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The effect of cuff size on the blood pressure in individuals with large arm diameter

Kol çevresi geniş bireylerde manşon çapının kan basıncına etkisi

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Original Article

Abstract

Objective: The aim of this study was to compare the blood pressure measurements obtained using 22x32 cm (standard) and 32x42 cm (wide) cuffs in individuals with large arm circumferences.
Method: A descriptive and cross sectional study was carried out in the obesity clinics of a university hospital between April and November 2011. The study included 122 adult individuals with 32 cm or larger arm circumference, without any physical interference on the measured arm (such as mastectomy, burn, fistula or deformity) and who accepted to participate in the study. After written informed consents were taken from the individuals participating in the study, ~~a~~ blood pressure measurement was first performed from the left arms of the individuals in ~~the~~ sitting position with the larger cuff of the sphygmomanometer, and then they were let to rest for 3 minutes. The measurement was repeated by using the smaller cuff of the sphygmomanometer. Wilcoxon paired two-sample test was used for the comparison of the blood pressure data obtained by using standard and large cuffs.

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Results: The blood pressure measurements performed by the standard cuff were higher than these performed by the large cuff ($p<0.001$). The systolic and diastolic blood pressure measurements performed by both the standard cuff and the large cuff was not statistically significant according to age group and gender ($p>0.05$).
Conclusion: The selection of proper sized cuffs for the measurement of blood pressure would prevent inaccurate results.

Keywords: Blood pressure, arm circumference, cuff size, sphygmomanometer.

Özet

Amaç: Bu çalışmanın amacı kol çevresi geniş olan hastalarda 22x32 cm (standart) ve 32x42 cm (geniş) çapında manşon kullanarak elde edilen kan basıncı ölçümlerinin karşılaştırılmasıdır.
Yöntem: Bu araştırma Nisan ve Kasım 2011 tarihleri arasında bir üniversite hastanesinin obezite kliniğinde yürütülmüş tanımlayıcı ve kesitsel bir araştırmadır. Araştırma ölçülen kolda herhangi bir fiziksel engel (mastektomi, yanık, fistül ve deformite vb.) bulunmayan ve araştırmaya katılmayı kabul eden kol çevresi 32 cm ya da daha fazla olan122 bireyi kapsamıştır. Araştırmaya katılan bireylerden yazılı onam alındıktan sonra, kan basıncı ölçümü önce oturma pozisyonundaki bireylerin sol kollarından manşonu daha geniş olan tansiyon aleti ile yapılmış, daha sonra birey 3 dakika dinlendirilmiştir. Ölçüm daha dar manşonlu tansiyon aleti ile tekrarlanmıştır. Standart ve geniş manşonlu tansiyon aletlerinden elde edilen kan basıncı verilerinin karşılaştırılmasında Wilcoxon eşleştirilmiş iki örnek testi kullanılmıştır.
Bulgular: Standart manşonlu tansiyon aleti ile ölçülen kan basıncı değerleri geniş manşonlu tansiyon aleti ile yapılan değerlerden daha fazla bulunmuştur($p<0.001$). Standart ve geniş manşonlu tansiyon aletleri ile yapılan ölçümlerde yaş grubu ve cinsiyete göre sistolik ve diastolik kan basınçları arasındaki fark anlamsız bulunmuştur ($p>0.05$).
Sonuç: Kan basıncı ölçümü için uygun manşonlu tansiyon aletinin kullanılması hatalı sonuçları önleyebilir.

Anahtar Sözcükler: Kan basıncı, kol çapı, manşon genişliği, sfigmomanometre.

Introduction

Measurement of the blood pressure is a simple and widely used method that provides important information on the health situation of an individual. However, many factors affect the accuracy and reliability of a measurement such as age, gender, exercise, pain, emotional state, circadian rhythm changes, position and shape of the arm, improper cuff width.[1-7]

Blood pressure is usually measured from the upper arm. The diameter of the upper arm and the size of the cuff used are important factors affecting the measurement of the blood pressure. Inappropriate cuff usage may result in inaccurate reading. Cuffs that are too small for the extremity may artificially cause a high systolic blood pressure reading.[8-11]Because the usage of small cuffs for individuals with large arm circumferences may cause over-inflation of the cuff and thus resulting in inaccurate reading, misclassification of individuals' BP levels and wrong treatment.[12-14]

Generally standard sized cuffs (22x32 cm) are used for the measurement of the blood pressures of individuals with large arm circumferences in the clinics. But the regular cuff size is too short for individuals with an arm circumference of 32 cm or larger.[8] For an accurate measurement, the cuff size should be appropriate for the arm circumference, and the diameter of the cuff should increase with the increase in the diameter of the extremity.[2,3,9,10,13]Although The Joint National Committee on

Prevention, Detection, and Treatment of High BP and current guidelines recommend the usage of a proper sized cuff for an accurate blood pressure measurement, health care providers infrequently follow guidelines.[3] In a study by Manzoli et al. (2012) 1334 adult patients answered a questionnaire containing 15 items on the main procedures related with blood pressure measurement, and only 1.4% patients have reported that during their stay in the hospital, before blood pressure measurement, their arm circumference was measured at least one.[15] Minor et al.(2012) presenting an evaluation of the accuracy of blood pressure measurements of 119 patients in their study also have reported that none of the blood pressure measurements contained the measurement of the arm circumference consistently with the study of Manzoli et al. (2012).[16]In another study by Machado et al. (2014) it was found that only 29.0% of the nursing professionals chose adequate cuff width and lack of measurement of arm circumference to choose the cuff size was one of the primary concern.[14] Similar findings were also reported by Almeida and Lamas (2013).[17]

As can be seen from these results, failures on measuring blood pressure including cuff-type chosen are still current issue among health care providers, although there are previous findings determining errors and gaps in knowledge and incomplete practices of blood pressure measurement.[18-21]

There is no study in the literature investigating the difference in the usage of standard or wide cuffs for the individuals with large arm circumferences. The aim of this study was to compare the blood pressure measurements obtained using 22x32 cm (standard) and 32x42 cm (wide) cuffs in individuals with large arm circumferences.

Study Questions:

The main purpose of the study was to compare the values of systolic and diastolic blood pressures obtained by different sized-cuffs (22x32 cm and 32x42 cm) in individuals with large arm circumferences.

Specifically, the following question could be asked:

Is there any significant relationship between the demographic variables of the sample and values of systolic and diastolic blood pressures obtained by different sized-cuffs?

Method

Design

This study was conducted as a descriptive and cross sectional design.

Study Sample

This study has been conducted in the obesity clinics of Ege University Medical Faculty Hospital between April and November 2011. This outpatient clinics is a department that provide consultation on the weight and dietary management of and perform follow-up to the obese individuals. Simple random sampling method was used in this study.The study included 122 adult individuals with 32 cm or larger arm circumference, without any physical interference on the measured arm (such as mastectomy, burn, fistula or deformity) and who accepted to participate in the study. In order to determine the power of the sample size, a Power Analysis was performed; the power of the test was detected to be 80% with 122 participants.

The cuff sizes were considered according to the arm circumference mentioned in the Turkish Society of Cardiology, National Hypertension Therapy and Follow-up Guidelines[4,22-25]and those with a 32 cm or larger arm circumference were included in the study. The arm circumferences of the individuals were determined by using tape measure. The arm was flexed 90° from theelbow and the measurement was performed in the middle of the distance between the acromial process and the olecranon. Individuals with an upper arm diameter of 32 cm or larger were included in the study.

Data Collection

A "Procedure Recording Form" was used in the collection of the data that included the informative data (such as age, gender, BKI, arm circumference) and the blood pressure values. The Mikrolife model BP 3AC1-2 sphygmomanometer used oscillometrically in the study was a calibrated automatic tension tool that measures the systolic and diastolic blood pressures and heart rates safely. It has two different cuffs with 22x32 and 32x42 cm sizes. It has been designed as a user-friendly tool that provides a high and tested measurement reliability.

Data Collection

Before study initation, a pre-application was carried out to 10 individuals, who were not covered by the research. Measurement of the blood pressures of the individuals was carried out with Mikrolife model BP 3AC1-2 sphygmomanometer consisting of two different cuffs with 22x32 and 32x42 cm sizes, and no problems occured related to blood pressure measurement. After unclear questions about demographic characteristics of the individuals were revised and then study was initiated.

A blood pressure measurement was first performed from the left arms of the individuals in the sitting position with the larger cuff of the sphygmomanometer, and then they were let to rest for 3 minutes by three researchers. Then the measurement was repeated by using the smaller cuff of the sphygmomanometer. The data obtained were recorded in the form. The blood pressure measurements were performed according to the blood pressure measurement guidelines designed by the investigators in accordance with the literature. [6,17-19]

Data Analysis

The data were analysed by Statistical Package for the Social Sciences for Windows (SPSS 15.0, Inc., Chicago, IL, USA) program. Descriptive analysis of the sample included numeric and percentile distributions. The level of significance was set at $p < .05$ for each test. Wilcoxon Paired Two-sample Testwas used for the comparison of the blood pressure data obtained by using standard and large cuffs. Mann- Whitney U and Kruskal Wallis tests were used for the analysis of independent variables.[20]

Ethical Aspect of the Study

The study was conducted upon approval of Ege University Medical Faculty and the Scientific Ethic Committees of the Medical Faculty, the Nursing Faculty of Ege University in İzmir, and written informed consents were taken from the individuals participating in the study.

Results

Fifty eight point two percent of the individuals included in the study were women, 41.8% was between 18 and 35 years of age, 4% was between 36 and 65 years of age (mean: 43.54±19.03).

It has been observed that the systolic and diastolic blood pressure measurements performed by the standard cuff were higher than these performed by the large cuff, and that the difference was statistically significant (p<0.001) (Table 1).

Table 1: Blood pressure values obtained by using standard and large cuffs

Cuff size*	Systolic blood pressure Median	Diastolic blood pressure Median
Standard cuff	137.50	79.00
Large cuff	127.50	71.50
p	0.001	0.001

** Wilcoxon paired two-sample test*

The systolic and diastolic blood pressure measurements performed by both the standard cuff and the large cuff was not statistically significant according to age group and gender (p>0,005).The difference between the values of systolic and diastolic pressures performed with both the standard and the large cuffs was mostly seen in the group under 35 years of age (Table 2).

Table 2: The percentage differences of the blood pressures performed by the standard and large cuffs according to the age group and gender of the individuals

	Age*	Median	p
Percentage difference of the systolic blood pressure	≤35 (n: 51)	8,94	0,202
	36-65 (n: 50)	5,71	
	>65 (n: 21)	6,42	
Percentage difference of the diastolic blood pressure	≤35 (n: 51)	11,11	0,234
	36-65 (n: 50)	6,45	
	>65 (n: 21)	7,22	
Gender†			
Percentage difference of the systolic blood pressure	Female(n: 71)	6,66	0,711
	Male (n: 51)	7,50	
Percentage difference of the diastolic blood pressure	Female (n: 71)	8,57	0,789
	Male(n: 51)	9,52	

** Kruskall Wallis*

† Mann-Whitney U Test

Discussion

The cuff size that may extensively affect the validity and accuracy of a blood pressure measurement, is an important component of blood pressure follow up. A standard cuff with a bladder measuring 12x26 cm for the majority of adult arms is suggested by British Hypertension Society, while American Heart Association recommends an adult cuff with a bladder measuring 13x30 cm for an arm circumference range of 27-34 cm. [8]Usage of a wrong cuff size will lead to inaccurate reading of the blood pressure. The data concerning the clinical usage show that there are widespread problems in the selection of the cuff sizes. The most frequent is the usage of the same cuff size for all adult individuals. Measurements with improper sized cuffs may lead to higher or lower readings than normal and result in misjudgement of a case. An inaccurate blood pressure value may lead to faulty decisions of treatment and consequently to negative outcomes that may worsen the present situation of a individual. Thus, choosing the right cuff size in the measurement of the blood pressure may be vital for the correct management of a individual. In this study we have compared the blood pressure outcomes obtained using standard or large cuffs for individuals with large arm circumference.[13-16]

The use of regular cuffs for overweight/obese/muscular individuals causes consistent overestimation of diastolic blood pressure by approximately 6 mmHg.[22-26,28]In our study, we have observed that the systolic and diastolic blood pressure measurements performed with standard cuffs gave higher results than those with large cuffs, and that the difference observed was statistically significant ($p<0.001$). In the study of Fonseca-Reeyes et al. (2003),which have included patients with an arm circumference of 33 cm or larger, the systolic and diastolic blood pressure measurements performed using a standard cuff were found to be higher than those performed using a large cuff. In the same study it was observed that each 5 cm of increase in the circumference of the arm have resulted in a 2-5 mmHg increase in the systolic blood pressure, and a 1-3 mmHg increase in the diastolic blood pressure.[29] In the study of Veiga et al. (2009),it was mentioned that the cuff size should be appropriate for the arm largeness of the patients in order to prevent inaccurate blood pressure measurements.[21] In another study on obese patients, the usage of small cuffs had resulted in 5-9 mmHg and 4-7 mmHg increases in the systolic and diastolic blood pressure measurements respectively.[30]The review of O'Brien (1996) has demonstrated significant increase in the blood pressure measurements observed using too small or narrow cuffs.[31] Doshi et al. (2010) have demonstrated that the systolic blood pressure measurements observed using standard cuffs in 87% of the women were equal to or higher than those observed using large cuffs. Similarly, the diastolic blood pressures observed using standard cuffs in 92% of the men were equal to or higher than those observed using large cuffs.[2] The findings observed in our study is in accordance with the findings of other studies and the literature.

It has been reported in the literature that the width of the cuff should be at least 40% of the arm circumference and the length should be 80% of the arm circumference. [8,13,31-35]The World Health Organisation report states that the standard sized cuffs are not proper for the patients with an arm circumference of 32 cm or larger in the measurement of blood pressure, and usage in such patients may result in higher than normal measurements.[8,24,25] The findings related to the cuff size in the literature supports our findings.

The difference in the systolic and diastolic blood pressure measurements between the standard and large cuff usage were mostly seen in the <35 age group in our study. However, the difference between the said independent variables and the pressure differences is not statistically significant. It is observed that the difference in the blood pressure measurements of the participants is increased in similar rates regarding the age groups and the gender.

This may be due to the similar physical properties (with an upper arm circumference of >32 cm) observed in the participants of all age groups and both genders in our study. It was observed in the study of Doshi et al. (2010) that, the systolic blood pressure measurements observed using standard cuffs in 87% of the women were equal to or higher than those observed using large cuffs.[2] Similarly, the diastolic blood pressures observed using standard cuffs in 92% of the men were equal to or higher than those observed using large cuffs.The discordant outcomes observed in our study with those of Doshi et al.'s (2010) may be due to different sample sizes and the differences in the sphygmomanometers used as well.

Study Limitations

The sample of the study is limited to the healthy individual. Unhealthy individuals were not included in the study, because any health problem can affect the results of blood pressure measurement.

Conclusion

As a conclusion, the systolic and diastolic blood pressure measurements obtained using standard cuff size were found to be higher than those obtained using large cuffs in individuals with an upper arm diameter of 32 cm or wider. The selection of proper sized cuffs for the measurement of blood pressure would prevent inaccurate results and faulty evaluations in the clinic practice, and provide an increased accuracy and reliability for the procedure.

Author contributions

Design of Study: G-T, Ş Ç-Y, E K-G, İ-E, L K
Data Collection or/and Analysis: G-T, Ş Ç-Y, E K-G
Preperation of Manuscript: G-T, Ş Ç-Y, E K-G, İ-E, L K

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Conflict of interest

No conflict of interest has been declared by the authors.

References

1. Pınar R, Sabuncu N, Oksay A. Effects of crossed leg on blood pressure. Blood Press 2004; 13(4): 252-254.
2. Doshi H, Weder AB, Bard RL, Brook RD. Does "hidden under cuffing" occur among obese patients? Effect of arm sizes and other predictors of the difference between wrist and upper arm blood pressures. J Clin Hypertens 2010; 12(2):82-88.
3. Ostchega Y, Dillon C, Prineas RJ, McDowell M, Carroll M. Tables for the selection of correct blood pressure cuff size based on self-reported height and weight and estimating equations for mid-arm circumference: data from the US national health and nutrition examination survey. J Hum Hypertens 2006; 20(1): 15-22.
4. Potter PA, Perry AG. Vital signs, Fetzer SJ. (Ed.) Fundamentals of Nursing. 7th edition, St. Louis: Mosby Elsevier, 2009; 536-549.

5. Rushing J. Taking blood pressure accurately. Nursing2004; 34 (11): 26.
6. Sabuncu N, Alpar ŞE, Özdilli K, Batmaz M, Bahçecik N, İlhan SE, Özhan F, Dursun S. Yaşam bulguları, Sabuncu N, Özhan F. (Eds.), Hemşirelik Bakımında İlke ve Uygulamalar, 2. baskı, Ankara: Alter Yayıncılık, 2008; 257-267.
7. Handler J. The importace of accurate blood pressure management. Perm J 2009; 13(3): 51-54.
8. Palatini P, Parati G. Blood Pressure measurement in very obese patients: a challenging problem. J Hypertens 2011; 29(3): 425-429.
9. İnanç N, Hatipoğlu S, Yurt V, Avcı E, Akbayrak N, Öztürk E. Yaşam bulguları, Yurt V. (ed.), Hemşirelik Esasları, 8. baskı, Ankara: Damla Matbaacılık, 2003; 187-190.
10. Anderson DJ, Anderson MA, Hill PD. Location of blood measurement. Medsurg Nursing 2010; 19(5):287-295.
11. Akpolat T. Obesity, hypertension and home sphygmomanometer cuffs. Eur J Intern Med 2010; 21(4):338-340.
12. Stergiou GS, Tzamouranis EG, Nasohimiou EG, Protogerou AD. Can an electronic device with a single cuff be accurate in a wide range of arm size? Validation of the visomat comfort 20/40 device for home blood pressure monitoring. J Hum Hypertens 2008; 22(11): 796-800.
13. McFarlane J. Blood pressure measurement in obese patients. Crit Care Nurse 2012; 32(6): 70-73.
14. Machado JP, Veiga EV, Ferreira PAC, Martins JCA, Daniel ACQGD, Oliveira AS, Silva PCS. Theoretical and practical knowledge of nursing professionals on indirect blood pressure measurement a coronary at a coronary care unit. Einstein 2014; 12(3): 330-335.
15. Manzoli L, Simonetti V, D' Errico MM, De Vito C, Flacco ME, Forni C, La Torre G, Liguori G, Messina G, Mezzetti A, Panella M, Pizzi C, Siliquini R, Villari P, Cicolini G.(In)accuracy of blood pressure measurement in 14 Italian Hospitals. J Hypertens 2012; 30(10): 1955-1960.
16. Minor D, Butler KR, Artman KL, Adair C, Wang W, Mcnair V, Wofford MR, Griswold M.Evaluation of blood pressure measurement and agreement in an academic health sciences center. J Clin Hypertens 2012; 14(4): 222-227.
17. Almeida TC, Lamas JL. Nurses of adult intensive care unit: evaluation about direct and indirect blood pressure measurement. Rev Esc Enferm USP 2013; 47(2): 369-376.
18. Armstrong RS. Nurses' knowledge or error in blood pressure measurement tecqnique. Int J Nurs Pract 2002; 8(3): 118-126.
19. Robello CC, Pierrin AM, Mion D. Health care professionals' knowledge of blood pressure measurement. Rev Esc Enferm USP 2004; 38(2): 127-134.
20. Dickson BK, Hajjar I. Blood pressure measurement education and evaluation program improves measurement accuracy in community-based nurses: a pilot study. J Am Acad Nurs Pract 2007; 19(2): 93-102.
21. Veiga EV, Arcuri EAM, Cloutier L, Santos JLF. Blood pressure measurement:arm circumference and cuff size availability. Rev Lat Am Enfermagem 2009; 17(4):455-461.
22. Perry AG, Potter AG. Vital signs, Fetzer SJ. (Ed.), Nursing Interventions and Clinical Skills.5th edition, St. Louis: Elsevier Mosby, 2012;103-107.
23. Berman AJ, Snyder S. Vital signs, Berman AJ, Snyder S. (Eds.), Kozier&Erb's Fundamentals of Nursing Concepts, Process, and Practice. 9th edition, Edinburgh Gate: Pearson Education Ltd., 2014;558-572.
24. The Seventh Report of the Joint National Committie of Prevention, Detection, Evaluation and Treatment of High Blood Pressure (İnternet). Ulaşım adresi: http://www.ncbi.nlm.nih.gov/books/NBK9630/pdf/TOC.pdf, (Ulaşım tarihi: 05.08.2013).
25. Report of a WHO Expert Committee. Arterial hypertension. World Health Organization Technical Report Series No.628. 1978; 3:11-12.
26. Atabek TA, Karadağ A. (Çeviri ed.), Yaşam Bulguları, Öztür D. Klinik Uygulama Becerileri ve Yöntemleri, Adana: Adana Nobel Kitabevi, 2010;517-531.
27. Munro BH. Statistical Methods for Health Care Research. 5 th. Edition, Boston: Lippincott Williams&Wilkins, 2004;121.
28. Perloff D, Grim C, Flack J, Frohlich ED, Hill M, McDonald M, Morgenstern BZ. Human blood pressure determination by sphygmomanometer. Circulation1993; 88(5 Pt 1): 2460-2470.
29. Fonseca-Reeyes S, de Alba-Garcia JG, Parra-Carillo JZ, Paczka-Zapata JA.Effect of standard cuff on blood pressure readings in patients with obese arms. Blood Press Monit 2003; 8:101-106.
30. Sprafka JM, Strickland D, Gomez-Marin O, Prineas RJ. The effect of cuff size on blood pressure measurement in adults. Epidemiology 1991; 2(3): 214-217.
31. O'Brien E. Review: a century of confusion; which bladder for accurate blood pressure measurement? J Hum Hypertens 1996 10(9): 556-572.
32. Kirkendal WM, Burton AC, Epstein FH, Freis ED. Recommendations for human blood pressure determination by sphygmomanometers. Circulation 1967; 36(6):980-988.
33. Frohlich ED, Grim C, Labarthe DR, Maxwell MH, Perloff D, Weidman WH. Recommendations for human blood pressure determination by sphygmomanometers: report of a special task force appointed by the Steering Committee, American Heart Association. Hypertension 1988; 11: 201A-221A.
34. Petrie JC, O'Brien ET, Littler WA, Swiet M. Recommandations on blood pressure measurement. Br Med J 1986; 293(6547):611-615.
35. Bonso E, Dorigatti F, Palatini P. Accuracy of the BP A100 blood pressure measuring device coupled with a single cuff with standard-size bladder over a wide range of arm circumferences. Blood Press Monit 2009; 14(5):216-219.