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Role of P Wave Duration and Tissue Doppler Imaging as Predictive Indicators for Paroxysmal Atrial Fibrillation in Hypertensive Patients

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Atrial fibrillation (AF) is the most prevalent chronic arrhythmia in the heart. AF accounts for one-third of rhythm disorder hospitalizations. AF increases profoundly the risk of stroke, heart failure, and death. This study used P-wave and transthoracic echocardiography with tissue Doppler imaging (TDI) to determine paroxysmal AF predictors in hypertensive individuals.
Methods: This case control study was performed on 100 hypertensive adult patients. They were classified into two equal group: Group I included hypertensive patients diagnosed to have paroxysmal AF. Group II (control group) included hypertensive patients with normal sinus rhythm. All subjects were subjected to electrocardiographic and conventional and tissue Doppler Imaging measurements.
Results: Pmax had significantly increased in PAF patients compared to sinus rhythm patients. PAL, PAR, PAI, LR, LI and IR had significantly increased in PAF patients compared to sinus rhythm

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patients. In Multivariate logistic regression analysis, Pmax, PAL, PAI, PAR, LR, LI and IR were found to be independent predictors for PAF. Therefore, Pmax, PAL PAI, PAR, LR, LI and IR were found to be significant predictors for PAF. Best cut-off values for Pmax, PAL, PAI, PAR, LR, LI and IR were: (118, 81, 61, 49.9, 34, 20 and 16 ms) with sensitivity (76, 96, 96, 88, 82, 86 and 77.5), specificity (84, 100, 98, 92, 78, 82 and 76) and the AUC of (0.850, 0.979, 0.987, 0.961, 0.836, 0.891 and 0.798) respectively.

Conclusions: Electrocardiographic P-wave analysis and echocardiographic TDI may identify hypertension patients at risk for paroxysmal AF, since the combination of Pmax and TDI may help in predicting the development of AF in hypertensive individuals.

Keywords: P-Wave; tissue doppler imaging; predictive indicators; paroxysmal AF hypertensive patients.

1. INTRODUCTION

Atrial fibrillation (AF) is the most prevalent chronic arrhythmia. AF accounts for one-third of rhythm disorder hospitalizations [1,2]. AF is one of the most urgent public health concerns because it significantly increases morbidity, mortality, and health-related expenses [3]. AF dramatically raises the risk of stroke, heart failure, and death [4,5].

Uncontrolled hypertension is a significant element in the establishment of an AF-vulnerable substrate, since higher systemic pressures affect the left atrium function and size [4,6].

The most prevalent cardiovascular comorbidity in AF patients is hypertension. Hypertension induces anatomical and electrical alterations in the left atrium that enhance the incidence of AF [6]. Current research shows that effective hypertension treatment may minimise the incidence of AF by avoiding atrial dilation from raising atrial fibrosis, ventricular filling pressures, and extracellular collagen deposition, as well as by a variety of other critical mechanisms. Therefore, from a therapeutic aspect, it is essential to forecast AF in hypertensive individuals and implement preventative measures against AF [7-10].

This study used P-wave and transthoracic echocardiography with tissue Doppler imaging (TDI) to determine paroxysmal AF predictors in hypertensive people.

2. METHODS

This case control study was conducted at Cardiology Department of Tanta University Hospital on 100 known hypertensive adult patients.

The inclusion criteria were hypertension on the basis of a DBP of 90 mmHg or more, or a SBP of 140 mmHg or more, measured on at least 2 different occasions [11]. Paroxysmal AF on the basis of duration ≤7 days that convert to sinus rhythm and more than 2 attacks within the last six months [12].

The exclusion criteria were ischemic heart disease, valvular heart disease, hyperthyroidism, secondary hypertension, congenital heart disease, corpulmonale, electrolyte disorder and other arrhythmia.

Patients were classified into two equal groups: Group I included hypertensive patients diagnosed to have paroxysmal AF. Group II (control group) included hypertensive patients with normal sinus rhythm.

2.1 All Patients were Subjected to the Following

Determination of baseline data e.g.: age, gender, atherosclerotic risk factors. Blood pressure (BP) measurements were obtained after the patient rested for 5 minutes in a comfortable quiet place, three BP measurements were taken, 1–2 min apart, and additional measurements when the first two readings differ by >10 mmHg. BP is reported as the mean of the last two measurements [11].

2.2 Electrocardiographic Measurements

Standard 12-lead ECG after the patient had rested in bed for 5 min, performed during sinus rhythm. The voltage was 1mV/cm and sweep speed was 50mm/s. Five cardiac recycles at least were recorded during the rest time and were selected for analysis and the mean value was used. The maximum and minimum P wave duration was recorded be measuring the

distance between the start point of the P wave to its end.

Diagnostic criteria of sinus rhythm: Obvious P wave (<0.12s) in the electrocardiogram, amplitude of P wave in the precordial leads <0.15mV, amplitude of P wave in the limb leads <0.25 mV, inversed on avR lead, upright on II, III and avF lead, Pr of 0.12-0.20s, and normal ST-T and QRS [12].

Diagnostic criteria of AF: A standard 12-lead ECG recording or a single-lead ECG tracing of >_30 s showing heart rhythm with no discernible repeating P waves and irregular RR intervals is diagnostic of clinical AF [13].

2.3 Conventional and Tissue Doppler Imaging Measurements

Examination was done using a Vivid 7, GE Medical system with a 3.5-MHz transducer. Patients were examined in the left lateral position, two-dimensional (2D) and M-mode echocardiography were performed with simultaneous ECG recording. LVEF was measured using Simpson Method [14]. Diameters of the left atrium (LA) and aortic root (AO) were measured [14].

A-wave velocity, Transmitral E-wave velocity, E/A ratio were obtained [14]. Peak systolic peak early (E') and late (A') diastolic annular velocities and mitral annular velocities (S'), were obtained using TDI modality (244). The time interval between the onset of P wave and the onset of late diastolic A wave of tissue velocity imaging (TVI) was measured as P-A time [15]. In addition, the time intervals between the onset of P wave and the onset of A wave of TDI in mitral annulus of the left ventricle lateral wall (PAL), mitral annulus of the interventricular septum (PAI), and tricuspid annulus of the right ventricle (PAR) were measured [16]. LR was calculated as the difference between the time intervals (PAL) and time intervals (PAR); LI was calculated the difference between the time intervals (PAL) and time intervals (PAI). IR was calculated as the difference between the time intervals (PAI) and time intervals (PAR) [16] Fig. 1.

2.4 Statistical Analysis

Using SPSS 22.0 for Windows, all data were gathered, tabulated, and statistically analysed (SPSS Inc., Chicago, IL, USA). Kolmogorov–Smirnov test was used to test data normality. Frequencies and relative percentages were utilised to depict qualitative data. Fisher exact and The Chi-square test (X^2) were employed to quantify the distinction between qualitative variables, as indicated. For parametric data, quantitative data were given as mean standard deviation (SD), but nonparametric as median and interquartile range. For parametric and non-parametric variables, respectively. Mann Whitney and independent T tests were employed to detect the difference between quantitative variables in two groups. Potential factors of PAF were identified through a multivariate logistic regression analysis. The odds ratio (OR) with a 95% confidence interval (CI) is used to determine the connection between an exposure and an outcome. ROC curve analysis was performed. Statically significant was considered at P value < 0.05.

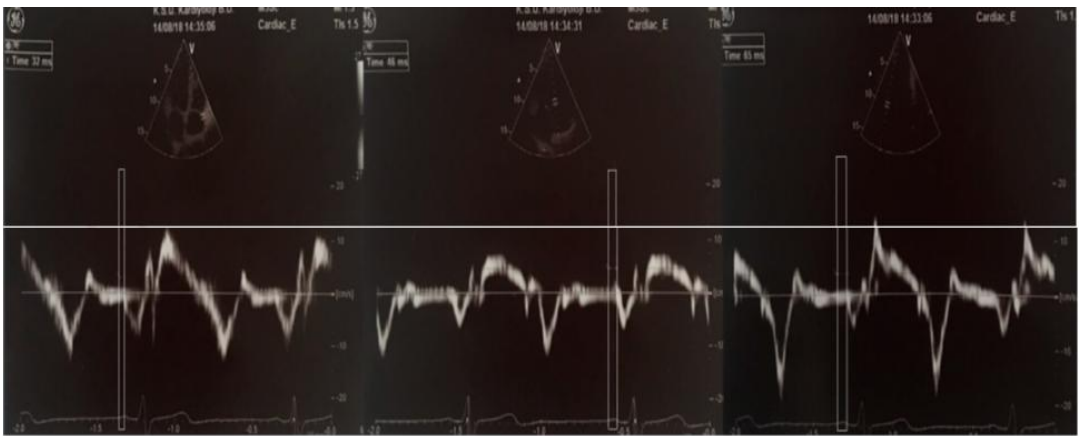

Fig. 1. Time interval between the onset of P wave and the onset of late diastolic A wave of tissue velocity imaging (TVI) at tricuspid annulus, septal mitral annulus and lateral mitral annulus respectively [17]

3. RESULTS

There is no significant difference regarding demographic characteristics, laboratory parameters and the baseline medications for hypertension.

Table 1. Baseline clinical characteristics

Variables		PAF (n=50)	Sinus rhythm (n=50)	P
Age (years)		56.58 ± 8.36	58.18 ± 8.44	0.343
Sex	Male	27 (54%)	30 (60%)	0.545
	Female	23 (46%)	20 (40%)	
BMI (kg/m^2)		26.45 ± 2.74	25.97 ± 3.35	0.435
Diabetes mellitus		20 (40%)	18(36%)	0.890
Smoking		26 (46 %)	22 (44%)	0.064
Dyslipidemia		16 (32%)	12 (24%)	0.072
HR (beat/min)		70.1 ± 11.5	68.5 ± 11.58	0.078
SBP (mmHg)		128.0 ± 7.63	129.2 ± 7.85	0.440
DBP (mmHg)		82.2 ± 5.64	83.2 ± 5.32	0.364
Total Cholesterol (mg/dl)		204.65 ± 30.5	194.1 ± 32.42	0.097
Triglycerides (mg/dl)		111.8 ± 16.81	108.27 ± 18.49	0.320
LDL (mg/dl)		103.14 ± 15.22	97.44 ± 14.28	0.056
HDL (mg/dl)		46.81 ± 7.95	48.9 ± 6.43	0.152
FBS (mg/dl)		113.33 ± 24.9	109.63 ± 26.88	0.519
Creatinine (mg/dl)		0.897 ± 0.167	0.837 ± 0.159	0.069
Baseline Medications	**BB**	18 (36%)	26 (53%)	0.206
	CCB	9 (19%)	14 (27%)	0.830
	ACE-I	12 (23%)	17 (33%)	0.904
	ARBs	11 (22%)	7 (13%)	0.489
	Diuretics	12 (23%)	20 (20%)	0.258

Table 2. ECG and Echo findings between both studied groups

Variables	PAF (n=50)	Sinus rhythm (n=50)	P
Pmax (ms)	122.78 ± 8.23	110.98 ± 9.44	**<0.001***
Pmin (ms)	80.45 ± 16.3	79.11 ± 18.4	0.701
EF (%)	60.06 ± 2.98	60.54 ± 4.46	0.529
Aortic root Diameter (cm)	2.98 ± 0.291	3.06 ± 0.367	0.234
LA diameter (cm)	4.01 ± 0.34	3.93 ± 0.30	0.420
Mitral E wave velocity (cm/s)	66 ± 14	68 ± 12	0.356
Mitral A wave velocity (cm/s)	70 ± 12	71 ± 16	0.542
E/A Ratio	0.94 ± 0.32	0.95 ± 0.30	0.485
S' (cm/s)	8.2 ± 1.3	8.3 ± 1.5	0.284
E'(cm/s)	9.5 ± 2.2	9.7 ± 3.1	0.271
A'(cm/s)	10.2 ± 1.6	10.0 ± 2.1	0.408
PAL (mm)	91.34 ± 7.05	71.7 ± 4.41	<0.001*
PAI (mm)	68.73 ± 4.99	52.96 ± 6.30	<0.001*
PAR (mm)	53.57 ± 4.39	39.3 ± 5.63	<0.001*
LR (mm)	37.76 ± 7.98	32.4 ± 6.51	<0.001*
LI (mm)	22.61 ± 8.07	18.74 ± 6.15	0.008*
IR (mm)	15.16 ± 5.8	13.66 ± 4.9	0.016

Pmax, PAL, PAR, PAI, LR, LI and IR were significantly higher in PAF patients compared to sinus rhythm patients. Otherwise, there was no significant difference regarding IR.

In Multivariate logistic regression analysis, Pmax, PAL, PAI, PAR, LR, LI and IR were found to be independent predictors for PAF (OR= 1.214 ; 95% CI, 1.054-1.397; p-value= 0.017), (OR = 1.257 ; 95% CI, 1.019-1.550; p-value= 0.001), (OR = 1.588; 95% CI, 1.002-2.517; p-value= 0.033), (OR= 1.124; 95% CI, 1.104 - 1.607; p-value= 0.021) (OR = 1.276; 95% CI, 1.045-1.452; p-value= 0.023) (OR= 1.325; 95% CI, 1.112-1.564; p-value= 0.032) respectively.

Table 3. Multivariate logistic regression analysis to determine the possible predictors of PAF

	OR	Sig.	95% CI
Pmax	1.214	0.027*	1.054 – 1.397
PAL	1.257	0.001*	1.019 - 1.550
PAI	1.588	0.033*	1.002 – 2.517
PAR	1.124	0.021*	1.104 - 1.607
LR	1.276	0.023*	1.045-1.452
LI	1.325	0.032*	1.112-1.564
IR	1.235	0.026*	1.094-1.571

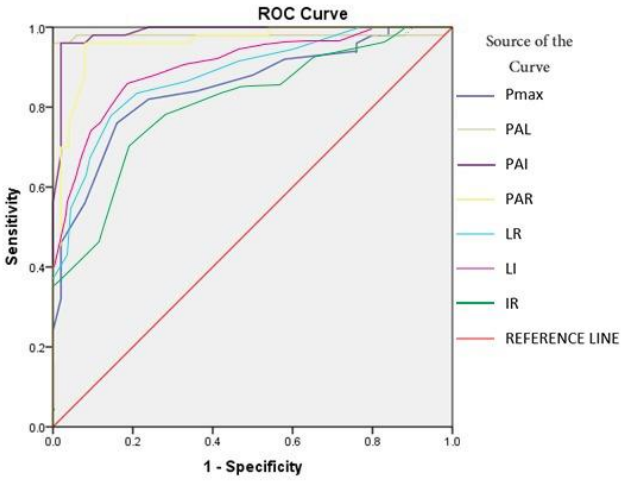

Fig. 2. ROC curve for possible predictors for PAF

Table 4. ROC cure analysis for possible predictors for PAF

Variables	Cut off	Sensitivity	Specificity	PPV	NPV	AUC	Sig.
Pmax	>118	76%	84%	82.6	77.8%	0.850	<0.001
PAL	>81	96%	100%	100%	96.2%	0.979	<0.001
PAI	>61	96%	98%	98%	96.1%	0.987	<0.001
PAR	>49.9	88%	92%	91.7%	88.5%	0.961	<0.001
LR	>34	82%	78%	78.8%	81.2%	0.836	<0.001
LI	>20	86%	82%	82.6	85.5%	0.891	<0.001
IR	>16	77.5%	76.4%	78%	76%	0.798	<0.001

In the ROC curve, the best cut-off values for Pmax, PAL, PAI, PAR, LR, LI and IR were: (118ms, 81, 61, 49.9, 34, 20 and 16 ms) with sensitivity (76, 96, 96, 88, 82, 86 and 77.5), specificity (84, 100, 98, 92, 78, 82 and 76.4) and the area under the curve of (0.850, 0.979, 0.987, 0.961, 0.836, 0.891 and 0.798) respectively. Fig. 2 and Table 4.

4. DISCUSSION

AF is the most frequent chronic heart arrhythmia, accounting for one-third of rhythm disorder hospitalizations. AF has a significant impact on morbidity, mortality, and health care costs, making it a public health concern. AF affects 33 million people globally, raises the risk of stroke, heart failure, and mortality, and diminishes the quality of life. In the majority of individuals, the development of persistent or chronic AF appears to be associated with the advancement of the underlying condition [3].

In agreement with our study, Zhang et al. [18] studied 120 consecutive patients, group I included 40 cases known to have PAF and group II: 80 cases known to have normal sinus rhythm (NAF). They reported that P wave dispersion (Pd) and Pmax was significantly longer (P < .05) in PAF group. They also reported that PAL, PAR,

PAI, LI, LR, and IR were increased significantly in PAF than in NAF group (P < 0.05).

Zhang et al. [18] also showed that Pmax ≥ 110ms, Pd ≥ 40ms and the combinations of them were predictors for paroxysmal AF which support the finding of the present study that prolonged Pmax is considered a reliable predictor of paroxysmal AF.

Also, Leung et al. [19] studied a total consecutive 944 patients divided into 602 patients with first episode of AF and 342 controls without known structural heart disease. They reported that PA-TDI had increased significantly in patients with AF compared to controls which support the finding of the present study.

In several clinical contexts, atrial electromechanical delay evaluated by tissue Doppler imaging has been described as a predictor of AF.

Sinan et al. [20] compared 26 pregnant women with preeclampsia to 24 pregnant women of the same age who did not have the condition (control group). In the preeclampsia group, PA lateral and PA septal durations were considerably longer than in the control group. In addition, the intra-atrial and inter-atrial EMD durations in the pre-eclampsia group were substantially longer than controls and may serve as predictors for the risk of AF in pre-eclamptic individuals.

Based on the results of a 24-hour Holter Electrocardiogram (Holter ECG), Hakan et al. [17] divided 77 haemodialysis patients over the age of 18 into two groups: those with AF attacks and those without. Intraatrial and interatrial electromechanical delay were significantly prolonged in individuals with AF (p < 0.05). According to the findings of this investigation, inter-atrial electromechanical delay is independently associated with episodes of AF detected on Holter ECG recordings of haemodialysis patients.

Also, concordant with the results of the current study, De Vos et al. [21] examined 249 individuals with no history of AF. The PA-TDI interval was measured in each of these individuals using echocardiography. During a mean (±SD) of 680 (±290) days of observation, 6% (15 patients) had AF. p=0.001; 172 (25) milliseconds against 150 (20) milliseconds, respectively. Within two years, 33 percent of individuals with a PA-TDI interval developed AF. 190 milliseconds vs 0% for those with a PA-TDI interval of 130 milliseconds (p=0.002) This lends confirmation to the current study's conclusion that a prolonged PA-TDI interval may be predictive of the beginning of new-onset AF.

In terms of TDI markers, Pmax, PAI, PAL, LR, PAR, LI and IR were considerably greater in PAF patients compared to sinus rhythm patients, as shown by the findings of the current study and supported by the findings of the aforementioned investigations. Therefore, atrial electromechanical time, intra-atrial and inter-atrial electromechanical delays were considerably greater in PAF patients and are good predictors of paroxysmal AF.

Lastly, this study has certain limitations, including a single-centre design and a small sample size. To reliably determine P-wavelength and TDI as prognostic markers for paroxysmal AF in hypertensive patients, more patients, a longer follow-up period, and multicenter experience are required.

5. CONCLUSIONS

Compared with the NAF group, the paroxysmal AF group had substantially longer atrial electromechanical time, intra-atrial and inter-atrial electromechanical delay. Pmax and TDI combination may be useful in predicting the onset of paroxysmal atrial fibrillation in hypertensive individuals.

CONSENT AND ETHICAL APPROVAL

The study was conducted after being approved by the institutional ethical committee, Tanta University from November 2018 to November 2019. Informed written consent was obtained from all patients included.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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