MEDDOCS Open Access Publisher

ISSN: 2639-9237

Journal of Case Reports and Medical Images

Open Access | Case Report

Novel Study to See Arterial Stiffness Changes with Posture in Hypertensive Subjects in Asian Population in Singapore

Ashish Anil Sule[1]*; Timothy Boey[2]; Ashita Sule[3]; Anna Marie Borja[4]

[1]Senior Consultant, Department of General Medicine, (sub-speciality- Vascular Medicine and Hypertension), Tan Tock Seng Hospital, Singapore.

[2]A. Level Student, Anglo-Chinese School, Singapore.

[3]A. Level Student, Raffles Institution, Singapore.

[4]Dr Anna Marie Borja, Principal Resident Physician, Tan Tock Seng Hospital, Singapore.

***Corresponding Author(s): Ashish Anil Sule**
Senior Consultant, Department of General Medicine, (sub-speciality- Vascular Medicine and Hypertension), 11, Jalan Tan Tock Seng, Tan Tock Seng Hospital, 308433, Singapore.
Tel: 63577893, Fax: 6563577588;
Email: ashishsule@yahoo.com

Received: Oct 27, 2021
Accepted: Dec 17, 2021
Published Online: Dec 21, 2021
Journal: Journal of Case Reports and Medical Images
Publisher: MedDocs Publishers LLC
Online edition: http://meddocsonline.org/

Introduction

Arterial stiffness is directly related to increased cardiovascular events [1-7]. Increased arterial stiffness, is a measure of the elasticity of arteries, has been shown to increase the risk of myocardial infarction and stroke.

European Society of Hypertension guidelines on the management of hypertension acknowledges that central pressures (measure of arterial stiffness) may be more predictive of cardiovascular events when compared to brachial pressures. This is due to different antihypertensive drugs potentially having different effects on peripheral pressures and central pressures [8]. Furthermore, increased arterial stiffness is a better predictor of disease progression as they more sensitive to cardiac changes as compared to peripheral pressures [9]. Effect of postural variation for parameters of arterial stiffness has not been well studied and was evaluated in this study.

Cite this article: Sule AA, Boey T, Sule A, Borja AM. Novel Study to See Arterial Stiffness Changes with Posture in Hypertensive Subjects in Asian Population in Singapore. J Case Rep Clin Images. 2021; 4(2): 1093.

Methods

In this study, postural variations and their effects on measures of arterial stiffness were analysed in 2 groups of patients consisting of hypertensive subjects (56 patients) and normotensive subjects (54 patients).

Hypertensive patients (56 patients) were further analysed in 2-groups.

1. Hypertensive patients on anti-hypertensive medication (41)
2. Hypertensive (labile) or white coat hypertensive patients not on anti-hypertensive medication as clinic readings fluctuated from high normal to pre-hypertensive to stage 1 hypertensive range on different clinic visits.

These patients were put on life style modifications by their clinic primary physicians (15).

Operator Index (OI), central pressures such as Aortic Systolic Pressure (ASP), Aortic Pulse Pressure (APP), Aortic Pulse Augmentation (APA), Augmentation Index (AI) and brachial Blood Pressures (BP) such as brachial Systolic Pressure (SP) and brachial Diastolic Pressure (DP) were measured in supine and sitting positions. Median values and interquartile range was calculated for all these parameters and compared between supine and sitting positions.

Subjects with hypertension had follow up with clinic physicians and were chosen based on their diagnosis of hypertension on ambulatory blood pressure monitoring or had two average brachial blood pressure readings above 140/90 mm Hg on at least two separate occasions in clinic.

The labile BP was seen in the in group of 15 patients who were diagnosed with stage 1 hypertension with no organ damage by primary physicians. These patients were not on medications but started on life style modifications. When these patients were recruited for study, the blood pressure ranged from normotensive to pre-hypertensive to hypertensive range. These patients had labile blood pressure or had white coat hypertension.

Normotensive subjects, didn't follow with clinic physician and were volunteers who had normal Blood Pressure (BP) readings on at-least 2 separate occasions in clinic.

The parameters of arterial stiffness were measured by using a Sphygmo-Cor device in the morning between 8 am to 10 am initially on supine position. After three minutes, values in sitting position were obtained. Subjects were advised to refrain from smoking, eating or drinking beverages three hours before the test and drinking alcohol 10 hours before the test.

As a clinic protocol, young hypertensives, hypertensive patients with diabetic mellitus with chronic kidney disease, patients with labile blood pressure and patients with aortic aneurysm and dissection were chosen to undergo the arterial stiffness study.

Normotensive volunteers were invited to participate in this study.

Informed verbal consent was obtained from all participants and ethics approval was obtained before the start of the study.

Summary measures on demographics such as age, race, gender, height, weight and BMI were noted. Differences between BP characteristics in supine and sitting were compared using paired T-test and Man Whitney u-test. A p-value of $p < 0.05$ was accepted as statistically significant. Bad or incomplete data, low operator index values (<80%) and data with incomplete patient information were excluded from the study.

Results

When postural variations parameters of arterial stiffness and brachial BP were studied in hypertensive subjects on antihypertensive medication, a statistically significant increase in APP (45 (35-54) *vs.* 42 (31-48) = 0.0058) and a significant decrease in DP (75 (69-83) *vs.* 78 (69-87), p = 0.023) was seen in the supine position as compared to in the sitting position (Table 1). A similar trend of significant increase in APP and decrease in DP (33 (28.3-36) *vs.* 30 (23.3-33.8), p= 0.00158 and 62 (55-67) *vs.* 65 (59-71), p = 0.0006 respectively) was seen in normotensive subjects (Table 2).

However, hypertensive subjects off antihypertensive medication showed no statistically significant difference between any parameters of arterial stiffness including APP and DP in sitting and supine position, contrary to the trend previously observed (Table 3).

Table 1: Hypertensive subjects on antihypertensive medication.

Hypertensive subjects on hypertensive medication			
Number	41		
Mean age in years(SD)	45.3 (19.5)		
Mean BMI(SD)	29.2 (7.4)		
Parameters	Supine	Sitting	P value
Median Aortic SP mm Hg (Interquartile range)	121 (112-130)	122 (113-127)	0.74896
Median Aortic PP mm Hg (Interquartile range)	45 (35-54)	42 (31-48)	0.00578
Median AP Aortic Augmentation (Interquartile range)	8.3 (0-17)	8.1 (1-14)	0.79486
Median AI Aortic Augmentation Index (Interquartile range)	14 (2-28)	13 (2-28)	0.83366
Median SP mm Hg (Interquartile range)	138 (128-144)	138 (131-144)	0.71138
Median DP mm Hg (Interquartile range)	75 (69-83)	78 (69-87)	0.0226

Table 2: Normotensive subjects.

Normotensive subjects			
Number	54		
Mean age in years(SD)	30 (8.18)		
Mean BMI(SD)	25.4 (6.5)		
Parameters	Supine	Sitting	P value
Median Aortic SP mm Hg (Interquartile range)	96 (87.5-105)	96 (90-105)	0.6818
Median Aortic PP mm Hg (Interquartile range)	33 (28.3-36)	30(23.3-33.8)	0.00158
Median AP Aortic Augmentation (Interquartile range)	5.3 (1.25-8)	4.7 (1-7)	0.09692
Median AI Aortic Augmentation Index (Interquartile range)	13.5 (5.5-20)	13.3 (4.5-21.8)	0.63122
Median SP mm Hg (Interquartile range)	111 (103.3-116.8)	112 (102.3-116)	0.60306
Median DP mm Hg (Interquartile range)	62 (55-67)	65 (59-71)	0.0006

Table 3: Labile Hypertensive subjects not on anti-hypertensive medication.

Labile Hypertensive subjects not on antihypertensive medication			
Number	15		
Mean age in years(SD)	33.1 (12.6)		
Mean BMI(SD)	26.9 (4.9)		
Parameters	Supine	Sitting	P value
Median Aortic SP mm Hg (Interquartile range)	118 (109-127.25)	120 (107.5-129)	0.201
Median Aortic PP mm Hg (Interquartile range)	40.1 (32-46.5)	41.8 (34.75-47.25)	0.85716
Median AP Aortic Augmentation (Interquartile range)	8.4 (3.75-15)	7.8 (4.25-12)	0.71884
Median AI Aortic Augmentation Index (Interquartile range)	16 (0.75-31)	14.4 (0.75-27.5)	0.5485
Median SP mm Hg (Interquartile range)	134.5 (128-139.25)	139 (128.75-147)	0.19706
Median DP mm Hg (Interquartile range)	77.2 (69.75-83.75)	79 (68.75-86.25)	0.18352

Discussion

In a recent study, a significant increase in APP and AI in supine position was discovered when compared to the values obtained from the sitting position [10]. The increase in APP in supine position was consistent with the results of this study in the groups with hypertensive subjects on medication and normotensive subjects. However, this variation was not seen in hypertensive subjects off medication. Moreover, no difference in AI was noted in any of the groups in this study. Another study by Nürnberger et al noted that there was a significant increase in the DP in sitting position as compared to in the supine position [11]. This was also consistent with our findings in hypertensive subjects on medication and normotensive subjects. The latter study also did not note any significant difference in the AI which is similar with our findings.

A previous prospective pilot study carried out at our centre on 21 patients by Ashish et al, reported that normotensive subjects had a significantly high supine APP and AI values compared with those in sitting postures while hypertensive subjects on anti-hypertensive medication had a reduction in APP and AI in supine position [12]. Multiple studies have shown the effects of different anti-hypertensive medication on arterial stiffness. Angiotensin-converting enzyme inhibitors, angiotensin receptor blockers and calcium channel blockers have beneficial effects on reducing arterial stiffness [13-24].

Studies have shown that arterial stiffness can vary with age, obesity and aerobic exercise [25-27]. Studies have shown that arterial stiffness varies posture. For central systolic BP, there was nonsignificant main effect for fasting state but there was a main effect for posture. Conversely, for AI, there was nonsignificant main effect for posture but there was a large main effect for fasting state [28]. Another study carried out by Alyssa Torjesen et al. concluded similar results of the study we carried out, adding that the negative relation between forward wave amplitude and change in mean arterial pressure on standing was accentuated in women [31]. Higher aortic stiffness was associated with a blunted orthostatic increase in mean arterial pressure, even in middle age. Authors believe that the clinical implications of these findings would warrant further study [29]. Furthermore, a study carried out by Yusuke Kobayashi et al. concluded that higher arterial stiffness could be deduced from the size of BP drop when moving from the supine to sitting position [30]. This could help identify patients with Diabetes Mellitus who have a higher cardiovascular risk for early intervention treatment.

A study conducted by Stoner Lee et al. concluded that pressure taken in the supine position was more reliable than when seated [31]. As APP and AI values also tended to be significantly higher in the supine position, underdiagnosis could be prevented when more weight is given to the BP values taken in the supine posture during diagnosis. A study carried out by Bas van

den Bogaard et al. highlighted that between supine and upright position, arterial wave reflection tended to be higher in the supine position [32].

There are some limitations to this study. There was variance of the demographics in the sample population. While 48% of the subjects in the normotensive group were Chinese, both the hypertensive groups consisted of more than 80% of Chinese population. Subjects from hypertensive group on medication had a higher BMI (29) and higher average age (44.7 +/- 19.5) compared to hypertensive subjects off medication and normotensive subjects whose BMI were 26 and 25 and average ages were 34.3 +/- 13.2 and 33.7 +/- 27.3 respectively. Several studies as above have highlighted that age, physical conditioning, obesity, ethnicity, obesity related diabetes, and body height are all strong determinants of augmentation index. Hence, this demographical variation could have had an effect on the data.

The group of labile hypertensive subjects not on anti-hypertensive medications had a relatively smaller sample size (15) to the other two groups. They had labile blood pressure or they were ones who had white coat hypertension and fluctuating blood pressure. They didn't need antihypertensive as per their physicians and were put on life style modifications with most doing well on subsequent follow up.

Despite the limitations, this study has several strengths too as it has novel data comparing BP characteristics on different positions and different patient groups were compared. Measurement of BP characteristics using SphygmoCor is a relatively safe and non-invasive procedure. The average operator index was > 90%, making the data more robust and accurate. New data on Asian population has been collected through this study.

Conclusion

Postural changes has an effect on arterial stiffness. Normotensive subjects and hypertensive patients on treatment behave similarly on postural changes. On the other hand, hypertensive subjects who are not on medications, behave differently with posture. Central aortic pulse pressure is a sensitive marker for postural variation response of arterial stiffness.

References

1. Mitchell G, Hwang S, Vasan R, Larson M, Pencina M, Hamburg N, et al. Arterial Stiffness and Cardiovascular Events: The Framingham Heart Study. Circulation. 2010; 121: 505-511.
2. Laurent S, Cockcroft J, Van Bortel L, Boutouyrie P, Giannattasio C, Hayoz D, et al. Expert consensus document on arterial stiffness: methodological issues and clinical applications. European Heart Journal. 2006; 27: 2588-2605.
3. Laurent S, Boutouyrie P, Asmar R, Gautier I, Laloux B, Guize L, et al. Aortic Stiffness Is an Independent Predictor of All-Cause and Cardiovascular Mortality in Hypertensive Patients. Hypertension. 2001; 37: 1236-1241.
4. Safar M. Current Perspectives on Arterial Stiffness and Pulse Pressure in Hypertension and Cardiovascular Diseases. Circulation. 2003; 107: 2864-2869.
5. Roman M, Devereux R, Kizer J, Lee E, Galloway J, Ali T, et al. Central Pressure More Strongly Relates to Vascular Disease and Outcome Than Does Brachial Pressure: The Strong Heart Study. Hypertension. 2007; 50: 197-203.
6. Van Bortel L, Struijker-Boudier H, Safar M. Pulse Pressure, Arterial Stiffness, and Drug Treatment of Hypertension. Hypertension. 2001; 38: 914-921.
7. Oliver J. Noninvasive Assessment of Arterial Stiffness and Risk of Atherosclerotic Events. Arteriosclerosis, Thrombosis, and Vascular Biology. 2003; 23: 554-566.
8. ESH/ESC Guidelines for the management of arterial hypertension. European Heart Journal. 2013; 34: 2159-2219.
9. Agabiti-Rosei E, Mancia G, O'Rourke M, Roman M, Safar M, Smulyan H, et al. Central Blood Pressure Measurements and Antihypertensive Therapy: A Consensus Document. Hypertension. 2007; 50: 154-160.
10. Vrachatis D, Papaioannou T, Konstantopoulou A, Nasothimiou E, Millasseau S, Blacher J, et al. Effect of supine versus sitting position on noninvasive assessment of aortic pressure waveform: a randomized cross-over study. Journal of Human Hypertension. 2013; 28: 236-241.
11. Nürnberger J, Michalski R, Türk T, Saez A, Witzke O, Kribben A. Can arterial stiffness parameters be measured in the sitting position? Hypertension Research. 2010; 34: 202-208.
12. Sule Ashish, Jun Du, Cheong Chin. Postural Changes in Measures of Arterial Stiffness in Hypertensive Subjects on Antihypertensive Drug Therapy: A Prospective, Pilot Study. Int J Angiol. 2017; 26: 78-82.
13. Lee H, Oh B. Aging and Arterial Stiffness. Circulation Journal. 2010; 74: 2257-2262.
14. Ghiadoni L. The effects of antihypertensive drugs on arterial stiffness. Artery Research. 2016; 14: 1-5.
15. Koumaras C, Tzimou M, Stavrinou E, Griva T, Gossios T, Katsiki N, et al. Role of Antihypertensive Drugs in Arterial 'De-Stiffening' and Central Pulsatile Hemodynamics. American Journal Cardiovascular Drugs. 2012; 12: 143-156.
16. Tropeano AI, Boutouyrie P, Pannier B, Joannides R, Balkestein E, Katsahian S, et al. Brachial pressure-independent reduction in carotid stiffness after long-term angiotensin-converting enzyme inhibition in diabetic hypertensives. Hypertension. 2006; 48: 80-86.
17. Ting CT, Chen CH, Chang MS, Yin FC. Short- and long-term effects of antihypertensive drugs on arterial reflections, compliance, and impedance. Hypertension. 1995; 26: 524-530.
18. Topouchian J, Brisac AM, Pannier B, Vicaut E, Safar M, Asmar R. Assessment of the acute arterial effects of converting enzyme inhibition in essential hypertension: A double-blind, comparative and crossover study. J Hum Hypertens. 1998; 12: 181-187.
19. Topouchian J, Asmar R, Sayegh F, Rudnicki A, Benetos A, Bacri AM, et al. Changes in arterial structure and function under trandolapril– verapamil combination in hypertension. Stroke. 1999; 30: 1056-1064.
20. Asmar RG, London GM, O'Rourke ME, Safar ME. Improvement in blood pressure, arterial stiffness and wave reflections with a very low-dose perindopril/indapamide combination in hypertensive patient: A comparison with atenolol. Hypertension. 2001; 38: 922-926.
21. Mahmud A, Feely J. Reduction in arterial stiffness with angiotensin II antagonist is comparable with and additive to ACE inhibition. Am J Hypertens. 2002; 15: 321-325.
22. Lacourciere Y, Beliveau R, Conter HS, Burgess ED, Lepage S, Pesant Y, et al. Effects of perindopril on elastic and structural properties of large arteries in essential hypertension. Can J Cardiol. 2004; 20: 795-799.
23. Mitchell GF, Arnold JM, Dunlap ME, O'Brien TX, Marchiori G, Warner E, et al. Pulsatile hemodynamic effects of candesartan

in patients with chronic heart failure: The CHARM Program. Eur J Heart Fail. 2006; 8: 191-197.

24. Mitchell GF, Dunlap ME, Warnica W, Ducharme A, Arnold JM, Tardif JC, et al. Long-term trandolapril treatment is associated with reduced aortic stiffness: The prevention of events with angiotensin converting enzyme inhibition hemodynamic substudy. Hypertension. 2007; 49: 1271-1277.

25. Vaitkevicius P, Fleg J, Engel J, O'Connor F, Wright J, Lakatta L, et al. Effects of age and aerobic capacity on arterial stiffness in healthy adults. Circulation. 1993; 88: 1456-1462.

26. Urbina E, Kimball T, Khoury P, Daniels S, Dolan L. Increased arterial stiffness is found in adolescents with obesity or obesity-related type 2 diabetes mellitus. Journal of Hypertension. 2010; 28: 1692-1698.

27. Chirinos J, Kips J, Roman M, Medina-Lezama J, Li Y, Woodiwiss A, et al. Ethnic Differences in Arterial Wave Reflections and Normative Equations for Augmentation Index. Hypertension. 2011; 57: 1108-1116.

28. Yves Yung, et al. Reliability of oscillometric central blood pressure and wave reflection readings: effects of posture and fasting. Journal of Hypertension. 2015; 33: 1588-1593.

29. Alyssa Torjesen , Leroy L Cooper , Jian Rong , Martin G Larson, et al. Relations of Arterial Stiffness With Postural Change in Mean Arterial Pressure in Middle-Aged Adults. Hypertension. The Framingham Heart Study. 2017; 69: 685-690.

30. Yusuke Kobayashi, Tetsuya Fujikawa, Hideo Kobayashi, Koichiro Sumida, Shota Suzuki, et al. Relationship between Arterial Stiffness and Blood Pressure Drop During the Sit-to-stand Test in Patients with Diabetes Mellitus. Journal of Atherosclerosis and Thrombosis. 2017; 24: 147-156.

31. S Lee, C Daniel, F Simon, et al. Reliability of pulse waveform separation analysis: effects of posture and fasting. Journal of Hypertension. 2017; 35: 501-505.

32. Bas van den Bogaard, Berend E Westerhof, Hendrik Best, Shyrin CAT Davis, Niels H Secher, Bert-Jan H van den Born, et al. Arterial wave reflection decreases gradually from supine to upright. Blood Pressure. 2011; 20: 370-375.