Rapid oscillometric blood pressure measurement compared to conventional oscillometric measurement

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Background There have been few reports studying the necessary interval between blood pressure measurements, after the initial rest period.

Methods Blood pressure was measured in 50 patients using the conventional oscillometric technique (COT) and the rapid oscillometric technique (ROT).

Results The difference between COT and ROT was $-1.1/-0.1$ mmHg, which was not significantly different ($p = 0.8/1.0$) and the pulse difference was -0.8 beats per minute ($p = 0.8$).

Conclusions It is concluded that a 15-second interval between blood pressure readings is as accurate as a one-minute interval providing that these measurements are started after a 5-minute rest period. *Blood Press Monit* 6:145–147 © 2001 Lippincott Williams & Wilkins.

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Introduction

Oscillometric blood pressure measurement has largely replaced the auscultatory method in electronic blood pressure monitors today. Although the measurement methods are different, the results are clinically equivalent and the devices are easier to manufacturer [1,2].

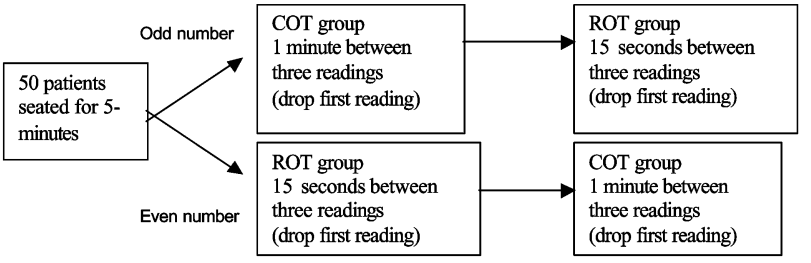
Measurement of blood pressure (BP) in research studies has used the average of three measurements [3,4]. The recommended technique is to have the patient sit for 5 min and take measurements with 1–2 min between the measurements. The recommendation from the American Heart Association to wait 1–2 min is based on the auscultatory method of measurement, however this recommendation has not been scientifically validated. It is theorized that venous engorgement that occurs with too rapid cuff re-inflation induces measurement errors [5]. Unfortunately, these errors are not considered in clinical practice and most clinicians do not use average BP but rather use single blood pressures to make clinical decisions and save time [6].

The purpose of this study was to determine if, after being seated for 5 min, waiting 15 sec between oscillometric blood pressure readings was equivalent to waiting 1 min between readings. If the rapid method is as effective, this will save time for the busy health care providers, which may increase the likelihood of repetitive blood pressures, which could improve the accuracy of measurement of hypertension.

Methods

Blood pressure was measured in 50 patients of at least 18 years of age using an Omron HEM-705CP automatic oscillometric device. The experimental protocol and the process for obtaining consent from the subjects was approved by the University of Michigan Medical School Institutional Review Board. The patients were normotensive and hypertensive volunteers from a general internal medicine practice. Each patient was seated upright for 5 min before measurement began and was instructed not to speak during measurement. During measurement, the patient was seated upright in a chair with back support. Each subject had three measurements with each technique (six measurements total per subject) using the same arm for both the conventional oscillometric technique (COT) and the rapid oscillometric technique (ROT), Figure 1. The COT measured three readings with 1 min between measurements, and the ROT measured three readings with 15 sec between measurements. Patients with odd patient numbers had

Fig. 1



Protocol schematic

the COT first, while patients with even patient numbers had the ROT first.

The first readings for each subject were always after 5 min of rest. The first reading was alternated with consecutive subjects between the COT and the ROT to avoid bias from the initial 5 min of relaxation. The first readings from each of the methods were not included in the analysis to avoid skewing the results due to the 5-min initial baseline rest before the first of the six readings per subject. Thus, the analysis only included measurements that allowed 15 sec (ROT) or 1 min (COT) between readings.

Microsoft Excel 97 was used for analysis of the data. The student's *t*-test with two-tail distribution and two-sample equal variance was used to determine any significance in the relationship between blood pressure and pulse. 50 subjects were calculated to have the 80% power to detect a 3 mmHg difference ($p = 0.05$). Confidence intervals were calculated with an alpha of 0.05.

Results

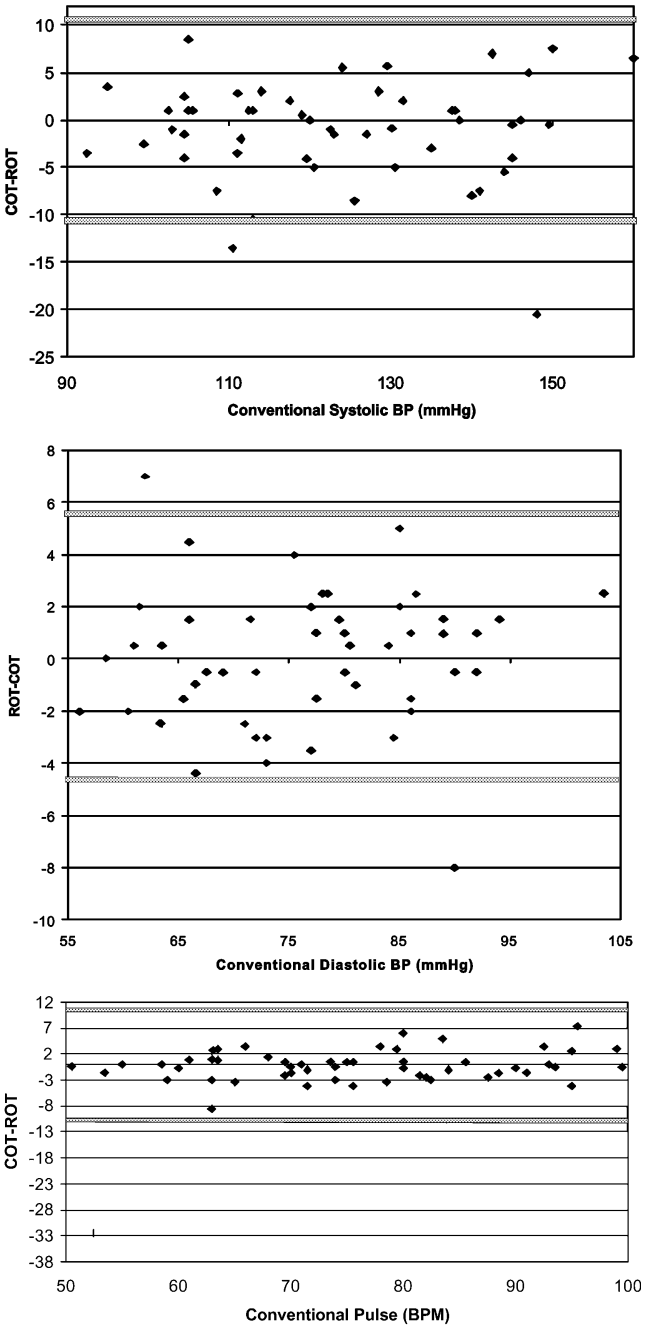
50 subjects volunteered for the study. The average age was 50 ($\pm$ 17) years old (range 18–97) with 55% of the subjects being male. The average blood pressure in the COT group was 123.4 (95% CI 120.0–126.9)/76.4 (95% CI 74.3–78.6) mmHg and in the ROT group was 124.5 (95% CI 121.0–128.1)/76.5(95% CI 74.3–78.6) mmHg with pulses 75.3 (95% CI 72.7–77.8) and 76.1 (95% CI 73.6–78.6) beats per min (bpm), respectively. The difference between COT and ROT was $-1.1/-0.0$ mmHg, which was not significantly different ($p = 0.8/1.0$) and the pulse difference was -0.8 bpm ($p = 0.8$). Including the first measurements with the second and third measurements produced similar results. The COT average was 124.0 (95% CI 119.5–129.1)/76.9 (95% CI 73.9–79.9) mmHg with a pulse of 75.4 (95% CI 71.8–78.9) bpm. The ROT group average was 125.6 (95% CI 120.7–130.5)/77.0 (95% CI 73.8–80.1) mmHg with a pulse of 75.9 (95% CI 72.5–79.3) bpm. The BP difference was $-1.3/-0.1$ mmHg with a pulse difference of -0.5 bpm ($p = 0.72/0.98$ and pulse p of 0.83). The maximum BP in the COT group was 161/104 mmHg and in the ROT group 170/101 mmHg. The minimum BP in the COT group was 90/55 mmHg and in the ROT group 87/54 mmHg.

The measurements were analysed according to conventional systolic BP ranges < 110, 110–139, and > 139 mmHg. The greatest difference was seen in the conventional systolic BP (SBP) < 100 mmHg in which the ROT under-measured the systolic by 2.3 mmHg. The diastolic and pulse in this range and all the measurements for the other blood pressure ranges all demonstrated differences of less than 1.6 mmHg between the techniques and these differences for systolic, diastolic, and pulse differences were not significant ($p > 0.05$). 8 percent of the ROT group was misclassified according to the conventional SBP range of < 110 mmHg. 12 percent was misclassified within the conventional SBP range of 110–139 mmHg, whereas 5% misclassified within the >139 mmHg range.

Figure 2 shows the Bland–Altman plot indicating a lack of difference in the measurement techniques based on conventional systolic and diastolic pressures. Most of the readings were within two standard deviations. The COT pulse was slightly greater than the ROT pulse at higher pulses and less than ROT at lower pulses, however this difference was slight and most of the readings were within two standard deviations.

One patient had a 21 mmHg systolic difference between the techniques and this patient had a rapid 24 mmHg decrease in systolic BP over the first 8 min including the 5-min waiting period. This suggests that the usual 5-min waiting period was not adequate for this patient. Another patient had a 33 bpm change in heart rate

Fig. 2



Conventional minus rapid oscillometric technique differences (y-axis) compared to conventional systolic BP, diastolic, and pulse (x-axis). Two-standard deviations indicated as dark horizontal line.

between the two techniques—a total variation of 50 bpm suggests an arrhythmia as the etiology.

Discussion

There is little experimental evidence to indicate the proper interval between BP measurements. The American Heart Association Committee in 1980 recommended that 1–2 min should elapse between measurements to allow the release of blood trapped in the veins before further determinations are made, although evidence supporting this was not cited [5]. Ischemia in an arm distal to the measurement will lower BP by 5/15 mmHg if the ischaemia is 20 mmHg above the systolic BP (SBP) for 90 sec, however it raises the BP slightly if the ischaemia is sustained for only 30 sec [7]. Since proper technique is to inflate the 20 mmHg above the SBP and use a deflation rate of 2 mmHg/second, ischaemia above the SBP would only last 10 sec and it is unlikely to change the measurement of the BP.

There was a non-significant (< 1.1 mmHg) difference between the rapid and conventional BP measurement techniques for systolic, diastolic and pulse readings. The rapid technique had the greatest difference compared to the conventional technique between systolic BP 90–109 mmHg based on the conventional technique, however this difference was also not significant ($p = 0.6$).

Conclusion

Blood pressure readings may be repeated after 15 sec without affecting the accuracy of the measurements. The proper technique is to have the patient seated for five minutes and perform 2–3 measurements with 15 sec between readings.

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