Comparison between the central and brachial blood pressure values in patients with hypertension undergoing cineangiocoronarography

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ABSTRACT

Introduction: Systolic blood pressure (SP) and pulse pressure (PP) rise gradually during the aging process as a consequence of a reduction in arterial elasticity. The measure of systemic arterial pressure (SAP) taken at the root of the aorta has been considered an independent determinant of cardiovascular mortality superior to the values of brachial SAP. **Aim:** To compare the values of SAP central to those of braquial SAP in patients of different age brackets who have systemic hypertension. **Method:** We evaluated the central SAP at the root of the aorta and the brachial SAP in the left arm using the ocillometric method 244 hypertensive patients who had been submitted to cineangiocoronarography. Five groups of patients were constituted: Group I, 39-49 years-old (y.o.), n = 36; Group II, 50-59 y.o., n = 67; Group III, 60-69 y.o., n = 69; Group IV, 70-79 y.o., n = 46; Group V, ≥ 80 y.o., n = 26. **Results:** When central SP was compared to brachial SP, it was possible to find significance in patients who were 50 y.o and upwards. It was not possible to find a statistical difference between central diastolic pressure and brachial except in patients between the ages of 60-69 y.o. When comparing central to brachial PP, we observed that central PP was significantly greater (between 11 and 15 mmHg) in all patient above the age of 50 y.o. **Conclusion:** In older people, the values of SP and PP, taken directly at the root of the aorta, are superior to those obtained by indirect means from the brachial artery. These differences are significant from the age of 50 y.o. onwards.

Keywords: health, hypertension, survivorship (public health).

INTRODUCTION

Systemic blood pressure (SBP) has important predictive value for cardiovascular events when measured by indirect methods. The measurement of the detected SBP levels, usually conducted using a sphygmomanometer connected to an upper extremity, has been used in both clinical practice and in research studies with large population samples.[1-4] The use of other SBP reading methods such as oscillometric devices with digital recording are also widespread in outpatient practice and in several clinical studies.[4,5]

Recently, some authors have shown that central SBP (cSBP) obtained from the root of the aorta is more strongly connected to cardiovascular diseases than the values obtained for brachial SBP (bSBP).[6] Among SBP components, both central and brachial, central pulse pressure (cPP) has been shown to be an independent predictor of cardiovascular events.[7,8] Benetos *et al.* verified that the role of pulse pressure (PP) is crucial in cardiovascular mortality and that values > 65 mmHg are accompanied by an increase in coronary risk, even with absolute values of systolic blood pressure (SBP) and diastolic blood pressure (DBP) within the normal limits.[9-11]

PP reflects the complex intermittent interaction between the ejection fraction and the hemodynamic properties of large arteries.[12] When increased, PP indicates rigidity of the arterial wall, with the consequential increase of pulse wave velocity, particularly in elderly individuals.[10-13]

With aging, there is a progressive increase of SBP, and a higher increase of systolic pressure in relation to diastolic pressure. SBP continues to increase, even after the age of 60, while diastolic pressure tends to remain constant or decrease after the fifth or sixth decade of life.[13,14]

Therefore, PP increases with age due to the structural changes in different components of the arterial wall, by decreasing the complacency of large arterial vessels due to a decrease in elastic fibers and an increase in the content of calcium ions and collagen fibers.[15] Data suggest that cPP is closely correlated with left ventricular hypertrophy,[16] to increase artery intima and media layer thickness,[17] and constitutes an independent predictor of cardiovascular risk, surpassing brachial pulse pressure (bPP).[18]

Objective

In this context, the objective of this work was to compare the values of cSBP and bSBP across different age groups of systemic hypertension (SH) patients.

Methods

This cross-sectional study assessed 260 patients aged between 39 and 88 years, selected in the period from November 2009 to June 2011, who were electively admitted to the Heart Institute of the Triângulo Mineiro (ICT) in Uberlândia, Minas Gerais, to undergo coronary angiograms due to clinical signs and symptoms compatible with coronary insufficiency. Anthropometric and demographic data were collected using a questionnaire that was completed prior to the coronary angiogram.

Five patient groups were created: Group I, patients aged between 39 and 49 years, n = 34; Group II, patients aged between 50 and 59 years, n = 67; Group III, patients aged between 60 and 69 years, n = 69; Group IV, patients aged between 70 and 79 years, n = 46; and Group V, patients aged ≥ 80 years, n = 26. The variables studied in each group included the following: central systolic pressure (cSP) and brachial systolic pressure (bSP), central diastolic pressure (cDP) and brachial diastolic pressure (bDP), and cPP and bPP. All values have been expressed in mmHg.

Patients aged ≥ 18 years with SH who signed the free and informed consent form were included in this study. The patients showing the following were excluded from the study: iodine allergy (7), hypertensive crisis (2), infected varicose ulcers (5), and mechanical failure of the hemodynamic system (4). The final sample included 242 patients, with 130 men and 112 women. All patients were hypertensive. Individuals who showed, at admission prior to the exam, SBP of ≥ 140 × 90 mmHg, with or without the use of antihypertensives, or SBP of < 140 × 90 mmHg with the use of antihypertensives, were considered to be hypertensive patients.

Hemodynamic study

In order to perform the cine coronary angiography, the patient was placed in the supine position (Siemens Coroskop T.O.P.) and the reading for the cSBP was conducted by positioning the catheter (Pig Tail 110 cm, caliber 5F) at the root of the aorta showing the values on a heart monitor (Siemens). The catheter was always introduced through the femoral or radial artery–the physician chose the best route. Confirmation of the exact catheter location was obtained by injection of contrast media (Pielograf [ionic] and Visipaque [non-ionic]). At a maximum of 60 s after reading the cSBP, the bSBP values were obtained via the oscillometric method using an Omron-HEM-431 digital device connected to the left upper extremity.

Statistical Analysis

The results of the variables have been expressed as mean ± standard deviation, and as mean ± standard error in the Figures, while categorical variables have been expressed as a ratio or percentage. Initially, each of the variables was assessed using analysis of variance (ANOVA) to verify whether there was a significant difference between the groups. The differences between the groups were considered significant if the *p*-value was < 0.05.

If there was a significant difference between the groups, the multiple comparison test (Tukey's test) was applied to verify which groups differed from others. The Student's *t* and *Mann-Whitney tests* were applied for the values of cPP and bPP according to sample normality. These differences were considered significant if the *p*-value was < 0.05. The statistical analysis was conducted using Prism 5 software for Windows, version 5.02.

Results

Study population

The clinical characteristics of the patients and the number of antihypertensives used (n = 242) are shown in Table 1. The male/female sex ratio was similarly maintained, emphasizing the homogeneity of the sample. The number of antihypertensives used in groups IV and V was greater than in those of groups I, II, and III, and the mean proportion of patients with diabetes mellitus in Groups IV and V was higher than those in Groups I, II, and III. In this study, we did not correlate the values of SBP with any other factors, such as comorbidities and the number of antihypertensives used; however, we performed a comparison between cSP and bSP.

When comparing cSP and bSP, we observed that cSP was significantly higher than bSP starting at age 50 ($p < 0.05$; Table 2 and Figure 1). We observed significant differences in these values between Group I *and* Group III; Group I *and* Group IV, and Group I *and* Group V. For bSP, we observed significant differences between Group I *and* Group IV and Group I *and* Group V, with $p < 0.05$ for all comparisons.

No significant variations in cDP were observed between any of the age groups. In the comparison of cDP versus bDP, significant differences were noted only in Group III (Table 3 and Figure 2).

In the comparison between cPP and bPP, we observed that cPP was higher than bPP starting at age 50 ($p < 0.05$; Table 4 and Figure 3). We observed significant differences in cPP between Group I *and* Group III, Group I *and* Group IV, and Group I *and* Group V. Regarding bPP, we observed significant differences between Group I *and* Group IV and Group I *and* Group V, with $p < 0.05$ for all comparisons.

Discussion

The diagnosis of SH is usually obtained through indirect methods using oscillometric devices and/or auscultation placed in the upper extremities of patients.[19-22] Epidemiological studies assume that brachial SBP is proportional to cardiovascular risk.[23] Recently, clinical trials have shown that cSBP is a better predictor of cardiovascular risk than bSBP[24]. In reality, cSBP and bSBP values may be significantly different.[25,26] Our data showed that an increase in bSP was statistically significant starting at age 70, in contrast to studies reported in the literature in which an increase of bSP is observed starting at age 50[27,28].

This finding likely is due to the use of the antihypertensive medications, which might have slowed the increase of bSP. The factors involved in the aging of the cardiovascular system such as hardening of arterial vessels could contribute to an increase of SBP, thus overcoming the effects of antihypertensive drugs. With regard to the behavior of central SP, our data demonstrated that it increases significantly starting at age 60, and again the use of antihypertensives may be responsible for its delayed manifestation.

Table 1 Clinical characteristics of the populations and number of antihypertensives by age group

Parameters	Group I (n = 34)	Group II (n = 67)	Group III (n = 69)	Group IV (n = 46)	Group V (n = 26)	*p*-value
Age	44 ± 4.6*	54 ± 2.8*	64 ± 2.7*	74 ± 3.0*	84 ± 2.6*	< 0.0001
Sex Male/Female	20/14	34/33	35/34	24/22	15/11	0.8639
DM (%)	26	27	23	41*	46*	0.0105
Smoking	12	40*	25	13	10	0.0009
Quantity of antihypertensives (n)	2.09 ± 1.09	2.20 ± 0.97	2.25 ± 0.92	2.39 ± 0.91*	2.94 ± 1.16*	0.0284
Beta-adrenergic blockers (%)	56	60	43	43	58	0.2492
ACEI (%)	33	28	22	28	31	0.7464
CCB (%)	22	27	29	30	27	0.9389
Diuretic (%)	22	27	23	28	23	0.9

* comparison between groups ($p < 0.05$). ACEI: angiotensin-converting enzyme inhibitor, CCB: calcium channel blocker, DM: diabetes mellitus. Group I, patients between 39 and 49 years of age; Group II, those aged between 50 and 59 years; Group III, those aged between 60 and 69 years; Group IV, those aged between 70 and 79 years; and Group V, those aged ≥ 80 years. The analysis of variance (ANOVA) and Tukey's test were used for statistical analysis.

Table 2 Systolic blood pressure according to age group

Parameters mmHg	Group I (n = 34)	Group II (n = 67)	Group III (n = 69)	Group IV (n = 46)	Group V (n = 26)	*p*-value
Central systolic pressure (cSP)	136 ± 20	147 ± 27[b]	152 ± 28[ab]	160 ± 22[ab]	163 ± 22[ab]	< 0.0001
Brachial systolic pressure (bSP)	132 ± 19	138 ± 23	142 ± 26	147 ± 24[a]	150 ± 21[a]	0.0061

[a] cSP: Group V = Group IV > Group III > Group I; Group I = Group II and Group II = Group III; [b] cSP > bSP in Groups II, III, IV, and V. Group I, patients between 39 and 49 years of age; Group II, those aged between 50 and 59 years; Group III, those aged between 60 and 69 years; Group IV, those aged between 70 and 79 years; and Group V, those aged ≥ 80 years.

Figure 1. Central and brachial systolic blood pressure variance according to age group. -a *vs.* a = $p > 0.05$; b *vs.* b = $p > 0.05$; a *vs.* b = $p < 0.05$; c = $p < 0.05$ (between the groups). Group I, patients aged between 39 and 49 years of age; Group II, those aged between 50 and 59 years; Group III, those aged between 60 and 69 years; Group IV, those between 70 and 79 years; and Group V, those aged ≥ 80 years. *Student's t* test and *Mann-Whitney* tests were used for statistical analysis.

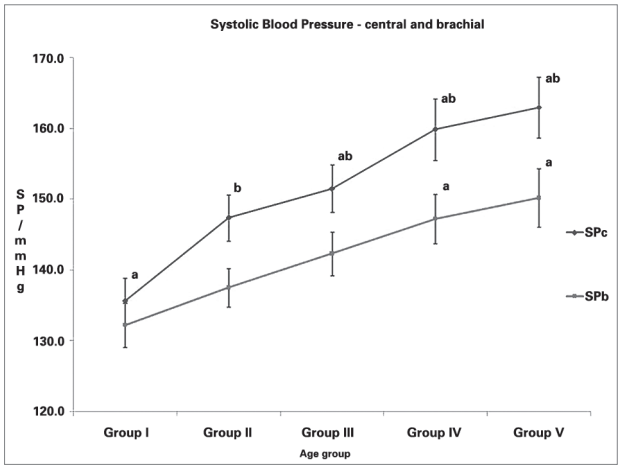
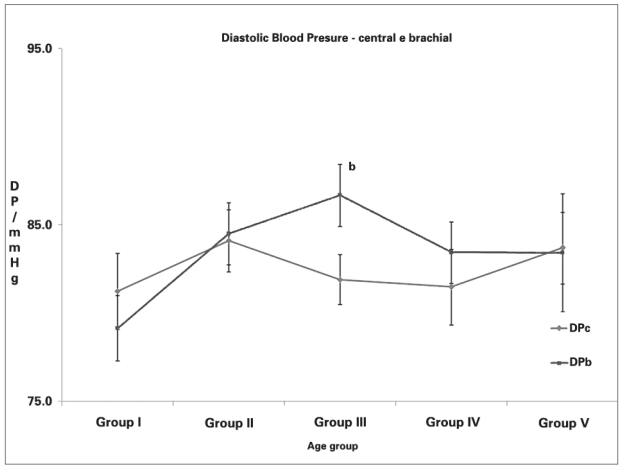


Figure 2. Central and brachial diastolic blood pressure variance according to age group. - c = $p < 0.05$ (between the groups). Group I, patients between 39 and 49 years of age; Group II, patients aged between 50 and 59 years; Group III, those aged between 60 and 69 years; Group IV, those aged between 70 and 79 years; and Group V, those aged ≥ 80 years. Student's t test and Mann-Whitney tests were used for statistical analysis.



When the cSP was compared to the bSP, we observed higher levels of cSP starting at age 50 (147 ± 27 *vs.* 138 ± 23 mmHg), and this difference was maintained in the other groups assessed. This finding demonstrates that the drugs used to treat SH are often ineffective in reducing cSP levels.

The Conduit Artery Functional Endpoint (CAFE) study, which compared atenolol to amlodipine, concluded that the beta-adrenergic blocker was less effective in reducing central pressure. In this study, 50% of the patients made use of beta blockers,[29,30] a percentage similar to that of the population assessed in our sample. As shown in Table 1, in all age groups, the use of beta-adrenergic blockers was > 40%. This finding may justify the differences observed between cSP and bSP. Other studies have previously shown that beta-adrenergic blockers are less effective in decreasing cSP than other hypotensives.[30-32]

bDP is elevated in adults until the fifth or sixth decade of life, and these values decrease in older individuals.[33] However, in our study, bDP remained similar across the groups, and the same result occurred with cDP levels. The use of antihypertensive drugs and the consequent maintenance of SBP within normal limits, appear to have restricted the increase of DP for the different age groups.

If we consider cPP < 50 mmHg as a normal level, the means of all the age groups in our study were above this value. When compared to the younger age groups, we observed that cPP was higher starting

Table 3 Diastolic blood pressure according to age group

Parameters mmHg	Group I (n = 34)	Group II (n = 67)	Group III (n = 69)	Group IV (n = 46)	Group V (n = 26)	*p*-value
Central diastolic pressure (CDP)	81 ± 13	84 ± 14	82 ± 12b	81 ± 15	84 ± 10	0.6288
Brachial diastolic pressure (BDP)	79 ± 11	84 ± 14	87 ± 15	83 ± 12	83 ± 17	0.1712

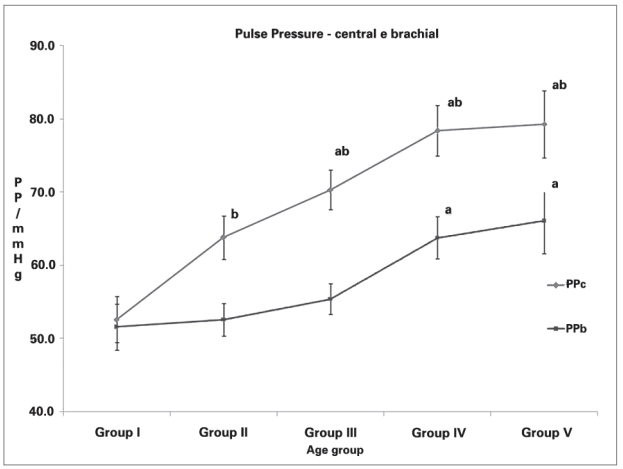
[b] CDP > bDP in Group III. Group I, patients between 39 and 49 years of age; Group II, those aged between 50 and 59 years; Group III, those aged between 60 and 69 years; Group IV, those aged between 70 and 79 years; and Group V, those aged ≥80 years.

Table 4 Pulse pressure according to age group

Parameters mmHg	Group I (n = 34)	Group II (n = 67)	Group III (n = 69)	Group IV (n = 46)	Group V (n = 26)	*p*-value
Central pulse pressure (cPP)	53 ± 19	64 ± 24[b]	70 ± 23[ab]	78 ± 23[ab]	79 ± 23[ab]	< 0.0001
Brachial pulse pressure (bPP)	52 ± 17	53 ± 18	55 ± 17	64 ± 20[a]	66 ± 21[a]	0.0003

[a] cPP: Group V = Group IV > Group III > Group I; Group I = Group II and Group II = Group III; [b] cPP > bPP in Groups II, III, IV, and V. Group I, patients between 39 and 49 years of age; Group II, those aged between 50 and 59 years; Group III, those aged between 60 and 69 years; Group IV, those aged between 70 and 79 years; and Group V, those aged ≥ 80 years.

Figure 3. Central and brachial pulse pressure variance according to age group. -a *vs.* a = $p > 0.05$; b *vs.* b = $p > 0.05$; a *vs.* b = $p < 0.05$; c = $p < 0.05$ (between the groups). Group I, patients between 39 and 49 years of age; Group II, those aged between 50 and 59 years; Group III, those aged between 60 and 69 years; Group IV, those aged between 70 and 79 years; and Group V, those aged ≥ 80 years. *Student's t* test and *Mann-Whitney* tests were used for statistical analysis.



at age 60 (70 ± 23 mmHg, $p < 0.0001$), while bPP increased starting at age 70 (64 ± 20 mmHg, $p < 0.0003$). If we analyze cPP versus bPP, we observe higher levels for cPP starting with Group II (64 ± 24 *vs.* 53 ± 18 mmHg), and this difference remains for the other groups assessed. This finding shows that antihypertensive drugs have not been able to maintain the same values for cPP and bPP; once again, the use of beta-adrenergic blockers may have interfered with a more effective reduction of cPP.

Study limitations

This cross-sectional study had limitations inherent to this type of design. Thus, it is possible that the central and brachial pressure differences observed may have been specific to the population analyzed in our study, which showed undertreated coronary lesions and high pressure levels. On the other hand, the study did not analyze hypertension time, and some of the patients may have shown sharp increases of blood pressure due to examination-related stress.

Conclusion

With aging, the pulse and systolic pressure values, measured directly at the root of the aorta, are higher than those obtained using an indirect method at the brachial artery. These differences are significant starting at age 50.

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