P-0641 Radial pulse spectrum may be a predictor of ischemic heart disease in patients with type 2 diabetes

Kuo-meng Liao[1], Ying-chun Chen[1], Sheng-Hung Wang[2], Ming-Yie Jan[2], Chi-Wei Chang[3]

[1]Division of Endocrinology & Metabolism of Zhongxiao Branch of Taipei City Hospital, *Taipei, Taiwan, ROC*
[2]*Biophysics Laboratory, Institute of Physics, Academia Sinica, Taipei, Taiwan, ROC*
[3]*Graduate Institute of Biomedical Electronics and Bioinformatics, National Taiwan University, Taipei, Taiwan, ROC*

Ischemic heart disease (IHD) contributes to a high percentage of morbidity and mortality of diabetes. A predictor of IHD can lead to an early diagnosis to prevent progression and to reduce future clinical events. The aim of the study was to examine whether the spectrum analysis of radial pressure wave can predict IHD in patients with Type 2 diabetes. Radial pressure wave was measured by a piezoresistive sensor in 1,137 (Male: 681, Female: 456) Type 2 diabetic patients with IHD (n=158) and without IHD (n=979), recruited from the Division of Endocrinology & Metabolism of Zhongxiao Branch of Taipei City Hospital. For each patient, spectrum analysis of radial pressure wave was calculated and transformed into Fourier series coefficients Cn. The means of first (C1), second (C2), and third (C3) harmonic of arterial pulse were significantly higher in patients with IHD (C1:0.996±0.104, C2: 0.529±0.099, C3:0.273±0.083) than in patients without IHD (C1:0.964±0.100, P<0.01; C2:0.514±0.104, P<0.1; C3:0.256±0.082, P<0.05, respectively). Chi-square test proved there were associations between C1~C3 and IHD (C1: P <0.01, C2: P <0.01, and C3: P <0.05, respectively). The risks of IHD in patients with diabetes were raised by the increments of C1 (Odds ratio: 1.80, 95% C.I. 1.28-2.52, P<0.01), C2 (Odds ratio: 1.57, 95% C.I. 1.12-2.21, P<0.01), and C3 (Odds ratio: 1.45, 95% C.I. 1.03-2.05, P<0.05). Multiple linear regression analysis showed C2, C3, gender, waist, triglyceride, low-density lipoprotein cholesterol, and duration of diabetes were associated with IHD(R=0.505, P=0.06). The preliminary findings from the study identified the first, second, and third harmonics of radial pressure wave could be a set of important predictors for early diagnosis of IHD in type 2 diabetic patients.

Patients with type 2 diabetes who underwent measurement of radial pressure wave between March 2016 and January 2017 at the Division of Endocrinology & Metabolism of Zhongxiao Branch of Taipei City Hospital were enrolled in this study after receiving approval from the institutional review board of Taipei City Hospital (IRB number: TCHIRB-10512113-E). All the subjects signed the informed consent about the pressure wave measurement and that cross-sectional clinical data were obtained from the medical records.Measurement of radial pressure wave was performed in a quiet room at a constant temperature of 23-25. During each measurement, the patient was lying in a supine position after 10 minutes of rest and the signal was received from harmonic wave analyzer TD01C (MII-ANN Technology, Taiwan) at the sampling rate of 400 Hz. Twelve-second sequential pulses were acquired and transformed into Fourier series coefficients for each pulse. The harmonic components are defined by the following equation: $C_n=A_n/A_0$

We performed two statistical analyses to assess the association between harmonics of the radial pressure wave and IHD. At first, the subjects were divided into two groups: type 2 diabetic patients with and without IHD. IHD was recognized and prescribed I-25.9(ICD 10) by the doctors in clinical practice. Variables from medical records and from the spectrum analysis of radial pressure wave were calculated in the two groups and were given as mean±SD (Table 1). We compared means of those functional variables of the two groups using the Student's t-test. The harmonics of radial pressure wave performed the chi-squared test to examine the independent association between the harmonics and IHD. The odds ratios for IHD with exposure to higher and lower values of those specific harmonics were assessed.

In the second, the risk of developing IHD was calculated by the multivariable linear regression model. Characteristics of radial pressure such as harmonic amplitude and phase were major screening parameters while age, gender, smoking, weight, waist, HBA1C, diastolic pressure, systolic pressure, LDL, TG, HDL, and duration of diabetes were included as covariates. P values <0.05 were considered statistically significant. The statistical analyses were performed using the Matlab software.The means of first (C1), second (C2), and third (C3) harmonic of arterial pulse were significantly higher in patients with IHD (C1:0.996±0.104, C2: 0.529±0.099, C3:0.273±0.083) than in patients without IHD (C1:0.964±0.100, P<0.01; C2:0.514±0.104, P<0.1; C3:0.256±0.082, P<0.05, respectively). Multivariable regression analysis showed C2 (β=-2.39, P<0.05), C3 (β=2.78, P<0.1), gender (β=-0.110, P<0.05), waist (β=0.0053, P<0.1), triglyceride (β=-5.88e-4, P<0.05), low density lipoprotein cholesterol (β=-0.0019, P<0.05), and duration of diabetes (β=0.01, P<0.01) had the independent effects on IHD(R=0.505 , P=0.06).

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Table 1. Clinical characteristics of the 1137 diabetic patients enrolled in the study, divided according to the presence or absence of ischemic heart disease.

	Diabetes With IHD	Diabetes Without IHD
N	158	979
Male (%)	67	59
Age (year)	65.9±11.7***	59.7±11.7
BMI (kg/m^2)	26.6±4.3	27.5±10.9
SBP (mmHg)	127±14	127±13
DBP (mmHg)	72±9**	74±8
HbA1C (%)	6.9±1.0*	7.0±1.2
LDL (mmol/L)	121±56	134±92
HDL (mmol/L)	49.5±13.6	49.5±15.8
TG (mmol/L)	154±35**	162±33
Albuminuria (mg/dL)	268±707**	89±255
Duration of diabetes (years)	13.1±8.3***	10.1±10.0
HR (beats/min)	72±11**	74±11
Smokers (%)	7.6***	16.5

IHD=ischemic heart disease, SBP= Systolic blood pressure, DBP= Diastolic blood pressure, LDL=low density lipoprotein cholesterol, HDL=high density lipoprotein cholesterol, TG= triglycerides, HR= heart rate.Single, double, and triple asterisks indicate that the means of variables in the group of diabetic patients with IHD differ significantly (p < 0.1, p < 0.05, and p <0.01 respectively) from the group of diabetic patients without IHD using the Student's t-test.

In this cross-sectional study, we proposed and proved significant associations of cardiovascular markers (C2 and C3) with IHD, after adjustment for age, gender waist, triglyceride, duration of diabetes, and low-density lipoprotein cholesterol Further investigation was needed to examine whether the characteristic of radial pulses such as C2 and C3 has the ability to improve the risk assessment based on routine clinical examination.

Figure 1 Comparison of first five harmonic amplitude of radial pressure wave in diabetic patients with IHD and without IHD.
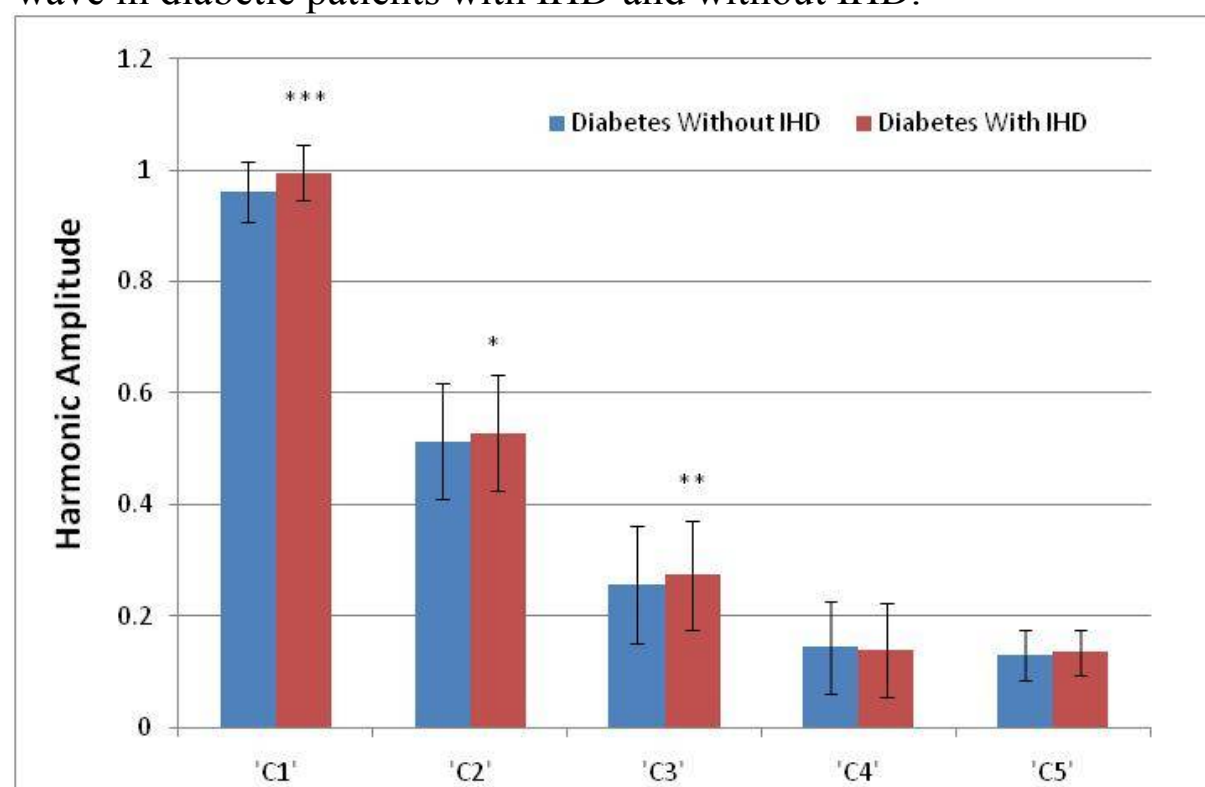
IHD：ischemic heart disease. Single, double, and triple asterisks indicate that the mean of Cn inthe group of diabetic patients with IHD differssignificantly (p <0.1, p < 0.05, and p <0.01 respectively) from the group of diabetic patients without IHD using the Student's t-test.