

Left ventricular hypertrophy are associated with increased ostial pulmonary vein diameter

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Abstrak

Fibrilasi atrium (FA) sering ditemui pada pasien hipertensi dengan hipertrofi ventrikel kiri (HVki). Vena pulmonalis (VP), yang berperan penting dalam terjadinya FA, mengalami peningkatan diameter ostialnya pada pasien FA. Tujuan penelitian ini untuk mengetahui perubahan vena pulmonalis pada HVki yang masih berirama sinus. Dari 70 subyek dengan hipertensi dan irama sinus, pada 42 subyek terdapat HVki. Ostium VP yang diukur memakai spiral multisliced CT scan, menunjukkan hasil berikut: kanan superior VP 19.6±2.78 vs 17.8±1.93 (p = 0.003), kanan inferior VP 18.4±3.12 vs 16.0±2.19 (p < 0.001), kiri superior VP 18.1±2.62 vs 16.0±2.16 (p < 0.001), dan kiri inferior VP 15.9±1.93 vs 15.4±1.85 mm (p = 0.284), pada pasien dengan dan tanpa HVki secara berturut-turut. Sekalipun dalam irama sinus, peningkatan diameter VP sudah terjadi pada HVki. Hasil ini mungkin dapat menerangkan tingginya prevalensi FA pada pasien dengan hipertensi. (Med J Indones 2006; 15:173-6)

Abstract

Atrial fibrillation (AF), which is called as a global epidemic disease, frequently found in hypertensive patients with left ventricular hypertrophy (LVH). Pulmonary vein (PV), which is known to have an important role in AF initiation and maintenance, increases in its diameter during AF. We sought to investigate PVs diameter changes in LVH with sinus rhythm. Of 70 hypertensive patients with sinus rhythm, 42 subjects demonstrated LVH. The mean ostial diameter of patient with and without LVH, assessed by doing spiral multisliced CT scan in the axial plane, were as follow: right superior (RSPV) of 19.6±2.78 vs 17.8±1.93 (p = 0.003), right inferior (RIPV) of 18.4±3.12 vs 16.0±2.19 (p < 0.001), left superior (LSPV) of 18.1±2.62 vs 16.0±2.16 (p < 0.001), and left inferior (LIPV) of 15.9±1.93 vs 15.4±1.85 mm (p = 0.284), respectively. Even during sinus rhythm, LVH causes PV dilation. This result might give an explanation of frequent AF prevalence in hypertensive patients. (Med J Indones 2006; 15:173-6)

Keywords: Pulmonary veins, Left ventricular hypertrophy

The huge incidence of atrial fibrillation (AF) in the world has been notified as a global epidemic disease. Pulmonary veins (PVs) were found to be important sources of ectopic beats for the initiation and maintenance of paroxysmal AF.¹ Recent publication showed the special electrophysiology characteristics of PV including an isolation of special conducting cell in the PV that augment the likelihood of AF origin.^{2,3}

Clinical data showed that AF is associated with hypertension especially if left ventricle hypertrophy (LVH) is present.⁴ The mechanism of hypertension induce AF still controversial. But, the dilation of PV has been found in AF patients and thought to be AF

risk factor.⁵ In addition, previous report revealed that diameter of arrhythmogenic PVs was significantly larger compared to non arrhythmogenic PVs.⁶ Since the PV anatomy in hypertensive patients with sinus rhythm has not been widely elucidated, we sought to elaborate the PV anatomy changes in hypertensive patients with evidence of left ventricle hypertrophy.

METHODS

Patients Selection

This is a case control study comparing the PVs ostial diameter of hypertensive patients with and without left ventricle hypertrophy using multislice CT scan. The study group consisted of 42 hypertensive patients with the evidence of LVH, and the control group consisted of sex matched 28 hypertensive patients without LVH.

CT Imaging

All subjects were underwent multi-sliced chest CT scan with 0.75 mm collimation and rapid administration of intravenous contrast media. The identification and measurement technique of PV has been noted elsewhere.⁷ In brief, the CT dataset was transferred to three-dimensional (3-D) workstation, where 3-D reconstruction of left atrium (LA) was performed to define the PV anatomy, ostial diameter, and its orientation at the junction of LA (**Figure 1**). Because PVs frequently do not make a 90° angle with the atrium but rather have funnel-shaped distal segments, the ostial diameter were measured at the point of the smallest angle with the atrial wall. Measurement of PVs was taken at the largest diameter on the axial plane (**Figure 2**). LVH is defined by thickening of interventricular septum wall more than 12 mm, and is determined by measuring axial plane of left ventricle (LV) by CT scan at the level of papillary muscle.⁸ (**Figure 3**) All measurements were performed by the single radiographer who was blinded to the patient history.

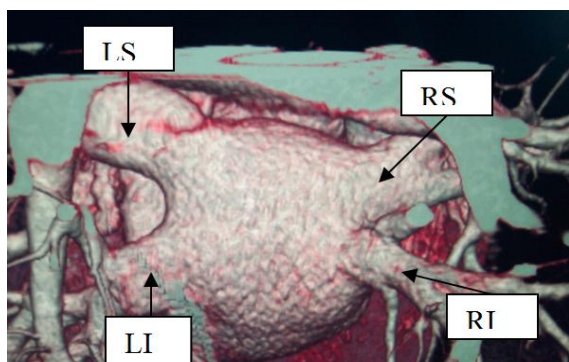


Figure 1. Three dimensional LA-PV reconstruction. The figure shows posterior view of LA-PV junction. LS = left superior PV, LI = left inferior PV, RS = right superior PV, RI = right inferior PV.

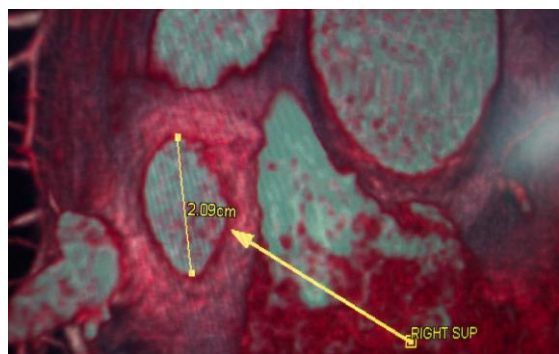


Figure 2. Measurement of ostial diameter. The figure shows largest ostial diameter measurement of right superior pulmonary vein. The measured diameter is 20.9 mm

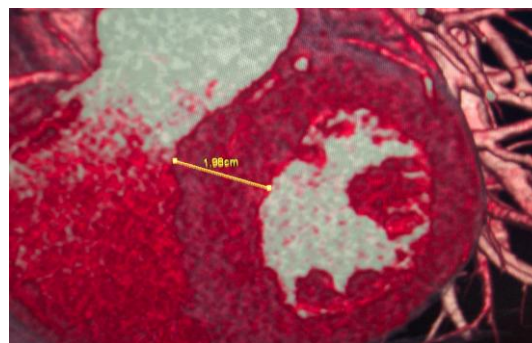


Figure 3. LVH identification. The interventricular septum was measured from axial plane at the level of papillary muscle. Here, the measured thickness was 19.0 mm

Statistical Analysis

Continues variables are expressed as mean ± 1 SD. Independent t-test was used to analyze difference of PVs diameter between patients with and without LVH. A p value < 0.05 was considered statistically significant. All statistical analysis was performed using the SPSS 13.0 software.

RESULTS

Clinical Characteristics

Of 70 subjects eligible for this study comprised of 48 male. In the majority of patients, hypertension was controlled by calcium channel blocker (CCB) (13%). The rests were taken angiotensin converting enzyme (ACE) inhibitor (9%) and angiotensin II receptor blocker (ARB) (3%) or other antihypertensive drug in anytime during their medication period. The mean values of blood pressure were 131±12.5/82±10.3 and 134±29.1/82±11.3 mmHg in LVH and non-LVH group respectively. The mean interventricular septum thickness in subjects with LVH was 15.1±0.23 mm as compare to 10.2±0.18 mm in non-LVH group (p< 0.001). (Table 1) Sixteen percent of patients had coronary artery disease, 2% had diabetes mellitus, and 2% had arrhythmias.

Table 1. Clinical Characteristics

Characteristics	LVH	Non-LVH
Age	58 ± 8.1	53 ± 10.3
IVS	15.1 ± 2.34	10.2 ± 1.81
SBP	131 ± 12.5	133 ± 29.1
DBP	82±10.3	82±11.3

LVH = left ventricle hypertrophy, age in year, IVS = interventricular septum thickness at the level of papillary muscle (in mm), SBP = systolic blood pressure, DBP = diastolic blood pressure

Ostial Diameter

We measured 280 PVs from 70 subjects. All subjects had 4 PVs which were divided into right inferior PV (RIPV), right superior PV (RSPV), left inferior PV (LIPV), and left superior PV (LSPV). The mean ostial diameters of patient with and without LVH were as follow: RSPV of 19.6 ± 2.78 vs 17.8 ± 1.93 ($p = 0.003$), RIPV of 18.4 ± 3.12 vs 16.0 ± 2.19 ($p < 0.001$), LSPV of 18.1 ± 2.62 vs 16.0 ± 2.16 ($p < 0.001$), and LIPV of 15.9 ± 1.93 vs 15.4 ± 1.85 mm ($p = 0.284$), respectively. (Table 2) More than 60 percent of subject demonstrated oblong ostial morphology and the rests were circular.

Table 2. Ostial Diameter

Pulmonary Veins	LVH (mm)	Non-LVH (mm)	p value
Right Superior	19.6 ± 2.78	17.8 ± 1.93	0.003
Right Inferior	18.4 ± 3.12	16.0 ± 2.18	< 0.001
Left Superior	18.1 ± 2.62	16.0 ± 2.16	< 0.001
Left Inferior	15.9 ± 1.93	15.4 ± 1.84	0.284

The largest PV ostial diameter measured from axial plane (in millimeter). LVH = left ventricle hypertrophy, p value < 0.05 was considered statistically significant.

DISCUSSION

This study demonstrated that patients with LVH are having larger PVs diameter compare to that without LVH. The increase of PVs diameter has been occurred even the cardiac rhythm still normal sinus rhythm.

Currently, either PV angiography, CT scan or magnetic resonance imaging (MRI) have been used to demonstrate the anatomy of LA and PVs. Using MRI, Kato et al⁹ showed that the PV ostia were more oblong than circular which give us reason to choose the largest diameter measurement in this study. The dilation of PVs in AF patients have been reported⁵ but its mechanisms is unclear. Herweg et al¹⁰ found that AF patients with hypertension and/or LVH had greater PVs diameter compare to that without hypertension and/or LVH. Our finding showed that the PVs dilation already happen in sinus rhythm patient with LVH. This new discovery gives away the possibility mechanism of AF in hypertensive patients. Since the prevalence of diastolic dysfunction is found approximately in 75 – 85% of mild to moderate hypertension and reached of 90% in LVH patients,¹¹

our finding supports the mechanism of diastolic dysfunction as the cause of PVs dilation.

Ostial PVs – LA junction areas demonstrate special histological structure. Nathan et al¹² are first to describe the presence of muscular sleeves continuing from LA into the PV with a mean extent of 13 mm. The longest sleeves were over the superior vein, and it was correlated with the relative distribution of PV ectopy described by Haissaguerre.¹ The meshlike arrangement of myocytes bundle in the sleeves appeared to be relevant to the role of the PVs in the initiation of AF.⁹ Compare to the control, patients with prior history of AF demonstrated shorter effective and functional refractory periods (ERP and FRP). Interestingly, the LA ERP of both patients group were similar, hence there was ERP gradient between LA and PV which was shorter in PVs of AF patients but longer in PVs of control patients.¹³ The consistent finding of PVs dilation in AF along with its electrophysiological changes seem to be an interdependency process which have important role in AF occurrence. Mechano-electrical feedback due to stretch might impacts on the triggering substrate and on the atrial myocardial remodeling processes leading to perpetuation of AF. In animal models, acutely elevated atrial pressure increases the rate and organization of wavelets emanating from the PVs.¹¹

The interesting results of our finding that the mean diameter of all PVs in Indonesian population are larger compare to that of western people¹⁴ (RIPV of 17.2 ± 2.93 vs 15.7 ± 2.8 mm, RSPV 18.7 ± 2.54 vs 16.3 ± 3.8 mm, LIPV of 15.6 ± 1.89 vs 15.8 ± 1.3 mm and LSPV of 17.1 ± 2.61 vs 14.8 ± 3.5 mm for Indonesia and western people respectively). It is of important value in electrophysiological field, especially in era of PV isolation for AF management. This basic information will guide the electrophysiologist or physician in choosing or designing appropriate electrode catheter for PV isolation. Unfortunately we couldn't perform statistical analysis to determine the significance of differences between those data.

The superior PVs diameter showed more significant enlargement compare to that of inferior PVs. These finding were relevant to the previous study. Tsao et al⁵ measured the PVs diameter of AF patients by mean of MRI and found that the superior PVs to be larger when this was corrected for concomitant increase in LA size. The more complex myocardial sleeves arrangement in superior PV has been thought

to be important for initiation and maintenance of AF. The mechanism of relation between complex myocardial arrangements of superior PVs and its larger diameter are unclear, but seminal work of Haissaguerre showed that the superior PVs are predominantly arrhythmogenic.¹ Furthermore Yamane et al⁶ reported that diameters of arrhythmogenic PVs were significantly larger than those of nonarrhythmogenic.

Limitation: Lack of medication matching between LVH and non-LVH group in current study might have influence to diastolic dysfunction. ACE inhibitor and CCB have been proven to regress LVH. The regression of LVH by ARB results in improvement of LA dimension and function¹⁵ which in turn might be influence the PVs diameter.

CONCLUSION

PVs diameter enlarge in LVH patient with sinus rhythm. This finding might be one explanation of high prevalence rate of AF in hypertensive patients.

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