



Association between Aortic Heart Sound and Blood Pressure

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ABSTRACT

Blood pressure is an important hemodynamic indicator of heart function. It is measured using sphygmomanometer and stethoscope. The objective of this study was to correlate the aortic heart sound and blood pressure. We performed a randomized research study on the relationship between heart sound and blood pressure by recruited 200 respondents among general public in Ipoh. The systolic and diastolic blood pressure was measured using sphygmomanometer whereas the first and second heart sound were recorded by placing diaphragm part of Electronic stethoscope onto samples chest at the aortic area. All of the measurements were measured in sitting position and analysed by using SPSS version 16. There were association between the blood pressure and aortic heart sound as the p-value for systolic and diastolic blood pressure with aortic heart sound is 0.000 ($p < 0.005$) and 0.001 respectively ($p < 0.005$). The four classifications of systolic and diastolic blood pressure; low, normal, high normal and hypertension was relatively significant in relation to the three groups of systole and diastole frequency of aortic heart sounds; low, normal and high with p-value of 0.000 and 0.001 respectively. There were close association between blood pressure and aortic heart sounds. Nevertheless, there were several factors that should be considered which may affect the blood pressure changes which eventually affect the heart sounds. Various factors may affect the blood pressure readings.

Keywords: Aortic heart sound, hypertension, heart function, and systolic blood pressure.

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INTRODUCTION

The physiological control of arterial blood pressure is explained as it is principally controlled by the heart activity, cardiac rate, cardiac output, blood volume circulation and mainly by the peripheral vascular resistance which includes the elasticity of the blood vessels and the vasomotor tone which are essentially labile and variable [1]. Blood vessels itself plays an important role in controlling the hemodynamic of the blood pressure. Its structure is made up of endothelium which is a metabolically active organ system that maintains vascular homeostasis. Heart valve closure is the result from dynamic events between interaction of the heart valve and the different pressure of the heart [2, 3]. Closure of mitral and tricuspid valve is triggered by contraction of left and right ventricle meanwhile extension triggers the closure the pulmonary and aortic valve [4]. Several studies have been done before by calculating several systolic time interval, left ventricular ejection time, and pre ejection time [5]. Other than that, acoustic sound of first and second heart sound vibration received on chest wall are also used. Traditionally, in the clinical practice, blood pressures have been measured using manual mercury sphygmomanometer. However, with advance of technology the use of automated blood pressure machines has been introduced in the clinical settings and it had been a trend in most hospitals. The use of automated blood pressure machines is said to be more convenient and time saving in handling a large number of patients in the hospital. Despite of saving more time, the blood pressure results based on the automated blood pressure machine seems to be less accurate and reliable [6, 7]. Based on the issues, we came up with the idea of, determining the relationship between acoustic characteristic of heart sound and blood pressure. From this study, we expected to found positive findings on relationship of heart sound and blood pressure, which later may helped us to measure blood pressure based on the heart sound. This may eventually make it easier for the clinician to measure the blood pressure more accurately.

MATERIAL AND METHODS

In this study an observational study was done by recruited 200 respondents among general public in Ipoh randomly. A study was conducted involving 200 randomly chosen respondents among the general public in Ipoh. A set of questionnaires were distributed and answered by the respondents. Since the target group were among the general public, the exclusion criteria in this study were those who were not able to speak in Malay or English as there will be language barrier in answering the set of questionnaires as well as obtaining the data. The respondents were of various races, gender and age group. In relax and comfortable sitting position, systolic and diastolic BP was measured from each sample using a well calibrated sphygmomanometer (Accoson, UK). By using appropriate cuff, the sphygmomanometer was placed at the heart level of the samples before the BP readings were taken. The systolic and diastolic blood pressure readings were recorded in mmHg unit. An Electronic stethoscope model 3200 (Littman, Minnesota, US) was first connected to the laptop and sample details (i.e: initials, name, age and blood pressure readings) were recorded. In a sitting position, the diaphragm part of the stethoscope was placed onto sample's chest at the aortic area (specifically at the second intercostals space on the right side of the chest), where the first and the second heart sound was recorded. Statistical analysis was conducted using SPSS Version 16. Various ethical issues were considered in this research. First, the data collected from the subjects were kept anonymous and confidential to respect human dignity and privacy. Second, the letter of consent was given to each subject to let them know the aim and objectives of this research and their permission to be a volunteer in this research was acquired. Lastly, the inclusion criteria and exclusion criteria ensures a rigidly controlled study and the error variance are reduced.

RESULTS

The chi-square test was conducted to determine the relation between the categorical independent variables (age, gender, exercise and coffee intake, prevalence of skipping major meals, prevalence of snacking) and categorical dependent variables (aortic heart sound and blood pressure). The p-values using chi-square test found that there were association between the blood pressure and aortic heart sound as illustrated in Table 1. Both p-values recorded are less than 0.005, hence, they are relatively significant.

Table 1: Association between systolic and diastolic blood pressure with systolic and diastolic aortic heart sound.

| Systolic blood pressure with systolic frequency aortic heart sound | | | | Diastolic blood pressure with diastolic frequency of aortic heart sound | | | |
|--|---------------------|----|-------------|---|---------------------|----|-------------|
| Chi-Square Tests | | | | Chi-Square Tests | | | |
| | Value | df | Significant | | Value | df | Significant |
| Pearson Chi-Square | 70.331 ^a | 6 | .000 | Pearson Chi-Square | 22.768 ^a | 6 | .001 |
| Likelihood Ratio | 76.295 | 6 | .000 | Likelihood Ratio | 20.863 | 6 | .002 |
| N of Valid Cases | 200 | | | N of Valid Cases | 200 | | |

*df, degree of freedom; p ≤ 0.000

Based on the figure 1, it was shown that most of the respondent had a normal systole frequency of aortic heart sound for different class of blood pressure except for the optimal systolic blood pressure respondents in which majority of the respondent recorded a low systole frequency of aortic heart sound. Based on the figure 2, it was shown that most of the respondent has a normal diastole frequency of aortic heart sound for different class of blood pressure except for the hypertension diastolic blood pressure respondents in which majority of the respondent recorded a high diastole frequency of aortic heart sound.

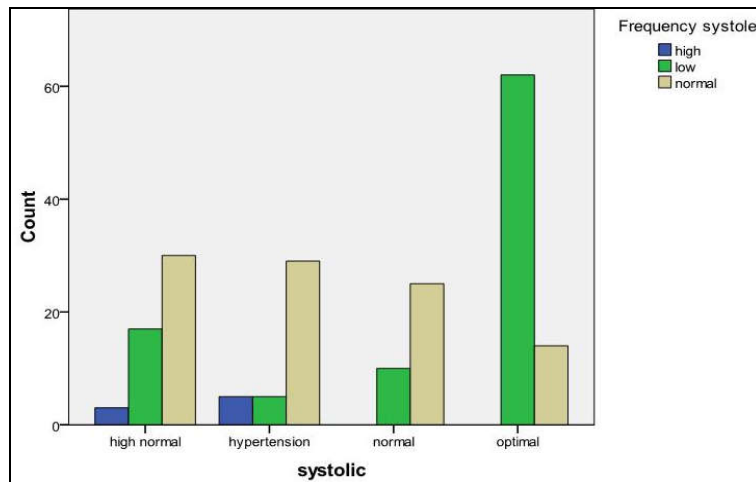


Figure 1: Association between systolic blood pressure and systole frequency of aortic heart sound.

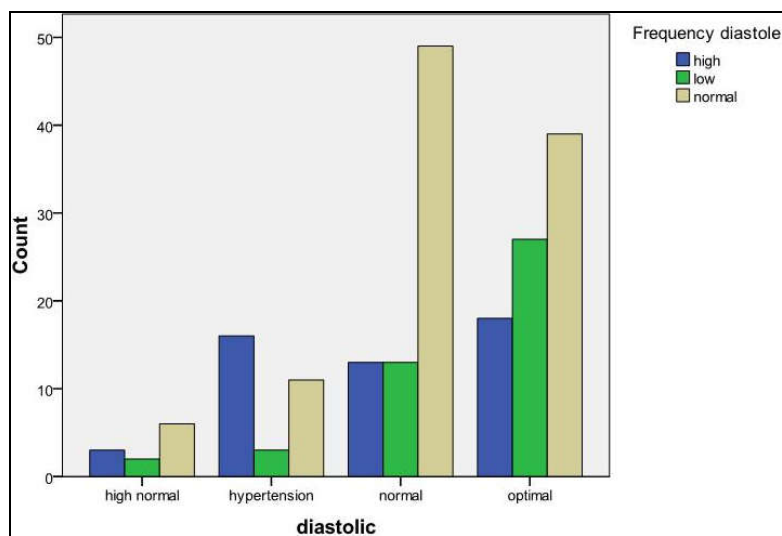


Figure 2: Association between diastolic blood pressure and diastole frequency of aortic heart sound.

DISCUSSION

Basically, the systolic blood pressure represent 1/3 of the time when heart was contracting, meanwhile diastolic blood pressure represents another 2/3 of the time when the heart was at rest. The mean of systolic blood pressure and diastolic blood pressure in this study was 119.74 ± 1.595 and 76.48 ± 0.852 respectively. In this study, the aortic heart sound was recorded for 15 seconds, to provide an enough time to analyse the time range for each systolic and diastolic phase. Besides, it was more convenient to choose the minimum time available to ensure subjects to sit still and keep silent during the auscultation and recording.

The purpose of this study was to determine the correlation of heart sound in relation to blood pressure. The significant functional relations between the parameters characterizing the cardiovascular system and hemodynamic characteristics and thus provides an interpretation of experimental relationship between first and second aortic heart sound with blood pressure [4]. In this study, we found that there was positive correlation between the aortic heart sounds with blood pressure. By using the chi square test, the four classifications of systolic blood pressure; low, normal, high normal and hypertension was relatively significant in relation to the three groups of systolic frequency of aortic heart sounds; low, normal and high with p-value of 0.000. Similarly, the association between the four classifications of diastolic blood pressure; low, normal, high normal and hypertension with three classifications of diastolic frequency of aortic heart sounds; low, normal and high were significant with p-value of 0.001.

According to this study, most of the respondents had the optimal and normal systolic and diastolic blood pressure range aged between 20-29 years old. Respondents recorded with high systolic and diastolic blood pressure were categorized in hypertensive group. The highest number recorded with high blood pressure or hypertensions were those who aged from 50 years and above, mostly the elderly groups. About three of the respondents recorded with hypertension and higher systolic and diastolic aortic heart

sound had background medical history of coronary heart disease and about 10 respondents had medical history of hypercholesterolemia. Due to the strong family history of the disease together with imbalance dietary intake making their blood pressure reading higher than normal range. In hypertension, there is more pressure exerted on the walls of the blood vessels due to the various mechanical forces being exerted on the endothelial surfaces of the blood vessels wall. Endothelial dysfunction and reduced nitric oxide (NO) bioactivity resulting in enhanced vasoconstrictor tone [8]. The stresses and strains experienced by the arteries eventually influenced the initiation of atherosclerotic lesions, which develop at regions of arteries that are exposed to complex blood flow [9]. And with more pressure in the blood vessels, the heart has to work harder with every beat [10]. This explains why those higher blood pressure readings were producing a higher frequency of the heart sounds. This was due to the changes on the blood vessels whereby the force of blood flow is high thus this will make the tissue that makes up the walls of the arteries get stretched beyond the normal limit and damage the blood vessels [11].

CONCLUSION

There are close association between blood pressure and aortic heart sounds. Nevertheless, there are several factors that should be considered which may affect the blood pressure changes which eventually affect the heart sounds. Various factors may affect the blood pressure readings. Besides applying the correct technique of measuring blood pressure, a proper calibration and correct position of the sphygmomanometer plays an important role in getting accurate blood pressure readings. Details on food intake, coffee intake, sleep pattern, smoking habit and exercise activity should be obtained as it indirectly affect the one blood pressure levels. Any underlying medical disease especially in relation to the blood pressure and heart like hypertension, hypercholesterolemia, and coronary heart disease are crucial information that should be ask in conducting such study related to the blood pressure and the heart sound. A correct clinical skill technique in taking blood pressure as well as auscultation of the aortic heart sound is a must in order to obtained accurate data and precise results.

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