Equipment

Accuracy of radial artery blood pressure determination with the Vasotrac™

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Purpose: To evaluate the accuracy of a new non-invasive method (Vasotrac™) to measure blood pressure (BP) with accompanying arterial wave-form and pulse-rate display when compared with BP and waveform measured invasively.

Methods: Healthy volunteers (n=53) served as subjects for the study. Blood pressures and waveforms obtained via a radial artery catheter (IABP) were compared with non-invasive measurements obtained every 12-15 beats by the new system (Vasotrac BP) from the opposite radial artery. In a sub-group of volunteers (n=11), BP was acutely increased and decreased with isoproterenol, phenylephrine and sodium nitroprusside. Data were analyzed by determining correlation and agreement between the two systems of measurement. Waveforms obtained by the two systems were qualitatively examined.

Results: Non-invasive BP measured every 12-15 beats by the Vasotrac correlated with IABP (systolic $r^2 = 0.89$; diastolic $r^2 = 0.88$; mean $r^2 = 0.94$). The actual values obtained by the two methods agreed closely with > 90% of readings being within 2SDs when plotted by the Bland Altman method. This was also true during vasoactive drug infusion when BP changed acutely and swiftly. During this dynamic period, Vasotrac BP accurately tracked the changes in IABP with correlations (systolic $r^2= 0.82$; diastolic $r^2 = 0.89$; mean $r^2 = 0.95$) and close agreement (> 90% of readings were within 2 SDs in the Bland Altman plot). Waveforms displayed by the two systems were qualitatively very similar. Pulse rates measured by the two systems were identical.

Conclusions: The Vasotrac system displayed an arterial waveform which was similar to that obtained directly and measured BP and pulse rate accurately. It should be a convenient device to measure BP continually in a non-invasive fashion.

Objectif : Évaluer l'exactitude d'une nouvelle méthode non effractive de mesure (Vasotrac™) de la tension artérielle (TA), avec les graphiques qui l'accompagnent montrant les ondes artérielles et les fréquences de pouls, en la comparant avec une méthode effractive et ses graphiques.

Méthode : Des volontaires en santé (n = 53) ont participé à l'étude. Les tensions artérielles et les courbes artérielles obtenues au moyen d'un cathéter de l'artère radiale (TAIA) ont été comparées aux mesures non effractives obtenues à tous les 12-15 battements de l'artère radiale opposée avec le nouveau système (TA Vasotrac). Chez des volontaires (n = 11) d'un sous-groupe, on a provoqué une hausse et une baisse soudaines de la TA avec de l'isoprotérénol, de la phényléphrine et du nitroprussiate de sodium. Les données ont été analysées en déterminant la corrélation et la concordance entre les deux systèmes de mesure. On a examiné les caractéristiques des graphiques obtenus des deux systèmes.

Résultats : Les mesures non effractives de TA faites tous les 12-15 battements avec le Vasotrac sont en corrélation avec celles du système de TAIA (r^2 systolique = 0,89 ; r^2 diastolique = 0,88 ; moyenne de $r^2 = 0,94$). Les tracés, d'après Bland Altman, des valeurs provenant des deux systèmes concordaient étroitement, indiquant > 90 % des mesures qui se situent à l'intérieurs de 2 écarts-types. Il y a eu la même corrélation pendant la perfusion de médicament vasoactif. Pendant cette période dynamique, la TA Vasotrac a suivi avec précision les changements de la TAIA avec des mesures correspondantes (r^2 systolique = 0,82 ; r^2 diastolique = 0,89 ; moyenne de r^2 = 0,95) et d'étroites concordances (> 90% à l'intérieur de 2 écarts-types). Les graphiques produits par les deux systèmes étaient qualitativement très similaires. Les fréquences de pouls étaient identiques.

Conclusion : Le système Vasotrac a permis de visualiser des ondes artérielles similaires à celles qui ont été obtenues directement, et a mesuré la TA et la fréquence de pouls avec précision. C'est un appareil qui peut être pratique pour mesurer continûment la TA d'une manière non effractive.

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BLOOD pressure (BP) is routinely measured during the perioperative care of patients.[1,2] Although many techniques are used, the most common uses the oscillometric principle of measurement and consists of the application of an upper arm cuff which is automatically inflated and deflated to yield a numeric display of systolic, diastolic and mean blood pressures.[3] When continuous monitoring of BP is required an arterial catheter is placed percutaneously and connected to a transducer and monitor.[4] This allows direct beat to beat display of the pressure waveform and numeric display of the average of several beats in a continuous fashion. The non-invasive oscillometric method can be cycled every 15-20 sec in the 'STAT' mode when necessary to provide rapid but intermittent BP readings.[5] Although accuracy during rapid cycling is the same as during less frequent sampling, BP readings still are obtained only once every 20 sec.[5] To prevent pressure injury from the high frequency of cycling in the 'STAT' mode, most automatic BP machines revert to the intermittent mode after a brief period of rapid cycling. In this report, we describe a new non-invasive method to measure radial artery BP and pulse rate along with an arterial waveform display every 12-15 beats. Unlike the oscillometric method, circumferential cuff compression is not required. To evaluate its accuracy we report the results of a study conducted in healthy volunteers who consented to the insertion of a radial arterial cathether. This allowed us to compare BP, radial arterial wave-form and pulse rate display obtained from the Vasotrac with simultaneous radial arterial catheter measurements.

Materials and Methods

The unit (Figure 1) used to measure BP, pulse rate and display a radial arterial pressure waveform is called the Vasotrac™ (Medwave Inc., Arden Hills, St. Paul, MN). It consists of a reusable circular sensor (dimensions: diameter 1.20"; width 0.35") which is strapped over the radial artery at the wrist. The sensor is supported by a control mechanism, a digital signal processor and a display screen. The raw information collected from the sensor is processed and the results are displayed on a graphical display screen. The pressure transducer should be positioned directly over the radial artery at the distal end of the radius. A disposable adhesive-backed Vasoguide™ strip helps to position and hold the sensor over the radial arterial site (Figure 2). Upon activation of the unit, the control mechanism actively compresses the pressure transducer over the radial artery in a nonocclusive manner until a radial pressure waveform is detected by the transducer. Compression of the transducer upon the radial pulse stops as soon as the maximum energy transfer between the radial artery and the sensor has been achieved. An external safety transducer provides feed back to the control mechanism and prevents the application of unsafe pressures to the radial artery and wrist. The wrist sensor module is so constructed as to measure only the pulsatile energy perpendicular to the artery. Using cyclical compression and decompression, several parameters are measured by the transducer during the period of maximum energy transfer. Based on these parameters and a set of predetermined coefficients, the systolic, diastolic, and mean pressures are estimated every 12-15 beats by the Medwave noninvasive arterial pressure system. A scaled pulsatile wave form is displayed on the monitor along with systolic,

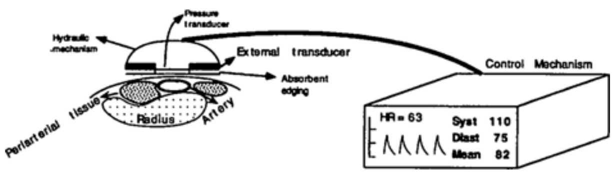

FIGURE 1 The components of the non-invasive Vasotrac system consist of a wrist-module and a monitor display unit. The systolic, mean, and diastolic blood pressures and pulse rate along with pulse waveform are displayed by the monitor. Cyclical compression and decompression of the sensor at the wrist allows almost continuous monitoring of blood pressure.

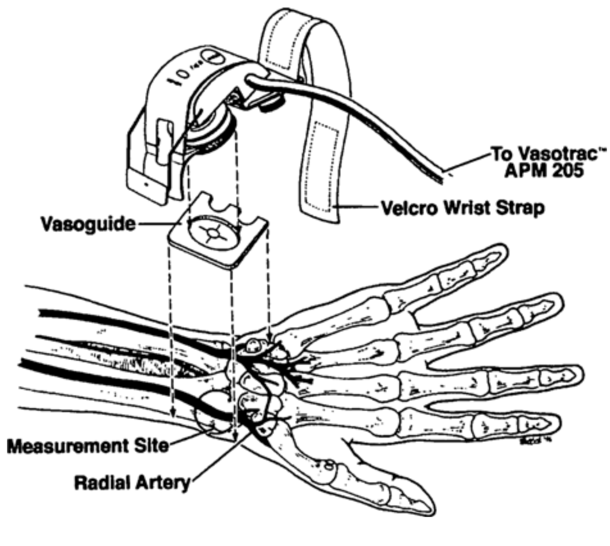

FIGURE 2 The Vasoguide™ is a disposable adhesive backed padding shaped to accept the wrist module of the Vasotrac system. It has a pre-cut circular area with a transparent thin plastic membrane imprinted with a cross hair target mark.

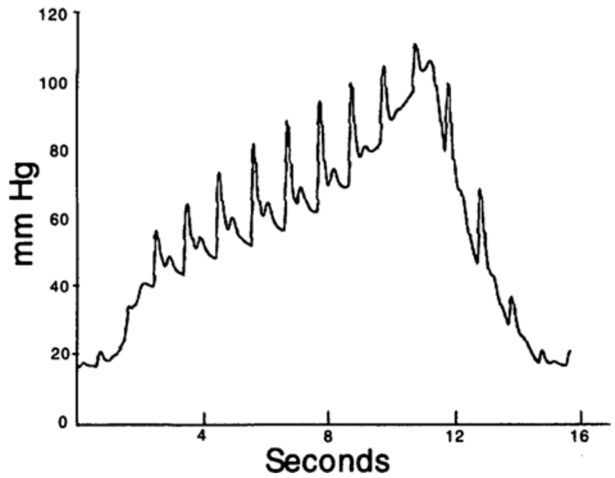

FIGURE 3 Generation of the pressure pulse signal elicited by the transducer during compression and release over the radial pulse. With gradual and increasing compression note the appearance of the pulsatile wave. Even though the Vasotrac processes information from 12-15 beats it selects one single beat for the calculation and display of BP and the pulse pressure waveform.

diastolic and mean blood pressures. The processor requires 12-15 consecutive beats without interference (movement artefacts) to obtain adequate energy information to generate the pulsatile calibrated beat (Figure 3). This displayed beat is *one* of the 12-15 pulsations sensed by the Vasotrac system. Thus, when used in the continual mode, single calibrated waveforms along with BP measurements and heart rate are displayed in an uninterrupted fashion every 12-15 beats.

Sensor check and calibration:
Prior to each application the sensor is zero adjusted when simply exposed to atmospheric pressure. This is accomplished by activating a zero key on the monitor. No further calibration is required because the pressure sensor measures the pulsatile energy relative to atmospheric pressure. The gain of the sensor remains stable over a large pressure range (0-300 mm Hg).[6]

Sensor placement
Since the Vasotrac sensor directly measures anterior pulsatile energy, precise positioning of the transducer over with the radial artery is essential for accuracy (Figure 2). This is achieved before instituting monitoring and while the unit is in the "placement mode". In this mode the sensor is placed on the pulsating vessel at the distal end of the radius. This point on the wrist is marked with a pen and the Vasoguide™ is centered over this point. The unit is then strapped in place with Velcro. The control mechanism is activated to commence BP monitoring.

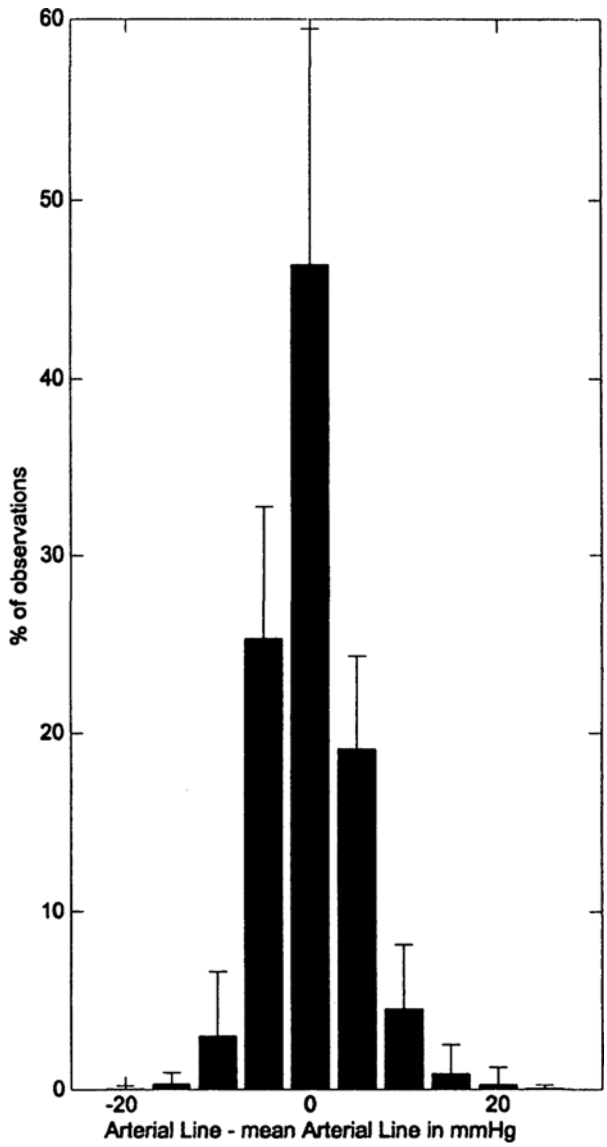

FIGURE 4 The variability of intraarterial (IA) blood pressure (BP) measurement was determined by comparing each IA BP (mean) value with the mean for the entire study and categorizing the difference into a specific range spanning 5 mmHg.

Study protocol
After we obtained approval from the institutional review board a study was conducted in healthy adult volunteers after obtaining written informed consent. All

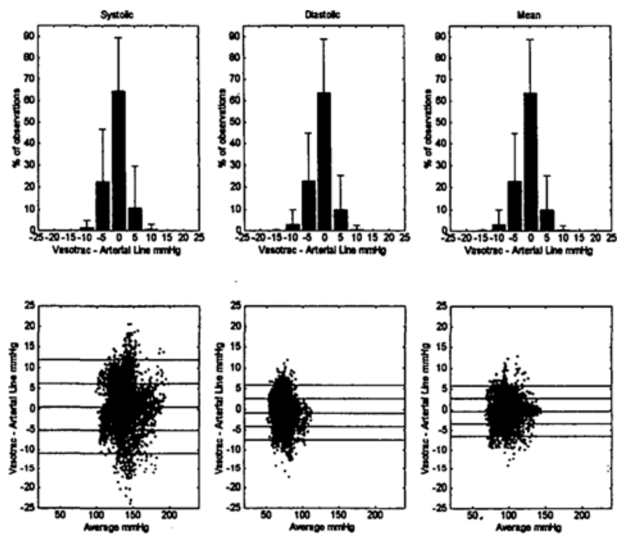

FIGURE 5 (*Upper half*) Bar plot distribution of the difference ± SD between Vasotrac and directly measured BP readings for systolic, mean and diastolic BP measurements in the volunteers who did not receive vasoactive agents.
(*Lower half*) Bland Altman Plots for systolic, mean and diastolic BP showing level of agreement over the entire range of BP measurements between 3955 simultaneous readings obtained by the Vasotrac and intraarterially. The x-axis is the average of the simultaneous Vasotrac and intraarterial BP readings being compared.

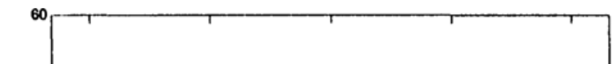

FIGURE 6 The variability of intraarterial (IA) blood pressure (BP) measurement in the eleven volunteers who received vasoactive drugs.

subjects were ASA physical status 1, and had no history of vascular disease, Raynaud's disease, intracranial aneurysm, bleeding tendency, coarctation of the aorta or deformity of the upper extremity. Females of childbearing age were excluded if there was a likelihood of pregnancy by history. In addition, to qualify as subjects for the study, it was necessary that there be no large difference (≥ 5 mmHg) in BP between the upper extremities as measured by the automatic oscillometric cuff method (Dinamap; Johnson & Johnson Medical, Arlington, TX 76004) as the subjects lay still before commencement of the study. All volunteers had a radial arterial line placed percutaneously in one extremity (size 20 g, 5 cm length; Cook Inc., Bloomington, IN). The catheter was connected directly (to eliminate the likelihood of extension-tubing artefact) to a transducer (Viggo Spectramed, Oxnard CA 93030 or Medex Inc. Hilliard OH 43026) and linked to a SpaceLabs monitor (SpaceLabs Medical, Bristol, CT 06010). Radial arterial line BP was monitored in real time and data files from each subject were recorded continuously on an IBM compatible laptop computer. The same computer was also connected to the Vasotrac system to collect information from the opposite radial artery. The computer then synchronized the Vasotrac beat used to calculate BP with the corresponding radial artery beat. Thus, the BP of the beat utilized by the Vasotrac system to calculate BP was compared to the BP obtained from the corresponding radial arterial beat.

During data collection, all volunteers were supine. Both arms were at the same hydrostatic position when compared with ground and cardiac level. Data were collected during several five-minute intervals. Recordings were made over 30 min to two hours. Data were collected while the volunteers were at rest and immediately after brief bouts of active isometric exercise followed by periods of relaxation. During data collection, the volunteers lay still.

In a separate group of volunteers, in addition to the procedures above, BP was either acutely and transiently (for 5-10 min) increased or decreased (± 20% of baseline BP recorded soon after radial catheter insertion while the volunteers were at rest) with rapidly acting vasoactive drugs (0.02-0.15 $\mu g \cdot kg^{-1} \cdot min^{-1}$ isoproterenol; 0.25-5 $\mu g \cdot kg^{-1} \cdot min^{-1}$ sodium nitroprusside; 0.15-0.75 $\mu g \cdot kg^{-1} \cdot min^{-1}$ phenylephrine *iv*). This was

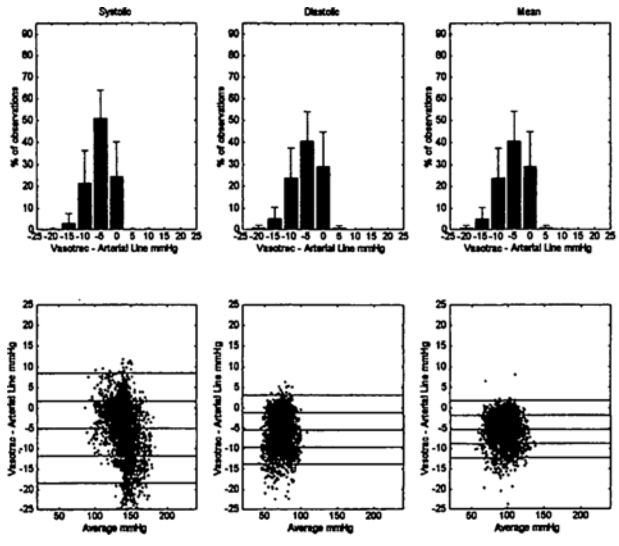

FIGURE 7 (*Upper half*) Bar plot distribution of the difference ± SD between Vasotrac and directly measured BP readings for systolic, mean and diastolic BP measurements in the volunteers whom BP was changed acutely with vasoactive drugs. (*Lower half*) Bland Altman Plots for systolic, mean and diastolic BP showing level of agreement over the entire range of BP measurements between 2861 simultaneous readings obtained by the Vasotrac and intraarterially. The x-axis is the average of the simultaneous Vasotrac and intraarterial BP readings being compared.

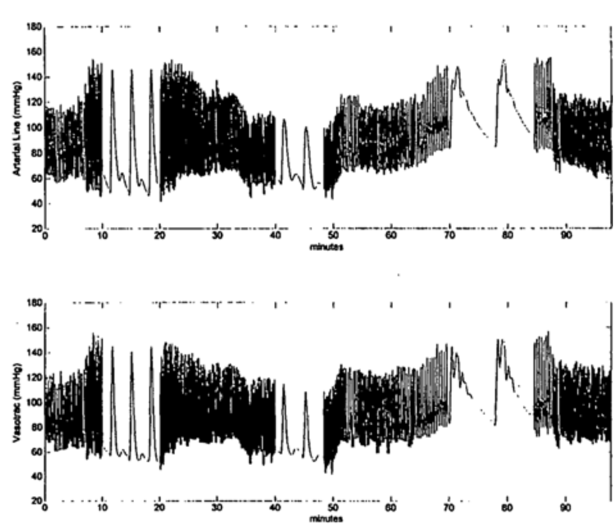

FIGURE 8 Graphic display of blood pressure in a supine healthy 20 yr old 50 kg female subject. The Vasotrac was used to measure blood pressure over the right radial artery (lower tracing) and compared to simultaneous blood pressure measurements in the left radial artery (upper tracing). During the approximate one and a half hour study period, blood pressure was altered with the transient 5-10 min infusion of three drugs given individually and in sequence: isoproterenol (started at approximately eight minutes), nitroprusside (started at approximately 32 min) and phenylephrine (started at approximately 65 min). To show similarity in waveforms between the Vasotrac and direct measurements, the speed of recording has been increased for a few simultaneous BP measurements during the drug infusion periods.

done to assess the ability of the new system to track the rapid changes in BP and the accompanying alterations in pulse rate.

All volunteers were asked to report any discomfort or other problems they suffered during use of the Vasotrac. In addition, we examined the sensor application site for any compression injury.

Data analysis

With the exception of artifacts (flushing, damped arterial waveform reading, movement) all paired readings obtained during data collection were utilized for analysis. Correlation and mean error (bias) were calculated. $P < 0.01$ was considered significant. A Bland-Altman plot[7] was constructed for systolic, diastolic and mean BP to allow visual observation of data for agreement between the two methods of measurement over a wide range of pressures. In addition, to check for differences in readings between the two methods and as previously reported by Siegel and associates[8] each determination of (Vasotrac BP - IABP) was categorized into a range spanning 5 mmHg (e.g. -10 to -5, -5 to -0.1, 0 to 5, or 5.1 to 10 mm Hg). Similarly, the variability of BP during the study was determined by comparing each of the recorded IA measured mean BP with the average mean BP for the entire study period and categorizing the difference into a specific range spanning 5 mm Hg. For each volunteer, the distribution was computed as a percentage of the total number of measurements. All of these distributions were then combined to produce an average ± SD distribution of the difference between mean IA and average mean IABP. For pulse rate analysis, the pulse rate displayed during each Vasotrac recording was compared with the calculated pulse rate from the simultaneous IA beats. The IA waveform display was qualitatively compared to the Vasotrac BP waveform display. We also recorded volunteer complaints (soreness, tingling) related to the use of the Vasotrac and their preference for the oscillometric method versus the Vasotrac method for BP monitoring.

Results

The results obtained in 54 volunteers are summarized in this report. Table I displays the demographic characteristics of the volunteers studied. Before the study (Table I), no differences were found in blood pressure between their upper extremities. In 43 volunteers vasoactive drugs were not used and a total of 3,955 BP readings were available for analysis. The observed variability of mean IA BP was 10 mmHg for only 4% of the readings indicating that comparisons in this group were made over a relatively stable range of BP (Figure 4). Table II lists the data obtained in these volunteers. There was negligible bias between the readings obtained by the two methods. The Vasotrac BP measurements correlated ($P < 0.01$) with IABP (systolic r^2 = 0.89; diastolic r^2 = 0.88; mean r^2 = 0. 94). Close agreement in BP measurement is illustrated in the bar diagrams (Figure 5) which show the differences in BP between IA and Vasotrac measurements. Greater than 90% of measurements were within ± 5 mm Hg. The Bland-Altman plots displayed in the same figure confirm that there was close agreement between the readings over the entire range of BPs studied in these volunteers. For systolic, diastolic and mean BP at least 93% of readings were within ± 2SDs.

TABLE I Demographic data and pre-study oscillometric (Dinamap®) BP measurements of volunteers enrolled in the study.

Sex	
Male	26
Female	28
Age (Yr)	34 ± 11
Height (cm)	170 ± 10
Weight (kg)	75 ± 16
Wrist Size (cm)	
Right	15.7 ± 1.2
Left	16.0 ± 1.3
*Blood pressure (mmHg)**	
Systolic	
Right	132 ± 16
Left	130 ± 17
Diastolic	
Right	79 ± 13
Left	79 ± 11
Mean	
Right	94 ± 13
Left	94 ± 13

* which represent the average of three readings in each subject. All individuals were supine at rest during these measurements. A standard BP cuff was used. The size chosen occupied 2/3rds of the upper arm.

In the 11 volunteers who received vasoactive drugs, 2861 sweeps were analyzed. Comparison of BP between the two instruments in this group were made while BP was changing much more than the volunteers who did not receive vasoactive drugs because the observed variability of IABP in these volunteers was 10 mmHg for 34.26% of the readings (Figure 6). Table II lists the BP data obtained in these volunteers. Again, there was negligible bias between the readings obtained by the two methods. Despite the rapid drastic changes in BP, the Vasotrac BP measurements correlated ($P <$ 0.01) with IABP (systolic r^2 = 0.82; diastolic r^2 = 0.89; mean r^2 = 0. 96). More than 90% of readings (Figure 7), were within 10 mm Hg of direct readings during the acutely induced changes in BP.

The Vasotrac BP waveforms were qualitatively very similar to those obtained intraarterially over a wide range of BPs. Samples of waveforms at three different pressures are demonstrated in Figure 8. The Vasotrac and IA pulse rates were identical (r^2 = 0.98).

None of the volunteers complained of discomfort during the application or operation of the Vasotrac device. Even though the Vasotrac was used continuously for the duration of the study, all subjects preferred the Vasotrac over the oscillometric arm cuff method of BP measurement which was used to check

TABLE II Average, mean error, and confidence interval of all systolic, mean and diastolic readings obtained by the arterial line and the Vasotrac. (Values for Direct, Vasotrac and Mean error also include standard deviation)

Blood pressure (mm Hg)	***Direct***	***Vasotrac***	***Mean error***	***95% confidence interval***
Systolic				
Without vasoactive drugs*	137.4 ± 16	137.6 ± 16	0.25 ± 5.6	(-10.9, 11.3)
With vasoactive drugs†	136.1 ± 15	136.5 ± 13	0.35 ± 6.5	(-12.7, 13.4)
Mean				
Without vasoactive drugs	97.3 ± 12.4	96.9 ± 12.4	-0.38 ± 3.1	(-6.5 , 5.7)
With vasoactive drugs	92.8 ± 12	92.8 ± 12	-0.01 ± 2.6	(-5.2 , 5.2)
Diastolic				
Without vasoactive drugs	75.0 ± 9.6	74.1 ± 9.1	-0.9 ± 3.3	(-7.5 , 5.8)
With vasoactive drugs	71.5 ± 9.6	71.5 ± 10	-0.03 ± 3.3	(-6.5 , 6.6)

*n=43 (3955 readings); †n=11 (2861 readings) for arm to arm differences. During the administration of the vasoactive agents, it was noted that the volunteers became transiently tense which was evident by shrugging of their shoulders. This shrugging stopped at the end of the study, by which time the administration of these drugs was discontinued. Examination of the wrist revealed the presence of minor pressure marks that conformed to the shape of the transducer and its ulnar supports. There was no evidence of nerve injury or venous congestion.

Discussion

Application of the Vasotrac in healthy volunteers resulted in accurate measurements of BP which very closely matched measurements obtained directly via a radial arterial line. The system accurately tracked the systolic, diastolic and mean BP in these volunteers at rest and immediately following periods of isometric exercise. In addition, when a sub group of volunteers were challenged with vasoactive drugs, the Vasotrac also tracked the resulting rapid and drastic changes in BP. This close tracking with minimal differences in actual BP readings during the administration of the rapidly acting vasoactive drugs is demonstrated in Figure 8. In this subject during the administration of isoproterenol, the Vasotrac correctly detected the increase in systolic pressure along with the accompanying decreases in mean and diastolic BP. Next, with the administration of sodium nitroprusside, systolic, diastolic and mean IABP decreased. Again, the Vasotrac accurately tracked these rapid changes in IABP. Finally, the increases in IABP (systolic, mean and diastolic) with phenylephrine were also correctly monitored by the Vasotrac. The minimal differences in actual BP readings may have been related to the arm tension observed during the acute transient administration of the vasoactive drugs.

During the routine care of patients in the perioperative period, BP is usually measured non-invasively by oscillometry in an intermittent fashion. If used in the rapid mode, the oscillometric method can check BP every 20-30sec. However, prolonged use of 'stat' measurements has resulted in compression injuries (skin avulsion, ulnar neuropathy, and venostasis) in the arm.[9-12] To reduce the likelihood of compression morbidity, 'stat' readings are usually only used for brief periods namely, during induction of anesthesia or when rapidly changing BP is anticipated. However, poor peripheral pulsation can extend the time taken to obtain an oscillometric reading with instruments like the Dinamap.[13] Hutton and associates indicate that the Dinamap is an unsuitable instrument to monitor BP when it is changing rapidly with drugs like sodium nitroprusside.[13] The Vasotrac on the other hand, utilizes gentle but repetitive compression and decompression of the radial artery at the wrist and provides arterial pressure, waveform and pulse rate every 12-15 beats without significant arm compression. In the volunteers studied it was able to track vasodilator induced changes in BP.

Unlike the tonometric method,[14] the Vasotrac does not require frequent recalibration whenever BP is changing rapidly due to changes in blood vessel diameter. However, the tonometric method does provide beat-to-beat BP with arterial waveform display. The Finapres,[15] another non-invasive BP device, also provides beat to beat BP readings with arterial waveform display. It does not require frequent recalibration but may cause troublesome venous congestion when used for prolonged periods.[16] This was not true with the Vasotrac in the volunteers studied. None of the volunteers complained of discomfort in the hand or wrist over which the Vasotrac sensor was applied. Examination of the wrist revealed only minor pressure marks conforming to the shape of the sensor and its supporting pads. In yet another study, Stokes and associates[17] found the Finapres to provide useful beat-to-beat information on BP trends but found it unreliable as a substitute for invasive arterial pressure monitoring. They found a considerable drift in baseline with time during monitoring and also an increase in variability when systolic and mean BP increased in value.

Since the Vasotrac system measures pulsatile energy by the direct application of pressure to the anterior wall of the radial artery, the only calibration required is a zero check of the transducer prior to use. This ensures that there is no surface pressure on the transducer. However, for accuracy in readings, precise placement of the sensor over the radial artery at the distal end of the radius is essential. Thus, clinicians must take the time to locate the radial pulse as if attempting to place an arterial catheter. Once the point of hypothetical puncture is identified, the clinician then applies the Vasoguide over this preidentified puncture site. Pursuing this protocol is essential to ensure accuracy of BP measurements.

The radial artery originates as a bifurcation of the brachial artery at the elbow. However, the Vasotrac is designed to measure BP over the radial artery only at the distal end near the wrist. This distal location of measurement may interfere with the ability of the Vasotrac transducer to detect anterior pulsatile energy during states of hemorrhage, hypothermia or at other times when significant vasoconstriction may be present. However, it detected BP accurately when hypotension was due to drug induced vasodilatation.

During the perioperative and intensive care of patients, continuous monitoring of heart rate, respiration, and pulse-oximetry is common. Continuous BP monitoring has been possible with an arterial line and non-invasively with the Finapres or by tonometry. Monitoring via the Vasotrac, although not truly continuous, can obtain BP readings frequently enough to negate the usual inadequacy of BP monitoring during the care of critically ill patients. It allows clinicians to track BP non-invasively almost continually in most patients during the administration of anesthesia. Unfortunately, the sensor is too large for use in infants and children thus limiting its role in this age group. However, it should be possible to use it in children with large wrists. Also, it will not be possible to use the Vasotrac in certain rare situations such as when there is a congenital absence of the radial pulse. The sensor has been designed to work best over the radial artery at the distal end of the radius. The flattened bony background of the distal end of the radius provides a firm base over which the sensor can press to obtain the pulsatile information from the radial artery. Because it requires pulsatility to measure the change in energy transfer as counterpressure is applied over the pulse it cannot measure BP when the patients are on non-pulsatile cardiopulmonary bypass. Being non-invasive, arterial blood samples cannot be obtained with the Vasotrac.

In contrast, benefits of the Vasotrac include the following: the method is easy to use, was preferred by all volunteers over the oscillometric cuff method and is as accurate as a radial arterial line. By providing an arterial waveform without arterial puncture the Vasotrac will increase measurement accuracy because its readings are unaffected by factors such as damping, presence of air-bubbles, clot formation at the catheter tip and other artifacts that commonly interfere with IABP measurements.

During the studies in volunteers we ensured that the hands were at the same level as the heart. During clinical use, any hydrostatic differences should be adjusted for when the Vasotrac is used. This is easily accomplished by activating a correction key on the Vasotrac monitor and entering the distance in inches between the monitored wrist and mid-axillary level. The corrected BP will then be automatically displayed on the monitor.

In conclusion, the Vasotrac is an instrument that utilizes a new method, to measure radial artery BP, display arterial waveform and pulse rate semi-continuously in a non-invasive manner. It offers clinicians and investigators a new non-invasive method to measure BP every 12-15 pulse beats as accurately as can be obtained invasively via an arterial line. It is simple to use and unlike the intermittent oscillometric occlusive cuff method it does not produce discomfort when used for continual BP monitoring.

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