

# Inter-arm blood pressure difference and resistant hypertension

## Abstract

The prevalence of hypertension is high in the Jamaican population, aggravated by the domination of the African Black origin of this community. It is also very obvious that most of the patients of hypertension are using multiple medications and most of them without true control. We tried in this study to correlate the presence of resistant hypertension and the inter-arm blood pressure difference. It is unclear to what extent inter-arm blood pressure (BP) differences are related to resistant hypertension. The present study was designed to resolve this issue especially for the True-drug induced resistant hypertension.

**Keywords:** hypertension, resistant hypertension, inter-arms blood pressure difference

Volume 2 Issue 2 - 2015

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**Received:** January 20, 2015 | **Published:** March 06, 2015

## Introduction

The background of our research was based on the high prevalence of uncontrolled hypertension in the form of true resistant hypertension in the studied community and how to relate it to the inter-arm blood pressure difference and the latter could be a clue to extract those patients for further management away from other hypertensive patients (without resistance to medications). This study was interesting to us especially no previous attempt was done to reveal this association.

## Methods

In This study, 82 consecutive subjects were volunteered from the hypertension clinic at heart institute of the Caribbean-Jamaica. None of the subjects had arrhythmia or chronic renal disease (defined as: serum Creatinine level  $>2.2$  mg/dL  $>194$   $\mu$ mol/L)<sup>1</sup> and all of them were taking their medications regularly during the study period. The following demographic variables were assessed at the initial visit: age, sex, handedness, race/ethnicity, body mass index, and history of cardiovascular disease. Arm circumference was measured, and the appropriate cuff size was selected. The patients sat quietly with their backs supported without crossing their legs and with both arms supported at heart level for 5minutes. The measurements were done first time by well trained nurses and repeated the second time by the attending physicians and at the third time by the nurses again. The three measurements were compared for accuracy. The instruments used are the regular mercury Sphygmo-manometers after checking their accuracy and performance and the model was-Baumanometer W A Baum Co. INC. Copiague, NY, USA. Data from 55 patients who had uncontrolled BP and on multiple medications were analyzed separately from those of the remaining 27 patients. Patients with Same arm BP difference were excluded from the study. The definition of resistant hypertension that was applied to the selected patients is (The failure to reach goal blood pressure in patients who are adhering to full doses of an appropriate 3 drug (or more)-regimen that includes a diuretic).<sup>2,3</sup> The goal was to reach with blood pressure  $< 140/90$  mmHg and according to this definition and criteria we selected our patients from the hypertensive clinic.

## Results

About 90% of the patients were right handed  $n=71.1$ , 60% were diabetics  $n= 47.4$  and 20% had stable angina  $n=15.8$ . Total of 100% of patients were on the regular anti-hypertensive medications. Comparison analysis was done between these 2 groups and seen

in (Table 1&2). Large inter-arm systolic BP differences were consistently seen in 54 patients with uncontrolled hypertension and on at least 3 medications for hypertension one of them was a diuretic. In the remaining patients,<sup>2</sup> the systolic BP and the diastolic BP, respectively, were either equal or slightly higher between both arms by less than 5-10mmHg and they were on one or two medications for hypertension. The large inter-arm BP difference was consistent mainly in individuals with uncontrolled BP and on multiple medications (at least 3 medications and one of them is a Diuretic) which we consider as a resistant hypertension group of patients<sup>2,3</sup> and prompt aggressive medical management should be taken to avoid series of complications that may take place and may establish an end organ damage with poor prognosis.<sup>4-6</sup> The patients were followed for 6 months and were given the optimum anti-hypertensive medications including the HCTZ diuretic. The improvement was slow and the difference in BP measurements between the arms was persistently wide giving us a strong clue to the presence of a resistant stage that we should seriously consider. In contrary, the group 2 individuals with a non significant difference in both arms BP, showed good compliance to medications during the same period of 6 months and same risk factors control. It was interesting that the female group was more resistant than the male group in this study, although we have done the same control on risk factors, including avoiding the oral contraception in active females. This was expressed by persistent high measure of inter-arm BP difference of 15-20 mmHg in female group 1, period 2. While it was a persistent high measure of inter-arm BP difference of (10-15 mmHg) in Male group 1, period 2. In the present study, we found that there is a persistent inter-arm BP difference among patients attending the hypertension clinic who have clinically uncontrolled blood pressure and on optimum medications. Blood pressure in the right arm was consistently higher than that in the left arm regardless of the handedness, and the difference was still observed at visit 2 and visit 3. We also found that, in the presence of resistant hypertension, there are apparently large inter-arm differences 10-20 mmHg, leading us to conclude that routinely taking measurements on a second arm does improve the accuracy of the measurement in persons with resistant uncontrolled hypertension.<sup>2,7,8</sup> On the other hand, marked and persistent inter-arm BP disparity should prompt an investigation for resistant hypertension.

There was a statistically significant difference between Group 1 and Group 2, determined by One-Way ANOVA ( $F(1, 10) = 8.71, P = (0.014)$ ).

**Table 1** Analysis of Group 1

Group 1 with major inter-arm BP difference and on the medications at the time of first measurements of BP. (Period 1)			Same group after 6 months of optimum medication treatment of blood pressure. (Period 2).		Number of medications given (Period 2).
BP mmHg average	Right arm	left arm			
Visit 1					
Systole	150	175	160	180	+3
Diastole	95	110	90	110	
Visit 2					
Systole	140	160	185	170	+3
Diastole	90	110	100	100	
Visit 3					
Systole	160	180	150	160	+3
Diastole	100	115	90	110	

**Table 2** Analysis of Group 2

Group 2 with minor inter-arm BP difference and on the medications at the time of first measurements of BP. (Period 1)			Same group after 6 months of mild to moderate medication treatment of blood pressure (Period 2).		Number of medications given (Period 2).
BP mmHg average	Right arm	left arm			
Visit 1					
Systole	140	135	135	140	1-2
Diastole	90	85	85	85	
Visit 2					
Systole	140	130	130	140	1-2
Diastole	80	80	85	80	
Visit 3					
Systole	145	140	130	130	1-2
Diastole	90	90	85	85	

**Table 3** Comparison of analysis of both groups

	Total patients group No.1	Total patients group No. 2	Group 1 /period 2 With inter-arm difference 15-20 mmHg	Group 1 /period 2 with inter-arm difference 10-15 mmHg
No.	54	25	-----	-----
Male	34	10	16	18
Female	20	15	18	2

**Table 4** Group 1 and 2 Together

		Interarm difference before intervention (mmHg )	Interarm difference after intervention (mmHg )	Systole or Or Diastole	Group 1 or 2
Interarm difference before intervention (mmHg)	Personcorrelation	1	.604	-0.415	-0.830
	Sig.(2-tailed)		.037	0.180	.001
	N	12	12	12	12
Interarm difference after intervention (mmHg )	Personcorrelation	0.604	1	-0.157	-0.682
	Sig.(2-tailed )	0.37		.625	.014
	N	12	12	12	12
Systole or Diastole	Personcorrelation	-0.415	-0.157	1	0.000
	Sig.(2-tailed )	0.180	0.625		1.000
	N	12	12	12	12
Group 1 or 2	Personcorrelation	-0.830	-0.682	0.000	1
	Sig. (2-tailed )	0.001	0.014	1.000	
	N	12	12	12	12

**Table 5** One way ANOVA, comparing inter-arm difference after intervention Inter-arm difference after intervention (mmHg)

	N	Mean	Std. Deviation	Std. Error	95% confidence interval for mean		Minimum	Maximum	-	-
					Lower Bound	Upper Bound				
Group 1	6	14.1667	8.01041	3.27024	5.7603	22.5731	.00	20.00	-	-
Group 2	6	3.3333	4.08248	1.66667	-.9510	7.6176	.00	10.00	-	-
Total	12	8.7500	8.29156	2.39357	3.4818	14.0182	.00	20.00	-	-

**Table 6** ANOVA Inter-arm difference after intervention (mmHg)

	Sum of squares	df	Mean Square	F	Sig.	-
Between Groups	352.83	1	352.083	8.711	.014	-
Within Groups	404.167	10	40.417			-
total	756.250	11				-

## Discussion

The data we got suggest that there is an inter-arm difference (10-20 mmHg) in patients with resistant hypertension<sup>8,9</sup> and on optimum medication for their hypertension, while those patients with controlled or almost controlled hypertension and on mild to moderate medications for their hypertension, are showing no major difference in readings of both arms (No inter-arm differences or there is a difference of 5-10 mmHg only). By this study, we support the recommendation that ask for both arms measurements for blood pressure<sup>1,10-13</sup> and if the difference is wide, we should expect the presence of some kind of resistant hypertension<sup>2,3</sup> even if the medications are optimum and this should give us a strong motive to search for the causes of this resistance especially the True-drug induced resistance and how to deal with it in the proper way. The question that should be answered in further study is: do these resistant patients regain their bilateral equivalent blood pressure after controlling of the high blood pressure? The other question is: does this study which was done in a special Caribbean Afro-American community can be used to demonstrate the same findings on other patients from other ethnic communities? Further studies are needed of large scale to support these study findings. Recent guidelines<sup>5,15</sup> are strongly recommending the bilateral arm blood pressure measurements and single arm measure habit should be strongly avoided. This adds value to our current study since this will allow physician to pick up more patients with large inter-arm BP difference and consider them as a resistant hypertensive patients and encourage those physicians to look for the cause of this resistance, i.e. is it due to patient resistance and non compliance, physician resistance, drug interactions, office hypertension, excessive salt intake,<sup>16</sup> secondary hypertension or it is a definite True-drug resistance hypertension.<sup>9,16-18</sup> Also here we need to exclude other factors that may build up the hypertension resistance like the habit of smoking, increased obesity, high ethanol consumption, anxiety induced hyperventilation or panic attacks or the presence of chronic pain.<sup>13,19,20</sup> This habit of bilateral arm blood pressure measurements will distinguish the resistant group from the non resistant one, and focus on the causes of this resistance and dealing with them accordingly, otherwise missing this group; especially the True-drug resistant group may eventually lead to an end organ damage leading to poorer prognosis and eventually to high morbidity and mortality rates.<sup>5,20-22</sup> In case of True-drug resistant group, the physician may consider more efficient interventional management like renal arteries sympathetic denervation<sup>23,24</sup> or baro-receptors stimulation,<sup>25</sup> and both may radically control the hypertension; decrease the number of medications used and will be cost effective for patients.

## Resistant hypertension trials

Always different studies were trying to find which arm has the higher reading for blood pressure,<sup>16,26-29</sup> is it right or left? Physicians are also thinking about the importance of the inter arm blood pressure difference and how to deal with this situation. The Guideline<sup>5,6</sup> is always asking for bilateral measurements of blood pressure to estimate the real pressure and avoid under estimation. These guidelines are putting the inter arm BP difference of 10mmHg or less as to be accepted as normal finding and if the difference is more than this in systole or diastole,<sup>1</sup> the patient to referred to a specialist to look

after that change. Studies<sup>12,26,30</sup> suggest that the inter arm difference of >10-15 mmHg will increase the risk of cardiovascular diseases including the peripheral vascular diseases and predispose to future events and death. Previous studies<sup>1,5,11,12,33</sup> also show that inter arm BP difference of >15mmHg may predispose to Aortic and /or Carotid artery diseases. Previous studies gave us a clue that a lot of patients with peripheral vascular diseases have an underlying inter arm BP difference and the presence of the latter will affect the prognosis of these patients.<sup>12,13,26,30,34</sup> Another studies showed that patients with systolic inter arm difference have a risk of increased death rates,<sup>1,5,9,11,12</sup> and the higher death rates were in inter arm systolic BP difference of > 10mmHg,<sup>7,16,17,27,35</sup> All the above mentioned studies and trials were supportive of the importance of existing inter arm BP difference and relating that to future CVD, events and death. Doctors in the primary care units are advised to follow the guidelines recommending of measuring blood pressure in both arms rather than one arm to avoid underestimation values.<sup>5,6</sup> Primary health care physicians usually think that there no correlation between inter arm BP differences and CVD and occurring of events and make them reluctant to do so, which will give the chance to miss a lot of patients with hypertension and future CVD. All patients with inter arm BP difference should be managed in a preventive manner against CVD risk predisposition, putting them on preventive measures like Statins and anti platelets or may need further advanced investigations in some of the patients. All studies and clinical trials are justifying this important issue and the presence of the risk of a hidden or dormant CVD in those patients which will need aggressive life style changes and medications modifications.<sup>9,22,37</sup>

## Conclusion

In all previous studies and clinical trials there was no correlation between the inter arm blood pressure difference and resistant hypertension, which our study is evaluating and suggesting.

## Conflicts of interest

Author declares there are no conflicts of interest.

## Acknowledgments

None.

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