

## Clinical Utility of Blood Pressure Measurement Using the Newer Palpatory Method for Both Systolic and Diastolic Blood Pressure

### Abstract

**Background:** Blood pressure (BP) measurement being a part of clinical examination gives a fair idea about the hemodynamic status. The auscultatory method is considered as a gold standard, a simple, noninvasive way to measure BP in patients as well as in the healthy controls. The present study was designed to compare systolic BP (SBP) and diastolic BP (DBP) readings using a newer palpatory method with the standard auscultatory method and further assessing the reliability of the newer palpatory method. **Materials and Methods:** A cross-sectional study comprising of a total of 400 (240 males and 160 females) individuals in the age range of 20–60 years were included in this study. BP measurement was done by the standard auscultatory method by one observer. Another observer blinded with BP records of the auscultatory method, measured BP using the newer palpatory method on the same individuals. The two methods were compared for the inter-rater reliability using intraclass correlation (ICC) statistics and agreement between two methods using Bland–Altman analysis. **Results:** The present study observed excellent reliability of the newer palpatory method with the standard auscultatory method with an ICC value of 0.997 and 0.993 for SBP and DBP, respectively. Bland–Altman plot for both SBP and DBP using the auscultatory and newer palpatory method has shown minimum variability and good reliability when both methods are used by independent observers. **Conclusions:** With practice and experience newer palpatory method can be used to assess BP with accuracy.

**Keywords:** Blood pressure determination, blood pressure, diastolic pressure, reproducibility of results

### Introduction

Blood pressure (BP) measurement is a routine part of clinical examination in practice. It gives a fair idea about the hemodynamic and circulatory status of the subject. Samuel Siegfried Karl Ritter von Basch in 1881 used mercury sphygmomanometer for recording arterial BP.<sup>[1]</sup> Mercury being stable at room temperature and has a high density (13.6 times denser than water), expands less as pressure changes, that favor its use in the mercury sphygmomanometer.<sup>[2]</sup> Various methods, such as auscultatory, palpatory, ultrasound, oscillometric, and tonometric methods,<sup>[3]</sup> give reliable BP readings and are prevalent in clinical practice.<sup>[4]</sup> However, there has been decreased use of mercury instruments globally due to the fear of the harmful effects of its potential toxicity and disposal-related problems. Due to the alike reasons, many countries

have directed phasing out of mercury instruments.<sup>[5]</sup> Similarly, the use of nonmercury sphygmomanometers, like aneroid, and a digital light emitting diode (LED) devices use is going on the rise and are replaced by digital sphygmomanometers in many settings.<sup>[6]</sup> Palpatory methods for BP recording give only systolic BP values which are used to get approximates of SBPs, while the auscultatory method is used to get both SBP and DBP readings.

In addition, the auscultatory method for BP recording is considered as a gold standard simple noninvasive way to measure BP in patients as well as in the healthy controls.<sup>[7]</sup>

Advantages of the auscultatory method are as follows:<sup>[8]</sup>

1. It is universal for clinical measurement of BP.
2. It gives an accurate estimation of SBP and DBP at the appearance and disappearance of Korotkoff sounds.

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The disadvantages of this method are as follows:

1. Limb movement artifacts and difficulties in the analysis due to variations of the Korotkoff sound patterns or poor signals
2. Difficulty in appreciating Korotkoff sound or very faint sounds heard through a stethoscope pose trouble in recording the BP precisely.

Hence, the limitations demand an alternative method that should be relatively easy, noninvasive, precise, and can give fairly accurate estimates of both SBP as well as DBP when there are difficulties in appreciating Korotkoff sounds. Sahu and Bhaskaran proposed a palpatory method for both SBP and DBP.<sup>[9]</sup> The present study tried to compare BP value obtained by auscultatory methods with that of a newer palpatory method to check its utility in bedside clinical measurement of BP. In addition, the study is intended to measure the accuracy, correctness, and reliability of this newer palpatory method proposed in estimating BP. Further, the study can check its applicability in a larger number of individuals and can propose the same in routine clinical practice.

The objectives of the study were:

To measure SBP and DBP in the adult population using a newer palpatory method and compare it with BP measurement by standard auscultatory method for statistical agreement and reliability.

The innovative aspect of the study was that the newer method should enable the clinician to use it after repeated practice among the patients, in the setting where a stethoscope is not available or in setup when the environment is noisy to appreciate the Korotkoff's sounds.

## Materials and Methods

The proposed study was an observational cross-sectional study with a duration of 2 months (August–September 2019). After getting IHEC approval, the present study was conducted in Family Medicine outpatient department (OPD) and General Medicine OPD and in patient department (IPD) wards. The sample size for this study was calculated using a convenience sampling method. Considering the medium effect size and using G\*Power statistical software (Heinrich Heine University Düsseldorf, Germany) at 95% confidence interval and power of 80%, the sample size of a total of 400 (240 males and 160 females) was calculated.

All the study individuals were the patients attending the Medicine and Family medicine OPD and IPD of the hospital.

### Inclusion criteria for study subjects

Adults in the age range of 20–60 years who have consented for the study and having recordable and stable BP parameters.

### Exclusion criteria for study subjects

Adults below 20 years and above 60 years of age who were noncompliant with unstable BP parameters.

All the study individuals were explained about the nature and purpose of the study and informed written consent for recording the study parameters was sought. Initial basic anthropometric parameters such as age and weight were recorded.

As BP measurement was a noninvasive procedure no harm or potential harm was inflicted on study individuals. The patient information, data, results, and conclusion of the study were kept confidential and used only for research purpose. BP readings were recorded using the mercury-free digital LED sphygmomanometer-BPDG 141 (Diamond Industrial Electronics and Allied Products Ltd.,) to accustom the investigator to the palpatory method before initiating the study. A fixed number of individuals (10 individuals) were assessed for BP measurement daily. A trained investigator measured BP by the auscultatory method in the supine position while taking the utmost precautions as required for recording BP. Three readings were recorded and the mean of the three values was taken as final reading for the auscultatory method. Another observer recorded BP by a new palpatory method as described below on the same subject using sphygmomanometer. The first observer was blinded to record BP and was not aware of the palpatory method. BP readings were taken at the same time each day to avoid any variation.

### Newer palpatory method for recording blood pressure<sup>[9]</sup>

The patient was placed in a comfortable position, sitting or lying, with forearm supported, and the palm upward. The patient's arm and forearm were exposed above the elbow. Any restrictive clothing was removed from the arm. Central rubber bladder of the cuff wrapped firmly and smoothly around the arm by placing over the brachial artery, one inch above the elbow joint (antecubital space). The cuff was positioned on the arm at the heart level. The radial pulse was palpated using the three fingers of the nondominant hand. The cuff was inflated above the pressure value at which the pulse has disappeared (30–50 mm of Hg higher). Using the palmar surface of these digits, kept in firm contact with antecubital fossa a thrill was palpated as the cuff was slowly deflated. A pulsatile thrill was appreciated with digits while deflating the cuff. The point of appearance of the thrill was taken as SBP reading and the disappearance of the thrill was taken DBP reading.

The principal of new palpatory method is outlined as:<sup>[9]</sup> when the cuff of a sphygmomanometer is placed around a patient's upper arm and inflated to a level above the patient's SBP and a stethoscope is placed over the brachial artery in the antecubital fossa in a normal person (without arterial disease), no sound should be audible. If the pressure

is dropped to a level equal to that of the patient's SBP, the blood starts flowing through the brachial artery with turbulence flow, which produces thrill and can be palpated with palmer surface of the digits. As the cuff pressure dropped to a level below the DBP, the flow becomes laminar flow and the thrilling characteristic of the pulse disappears or the pulse becomes soft and then disappears very shortly. One can learn to differentiate by experience the purring nature of thrill from the soft nature of pulse before the disappearance.

The final readings for both methods were recorded independently by both the observers. Data were checked for correctness and completeness. Using Statistical Package for Social Sciences (IBM Corp Released 2017, IBM SPSS for Windows 10 Version 25.0 Armonk, NY: IBM Corp.) software and appropriate statistical tools, data were compared and analyzed to draw a meaningful conclusion. To assess the reliability of the palpatory method, intraclass correlation (ICC) statistics and Bland-Altman analysis were used.

## Results

Table 1 shows the anthropometric characteristics of the study individuals. Mean age was 40.81 years (SD  $\pm 16.76$ ) years, with mean weight 61.66 kg (SD  $\pm 14.04$ ). Readings of the BP values using auscultatory method and newer palpatory methods are given in the table.

Table 2 shows the results of the study expressed as a percentage of subjects having the same BP readings with both of the two methods. About 63.75% of individuals

showed similar readings with both methods, while 32.25% showed readings within  $\pm 2$  mm of Hg indicating good reliability and reproducibility. While 3.75% of individuals have readings within  $\pm 4$  mm of Hg and 0.25% individuals had more than  $\pm 4$  mm of Hg variation in BP values among both methods.

The present study observed excellent interrater reliability as evident from the ICC statistics [Tables 3 and 4] for both SBP and DBP reading when a newer palpatory method is compared with the standard auscultatory method. Herein, the obtained ICC value is 0.997 and 0.995 (indicating excellent reliability), its 95% confidence interval ranges between 0.997–0.998 and 0.993–0.996 for SBP and DBP, respectively, meaning that there is 95% chance that the true ICC value lands on any point between 0.997 and 0.998 for SBP and 0.993 and 0.996 for DBP. Therefore, based on statistical inference, it would be more appropriate to conclude the level of reliability as “excellent” on the absolute agreement which concerns the extent to which SBP and DBP by newer palpatory method equals auscultatory method. Figures 1 and 2 show the Bland Altman plot for both SBP and DBP using the auscultatory and the newer palpatory method showing minimum variability and good agreement between the two methods. As evident from the graph DBP is showing the least variability than SBP when measured with a newer palpatory method.

## Discussion

We measured BP parameters using the auscultatory and the newer palpatory method. Our study was designed to

**Table 1: Characteristics of study population**

Study Parameters	Males (n=240)	Females (n=160)	Total (n=400)
Age (years), mean $\pm$ SD	40.80 $\pm$ 16.78	41.01 $\pm$ 16.82	40.81 $\pm$ 16.76
Weight (kg), mean $\pm$ SD	63.95 $\pm$ 13.37	58.24 $\pm$ 14.36	61.66 $\pm$ 14.04
Auscultatory method			
SBP (mm of Hg), mean $\pm$ SD	122.53 $\pm$ 16.45	122.88 $\pm$ 15.64	122.67 $\pm$ 16.18
DBP (mm of Hg), mean $\pm$ SD	79.03 $\pm$ 11.91	75.96 $\pm$ 10	77.80 $\pm$ 11.27
Palpatory method			
SBP (mm of Hg), mean $\pm$ SD	122.82 $\pm$ 16.39	123.15 $\pm$ 15.65	122.95 $\pm$ 16.08
DBP (mm of Hg), mean $\pm$ SD	79.26 $\pm$ 11.97	76.06 $\pm$ 10.22	77.98 $\pm$ 11.40

SBP: Systolic blood pressure, DBP: Diastolic blood pressure, SD: Standard deviation

**Table 2: Results of the study expressed as percentages and numbers**

Observations	Males (n=240), n (%)	Females (n=160), n (%)	Total (n=400), n (%)
Percentage of observations showing the same BP readings with both methods	162 (67.5)	93 (58.22)	255 (63.75)
Percentage of observations showing readings within $\pm 2$ mm of Hg using both methods	70 (29.16)	59 (36.86)	129 (32.25)
Percentage of observations showing readings within $\pm 4$ mm of Hg using both methods	8 (3.34)	7 (4.30)	15 (3.75)
Percentage of observations showing readings more than $\pm 4$ mm of Hg using both methods	0	1 (0.62)	1 (0.25)

compare and assess the reliability of the newer palpatory method for both systolic and diastolic BP with standard auscultatory method used in clinical practice. The findings of our study have revealed an excellent agreement between the two methods.

The newer palpatory method can give reliable and reproducible BP values as compared to the standard auscultatory method. Sahu and Bhaskaran<sup>[9]</sup> estimated SBP and DBP using palpatory method in 200 patients. It was reported that 51% of patients had SBP and DBP, within  $\pm 2$  mmHg range, 20% patients within  $\pm 4$  mmHg, 25% of patients had the same readings by both the methods. While in 0.5% of patients, BP could not be measured.

Our study, however, has shown consistency of 63.75% with both these methods and recorded the same BP values using the two methods. While in 32.25% of the individuals, the difference for BP was within a range of  $\pm 2$  mm of Hg. We observed a difference of  $\pm 4$  mm of Hg in 3.75% of

the individuals and difference in both methods  $> \pm 4$  mm of Hg in 0.25% individuals. The findings of our study are in agreement with those of Sahu and Bhaskaran.<sup>[9]</sup>

Clinically, the measurement of both SBP and DBP has equal importance and this method can record both the values with confidence. Hence, the newer palpatory method has added advantage over the conventional palpatory method which measures only SBP. The results of our study indicated excellent absolute agreement indicating minimal variability in the BP readings. Thus by repeated practice, this new method can be mastered and could be easy and convenient for application. The other advantage of this method is that there is the least dependency on the stethoscope. As pointed out by Perloff *et al.*,<sup>[10]</sup> the known limitation of the auscultatory method is the lack of consistency for reliably measuring BP in a person using a treadmill, so in such cases, this newer palpatory method can be used. Similarly, it can also be useful in the setting

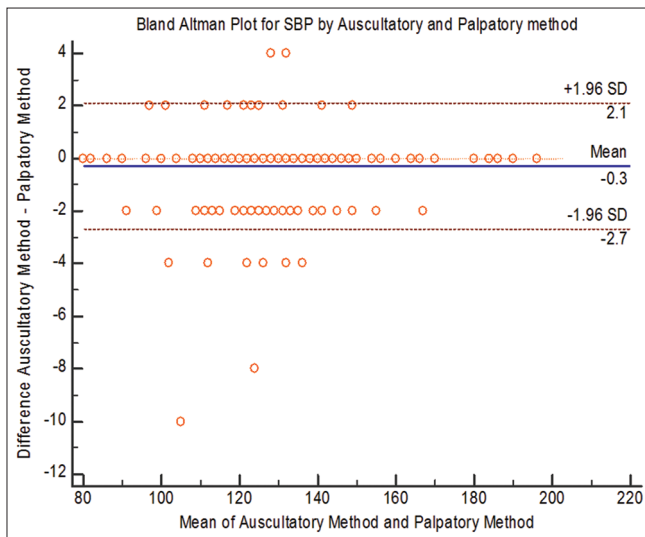


Figure 1: Bland Altman plot for systolic blood pressure by auscultatory and palpatory method

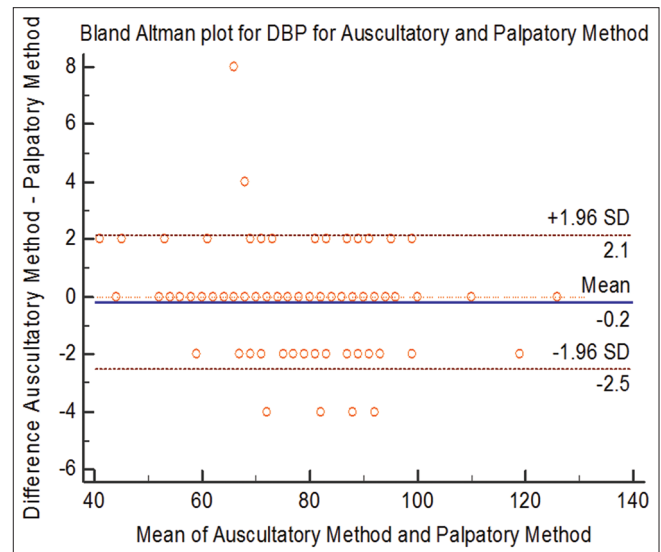


Figure 2: Bland–Altman plot for diastolic blood pressure by auscultatory and palpatory method

**Table 3: Intraclass correlation statistics for inter-rater reliability for the palpatory method and auscultatory method for systolic blood pressure**

Systolic BP palpatory method versus auscultatory method	ICC <sup>b</sup>	95% CI		F test with true value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single measures	0.997	0.997	0.998	697.176	399	399	<0.001

<sup>b</sup>ICC estimates and their 95% confidence intervals were calculated using SPSS statistical package version 25 based on a mean-rating ( $k=3$ ), absolute-agreement, two-way mixed-effects model. CI: Confidence interval, ICC: Intraclass correlation

**Table 4: Intra class correlation statistics for inter-rater reliability for palpatory method and auscultatory method for diastolic blood pressure**

Diastolic BP palpatory method versus auscultatory method	ICC <sup>b</sup>	95% CI		F test with true value 0			
		Lower bound	Upper bound	Value	df1	df2	Significant
Single measures	0.995	0.993	0.996	368.818	399	399	<0.001

<sup>b</sup>ICC estimates and their 95% CIs were calculated using SPSS statistical package version 25 based on a mean-rating ( $k=3$ ), absolute-agreement, two-way mixed-effects model. CI: Confidence interval, BP: Blood pressure, ICC: Intraclass correlation

of nonavailability of automated BP monitoring setup, nonavailability of stethoscope, and noisy environment.

Shivering, severe obesity, tremor, and moderate-to-severe hypotension are the other known limitations of the palpatory method. We also noted similar limitations in recording BP with this method as shivering, and the tremor causes mechanical interference in measurement. In the case of a severely obese person, thick subcutaneous fat probably prevents the thrill transmission to the skin surface. Likewise in elderly subjects with very thin subcutaneous fat, there is continuous palpation of the pulse throughout measurement which poses difficulty to identify thrill.

With repeated practice and experience, the appreciation of appearance and disappearance of the thrill can be learned and the difficulty of thrill palpation in the elderly can be overcome. Jules constant<sup>[11]</sup> has also described a palpatory method to measure diastolic pressure in which they said that the brachial artery is palpated at the cuff edge when pulse return after deflation will give SBP readings and the value at which dynamic pulse suddenly feels normal will give DBP readings. Considering this thing in mind, the newer method was designed.

Earlier researchers noted a variation of  $\pm 2$  to  $\pm 4$  mm of Hg using this method and have suggested that this could be used to get fair estimates of SBP and DBP values.<sup>[9]</sup> The present study can be regarded as a further extension of the work involving a larger sample size and observed good reliability and excellent agreement between the two methods.

As per the findings of this study, even for hypertensive patients, the BP readings were closer, or same with both of these methods and no significant difference was observed for BP readings using the two methods.

The auscultatory gap which is observed in some hypertensive patients is not a stable finding and is often variable. In present study, there was not any difficulty measuring BP among hypertensives using newer palpatory method. Auscultatory gap has an incidence ranging from 5% to 20% among hypertensives. In addition, it is associated with female sex, age >65 years ages and arterial stiffness index >8.5.<sup>[12]</sup>

Although in hypertensives with systemic sclerosis auscultatory gap has found to be having incidence up to 32% due to characteristic thickening and stiffening of arteries.<sup>[13]</sup> Further auscultatory gap is associated when only the auscultatory method is used while recording BP if not supplemented by palpation of the radial pulse. As pointed out by Mudd and White, an auscultatory gap in sphygmomanometry is a period of abnormal silence or diminished intensity during one of the Korotkoff sound phases.<sup>[14]</sup> During the auscultatory gap, the pulse wave is palpable and appreciable. Since in newer palpatory method we are feeling the thrill for the measurement of both SBP

and DBP, the auscultatory gap did not have posed any problem.<sup>[15]</sup> Hence, it can be asserted that this method may be applicable in measuring BP with auscultatory gap as well. Further study related to applicability of this newer palpatory method can be taken over in subjects showing the auscultatory gap.

The novelty of this study is that the newer palpatory method for both SBP and DBP was applied and tested in larger study population (sample size 400) and found to be reliable in 67.5% of subjects recording the exactly same reading. However, where both methods recorded BP within acceptable range of  $\pm 4$  mm of Hg for both SBP and DBP.

The narrow acceptable range of BP in this study as compared to previous studies add validity to our study. Further ICC statistics of the study revealed excellent inter-rater reliability and agreement between two methods for both SBP and DBP when a narrow with narrow range in BP values was considered ( $\pm 2$  to  $\pm 4$  mm of Hg).

Sadwarte *et al.*<sup>[16]</sup> applied similar palpatory method for BP recording and had reported exact readings in larger percentage of subject with acceptable BP range of up to 20 mm of Hg for systolic and up to 10 mm of Hg for diastolic BP. Although they found the palpatory method more acceptable in terms of larger accuracy as evident from their observations. In contrast to these findings of ICC statistics which shown excellent agreement for SBP (ICC coefficient 0.951) and moderate agreement for DBP (ICC coefficient 0.566), the present study observed has observed excellent agreement for both SBP and DBP values using the two methods.

Similarly, Dinesh Sahu *et al.* reported accuracy of 51% within range of  $\pm 2$  mm of Hg and 20% within range of  $\pm 4$  mm of Hg and proposed this method for BP measurement in noisy environment and when stethoscope is not available. ICC coefficient was not assessed and hence the level of agreement was not commented on.

The results of present study indicated excellent inter-rater reliability and good agreement between the newer palpatory method and gold standard auscultatory method.

Being an important part of BP evaluation, DBP readings can be fairly obtained using the newer palpatory method which is an easy, quick, and convenient method for the purpose. The incorporation of DBP reading in this newer palpatory method would make it a very useful and popular method. It is also very useful in settings where frequent BP measurements are done manually as in IPD wards, in OPD, during cardiac pulmonary resuscitation and patients on the treadmill.

## Conclusions

BP measurement is critical for assessing the patient admitted in intensive care unit or an ambulant patient attending the Physician's clinic. Although the auscultatory

method is the gold standard for BP measurement, the newer palpatory method for both SBP and DBP values is quick and could be reliable. Similarly, it can give estimates of BP without the need for a stethoscope or automated sphygmomanometers, and can be done in a noisy environment as well.

The present study compared a newer palpatory method with that of standard auscultatory method for BP recording among 400 adult subjects in the age range of 20–60 years. The results of our study have shown that the newer palpatory method is in excellent agreement with the gold standard auscultatory method. It is further concluded that the newer palpatory method is found to be reliable for both SBP and DBP measurements and is easy, quick, and estimates DBP without the need of a stethoscope just by palpating the thrill of brachial artery at ante-cubital fossa level.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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