Blood pressure laboratory report

Abstract

The aims of the experiment were to measure blood pressure in a female volunteer using auscultation, cardiac microphone and an automated blood pressure meter. Moreover, monitoring changes in blood flow and blood pressure in the leg whilst sitting and standing. In some exercises this was carried out by using a pressure cuff and listening for Korotkoff sounds with a stethoscope or microphone. An automated blood pressure meter was also used as well as recording when the pulse reappeared in the finger/leg after the blood pressure cuff had been inflated, via the use of a pulse transducer. The main conclusions of the experiment were that the blood pressure measurement differed more for the cardiac microphone technique (mean of 96. 31/77. 01 mmHg) than auscultation (93/71. 33 mmHg) and automated blood pressure meter (94. 33/71. 33 mmHg); however there was little variation between trials in all methods. In exercise 4 there was a delay from hearing the Korotkoff sounds, to observing a pulse after the cuff was deflated. Lastly, there was a difference in blood pressure between the arm and leg whilst sitting (96. 33 and 89. 98 mmHg respectively) and between the leg whilst sitting and standing (89. 98 and 114. 44 mmHg respectively).

Introduction

The cardiac cycle involves increasing aortic blood pressure above the veins, causing blood flow through the systemic circulation. Blood flow (pulse) through the pulmonary circulation is caused by higher pressure in the pulmonary arteries than pulmonary veins [1]. Systolic blood pressure, the maximum blood pressure, arises when the heart contracts, pumping blood into the aorta (systole). Diastolic blood pressure, minimum blood pressure level, in which the ventricles relax causes arterial pressure to decrease resulting in the heart refilling with blood (diastole) [2].

The mean arterial pressure (MAP) can be calculated by taking into account the diastolic and systolic blood pressures. However, this value is not just the average of the two determinants [4]. Both these pressures can be determined by implanting a pressure catheter into an artery, and measuring pressure changes as the heart beats [5]. This process though accurate, can be both uncomfortable and invasive, and is rarely used. Hence, blood pressure is more commonly measured by way of auscultation, an indirect, non-invasive technique, whose setup can be seen in figure 1.

Auscultation depends on silent streamlined flow but the production of Korotkoff sounds during turbulent flow, by listening through a stethoscope placed on the brachial artery, and recorded by a sphygmomanometer. This method involves placing an inflatable cuff around the patients’ upper arm, which is slowly inflated until the pulse cannot be felt (cuff pressure higher than systolic pressure). The pressure inside the cuff is steadily lowered until a tapping sound is heard (systolic blood pressure) where the artery pressure is now adequate to rise above that in the cuff. As cuff pressure is further reduced, the heart sounds become louder and then abruptly become weakened as diastolic pressure is approaching and flow is more streamlined. The point at which the heart sounds stop altogether is the diastolic blood pressure, in which normal flow has been resumed [1]. Normal blood pressure should be around 120/80 mmHg [6].

The main aims of the experiment are to compare the auscultation, cardiac microphone and automated blood pressure meter techniques for measuring blood pressure. In addition, compare blood pressure at different body locations i. e. arm and leg whilst sitting and standing.

Results

The mean blood pressure was 93/71. 33 mmHg, showing diastolic and especially systolic values are below reference range. Over the three trails the MAP was 78. 55 mmHg, which is within the normal range (~ 70-100 mmHg). The standard deviation for each parameter was very similar (2, 1. 53 and 1. 68), implying that the normal distribution is very narrow, with the majority of data concentrated around the mean.

A mean blood pressure of 96. 31/77. 01 mmHg indicates that diastolic and systolic values are below normal reference range. Over the three trials, the MAP was 83. 44 mmHg, which is within the normal range. The standard deviations for each parameter were similar (2. 39, 1. 15 and 1. 53), implying the data had low dispersion.

The reappearance of Korotkoff sounds while the pressure cuff was being deflated corresponds to the systolic blood pressure (96. 21 mmHg). The diastolic blood pressure is marked when the sounds fade away (77. 52 mmHg).

The mean blood pressure was 94. 33/71. 33 mmHg, indicating that diastolic and systolic values are below normal range, whereas the MAP (79 mmHg) over all three trials, were in normal range. The standard deviations for each parameter were extremely similar (1. 15, 1. 15 and 0. 67), implying little variation.

The Korotkoff sounds and pulse signal fade away when the pressure cuff is inflated and then reappear while the cuff is being deflated. The pressure at which the Korotkoff sounds reappear is recorded as the systolic blood pressure (96. 33 mmHg) which appears just before that of the pulse.

The leg systolic pressure (114. 44 mmHg) whilst standing, taken from when the pulse reappeared when the pressure cuff was being deflated, was higher than that whilst sitting (89. 98 mmHg). Moreover, the pressure in the arm (96. 33 mmHg) was higher than that of the leg whilst sitting but lower than that of the leg whilst standing.

Discussion

Using the stethoscope can lead to errors such as the pressure cuff being too big, leading to lower results than expected e. g. mean blood pressure of 93/71. 33 mmHg in the auscultation technique. Moreover, incorrect positioning of the stethoscope or slow inflation of the pressure cuff can cause venous congestion resulting in faint Korotkoff sounds. Likewise, if the cuff is inflated immediately after the previous trial, it can cause venous distension, distorting the Korotkoff sounds. Excess pressure on the stethoscope bell can disturb arterial flow, muffling the sounds, especially in a noisy environment. In addition, one individuals’ perception of systolic, tapping sounds may be different to that of another [3]. Lastly, the volunteer may be suffering from white coat hypertension or feel uneasy as a result of the laboratory setting; however these tend to result increase blood pressure [6]. The experiment could have been improved by having different sized pressure cuffs, having separate rooms when listening for Korotkoff sounds to reduce misinterpretation, and taking longer breaks in between the different trials to ensure normal blood flow has been resumed.

The Korotkoff sounds reappear just before that of the pulse in exercise 4, because the sound of the blood spurting into the artery happens before the pulse manages to flow to the finger. An ausculatory gap can arise in between the systolic and diastolic pressures, in which the Korotkoff sounds fade away and then reappear at a lower pressure [1]. This can bring about some confusion to what is the true blood pressure; however this could not be seen in any of the exercises.

The reappearance of blood flow to measure systolic pressure can be more accurate if the pressure cuff is released at a lower rate (e. g. 1 mmHg each time), as the true pressure may be missed if the pressure is released too quickly, and hence would lead to a lower result. In exercise 4, the diastolic pressure corresponds to the reappearance of the pulse. Hence, this method will be able to replace the auscultation and cardiac microphone techniques as it can measure both systolic (reappearance of Korotkoff sounds) and the diastolic pressure (reappearance of the pulse).

There was a noticeable difference between pressure in the arm (96. 33 mmHg) than in the leg (89. 98 mmHg) whilst standing (6. 35 mmHg). This difference will probably be due to experimental errors such as cuff size or misinterpretation of sounds. Less obvious explanations may be narrowing of the arteries or reduced blood flow in the leg. When the volunteer stood up, the blood pressure in the leg increased by 24. 46 mmHg, because the pressure in the veins below the heart are increased, but are reduced in veins above the heart due to gravity. Hence, there is a reduced venous return, causing the leg pressure to increase.

Furthermore, when comparing the three different techniques, the cardiac microphone had less similar results to the other two. For example, this method had a MAP of 83. 44 mmHg compared to 78. 55 and 79 mmHg for auscultation and automated blood pressure meter respectively. It seems that the cardiac microphone had greater values, especially diastolic pressures, having a mean of 77. 01 mmHg. This could indicate incorrect positioning of the microphone, too much finger pressure on the microphone, difficultly listening for the sounds or inaccurate interpretation of the graph/sounds. There was little variation between the trials in all the methods, indicating that the results were accurate and reliable.

As mentioned previously, the MAP is not simply the average of diastolic and systolic pressure because the arterial blood spends more time near to the diastolic pressure than the systolic pressure, and hence the equation takes this into account. The diastolic pressure has been shown to be less variable across the methods (low standard deviation) as it occurs in between heart beats, whereas systolic pressure can rapidly change in response to various triggers such as exercise.