [7].

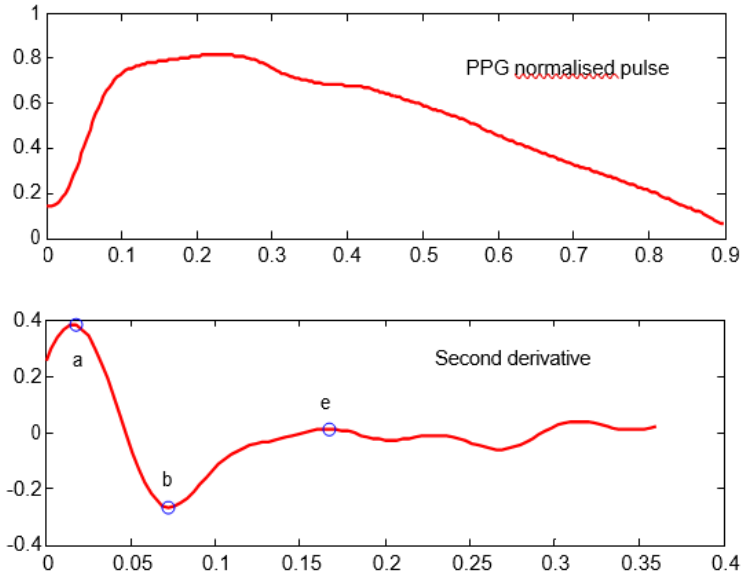

Figure 2: Finger Ppg Normalised Waveform (Top) and SDPPG Waveform (Bottom) With a Missing Wave

In light of this fact, only these waves were taken into consideration for the SDPPG-AI calculation. In the case of the unofficial method, the equation that corresponds to it is [7].

SDPPG□ AI □ □b□ c□ d□ e□ a----------1

People with diabetes have a significantly greater ageing index than healthy people, as shown in Figure 3. The results showed that people with diabetes fared better than those without the disease.

SDPPG□ AI □ □b□ e□ a--------2

Table 1 provides a comparison between diabetes patients and healthy individuals based on their means and standard deviations from the informal SDPPG-AI. The unofficial SDPPG-AI increased with age in both healthy individuals and those with diabetes. This held true whether or not the subjects were diabetic. The arteries get wider and stiffer as a natural consequence of ageing [6]. When other risk factors are present, such as in the case of diabetes mellitus, this progression can speed up. The cardiovascular system suffers damage when blood glucose levels increase and fall often due to changes in insulin secretion. Damage to the heart and blood vessels can occur at an earlier age in those with diabetes [8].

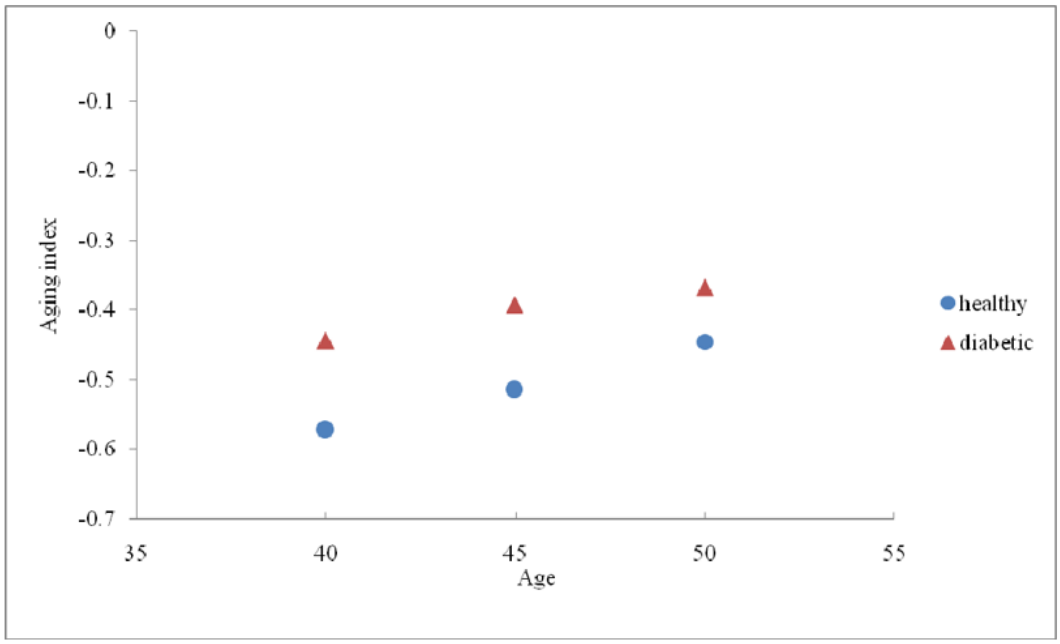

Figure 3: The Average Number Of Years Lived By Each Sample

Table 1: Example Data Summarization

Parameter	41-45 Mean±S.D		46-50 Mean±S.D		51-55 Mean±S.D	
	D	H	D	H	D	H
Subjects	9	20	9	12	8	5
Age (years)	43.39 ±1.87	42.85 ±1.64	48.01 ±1.87	47.65 ±1.85	52.71 ±1.21	52.26 ±1.99
Aging index	-0.65 ±0.21	-0.77 ±0.17	-0.49 ±0.23	-0.62 ±0.27	-0.47 ±0.27	-0.55 ±0.27

IV. CONCLUSION

Our investigation revealed that 33.9% of study participants who were diagnosed with type 2 diabetes also had carotid artery stenosis. These conclusions were based on the findings of our research. Diabetes, renal disease, peripheral artery disease, coronary artery disease, and a history of having a heart attack or stroke are all risk factors that have been linked to carotid stenosis. Carotid stenosis is a condition that narrows the carotid artery. Patients with type 2 diabetes who are older, have had diabetes for a longer period of time, and have higher levels of nitric oxide in their serum are at a larger risk of developing carotid stenosis. Patients with type 1 diabetes are not at an increased risk of developing carotid stenosis.

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