INFLUENCE OF AGING ON DOPPLER ECHOCARDIOGRAPHIC INDICES OF LEFT VENTRICULAR DIASTOLIC FUNCTION

Thesis

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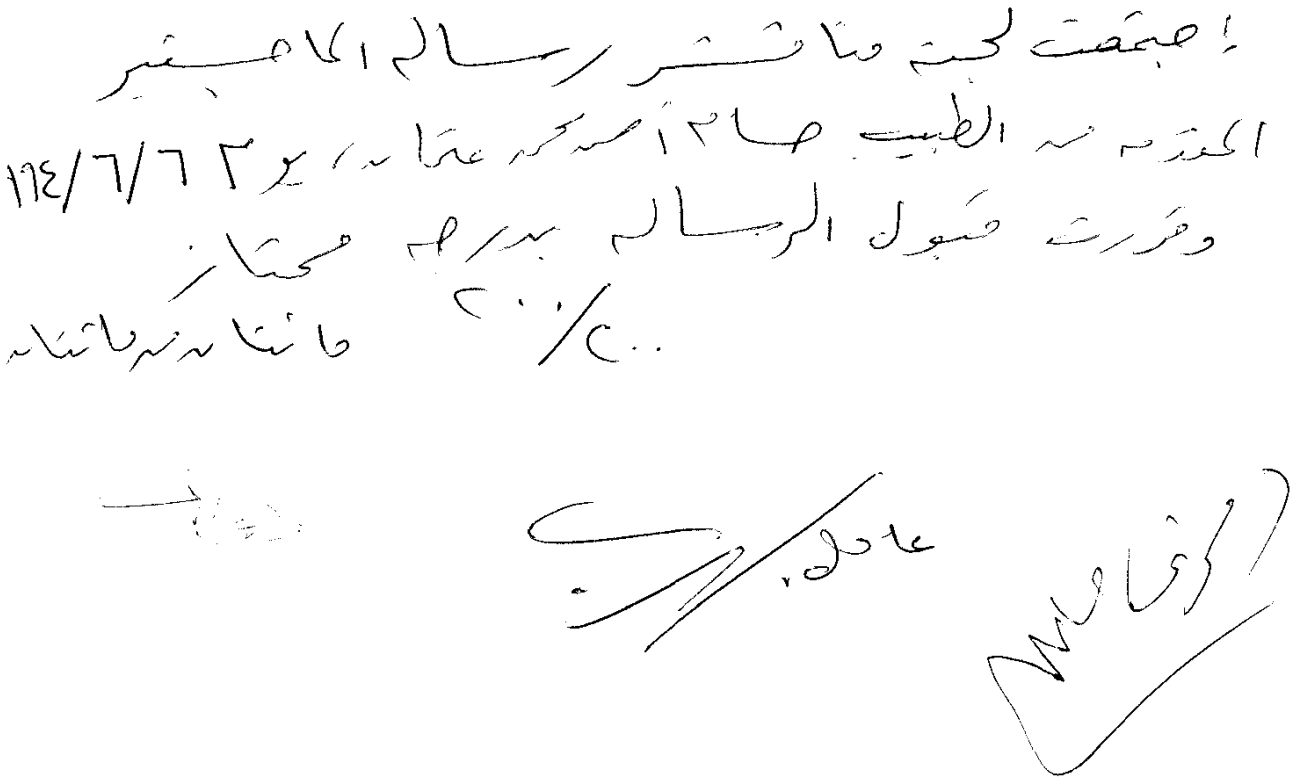
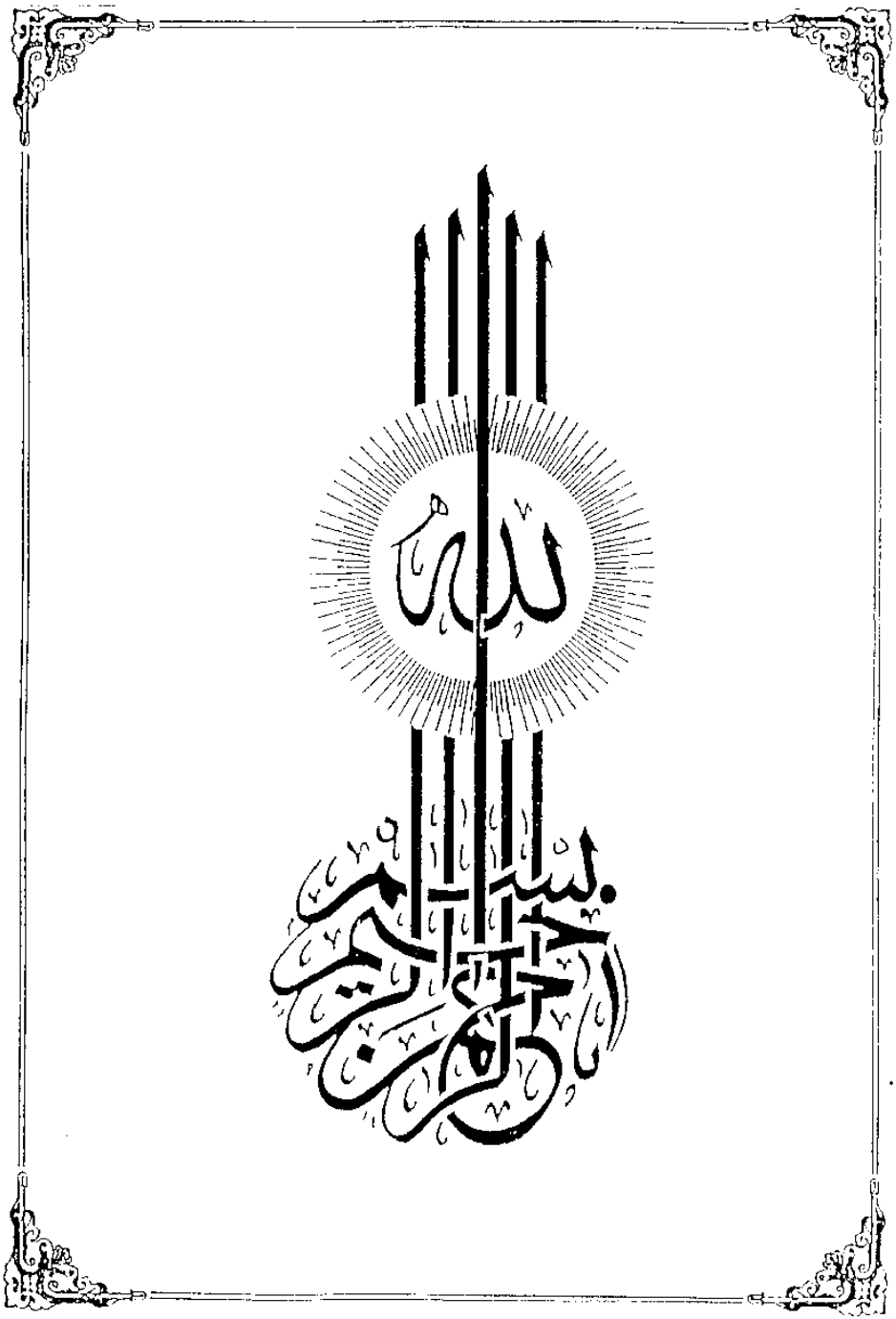


بسم الله الرحمن الرحيم

" وما أوتيتم من العلم إلا قليلا "

صدق الله العظيم



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CONTENTS

INTRODUCTION

Introduction

Recently, Doppler echocardiograghy has been used to assess left ventricular diastolic function in patients with various cardiac diseases and in normal subjects (Miyatake K, et al., 1984, Fujii J, et al., 1985, Sinder RA, et al., 1985, Rokey R, et al., 1985, spirito P, et al., 1986, Takenaka K, et al., 1989, Gardin JM, et al., 1986, Spirito P, et al., 1986, Louie EK, et al., 1986, Fridman BJ, et al., 1986) .

Indices of diastolic function obtained by Doppler echocardiography have also been shown to correlate well with those measured by either contrast angiography or radionuclide angiography (Spirito P , et al., 1986, Takenaka K, et al., 1986, Gardin JM, et al., 1986, Spirito P, et al., 1986, Louie EK, et al., 1986, Fridman BJ, et al., 1986) .

Some determinants of left ventricular filling assessed by Doppler, however, seem, to be affected by age (Gardin JM, et al., 1986, Spirito P, et al., 1986, Louie EK, et al., 1986, Fridman BJ, et al., 1986, Bryg RJ, et al., 1987) .

Such age related changes in left ventricular filling patterns may be important in defining normal values for Doppler indices of diastolic function.
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To achieve a better understanding of the effects of aging on Doppler indices of left ventricular diastolic performance, we obtained Doppler echocardiographic measurements in a group of healthy volunteers classified into two groups of younger and elderly persons .

AIM OF THE WORK

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The aim of this work is to assess the effect of aging on Doppler echocardiographic indices of left ventricular diastolic function .

REVIEW OF LITERATURE

Diastolic Function of the left Ventricle

Introduction :

Diastolic events have recieved much less attention than the corresponding ones of systole inspite of their theoretical and clinical significance.

Henderson was among the first to make quantative study of ventricular volume curves in isolated mammalian hearts. He described the filling phase as an early rapid filling period which was followed by a phase of slower volume increases which he termed diastasis . Later, authors emphasized the role of arterial contraction (Trail and Gibson, 1979) .

Wiggers provided the oldest division of early diastole now in common use . He divided the early phase (before the left ventricular) into protodiastole coincident with the duration of incisura on aortic pressure curve & isometric relaxation from the time of aortic closure to the onset of left ventricular filling . Later, the term isovolumic relaxation was introduced, the earlier term isometric relaxation being rejected by Rushmer because of his observation of changes in the left ventricular shape although cavity volume remained constant (Trail & Gibson 1979) .

Sequential phases of left ventricular diastole may be described as protodiastole, isovolumic relaxation & left ventricular filling phases .

Sequential Phases of Left Ventricular Diastole :

1- Protodiastole :

Protodiastole is the time required for the reversal of flow in the aorta & for closure of the aortic valve & is responsible for the incisura on the aortic pressure trace . Its duration is about 0.04 sec (Oram, 1981) .

2-Isovolumic relaxation Phase :

Isovolumic relaxation is the period between aortic valve clousre & the onset of mitral valve opening .

It is the time taken by the ventricular pressure to drop from diastolic

pressure to that of the left atrium .

It lasts for about 0.07 sec (Oram. 1981) .

3- Left Ventricular Filling :

Immediately after mitral valve opening there is a period of rapid filling lasting up to 200 m sec when approximately 70% of the stroke volume enters the ventricle .

In mid-diastole or diastasis, volume changes little & finally the remaining 30% enters during left atrial systole (Gibson, 1984) .

These three phases are apparent only at rest .

As heart rate increases, diastasis becomes shorter & rapid filling merges with atrial systole (Gibson, 1984) . (Fig 1) .

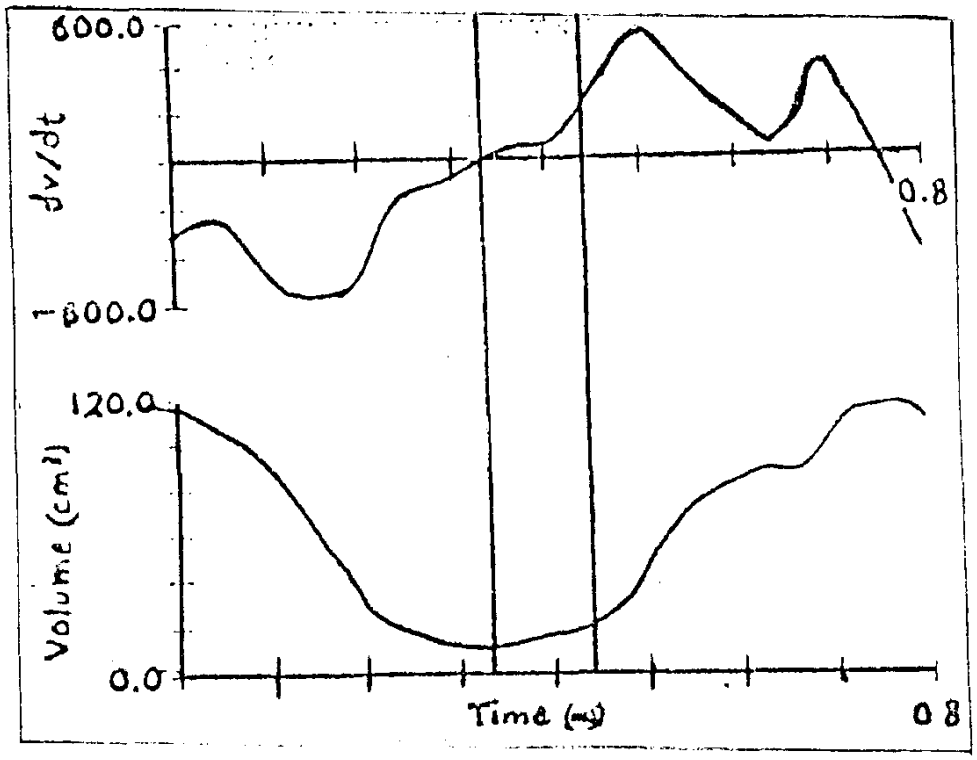

Fig. 1 Left ventricular volume and its rate of change from a normal subject . Note that during diastole, there is an early rapid increase, a mid-diastolic period when it remains virtually constant, and a farther late diastolic increase with atrial systole . The vertical lines represent the timing of aortic valve closure and mitral valve opening .[From Gibson DG , Oxford Textbook of Medicine1984., chapter 13]

Mechanism of Left Ventricular Filling :

There has been some 60 years of controversy between those who believed relaxation & filling to be purely passive processes determined by the venous pressure & those who considered that diastolic filling was governed at least in part by an active process originating in the myocardium .

The mechanism underlying rapid filling can be defined more clearly when simultaneous left ventricular pressure changes are considered. Diastolic pressure falls rapidly once the aortic valve closes & continues to do so for 50-100 ms after the mitral valve opens .

During diastasis, left ventricular pressure & volume both remain virtually constant & in normal subjects, pressure may increase by up to 5mm Hg during atrial systole . When these interrelations between diastolic pressure & volume are considered, it is clear that ventricular filling can not be considered in the same terms as that of a passive elastic structure since at the time of peak filling ventricular pressure is falling rather than rising (Gibson, 1984) . Ideas as to the nature of this process varied, the possibilities including elastic recoil, active lengthening of muscular elements, distension from coronary filling & forces derived from energy stored during systole (Traile & Gibson, 1979) .

However, it seems likely that the ventricle is deformed at end-systole with energy stored in its walls as elastic forces.

With the onset of relaxation it shows a striking tendency to return to its end-diastolic shape .

The complex fiber architecture of the left ventricle would seem idealy adapted to supporting restoring forces of this sort, So that normal early diastolic filling is likely to depend on the integrity of fiber structure (Gibson, 1984) .

Also, it is now well established that myocardial relaxation is an active energy requiring process . At the cellular level, calcium must move away from the myofilament for relaxation to occur . ATP is hydrolyzed to fuel active transport of calcium ions from the myofilaments to the sarcoplasmic reticulum where it is sequestered .

Langer has estimated that 15 percent of the heart's total energy output is accounted in the active process of relaxation (Danford et al., 1986) .

Diastolic Properties of Left Ventricle

Certain mechanical properties & relations are used to describe the diastolic properties of the left ventricle .

stress : is the force per unit - cross - sectional area (gm/cm 2) .

Strain : is the fractional change in dimension that result from the application of stress .

Volume (chamber) stiffness & pressure - volume relation :

The diastolic properties of a ventricle are defined by its curvilinear pressure - volume relation . The slope of tangent (dp/dv) to this curvilinear relation defines the operative volume stiffness at each level of filling pressure . An increase in volume stiffness (dp/dv) secondary to an increase in filling pressure is diagramatically shown in (Fig. 2) . The relation between volume stiffness (dp/dv) & pressure may be expressed in a linear relation . The slope of which is the modulus of chamber (volume) stiffness

(kp) . Thus, volume stiffness may change by virtue of a change in the filling pressure, or through a shift to a different pressure volume curve .

In the latter instance, a leftward shift of the curve increase in (kp) results in an increase in volume stiffness if the comparison is made at equal levels of the filling pressure (Fig. 2) (Gaasch et al., 1976; Braunwald, 1985) .

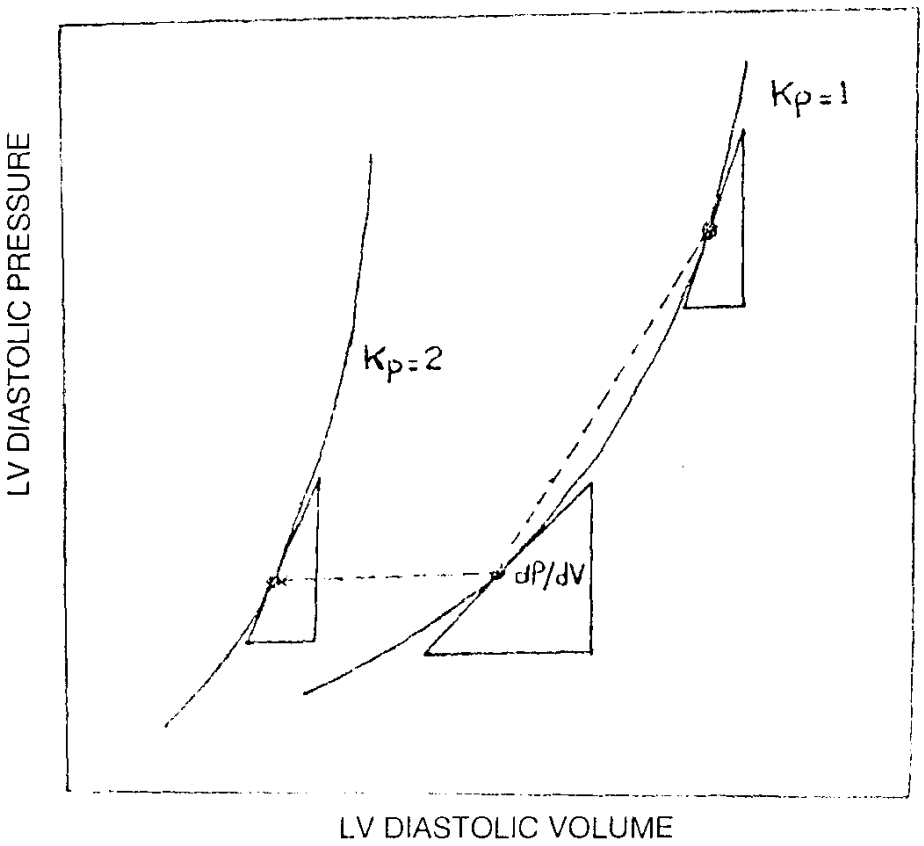

Fig. 2 Diagramatic representation of left ventricular (LV) diastolic pressure-volume relation .

Right, there is an increase in operative volume stiffness (dp/dv) in the absence of any change in the modulus of chamber stiffness (kp) .

Left, there is an increase in the volume stiffness as a result of an increase in the modulus of chamber stiffness (relative to the curve in the right) .Because operative volume stiffness depends on the modulus of chamber stiffness and the level of operative filling pressure, this volume stiffness comparison was made at equivalent levels of pressure [From Gaash WH, Am J Cardiol 1976 ., 38 : 645] .