Nigerian Journal of Clinical Practice
Dec. 2005: Vol. 8(2): 86 - 89.

A COMPARISON OF SPHYGMOMANOMETRIC AND OSCILLOMETRIC METHODS OF BLOOD PRESSURE MEASUREMENTS IN ADULT IN-PATIENTS

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ABSTRACT

The study compared two non-invasive methods of blood pressure measurements used in the anaesthetic management of patients, the conventional sphygmomanometric and the oscillometric methods. One hundred adult in-patients were involved, and 400 blood pressure measurements were done with the two devices. The sphygmomanometric measurements were higher in systolic, diastolic and mean arterial pressure values. Correlation coefficient values between the two methods were r = 0.97, 0.81, 0.95 for systolic, diastolic and mean arterial pressures respectively, ($p< 0.05$). We conclude that there is a statistically significant difference in haemodynamic values determined by the two devices. This difference is however, not clinically significant to warrant a recommendation of adjustment when comparing values determined by the two devices.

Key Words: Blood Pressure Measurement, sphygmomanometer, Oscillometer.

INTRODUCTION

Arterial blood pressure is a fundamental cardiovascular parameter representing the driving force available for organ and tissue perfusion. It is an essential component of minimal standards of monitoring during anaesthesia[1-3]. Whereas, direct intra-arterial cannulation is accepted to be the "gold standard" for blood pressure measurement[4], non-invasive blood pressure measurement is the norm in routine clinical practice. Non-invasive blood pressure (NIBP) measurement is an easy and reasonably reliable method of clinical evaluation and monitoring of patients. The measurement may be achieved by auscultatory or oscillometric methods. The oscillometric method is used in the automatic (electronic) blood pressure measuring devices. While the auscultation method is the most commonly used in routine patient care, the oscillometric mode is increasingly being used in many centres for monitoring in the operating theatres and intensive care units. In anaesthetic practice, the auscultation method is usually employed during preoperative assessment of patients in the ward. When the patients get to the operating theatre, perioperative blood pressure evaluation and monitoring may be done with the oscillometer, in centres equipped with such devices. Quite often, inferences are made to the patient's preoperative blood pressure values, vis-à-vis the intraoperative values, even though different devices have been used in measuring the haemodynamic parameters. How well values derived by the two methods can be exchanged for each other is not too clear. This study is designed to see if there is any significant difference in value of haemodynamic parameters determined by these two methods of measurement, and to see how well the values correlate.

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MATERIALS AND METHODS

The study was prospective, and carried out among adult male and female in-patients at the University of Benin Teaching Hospital, Benin City, Nigeria. Patient's informed consent was obtained in every case. One hundred (100) patients between the ages of 18 and 75 years, were included in the study. Two observers conducted the measurements, one using the sphygmomanometer and auscultation, and the other the automatic oscillometer (Siemens Sirecust 610 model). The patients were visited in the ward and rapport established. While in the recumbent position, the blood pressure was simultaneously measured in both upper arms with the two measuring devices. Thereafter, observer and instrument switched over and the procedure was repeated in the other arm. Thus, two measurements were made in each patient with each device, making 200 measurements with each device, and a total of 400 measurements. In the sphygmomanometer and auscultation group, the systolic and diastolic pressures were derived from the 1st and 4th Korotkoff sounds respectively, and the mean arterial pressure (MAP) was derived thus: MAP = DAP + 1/3 pulse pressure. The automatic oscillometer electronically measures and displays the numerical values of the systolic, diastolic and mean arterial pressures and the heart rate. Many studies report blood pressure measurements with either the sphygmomanometric or oscillometric

methods. Most earlier studies used the Dinamap brand of oscillometer. Many other brands are now in the market. The Siemens Sirecust 610 model used in this study was standardized by our institutional instrument engineers, using mercury sphygmomanometers. The results were collated, analyzed, and appropriate statistical tests applied. The Student's t-test and test of significance of correlation were used, and the null hypothesis was rejected at $p < 0.05$.

RESULTS

The patient characteristics are as outlined in table 1. There were a total of 400 measurements in 100 patients. Two hundred measurements were each made with the auscultatory and oscillometric methods. The results are presented as mean, and at 95% confidence level (table 2). Auscultatory blood pressure measurements were consistently higher than the corresponding oscillometric values. The systolic arterial pressure (SAP) by auscultation was 7.3 mmHg higher than the oscillometric value (124.7 vs. 117.4). Also, auscultatory diastolic arterial pressure (DAP) was 3.7 mmHg higher than the value from oscillometry (81.0 vs. 77.3). The mean arterial pressure (MAP) derived from auscultatory measurement was 4.7 mmHg higher than the value measured by oscillometry (96.1 vs. 91.9). Paired student's t-test showed these differences to be statistically significant at the 95% confidence level (i.e. $p < 0.05$). Correlation coefficient of measurements from the two methods were $r = 0.97$, $r = 0.81$ and $r = 0.95$ for SAP, DAP and MAP respectively. Test of significance of correlation showed these to be highly significant ($p < 0.05$).

Table 1: **Patient characteristics**

Number of	*100*
Age range	80
Mean age	41.1yrs (sd+/-19.1)
Sex ratio	m/f=50/50

Table 2: **Values of haemodynamic parameters measured by auscultatory and oscillometric methods.**

Haemodynamic Variable	**Mean values(mmHg) (+/- SD) Auscultatory**	**scillommetric**	**Mean difference (mmHg)**	**Correlation Coefficient (r)**
Systolic arterial Pressure (SAP)	124.7 (+/-20.3)	117.4(+/- 20.5)	7.3 ($p < 0.05$)	0.97 ($p< 0.05$)
Diastolic arterial Pressure (DAP)	81.0 (+/-14.4)	77.3 (+/- 13.0)	3.7 ($p< 0.05$	0.85 ($p < 0.05$)
Mean arterial Pressure (MAP)	96.1 (+/-16.0)	91.9(+/- 13.9)	4.7 ($p < 0.05$)	0.91 ($p< 0.055$)

DISCUSSION

Many studies have in the past tried to compare auscultatory and oscillometric devices of blood pressure measurement in the general[5, 6] and obstetric[7, 8] populations. Comparisons have also been made in other studies between these non-invasive devices and direct intra-arterial blood pressure measurements[7-15].

Our results have shown a statistically significant difference in the haemodynamic variables measured or determined in this study. We however do not think the differences are clinically important, being less than 10% of baseline values. Whereas all the values were consistently higher in the auscultation group, the difference in value was most marked in systolic pressure (7.3 mmHg). This compares well with values from other studies in the general population[1]. Hassan et al.[8] however, found a difference of 2.7 mmHg in their study on parturients in the labour ward. This difference is not thought to be statistically or clinically significant. In their study, it was the oscillometric systolic blood pressure measurement that was higher, as against the auscultatory values in our study. The diastolic arterial pressure (DAP) was 3.7 mmHg higher in the auscultation measurements. Though the difference showed statistical significance, what clinical significance can be attached to it is less clear. The difference would have been lesser if the sphygmomanometric diastolic measurements were determined by Korotkoff phase 5 sound. This is because oscillometric diastolic blood pressure measurements are standardized against phase 5 sound. The reasons for using phase 4 Korotkoff sound for determining diastolic blood pressure measurements in this study are explained below. Although greater importance used to be attached to the diastolic blood pressure in clinical practice[16], recent research seem to suggest that the systolic pressure is as important as the diastolic, in predicting impact of blood pressure on life. It is even thought to be more important in the older age group[17]. The difference in mean arterial pressure (MAP) was 4.7 mmHg in our study. Previous studies of the subject hardly highlight this haemodynamic variable.This may be due to the fact that whereas MAP can measured directly by oscillometry, it is mathematically derived by auscultation. In routine clinical practice, MAP is not usually determined during auscultatory measurement of blood pressure. MAP may be used in predicting ischaemic threshold in the anaesthetic management of cardiac patients for non-cardiac surgery[18]. According to this view, no myocardial ischaemia occurs if MAP exceeds the heart rate (HR), i.e. if the pressure-rate quotient (PRQ) exceeds unity (if MAP/HR > 1). This is

said to be a more useful index of myocardial oxygen demand than the rate-pressure product (RPP) [18]. This view is however disputed by other workers[19, 20].

There were high correlations between the two methods for the three haemodynamic variables measured. DAP showed the lowest correlation of the three variables ($r = 0.81$). This may not be unconnected with the fact that the diastolic pressure in this study was determined with Korotkoff phase 4 sound (point of muffling). Oscillometric diastolic measurements corresponds more with Korotkoff phase 5 sound (cessation of sound) [5]. Direct intra-arterial measurement corresponds more with Korotkoff phase 5 sound[15]. We used the Korotkoff phase 4 sound in this study due to the inconstancy of Korotkoff phase 5 sound in certain individuals or clinical states. Difficulties are encountered often in children, high output states and pregnancy. Although our hospital in-patient population for this study did not include children, it included pregnant women and high output state patients. For example, a large survey showed that there could be large gaps between phases 4 and 5 in pregnant women, with sometimes very low phase 5 sound (approaching zero)[21]. Using the phase 4 sound therefore, made for a greater consistency in measurement.

CONCLUSION

The study shows that there are differences in blood pressure measurements taken by auscultatory and oscillometric methods. The differences though statistically significant, are not clinically significant. Thus, it may be permissible to use the two devices interchangeably in routine clinical practice. This may however not be the case for research purposes, where interchangeability may affect the rigour and quality of the study.

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