Effects of first, early morning and last measurements on blood pressure total average in ambulatory blood pressure monitoring

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SUMMARY

The purpose of this study was to examine the effects of first, early morning and last measurements on daily average blood pressure during the ABPM. Previously done 525 ABPM were analyzed, retrospectively. 66.7% of these measures were in male patients. Mean age of all the patients was 43.3±16.1 years. Thirty-eight measurements per day every patient were planned. .The differences between the average of total measurements(n) and the average of n-1, n-2, n-3 which were calculated with the elimination of first, early morning and last measurements from total daily measurements were investigated. The mean of total average of all measurements (n) was 130.7±14.2/79.0±10.9 mmHg. The means of averages of first, early morning and last measurements were 140.5± 17.6/ 88.0±12.2, 134.3±18.3/ 81.9±13.4 and 135.2±19.4/ 82.9±13.5 mmHg respectively. The average of first, early morning and last measurements were statictically higher than the average of total measurements(n) realized during the day (p<0.001, for both systolic and diastolic values of each measure). Research results shows that, regarding both systolic and diastolic blood pressures, there were statistically significant differences between the average of total measurements(n) and the averages of n-1, n-2 and n-3 measurements which were calculated with the elimination of first, early morning and last measures from total daily measurements.(p<0.001 for all systolic and diastolic comparisons). The ones with systolic blood pressure < 140 mmHg (n=256) at the first measurement of monitoring were according hypertensive according to the total average (>135 mmhg, n=43, 16.8%), whereas hypertension ratio in the ones with systolic blood pressure > 140 mmHg (n=269) at the first measurement was (n=153, 56.9%). Research results suggest that, the first measurement > 140 mmHg increases the probability of hypertension by 3.4 times when compared with those whose first measurement being < 140 mmHg.

Key words: *Ambulatory blood pressure monitoring Hypertention*

ÖZET

Ambulatuar Kan basıncı Ölçümünde İlk, Sabah Erken ve Son Ölçümün Ortalama Kan Basıncına Etkisi

Bu çalışmanın amacı AKBİ'de ilk, sabah erken ve son ölçümlerin günlük ortalama kan basıncı üzerine olan etkilerini araştırmaktır. Retrospektif olarak evvelce yapılmış 525 AKBİ incelendi. Bu ölçümlerin %66.7 si erkeklerdeki ölçümlerdi. Ölçümlerin yaş ortalaması 43.3 + 16.1 yıl idi Her AKBİ için günlük 38 ölçüm planlanmıştı Tüm ölçümlerin ortalaması (n) ile total ortalamadan ilk, son ve sabah erken ölçümlerin elimine edilmesi ile edilen n-1, n-2, n-3 ortalaması arasındaki farkı araştırdık. Tüm ölçümlerin ortalaması 130.7 + 14.2/79.0+10.9 mmHg idi. Monitörizasyonun ilk ölçümlerinin ortalaması 140.5+ 17.6/ 88.0+12.2 mmHg, sabah erken ölçümlerinin ortalaması 134.3+ 18.3/ 81.9+13.4 mmHg ve son ölçümlerin ortalaması ise 135.2 + 19.4/ 82.9+13.5 olarak bulundu. İlk, sabah erken ve son ölçümlerin hepsinin ortalaması tüm ölçümlerin(n) ortalamasından yüksekti(p<0.001, her ölçümün gerek sistolik gerek diastolik değerleri için). Tüm ölçümlerin(n) ortalaması ilk, sabah erken ve son ölçümlerin elimine edilmesiyle kalan n-1, n-2, n-3 sayıdaki ölçümlerin ortalama değerleri ile gerek sistolik ve gerekse diastolik kan basıncı açısından anlamlı bir farklılık (p<0.001, gerek sistolik,gerek diastolik tüm karşılaştırmalar için) gösteriyordu. İlk ölçümde sistolik kan basıncı <140 mmHg (n=256) olanların tüm ölçümlerin ortalaması bakımından hipertansif saptanma (>135 mmhg, n=43) oranı %16,8 iken, ilk ölçüm >140 mmHg olduğu durumda(n=269) tüm ölçümlerin ortalaması ile hipertansiyon (n=153) saptanma oranı %56.9 di. Çalışma sonuçlarına göre izlemin ilk ölçümünün >140 mmHg olması kişinin hipertansif çıkma ihtimalini ilk ölçümü <140 mmHg olanlara göre 3.4 kat arttırdığını telkin etmektedir.

Anahtar kelimeler: *Ambulatuar kan basıncı ölçümü Hipertansiyorn*

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Introduction

Hypertension is an important risk factor for the development of diseases such as myocardial infarction, stroke, heart failure and chronic renal failure. Therefore, early intervention in hypertensive patients correlates with long-term quality of life. The accurate diagnosis of hypertension is as important as the treatment in management of hypertension. Although there are intensive efforts to develop appropriate techniques for correct blood pressure measurement, common concerns about accurate measurement of blood pressure in clinical practice remain. For this reason, Ambulatory Blood Pressure Monitoring (ABPM) has been used effectively for the exact diagnosis of hypertension over the last 25 years. Recent clinical studies and guidelines recommend the use of ABPM in the diagnosis and follow-up treatment (1-6). Average ABPM blood pressure is lower than the manual blood pressure readings taken in the physician's office. In PAMELA study it was observed that an office blood pressure of 140/90 mmHg corresponds to a home value of 121-132 mmHg for systolic and 75-81 mmHg for diastolic. Therefore, accepted upper limit of ABPM blood pressure value is 135/85 mmHg (7).

Patients are at risk for blood pressure elevations at different time zones due to the circadian rhythm of blood pressure during the day. Even if an average daytime ABPM is below 135/85 mmHg, the night and early morning blood pressure elevations create a risk for cardiovascular diseases (8,9). Also, at the beginning and at the end of the ABPM, blood pressure elevations may be observed due to emotional factors. For this reason, even if a total average ABPM measurement is above 135/85 mmHg, the patient may not be hypertensive.

The aim of this retrospective study was to evaluate the effect of first, early morning and last measurements of ABPM on daily average blood pressure of patients previously untreated for hypertension.

Table 1. Ambulatory Blood Pressure Monitoring Values

	Systolic Blood Pressure (mmHg)	Diastolic Blood pressure (mmHg)
Total average	130.7±14.2	79.0 ±10.9
Daytime	133.8 ±14.6	81.1 ±10.4
Night	121 ±14.6	71,8 ±10,3
First measurement	140.5 ±17.6	88.0 ±12.2
Early morning	134.3 ±18.3	81.9 ±13.4
Last measurement	135.2 ±19.4	82.9 ±13.5

p<0.001 in all comparisons, both systolic and diastolic blood pressure

Method

The ABPM measurements of patients who were evaluated in our internal medicine service with suspect of hypertension were retrospectively studied from January 2009 to May 2010. The study was performed at Ankara Gulhane School of Medicine, Department of Internal Medicine between June and September 2010. None of the patients had previously received treatment for hypertension. Information about co-morbid diseases, smoking and alcohol use was limited. Some measurements were the repeated measurements from the same patients. The results of patients with more than 20 valid measurements within 24 hours were enrolled in to the study.

Blood pressure measurement

Ambulatory blood pressure monitoring had performed with a measuring device (Delmar Reynolds Medical Tracker NIBP Blood Pressure Recorder, Cardiff, UK) that meet the criteria of ESC / ESH guidelines. The device was applied to the nondominant arm by an experienced physician in a quiet examination room. The patient was instructed to perform normal activities, avoid heavy exercise between measurements and rest the arm at heart level after stopping activity during measurements. The device have recorded an mean of 38 blood pressure measurements at 30-minute intervals between 08: 00 AM- 12: 00 PM and 60 -minute intervals between 12:00 PM- 08:00 AM. Some recordings were detected as incorrect by device and were not included in the analysis of ABPM total average BP. At the end of 24 hours, the monitor was removed by a physician and the data were transferred to a computer.

A new total average blood pressure value (n-1) was calculated by excluding the first measurement of systolic and diastolic blood pressure value from the total average ABPM (n). In the same way new average blood pressure values obtained by excluding ABPM first and early morning measurements (n-2) and excluding ABPM first, early morning and last measurements (n-3) from the total average ABPM. Early morning was defined as the readings between 07:00 AM and 08:00 AM

Statistical analysis

The ABPM data were processed by use of statistical analysis software package (SPSS, SPSS Inc). Data were evaluated using SPSS 15.0 package program. The number, percentage, mean, standard deviation values were used to define data. Compliance of continuous variables to normally distribution was assessed by Kolmogorov Smirnov test. Student's t-test was used to compare the groups. Paired t test was used for intra-group comparisons. Pearson correlation test was used for the evaluation of the relationship between variables. Statistical significance was accepted for p-values < 0.05.

Results

602 ABPM results were analyzed and 525 of them were included in the study. 28 of these were repeated measurements of the same patients. Of them, 66.7% (n = 350) were obtained from the men. The mean age of the patients was 43.3 ± 16.1 years (the mean age of men was 39.6 ± 15.6 years, and women was 50.8 ± 14.6 years). The mean age difference between men and women was statistically significant (p <0.001). The mean of total average of blood pressure was 130.7 ± 14.2/79.0 ± 10.9 mmHg. (the mean blood pressure was 133.8 ± 14.6 / 81.1 ± 10.4 in the daytime ,and 121 ±14.6 /71.8 ± 10.3 mmHg in the night). The mean blood pressure was 133.4 ± 13.9/80.9 ± 11.5 mmHg in men and 125.1 ± 13.1/75.1 ± 8.4

mmHg in women (p <0.001). The mean of the first measurements was 140.5 ± 17.6 / 88.0 ± 12.2 mmHg, early morning measurements was 134.3 + 18.3 / 81.9 +13.4 mmHg and the last measurements was 135.2 ± 19.4 / 82.9 ± 13.5 mmHg. The means of the first, the early morning and the last measurements were all higher than the mean of total average (n) (p<0.001 in all comparisons, both systolic and diastolic blood pressure) (Tab le 1). The average of n-1, n-2 and n-3 measurements are 130,4±14,2/78,6±10,1 mmHg, 130,4±14,1/78,6±9,9 mmHg and 130,3±14,1/78,4±9,9 mmHg, respectively. Research results show that, regarding both systolic and diastolic blood pressures, there were statistically significant difference between the average of all measurements (n) and average of n-1, n-2 and n-3 measurements (p<0.001 in all comparisons, for both systolic and diastolic blood pressures) (Table 2).

Table 2. Total average Blood Pressure Values

	Systolic Blood Pressure (mmHg)	Diastolic Blood Pressure (mmHg)
n	130.7±14.2	79.0 ±10.9
n-1	130.4±14.2	78.6±10.1
n-2	1130.4±14.1	78.6±9.9
n-3	130.3±14.1	78.4±9.9

p<0.001 in all comparisons, both systolic and diastolic blood pressure
n; Total average blood pressure
n-1; Firs measurement extracted total average blood pressure
n-2, First and early moming measurements extracted total average blood pressure
n-3; First early moming and last measurements extracted total average blood pressure

The number of patients whose systolic blood pressure were <140 mmHg at the first measurement was 256 as a subanalysis of the study. In 43 of these patients total average systolic blood pressure was higher than ≥135 mmHg. So, systolic hypertension was detected in 16.8% of patients whose the first measurements were normal. The number of patients whose the first measurement systolic blood pressure ≥140 mmHg was 269. In 153 of these patients the total average systolic blood pressure was higher than ≥135 mmHg. Systolic hypertension was detected in 56.9% of patients whose the first measurement was in hypertensive levels (Table 3).

Table 3. First Mcasuncmcnts Systolic Prcssurc.

	First measurement SP<140 mmHg (N-256,%48.7)	First measurement SP<140 mmHg (n-269,%51.2)
Total average SP ≥ 135 mmHg	43 (%16.8)	153 (%56.9)
Total average SP <135 mmHg	213(%83.2)	116(%43.L)

SP. Systulic Pressure

The number of patients whose mean toal systolic blood pressure <135 mmHg in ABPM was 329 (%62.6). In 57 (%17.4) of these patients the early morning blood pressure was higher than ≥140 mmHg. The number of patients whose mean toal systolic blood pressure ≥135 mmHg in ABPM was 196 (%37.4). In 137 (%69.9) of these patients the early morning blood pressure was higher than ≥140 mmHg. (Table 4)

Discussion

In present study, ABPM results of 525 measurements of 497 patients who were not on antihypertensive therapy were evaluated and observed that first, early morning and the last

Table 4. Early Moming Measurements Systolic Pressure		
	Total average	Total average
	SP ≥135 mmHg	SP<135 mmHg
	(n-196,% 37,4)	(n-329,%62,6)
Early morning measurement SP <140 mmHg	59 (%30.1)	272(%82,6)
Early morning measurement SP≥140 mmHg	137(%59.9)	57(%17,4)
SP. Systulic Pressure		

readings were higher than total average ABPM (n). Owens et al, in their study about the determination of the white coat effect by ABPM, reported that the first and last measurements of patients were seen to be higher than the daily average (10). New total averages calculated by excluding the elevated blood pressure readings thought to be due to emotional factors were lower significantly. In our study, the differences in blood pressure between the total averages were less than 1 mm Hg, so these results were not clinically significant. It's reported in previous studies that the difference between the readings of different measurement techniques should be more than 5 mmHg systolic or diastolic for clinical significance (11).

The findings of our study showed that blood pressure elevations due to emotional factors didn't affect the average daily ABPM clinically. This may be ascribed to the large number of measurements during monitoring that alleviate the effect of blood pressure elevations caused by various factors. These findings proved once again the reliability of the ABPM. JNC VI reports also suggested that ABPM could be used for the discrimination of conditions such as white coat hypertension, elevation of night blood pressure and hypotension due to antihypertensive therapy (3). ABPM is a well tolerated measurement technique by patients. In a study, more than 90% of 672 patients agreed to a second recording (12). In our study, some measurements were repeated and the patients agreed to a second recording.

The blood pressure is affected by the circadian rhythm. The cause of coronary events such as myocardial infarction to be seen more frequently in the early morning hours is known to be increase in blood pressure due to activation of the sympathetic system. Increase in blood pressure in the early morning hours is independent of office blood pressure values and associated with cardiovascular events (13). ABPM is the most effective method to detect the increase in blood pressure in the early morning hours. In this study, the early morning blood pressure was higher than daily average blood pressure value and there was early morning blood pressure elevation in 17.4% of patients with normal average daily blood pressure. This result shows that patients with seemingly normotensive also may be risky for cardiovascular diseases. Especially the patients with chronic diseases such as diabetes mellitus, chronic kidney disease should be followed for early morning blood pressure even if they have normal blood pressure measurements (13).

At the end of the study we determined that patients with the first measurement of ABPM above 140 mmHg have the possibility of presenting hypertension, 3.4 times more than the patients with the first measurement of ABPM below 140 mmHg. This result shows that elevated first measurement during ABPM increased the possibility of being hypertensive. High blood pressure due to emotional factors is also seen in a white coat effect and it's known that these patients are more suscep-

tible to hypertension. Recent studies suggest that white coat effect increases the risk of cardiovascular disease and antihypertensive therapy is beneficial (14). A similar situation can be considered for patients with elevated first measurement of ABPM and having normal average blood pressure. Prospective, controlled studies with long-term follow-up are needed to clarify this situation.

The phenomenon of masked hypertension is defined as a clinical condition in which a patient's office blood pressure (BP) level is <140/90 mm Hg but ambulatory or home BP readings are in the hypertensive range. Masked hypertension is seen in 10 to 15% of all hypertensive patients and poses a risk for cardiovascular diseases. The ABPM is the most effective way of identifying masked hypertension. In our study the masked hypertension was found in 16.8 % of patients. This was correlated with the results of previous studies (15,16).

Our study was a retrospective study, so the information about comorbid conditions, smoking and alcohol consumption, body weight and daily activities was limited. This situation has hampered our understanding of how the results of ABPM are affected by personal factors of patients. Also, the patient group consisted of young people with suspected hypertension, which causes the blood pressure to be more prone to the emotional factors. Multicenter prospective randomized controlled trials with more patients can contribute to a more accurate assessment of the effect of emotional factors to daily average of ABPM.

Finally, depending on various factors, average of the first, early morning and the last ABPM measurements are higher than the average of all ABPM measurements. Although eliminating the first, early morning and the last measurements diminishes the average daily blood pressure, this reduction is not clinically significant. The first measurement systolic pressure > 140 mmHg increases the probability of hypertension in ABPM by 3.4 times. In addition, it is considered that if the early morning systolic BP measurements are ≥ 140, the risk of cardiovascular disease diagnosis due to ABPM considerably increases.

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