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Research Article / Araştırma Makalesi

The Effect of Different Body Possition on Calf Blood Pressure: A Cross-Sectional Study

Bacaktan Kan Basıncı Ölçümünde Farklı Vücut Pozisyonlarının Kan Basıncına Etkisi: Kesitsel Bir Çalışma

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Abstract: The calf area is an alternative measurement site when blood pressure cannot be measured at the arm. To determine the effects of different body positions on calf blood pressure readings in healthy young students. A total of 100 healthy young students who agreed to participate in the study were randomly selected. The study was carried out in Aydın Adnan Menderes University Nursing Faculty. In all participants, blood pressure was measured: supine, prone, right lateral, and left lateral recumbent. All measurements were performed three times at 1-min intervals, and the results were compared. There was no statistically significant difference between the blood pressure measurements in the supine and prone positions ($p>0.05$). The systolic blood pressure value was significantly lower in the left lateral recumbent position than in the other positions ($p<0.05$). The diastolic blood pressure was significantly higher in the right lateral recumbent position than in the other positions ($p<0.05$). When assessing calf blood pressure, it is important to consider the body position of the patient. It should be known that different results can be obtained in lateral recumbent positions.

Keywords: Blood pressure measurement, Calf, Vital sings.

Öz: Bacakta baldır bölgesi, kan basıncının koldan ölçülemediği durumlarda alternatif bir ölçüm yeridir. Bu çalışmada sağlıklı genç öğrencilerde farklı vücut pozisyonlarının bacaktan ölçülen kan basıncına etkisini belirlemek amaçlanmıştır. Araştırma rastgele seçilen ve araştırmaya katılmayı kabul eden toplam 100 sağlıklı genç öğrenci ile yapıldı. Çalışma Aydın Adnan Menderes Üniversitesi Hemşirelik Fakültesi'nde gerçekleştirildi. Tüm katılımcılarda kan basıncı: sırtüstü, yüzüstü, sağ yan ve sol yan yatar pozisyonda ölçüldü. Tüm ölçümler 1 dakikalık aralıklarla üç kez yapıldı ve sonuçlar karşılaştırıldı. Sırtüstü ve yüzüstü pozisyonda yapılan kan basıncı ölçümleri arasında istatistiksel olarak anlamlı fark yoktu ($p>0.05$). Sistolik kan basıncı değeri sol yan yatar pozisyonda diğer pozisyonlara göre daha düşüktü ($p<0.05$). Diyastolik kan basıncı sağ yan yatar pozisyonda diğer pozisyonlara göre daha yüksekti ($p<0.05$). Bacakta baldırdan kan basıncını değerlendirirken, hastanın vücut pozisyonunu dikkate almak önemlidir. Yan yatış pozisyonlarında farklı sonuçlar alınabileceği bilinmelidir.

Anahtar Kelimeler: Kan basıncı ölçümü, Baldır, Vital bulgular.

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Introduction

Vital signs provide essential information about the homeostatic balance and body's physiological state. Blood pressure is an important vital sign that indicates the general health status of individuals and plays a role in determining the treatment process of the patient (Cardona-Morrelli et. al., 2016). Therefore, it is necessary to measure blood pressure correctly. Although blood pressure measurement is one of the most routine examinations, it has a high probability of error. Accurate blood pressure measurements and diagnosis of hypertension are important in treating patients, regulating drug modifications, and determining cardiac risk factors (Netea et. al., 2003). Incorrect measurements cause unnecessary examinations and initiation or continuation of unnecessary drugs, which are detrimental to both the individual and the country's economy (Mok et. al., 2015).

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The upper arm is typically used for blood pressure measurements. However, an alternative measurement site is required if the arm cannot be used, especially in patients undergoing orthopaedic and plastic surgery, those recovering from a mastectomy or stroke, those with upper extremity fractures or burns, and those who have received multiple intravenous injections. Also, choosing an alternative site for measuring blood pressure is required in patients with upper limb deformities or amputations. Therefore, as an alternative to the arm, the calf region of the leg is the most commonly used area for blood pressure measurement (Sareen et. al., 2012).

Calf blood pressure can be measured in the supine position, with the leg slightly bent at the knee (Craven et.al., 2009) or in the prone position (Enç, 2015). Generally, electronic blood pressure instruments are used for these measurements, which are calibrated at regular intervals (Craven et.al., 2009).

Certain studies comparing blood pressures measured at the arm, leg, and ankle reported that the ankle might be a suitable alternative region to the arm for assessing blood pressure. (Block & Schulte, 1996; Korhonen, 2006; Lee et.al., 2020; Wilkes et.al., 2004). Some studies have revealed that the calf can also be an alternative to the arm for measuring blood pressure. The blood pressure measurements made at the ankle were, on average 4 mmHg higher than measurements made at the calf (Moore et.al., 2008).

Patients with movement restrictions in supine, prone, or lateral recumbent positions may need calf blood pressure measurements. Although the calf region may be suitable for blood pressure measurements, the patients may be positioned differently during the procedure. However, no evidence-based study shows which positions are more reliable for measuring calf blood pressure. Further studies are needed to determine which position can reliably measure calf blood pressure. The study aimed to test the effects of different body positions on calf blood pressure measurements in healthy young Turkish students.

Materials and Methods

Study Design

This is a cross-sectional study. This study was approved by the Aydın Adnan Menderes University Nursing Faculty Non-Interventional Clinical Research Ethics Committee (No: E-76261397-050.04.04-88340). The aim of the study was explained to the students, they were informed of the study procedure, and their verbal consent was obtained. This study was conducted in accordance with the Declaration of Helsinki of 1964, as revised in 2013.

Study Population

This study included 100 healthy young students randomly selected from among students from the Aydın Adnan Menderes University Faculty of Nursing between January, 2022 and June, 2022. Inclusion criteria were (1) being 18 years of age or older and (2) not having any adverse condition (open wound, burns, fracture, lymphatic drainage problems, etc.) that could affect blood pressure measurement in the legs. Patients with anatomical disorders and those who could not lie in the prone or lateral recumbent positions were excluded from the study.

Sample

The study's sample size was calculated using the software G*Power version 3.1.9.2. The study by Lee et al. (2020) was used as a reference to estimate the effect size (Lee et.al., 2020). Considering the effect size (d=0.462), 5% margin of error (α=0.05), and 80% power, the sample size was determined to be 56. A total of 100 participants (79 women and 27 men) were included in the study using a random sampling method, taking into account possible data losses.

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Study Procedures and Data Collection

A questionnaire and blood pressure record form were used to collect the research data. The questionnaire included questions about sex, age, body mass index, drug use, smoking and presence of chronic disease. The blood pressure was measured supine, prone, and lateral recumbent positions were recorded on the blood pressure record form. An electronic sphygmomanometer of the Fortune brand (for adults) was used for blood pressure measurement. The sphygmomanometer used in the research is a valid device. A medical supplier calibrated the blood pressure monitor after every 20 measures. Before its use in the study, the sphygmomanometer was tested on 10 individuals, and its standardisation was evaluated.

In the research, the questionnaires were completed through in-person interviews. During blood pressure measurement, each participant's calf was adequately exposed, and the blood pressure measurements were initiated by having them lie on a comfortable bed.

Blood Pressure Measurements

Blood pressure measurements were made 30 min after smoking, consuming caffeinated beverages (tea and coffee), eating, and exercising. Individuals rested for 10 min before the measurements were made. Sphygmomanometer cuffs compatible with the circumference of the legs and the participant's weight were utilised. The cuff was placed 2–3 cm above the popliteal artery for the measurements. All measurements were performed on the right leg. The first measurement was made with the participants in the supine position, with the head supported by a pillow at shoulder level. The second measurement was made in the prone position, with the head and shoulder supported by a pillow and the arms extended to both sides.

Other measurements were performed with the participants in the right and left lateral recumbent positions. In these positions, the individual's head was supported by a pillow that did not extend past the shoulder level. In the right lateral recumbent position, the upper leg was slightly bent at the knee, the right leg was pulled back, and a thin pillow was placed under the left leg. Similarly, while in the left lateral recumbent position, the blood pressure was measured by slightly bending the upper right leg at the knee. A 1-min break was given between each measurement; the measurements were repeated three times in each position, and the average of all three measurements was recorded as the blood pressure value.

Statistical analysis

The statistical package for the social sciences version 25.0 (SPSS Inc., IL, USA) program was used to analyse the data. The data conformity to the normal distribution was analysed using the skewness test, and it was determined that the data conformed to the normal distribution (0.348±0.241–0.183±0.478). Data were expressed as numbers, percentages, and mean ± standard deviation. Repeated measures analysis of variance was used to compare the means of measurement made at different positions. Adjustment for multiple comparisons was performed using the Bonferroni correction. Differences were considered statistically significant at $p < 0.05$, unless otherwise stated.

Results

The mean age of the participants in the study was 20.27±1.21 years (range:18–26 years); 75% were 19–21 years old, and 79% were women. While 33% of the participants were smokers, 10% had a chronic disease, and 6% used drugs continuously. The mean body mass index of the participants was 21.71±3.12 kg/m^2 (range:16.96–33.13 kg/m^2). The calf blood pressure values (systolic and diastolic) of the participants in the four positions are presented in Table 1. The difference between systolic and diastolic blood pressures in all positions was statistically significant ($p<0.05$).

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Table 1. Calf blood pressure recordings for all positions

	Supine	Prone	Right lateral recumbent	Left lateral recumbent	F/p
Mean systolic BP	122.89±13.46	122.88±12.63	125.09±16.66	118.09±13.66	*F=12.26 **<0.01**
Mean diastolic BP	64.98±6.87	64.66±8.15	68.42±8.96	63.35±7.36	*F=14.14 **<0.01**

BP; blood pressure,*: Repeated measures analysis of variance.

Table 2. Pairwise comparisons between positions in systolic and diastolic calf blood pressure.

	Supine	Prone	Right Side Lying	Left Side Lying
Sistolic BP				
Supine				*
Prone				*
Right lateral recumbent				*
Left lateral recumbent	*	*	*	
Diastolic BP				
Supine			*	
Prone			*	*
Right lateral recumbent	*	*		*
Left lateral recumbent			*	

* p<0.05 statistically significant, Bonferroni test.

The pair-wise comparisons made between the positions for diastolic and systolic blood pressure (Table 2). Systolic blood pressure measured in the left side lying position was significantly lower (p<0.05). Diastolic blood pressure was higher in the lateral recumbent position. In the left lateral recumbent; was quite low compared to the prone position (p<0.05).

The limits of agreement for systolic and diastolic blood pressure measurements according to the left and right lateral recumbent positions are presented in Table 3. Accordingly, it was determined that the greatest difference in systolic blood pressure was between the right and the left lateral recumbent positions (6.99 mmHg more). In the diastolic blood pressure measurement, it was determined that the most significant difference was again in the right and left lateral recumbent positions (5.06 mmHg lower).

Discussion

The study aimed to determined the effects of different body positions on calf blood pressure readings in 100 healthy young Turkish students. A review of relevant literature reveals studies comparing the blood pressure measurements made at the arm, wrist, and leg. However, no study has evaluated the relationship between calf blood pressure measurements and the body position. The study's results indicated a difference between blood pressure values in all the four body positions. Based on the Bonferroni test, it was determined that there was no difference between the blood pressure measured in the supine and prone positions. While systolic blood pressure was

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the lowest in the left lateral recumbent position, diastolic blood pressure was the highest in the right lateral recumbent position.

Table 3. Limits of agreement for SBP, DBP (mmHg)

	Mean difference	**% 95 limits of agreement**
Systolic BP		
Supine - Left lateral recumbent	4.79	2.73 to 6.85
Prone - Left lateral recumbent	4.81	2.51 to 7.07
Right lateral recumbent-Left lateral recumbent	6.99	4.38 to 9.60
Diastolic BP		
Supine - Right lateral recumbent	-3.43	-4.95 to -1.91
Prone - Right lateral recumbent	-3.76	-5.42 to -2.10
Left lateral recumbent-Right lateral recumbent	-5.06	-6.83 to -3.29

BP - Blood pressure SBP - Systolic blood pressure, DBP - Diastolic blood**.**

Studies have reported that the calf and ankle may be viable alternatives to the arm for blood pressure measurement (Lakhal et.al., 2011; Moore et.al., 2008). However, in these studies, all blood pressure measurements were made at the calf in the supine position. In a study comparing blood pressure measured at the arms and legs in the supine position, calf blood pressure was, on average 4 mmHg higher than arm blood pressure, while the blood pressure measurements made at the wrist were 8 mmHg higher than the arm measures. The results of this study suggest that the calf could be used as an alternative region for measuring blood pressure (Sareen et.al., 2012).

In our study, systolic blood pressure measured in the left lateral position was lower than in all positions. There were studies reporting results similar to our study (Almeida et.al., 2009; Armstrong et.al., 2011; Ribeiro et.al., 2016; Tran et.al., 2014). According to another study, the blood pressure determined in the right lateral recumbent position was 16 mmHg lower than other positions (Bein et.al., 1996).

The reasons for these differences in blood pressure measurements and hydrostatic effects have been reported. Pressure in any vessel below the heart level tends to be high, whereas pressure in any vessel above the heart level tends to be low due to the influence of gravity (Park and Park, 2002). However, because all measurements were performed in the recumbent position in our study, there was no significant difference between leg and heart alignment. In our study, the difference between the lateral recumbent and other positions was much smaller than in other studies. These differences can be attributed to individual characteristics unrelated to the effects of the recumbent body position or the position of the leg. However, because all measurements in our study were performed in the recumbent position In addition, this difference may suggest that differences in body position do not result in significant haemodynamic changes. In addition, these results may have been obtained in blood pressure measurements due to individual variances in the calf muscle structure.

As a limitations, the study was conducted at a single centre and the number of patients was small.

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The study was performed in healthy young students and cannot necessarily be extrapolated to other populations. Calf blood pressure in the lying position was evaluated, and measurements were repeated in different positions. Blood pressure was measured only in the right leg.

In conclusion; the study's results indicate that different body positions affect the measurement of blood pressure in healthy young students. This study confirms the literature-suggested practise of taking blood pressure from the leg in the supine or prone posture. It was determined that the systolic blood pressure value was lower in the left lateral recumbent position. Also, the diastolic blood pressure was higher in the right lateral recumbent position and lower in the left lateral recumbent position than in the prone position. According to the results of the study, it is recommended that the blood pressure measurements of the patients be made in the prone or supine position if possible, and if it must be measured in the lateral recumbent position. It is recommended to evaluate the blood pressure values of the patient by being aware of these differences in the measurement results. In addition, the body position in which the blood pressure measurements were performed should be documented.

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