ANALYSIS OF PULMONARY VENOUS FLOW VELOCITY PATTERNS IN HYPERTENSIVE HEARTS: ITS COMPLEMENTARY VALUE IN INTERPRETATION OF MITRAL FLOW VELOCITY PATTERNS

A Thesis

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Presented By:

Ayman Anwar Ahmed;
M.B., B.Ch.

Under Supervision of :

Prof. Dr.
Mohamed Awad Taher M.D.
Professor of Cardiology
Faculty of Medicine, Ain Shams University.

Dr.
Sameh Mohamed Shaheen M.D.
Lecturer of Cardiology
Faculty of Medicine, Ain Shams University.

Dr. Hanaa El Said M.D.
Fellow of Cardiology
National Heart Institute

Faculty of Medicine
Ain Shams University
1994

بسم الله الرحمن الرحيم

قُلْ هَلْ يَسْتَوِي الَّذِينَ يَعْلَمُونَ وَالَّذِينَ لَا يَعْلَمُونَ

إِنَّمَا يَتَذَكَّرُ أُولُوا الْأَلْبَابِ

صدق الله العظيم

الزُمَر - آية ٩

بسم الله الرحمن الرحيم

This work
is dedicated to

My Father, My Mother, My Wife
& My Son Assem

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INTRODUCTION AND AIM OF THE WORK

INTRODUCTION

The importance of assessing left ventricular diastolic function in individual patients has been implied in a number of clinical studies *(Masuyama et al., 1992)*.

Mild diastolic dysfunction may be frequently observed in advance to systolic dysfunction in some cardiac disorders. Severe diastolic dysfunction may cause pulmonary congestion even without any deterioration of systolic function *(Masuyama et al., 1992)*.

Previous non-invasive evaluation of hypertensive subjects has shown that left ventricular diastolic abnormalities may precede systolic dysfunction *(Phillips et al., 1987)*.

Early detection and prevention of cardiac dysfunction is an important goal in the management of hypertensive patients *(Phillips et al., 1987)*.

Transmitral flow velocity patterns recorded by pulsed Doppler echocardiography correlated well with measurement of diastolic left ventricular filling *(Castello et al., 1988)*.

Recently, it has been shown in several groups of hypertensive patients that the characteristic abnormal mitral flow velocity patterns can be normalized in association with concomitant congestive heart failure *(Masuyama et al., 1992)*.

The normal pulmonary venous flow has two phases that reflect changes in left atrial pressure *(Keren et al., 1988)*.

Although the value of the analysis of the pulmonary venous flow velocity pattern has been implied in recent studies; the pulmonary venous flow velocity pattern has not been studied in hypertensive patients.

So this study will clarify whether the pulmonary venous flow velocity pattern can provide a complementary information for understanding cardiac function in hypertensive patients.

AIM OF THE WORK

This study aims at characterizing the pulmonary venous velocity patterns in hypertensive patients with and without congestive heart failure and to study whether analysis of the pulmonary venous flow velocity pattern provides some complementary information for understanding cardiac function in hypertensive patients.

Part I, Review of Literature

DIASTOLIC FUNCTION OF THE HEART

The importance of left ventricular systolic performance has traditionally been emphasized in cardiac evaluation, whereas, left ventricular diastolic performance has only recently received attention.

Many recent studies have re-emphasized the importance of left ventricular diastolic dysfunction in the production of signs and symptoms of cardiac disease *(Anthony et al., 1987)*.

As many as a third of patients who have congestive heart failure have normal systolic function and thus are thought to have symptoms attributable to abnormal diastolic function *(Rick et al., 1989)*.

Investigators have demonstrated that in most disease states, diastolic dysfunction precedes the onset of systolic dysfunction *(Rick et al., 1989)*.

Abnormal left ventricular diastolic performance has been observed in patients with cardiac hypertrophy and coronary artery disease even in the absence of impaired systolic function *(Anthony et al., 1987).*

An over-expanding and confusing array of measures of diastolic function has been derived from invasive and, more recently, non-invasive tests. These indices quantitate aspects of the rate of left ventricular relaxation, the passive properties of the left ventricle and the pattern of left ventricular filling *(William et al., 1990).*

It is clear that cardiac output is directly related to ventricular filling and the latter is strongly influenced by ventricular diastolic properties. Transmitral flow pattern, therefore, should provide information on the diastolic state of the ventricle and the myocardium *(Edward et al., 1990).*

Digitized M-mode echocardiography, radionuclide angiography and Doppler echocardiography have all been used to evaluate normal left ventricular diastolic filling and to detect abnormalities in a wide range of heart disease *(Richard et al., 1989).*

Definition of Diastole:

The term diastole originated from the Greek word that means a drawing asunder or expansion of the heart. The clinical definition of diastole is the time period beginning at the end of ejection and extending until closure of atrioventricular valve *(Rick., 1989).*

Phases of Diastole:

1. *Isovolumic relaxation:*

Left ventricular ejection terminates with closure of aortic valve; from the time of aortic valve closure until mitral valve opening, the left ventricle is a closed chamber with no alteration in volume. Myocardial relaxation continues causing a steep exponential fall in intra-ventricular pressure {fig 1}.

When left ventricular pressure decreases below that of left atrium, the mitral valve opens and rapid filling of the ventricle begins. Although no filling of the ventricle during isovolumic relaxation the rate of decline of pressure may influence ventricular filling following mitral valve opening *(Brutsaert et al., 1984).*

2. *Rapid filling phase:*

When left ventricular pressure falls below that of left atrium, the mitral valve opens {fig 1}. Left ventricular pressure continues to fall due to myocardial relaxation and elastic recoil. This results in the development of pressure gradient between the left atrium and left ventricle. The magnitude of this pressure gradient in early diastole is determined primarily by the level of left atrial pressure at the time of mitral valve opening and rate of decline of left ventricular pressure *(Ishida et al., 1986; Cheng et al., 1987; Choong et al., 1988).*

Left ventricular volume increases rapidly with 60% to 80% of its stroke volume entering during the first third of diastole. Much of this increase in left ventricular filling occurs while its pressure continues to decline demonstrating that left ventricular relaxation and recoil continues after mitral valve opening *(Cheng et al., 1987; Courtois et al., 1988).*

Early filling ends when atrioventricular pressure gradient equalizes. This occurs when the left ventricular relaxation is almost complete and the blood flow from the left atrium had filled the left ventricle *(Nikolic et al., 1988; Keren et al., 1986).*

3. *Diastasis:*

Rapid filling ends after approximately one third of diastole {fig 1}. The left ventricular filling is slow during the midportion of diastole. Only the blood returning from the lungs flows through the