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Mercury versus Oscillometric Device in Measuring Blood Pressure in Elderly: Which Is Authentic?

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Abstract

Aim: To compare the systolic and diastolic blood pressure in both arms in elderly patients by mercury sphygmomanometer and oscillometric recorders adopting standard practice of measuring blood pressure. **Materials and methods**: It is a cross sectional study done in 204 elderly patients aged more than 60 years over a period of two months at teaching hospital, Jaffna, Sri Lanka. Blood pressure was measured in both arms by both devices adopting the standard practice of blood pressure measurements. **Results:** The mean Systolic Blood Pressure (SBP) by oscillometric recorder on both right and left arm was 4.18mmHg and 3.66 mmHg higher than mercury sphygmomanometer readings. The mean Diastolic Blood Pressure (DBP) by oscillometric recorder on both right arm and left arm was 1.67 and 1.64 mmHg lower than mercury sphygmomanometer readings. There wasn't any significant difference in inter arm blood pressure measurement. The study group consisted of 54.3% males and 45.7% of females. The mean age of the study group was 69.46 years. **Conclusion**: Though there is no much difference observed in the gross values in reading the blood pressure by both oscillometric recorders and mercury sphygmomanometers, there is statistically significant discrepancy in blood pressure readings particularly in the elderly population which needs to be studied further in detail.

Subject Areas

Cardiology, Geriatrics, Public Health

Keywords

Oscillometric, Blood Pressure, Elderly Mercury, Sphygmomanometer

manometer cuff (appropriate size) was wrapped around right arm first and then left arm followed by oscillometric recorder. Three readings were taken in each arm with oscillometric recorders and the average was taken for the analysis [10].

3. Data Analysis

The data was analyzed using SPSS (version 24) statistical package. Descriptive statistics like frequency, percentage, mean and standard deviation were used to summarize the data and t-test was used to assess the significance between right and left arm blood pressure by using both mercury and oscillometric blood pressure recorders.

4. Results

A total of 204 patients aged more than 60 years were analyzed out of which 54.3% (110 patients) were males and 45.7% (94 patients) were females.64.5% (131 patients) of the study group were known to have hypertension and 35.5% (73 patients) were not known to have hypertension. The mean age of the study group was 69.46 years. The mean SBP by mercury sphygmomanometer on both right and left arm were 128.25 mmHg and 127.83 mmHg respectively without any significant inter arm difference. The mean DBP by mercury sphygmomanometer on both right arm and left arm were 74.45 and 74.09 mmHg respectively.

Similarly the mean SBP by oscillometric sphygmomanometer on both right and left arm were 132.44 and 131.49 mmHg which were significantly higher than the mercury readings ($p < 0.01$). The mean DBP by oscillometric sphygmomanometer on both right and left arm were 72.78 and 72.45 mmHg which were lower than the mercury readings (Table 1, Table 2). High blood pressure, both systolic and diastolic was noted by oscillometric recorders when the heart rate was high (Table 3).

5. Discussion

Though the gold standard measurement of arterial blood pressure is direct intra-

Table 1. Mean blood pressure readings of right and left arm by both methods (paired samples descriptive statistics).

Pair	Variable	N	Mean	Standard Deviation
Pair 1	MSR	204	128.25	23.64
	OSR	204	132.44	22.77
Pair 2	MDR	204	74.45	12.61
	ODR	204	72.78	12.08
Pair 3	MSL	204	127.83	22.95
	OSL	204	131.49	22.72
Pair 4	MDL	204	74.09	12.66
	ODL	204	72.45	12.19

Table 2. Comparison of systolic and diastolic blood pressure by both devices (paired samples test).

Pair	Variable	Mean	Standard Deviation	Standard Error Mean	Significant (2-tailed) P-Value
Pair 1	MSR-OSR	−4.18	12.44	0.87	0.00
Pair 2	MDR-ODR	1.67	8.86	0.62	0.01
Pair 3	MSL-OSL	−3.66	12.84	0.90	0.00
Pair 4	MDL-ODL	1.64	8.88	0.62	0.01

Table 3. Comparison of blood pressure measurement by oscillometric recorder with different pulse rate.

PR	N	OSR	ODR	OSL	ODL
Pulse rate less than 72	44	131.89	69.61	129.05	69.30
Pulse rate more than 72	160	132.59	73.65	132.16	73.31

PR-Pulse Rate, N-Number, OSR-Oscillometric Systolic blood pressure of Right arm, ODR-Oscillometric Diastolic blood pressure of Right arm, OSL-Oscillometric Systolic Blood pressure of Left arm, ODL-Oscillometric Diastolic blood pressure of Left arm.

arterial measurement, it is not practical. We use indirect methods such as palpatory and auscultatory methods which are sufficiently accurate for many diagnostic and therapeutic studies [11]. Mercury sphygmomanometers are gradually being phased out, not because of technological advances but because of environmental concerns [12] [13]. It also has inter-observer differences which has a major impact on clinical assessment. Hence, oscillometric recorders are promoted among health care workers in Sri Lanka instead of mercury sphygmomanometers in recent times. The study was aimed to compare the differences in the measured blood pressure values with both these methods.

The mean systolic and diastolic blood pressure of the study group in both arms remains within the normal range irrespective of the method used. However, it is noted that the pulse pressure is increased in the study population when we used oscillometric recorders. Studies show that in the elderly the most powerful predictor of risk is increased pulse pressure due to decreased diastolic and increased systolic blood pressure [14]. Isolated systolic hypertension, an elevation of systolic but not diastolic blood pressure is the most prevalent type of hypertension in the elderly [15] and there is ample evidence to show that treating them will reduce the risk of cardiovascular events [14] [16]. Our study results also show a low normal diastolic and high normal systolic blood pressure compatible with previous studies.

The mean difference of the mercury and oscillometric readings in systolic blood pressure is 4.18 mmHg in right arm and 3.66 mmHg in left arm which are statistically significant. The reasons for high oscillometric readings are to be established, whether oscillometric records the initial subtle pressure waves conducted by the stiff vessels of the elderly needs further exploration. Many studies

have compared mercury with oscillometric and digital devices and found oscillometric devices had better accuracy than the digital devices [17].

Similarly a small but statistically significant difference in measurement of diastolic blood pressure by both methods was found. Diastolic blood pressure by mercury sphygmomanometer was found to be higher than the oscillometric readings which may be attributed to low detection rates of korotkoff sounds by the observer. Phase 4 korotkoff sounds could have been picked up rather than the phase 5 (complete disappearance of sound) and the oscillometric recorder could have detected even the lowest intensity waves and given lower diastolic blood pressure.

There is not much inter-arm blood pressure difference by both methods. This is comparable to previous studies where minimum difference was observed [18]. The prevalence of inter-arm blood pressure difference could be low in the study population as it is very common in very elderly population with significant peripheral disease with multiple risk factors for atherosclerotic vascular disease to be present in both upper limbs [19].

It is observed that high blood pressure level was recorded when there is a high normal heart rate compared to subnormal heart rate. It's quite obvious that the recorder has more chance to pick up an early systolic and diastolic wave when the heart beats more often not giving a lag phase. When the heart rate is high, a high sympathetic drive is expected and obviously the blood pressure also tends to be high. Also physiologically, up to certain extent the elevation of heart rate increases cardiac output which accounts for a high blood pressure. These mechanisms would probably explain our findings. However, it needs further detailed study for better understanding.

6. Conclusion

Though there are not many differences observed in the gross values in reading the blood pressure by both oscillometric recorders and mercury sphygmomanometers, there are statistically significant discrepancies in reading the blood pressure in particular the elderly population. This needs expanded further research on different mercury sphygmomanometers and oscillometric devices to generalize the findings. This could have a great impact in the treatment of blood pressure in the post SPRINT era taking even subtle blood pressure levels into account in drawing guidelines and setting treatment goals.

7. Limitations

The limitations of this study are: 1) Number of subjects-For more reliable results the study can be done in expanded population; 2) Different brands of oscillometric devices could be employed in measuring the blood pressure and hence the results may vary in different studies; 3) The arterial pulse wave velocity also could be measured along with blood pressure measurements for better interpretation which was not done here.

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Competing Interest

The authors declare that there is no competing interest.

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Self-funding for the materials is used.

Consent for Publication

Not applicable.

Authors' Contribution

TI and VS collected the data, TK and VS analyzed the data and are the main contributors in writing the report. All authors read and approved the final manuscript.

Ethics, Consent and Permission

The ethical approval for this study was obtained from Ethical review committee of Faculty of Medicine, University of Jaffna (Reference number J/ERC/16/73/NDR/0145) and informed written consent was taken from each participant.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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List of Abbreviations:

MSR	Mercury Systolic blood pressure of Right arm
OSR	Oscillometric Systolic blood pressure of Right arm
MDR	Mercury Diastolic blood pressure of Right arm
ODR	Oscillometric Diastolic blood pressure of Right arm
MSL	Mercury Systolic blood pressure of Left arm
OSL	Oscillometric Systolic blood pressure of Left arm
MDL	Mercury Diastolic blood pressure of Left arm
ODL	Oscillometric Diastolic blood pressure of Left arm
PR	Pulse Rate