# The effect of Mean Period and Ejection Time in patients with Hypertension

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***Abstract***
*The study included 60 hypertensive patients and 40 control subjects referred to the echocardiography unit at AL-Yarmok Teaching Hospital / Baghdad. Statistical Analysis of Period Time and Ejected Time was obtained in the controls group and patients group. The statistical analyses were carried out by the using Excel program. All values were expressed as mean values with percentage change for every parameter for control and patients groups. The mean for the older age group is higher for both controls and patients than the younger age group with steeper rising mean in controls than in patients indicating the rate of change in period time and eject time.*

**Keywords:** Ejection Time, Period Time, Ultrasound, Echocardiography.

## Introduction

Ultrasound or sound waves are mechanical, longitudinal, pressure wave and require medium for its transmission (gas or liquid or solid). Human ears respond to sound in the frequency range of about 20 to 20000 Hz, although many animals can produce and hear sounds of higher frequencies. Medical engineers developed techniques for using ultrasound for diagnosis. Basically, an ultrasound source sends a beam of pulses of 1 to 5 MHz sound into the body. The time required for the sound pulses to be reflected gives information on the distances to the various structures or organs in the path of the ultrasound beam.[1] The specular ultrasound echoes used for imaging the heart are derived from relatively extensive tissue interfaces.

When the ultrasound beam encounters much smaller structures, it interacts with them in a completely different way and instead of being reflected along a defined path, it is scattered equally in all directions just as the circular ripples are formed when a small stone is thrown into a pond. The consequence is that most of the incident energy is dissipated, but a small amount returns along the incident path and can be detected, though the resulting signals are much weaker than the specular image echoes. Red blood cells are ideal scatterers; although the echo from a single cell is negligible, signals from millions of them added together can be detected and, if the blood is moving, the frequency of the backscattered echoes is modified by the Doppler effect.

Ejection time is the time taken to eject the blood from the ventricle, so here if you decrease the preload, you decrease the volume in the ventricle, so less amount of blood is easily ejected faster and so less is ejection time.

Doppler effect was first described in 1843 by Christian Doppler, an Austrian mathematician and scientist. He studied the light spectra of double stars and hypothesized that the shifts he observed in the hydrogen spectral lines arose from rotation of the stars about each other. If a star is moving toward the earth, the spectral lines are shifted toward blue and if its distance is increasing, the shift is toward red. Doppler’s theory was confirmed by Buys Ballot in a classical experiment with two trumpeters, one on a moving train and the other on the station. Both played the same note, but observers heard the pitch of the note from the passing train change as it first approached and then receded.

As the wave source moves toward the observer, the waves are compressed, decreasing the wavelength and increasing the pitch and as the source moves away from the observer, the apparent wavelength increases and pitch lowers.[2,3] Thus, if an ultrasound beam encounters a stream of moving blood, returning backscattered echoes have a slightly different frequency from that of the transmitted beam, the difference being known as the Doppler shift or Doppler frequency. The Doppler equation (Fig. 1) shows how this can be used to calculate the blood flow velocity. For a velocity of 1 $m.s^{-1}$ and ultrasound frequency 2.5 MHz, the Doppler shift is about 3.3 kHz, only 0.1%, but readily detected and directly proportional to the blood velocity.

Application of the Doppler equation requires that that the angle between the beam axis and blood flow direction either must be known or must be so small that its cosine is effectively unity [2, 3]. Also, the Doppler shift for a given blood velocity is related to the ultrasound frequency, so is twice as large for the same blood velocity at 5 MHz as for 2.5 MHz.[2]

Cacciapuoti et al[4], have shown that systolic and diastolic functions are impaired in patients with hypertensive heart disease. Their method included many of normotensive healthy controls (group I) and many of hypertensive (group II). Hypertensive patients were divided into two sub-groups according to echocardiographic signs of left ventricular hypertrophy (LVH). Result has shown an increased IMP derived from the rise of isovolumetric relaxation time (IVRT) in hypertensive without LVH whereas isovolumetric contraction time (IVCT) and myocardial systolic Motion (SM) were unchanged. Doppler echocardiography appears able to distinguish the different forms and degrees of LV dysfunction in systemic hypertension in relation to the different phases of the hypertensive disease process. [5]

M-mode, two-dimensional (2-D) and Doppler echocardiography examinations were obtained by using a commercial instrument with 2-5 MHz transduce. The system is capable to carry out a variety of applications so that it is optimized for use in a variety of ultrasound departments including general abdomen, vascular, cardiac, breast and so forth. [6]

## Methods

The study included 60 hypertensive patients and 40 control subjects referred to the echocardiography unit at AL-Yarmok Teaching Hospital / Baghdad. Patients with hypertension were having an average BP ≥ 140/90 mmHg. The study was carried out as follows:

The population of study was divided into three groups. The first main group represents controls group including 40 normal, 22 males and 18 females. Then, the same group was divided according to age into three groups where:

The first group includes 18 normal individuals (18 to 45 years). The second group includes 12 normal individuals (46 to 70 years). The third group includes 10 normal individuals (71 to 85 years). The second main group represents patients with hypertension (HT) including 60 patients, 25 males and 35 females, also divided into three groups:

The first group includes 28 patient individuals (18 to 45 years). The second group includes 48 patient individuals (46 to 70 years). The third group includes 29 patient individuals (71 to 85 years). Before considering patient for study we have excluded all other diseases apart from hypertension. Patients were subjected to a series examination. The height and weight were measured for both patients and normal subjects. The history of HT was recorded to help the cardiologist for better evaluation of echocardiographic diagnosis. Statistical analysis of Period Time and Ejected Time was obtained in the controls group and patients group. The statistical analyses were carried out by using Excel program. All values were expressed as mean values with percentage changing for every parameter for control and patients groups were calculated.

## Results and Discussion

Because the myocardial stiffness and the stiffness index are influenced by aging, divided the study population into three categories; each category involves one age group. The first category is for age group ranging from 18-45 years, the second is for age range 46-70 years and the third is for age range 71-85 years.

**The effect of Mean Period Time (ms) on healthy and patients:** For the ages range (18-45 years), the difference in period Time (ms) between patients and controls was clear where increasing in period time for patients comparing with control. Figures 2, 3 and 4 show the relationship between control and patients with hypertension.

**The effect of Mean Ejection Time (ms) on health and patients:** For the ages range 18-45 years, the difference in Ejection Time (ms) between patients and controls was clear, where increasing in ejection time for patients comparing with control. Figures5,6 and 7 show the relationship between control and patients with hypertension.

For the age range (18-45 years), the difference in Mean Period Time (ms) between patients and controls was 17.64%, while change percent in Mean Ejection Time was 13.82%, consequently. The difference in Mean Period Time between patients and controls was 17.34% in the age range (46-70 years), while change percent in Mean Ejection Time is 14.23%. The difference in Mean Period Time between patients and controls is 16.31 % while change percent in Mean Ejection Time are 16.18 %, as illustrated in table 1.

In this study, the effect of hypertension is studied on the cardiac muscle by assessing the myocardial stiffness through the use of tissue Doppler by the measurement of the change in the annular velocity in relation with the myocardium performance and the mechanical movement together with the geometrical changes. A change in myocardial stiffness can happen due to many reasons; it can be induced by some types of diseases such as diabetes, ischemia or hypertension. Myocardial stiffness is related to fibrosis caused by increased collagen content in the muscle, which, in turn, increases stiffness.[7-10]

The results show that higher increase in the percentage of period time and eject time for HT patient over control for the older age group (18.75%) was compared with 26.67% for the young group, as shown in figures. This is because that in the older age group the myocardium within certain extent is stiffened already with age, without the pressure overload, so the increase in the stiffness caused by hypertension over the age stiffness will possibly be less effective on the cardiac performance than what one can observe for the younger group, as the myocardium of the later is still intact and flexible so an increase in the overload will appear more significant. Similar results were reported previously by[11].

The mean for the older age group is higher for both controls and patients than the younger age group with steeper rising mean in controls than in patients indicating the rate of change in period time and eject time[8]. The gap seen in figures between the three graphs patients and controls probably indicates that the muscle mass may have started to increase before the start of the muscle stiffness and the descending graphs for patients and controls also for both age groups are possibly caused by longer overload which may indicate a beginning of the muscle (eccentric hypertrophy).

This can happen secondary to a predominant increase in the wall thickness with normal chamber sizes as is seen in the pressure overload of systemic hypertension [6,7]. These results are in agreement with the previous study of Mahdi[12].

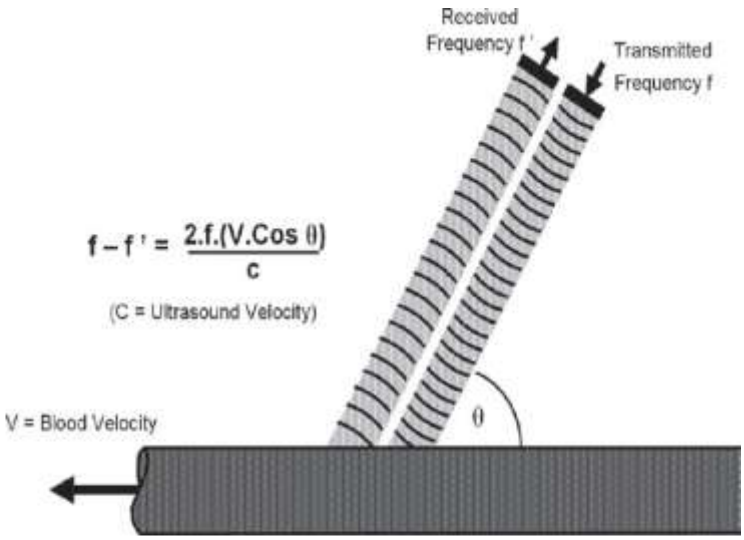


**Figure 1: The Doppler equation, relating flow velocity to the ultrasound "Doppler Shift"[2]**

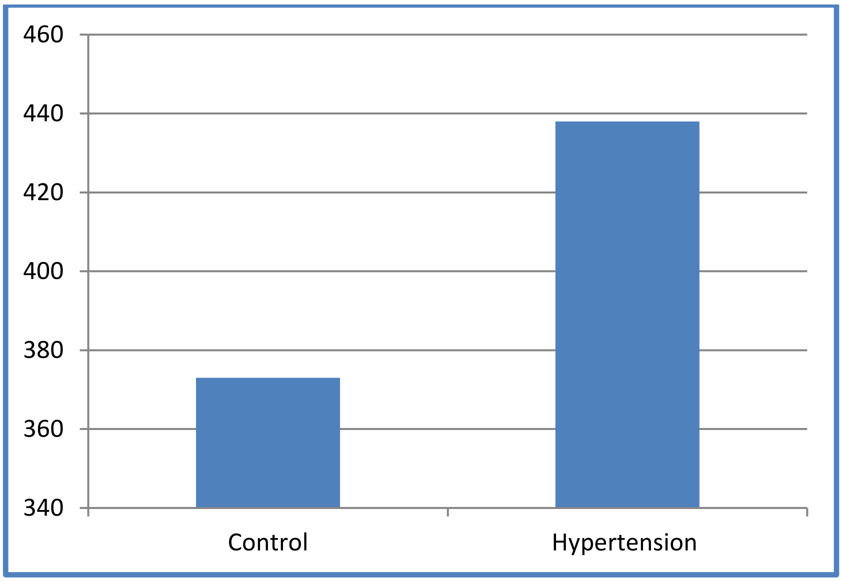


**Figure 2: comparing between control and hypertension for Mean Period Time of ages range (18-45 years).**

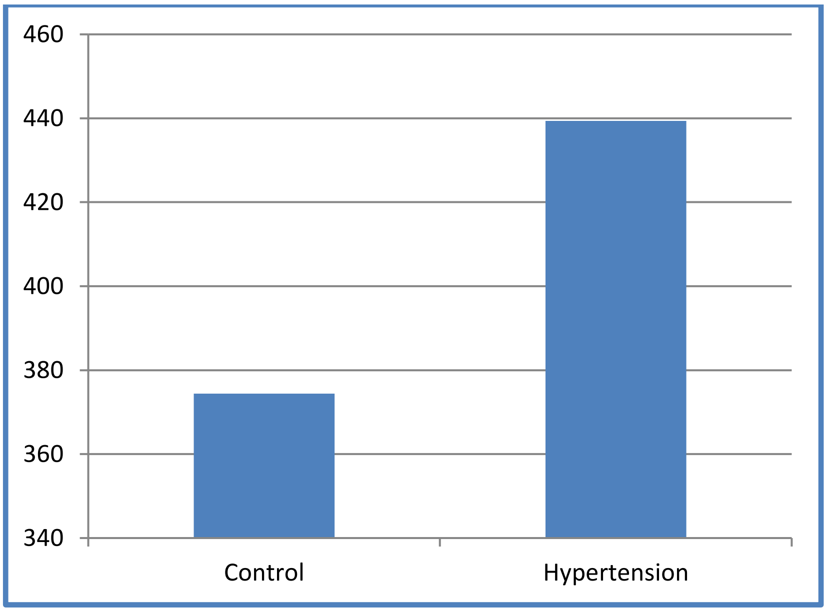


**Figure 3: comparing between control and hypertension for Mean Period Time of ages range (46-70 years)**

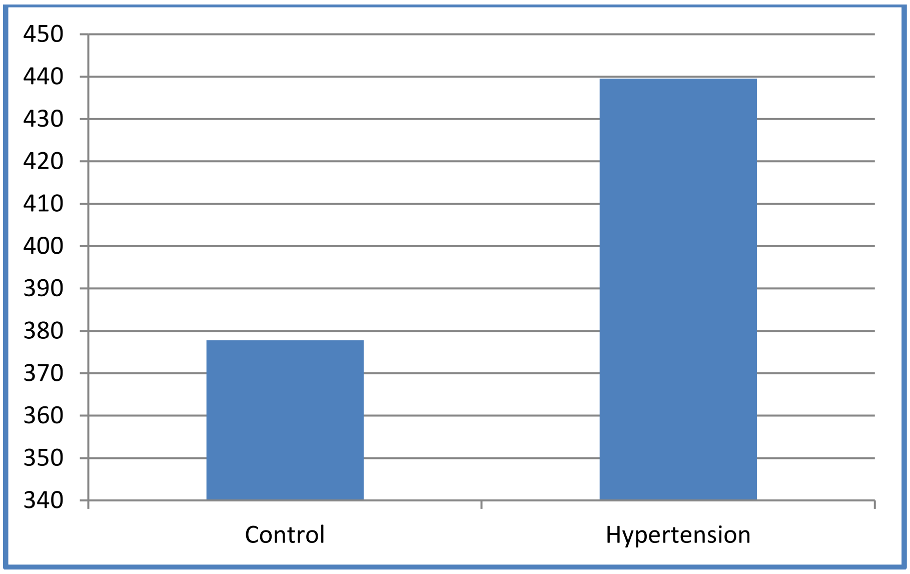


**Figure 4: comparing between control and hypertension for Mean Period Time of ages range (71-85 years)**

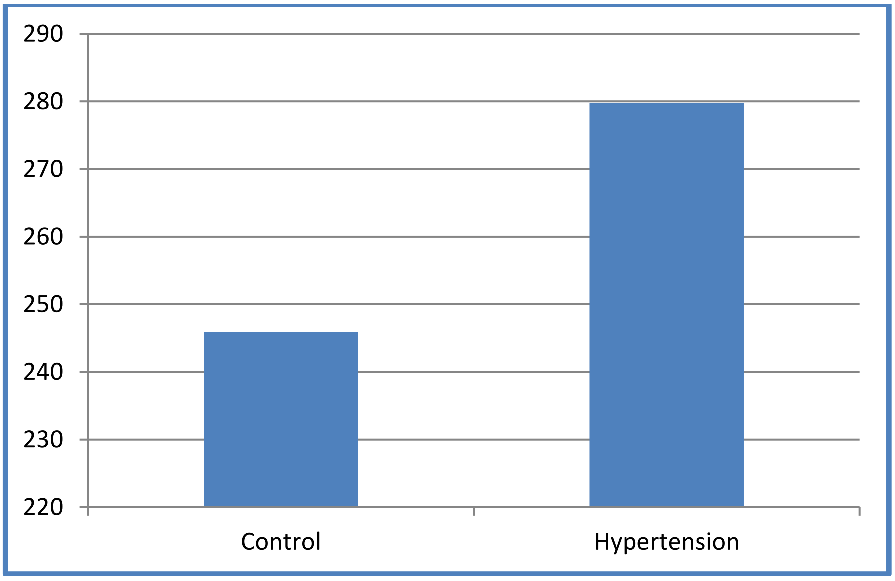


**Figure 5: comparing between control and hypertension for Mean Ejection Time of ages range (18-45 years)**

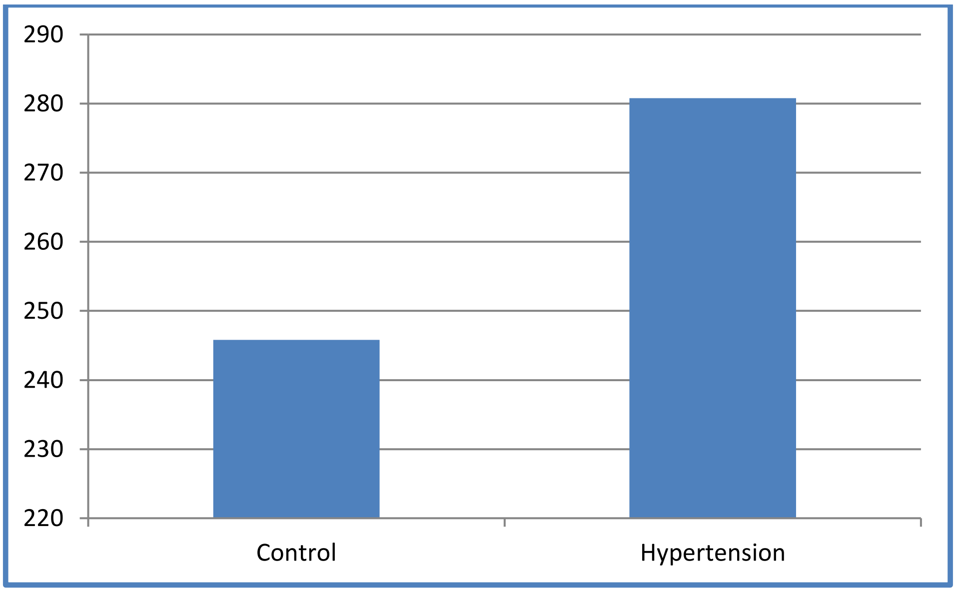


**Figure 6: comparing between control and hypertension for Mean Ejection Time of ages range (46-70 years)**

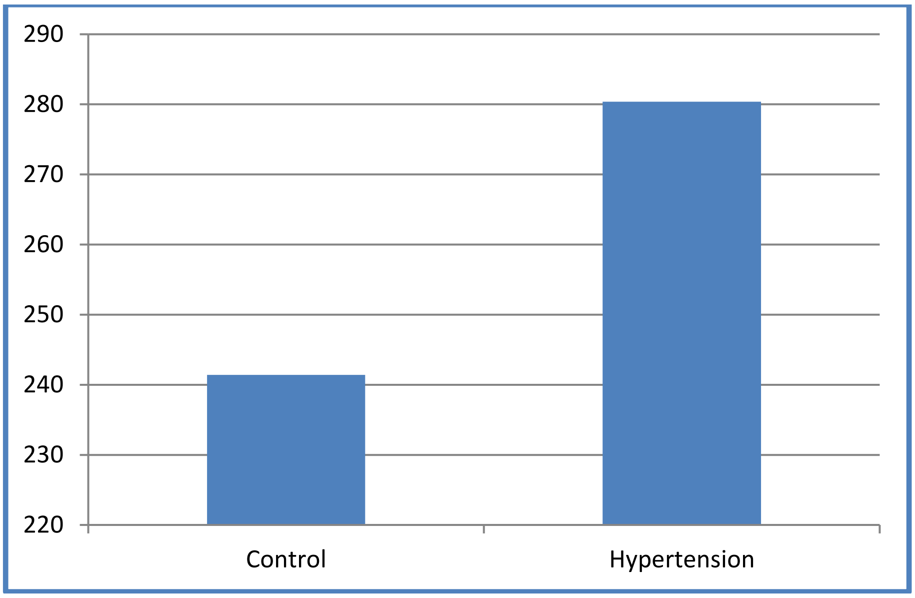


**Figure 7: comparing between control and hypertension for Mean Ejection Time of ages range (71-85 years)**

**Table 1**
**Doppler echocardiography showing Different % for Mean Period Time & Mean Ejection Time**

| Parameter | control | HT | Different % |
|---|---|---|---|
| | Mean ± SD | Mean ± SD | |
| **Ages range (18 - 45 years)** | | | |
| **Period Time (ms)** | 373 ± 26.93 | 438.79 ± 47.86 | 17.64 |
| **Ejection time (ms)** | 245.95 ± 36.85 | 279.93 ± 59.34 | 13.82 |
| **Ages range (46 - 70 years)** | | | |
| **Period Time (ms)** | 374.39 ± 26.70 | 439.32 ± 48.09 | 17.34 |
| **Ejection time (ms)** | 245.93 ± 37.44 | 280.92 ± 59.18 | 14.23 |
| **Ages range (71 - 85 years)** | | | |
| **Period Time (ms)** | 377.89 ± 21.92 | 439.53 ± 48.20 | 16.31 |
| **Ejection time (ms)** | 241.42 ± 37.83 | 280.48 ± 59.12 | 16.18 |

## Conclusion

Ultrasound or sound waves are mechanical, longitudinal, pressure wave and require medium for its transmission (gas or liquid or solid). Echocardiography system was used in this work, M-mode, two-dimensional (2-D) and Doppler echocardiography examinations were obtained by using a commercial instrument with 2-5 MHz transduce. The results show higher increase in the percentage of period time and eject time for HT patient over control for the older age group (18.75%) compared with (26.67%) for the young group. The gap seen in figures between the three graphs patients and controls probably indicates that the muscle mass may have started to increase before the start of the muscle stiffness and the descending graphs for patients and controls also for both age groups.

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