Sonographic and Doppler Evaluation of Carotid Artery in Hypertension - A Correlative Study with Biochemical Parameters

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ABSTRACT

Introduction: Hypertension is an important cause of serious cardiovascular diseases and premature mortality from such diseases. 80–95% of hypertensive patients are diagnosed as having "essential" hypertension. Hypertension plays an important and critical role in atherosclerotic cardiovascular disease. Increase in Intima-media thickness (IMT) of an artery has been used as a surrogate marker of the early atherosclerotic process. Duplex Sonography combining high resolution Imaging and Doppler spectrum analysis has proved to be a popular, noninvasive, accurate, cost effective means of detecting and assessing carotid disease. The present cross sectional study was undertaken to assess the Carotid IMT changes and associated changes in hypertensive patients using high frequency ultrasound and color Doppler.

Material and methods: This case control study was carried out at Aarupadai Veedu Medical College & Hospital, Pondicherry from September 1st 2016 to August 31st 2018(2years) with total of 100 cases (50 patients and 50 controls).

Results: Out of 100 cases, we selected 50 hypertensive patients aged above 50 years and 50 normotensive subjects of same age group. In normotensives, 25 (50%) of patients were between 55-60 years, and in hypertensives, 26 (52%) of patients were between 55-60 years. Mean of both right and left CCA Intima Media Thickness (IMT) was significantly higher in hypertensive patients when comparing to normotensive patients. The mean CCA Resistive Index (RI) was significantly higher in hypertensive patients when comparing to normotensive patients.

Conclusion: High frequency ultrasound and Color Doppler can be effectively used to study both IMT and RI of CCA together which are significantly increased in hypertensive patients.

Keywords: Hypertensive, Solography, Doppler

INTRODUCTION

Hypertension is an important cause of serious cardiovascular diseases and premature mortality from such diseases.[1] 80–95% of hypertensive patients are diagnosed as having "essential" hypertension. In the remaining 5–20% of hypertensive patients, a specific underlying disorder causing the elevation of blood pressure can be identified.[2]

In India, hypertension is the leading non-communicable disease risk and estimated to be attributable for nearly 10 per cent of all deaths.[3] Hypertension plays an important and critical role in atherosclerotic cardiovascular disease, but its impact is greatly influenced by coexistent contributors, particularly abnormalities in blood lipid and glucose metabolism. Atherosclerotic cardiovascular sequelae including stroke, coronary disease and peripheral arterial disease, all occur with two- three fold frequencies in hypertensive compared to normotensives of the same age.[4] Increase in Intima-media thickness (IMT) of an artery has been used as a surrogate marker of the early atherosclerotic process.[5] Progressive atherosclerotic disease results into pathological intimal thickening, fibrous cap atheroma and plaque formation. Early detection helps to control the disease in patients who are at risk.[6] Atherosclerotic process starts in the carotids approximately at the same time as in aorta, actually preceding plaque occurrence in coronary arteries. Carotid atherosclerosis significantly correlates with extent of coronary artery atherosclerosis suggesting that increased IMT not only reflects the local morphological alterations in the carotid arteries but also corresponds to generalized atherosclerosis.[7] Ultrasound imaging of the far wall of the carotid artery produces two echogenic lines, which correspond to the lumen-intima interface and the media-adventitia interface. The current ultrasound technology enables in the clinical practice the combined measurement of the thickness of the intimal and medial layers of the arterial wall which constitute the IMT. Carotid plaque is defined as the presence of focal wall thickening that is at least 50% greater than that of the surrounding vessel wall or as a focal region with IMT greater than 1.5 mm that protrudes into the lumen.[8]

Duplex Sonography combining high resolution Imaging and Doppler spectrum analysis has proved to be a popular, noninvasive, accurate, cost effective means of detecting and assessing carotid disease. Carotid Sonography is now playing a major role in assessing the vascular pathology, replacing slowly the role and application of angiography for

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How to cite this article: Vikash, Divya Nijhawan, Kritesh Goel, Sai Shankar Mankuzhy, Koukutla Sri Venkat Reddy. Sonographic and doppler evaluation of carotid artery in hypertension - a correlative study with biochemical parameters. International Journal of Contemporary Medical Research 2019;6(10):J4-J7.

DOI: http://dx.doi.org/10.21276/ijcmr.2019.6.10.14

suspected carotid atherosclerosis.

The present cross sectional study was undertaken to assess the Carotid IMT changes and associated changes in RI in hypertensive patients using high frequency ultrasound and color Doppler and to compare the findings in hypertensive subjects with normotensive subjects. Mean TC, TG, <LDL wer significantly higher in hypertensive group while mean HDL was significantly lower compared to normotensive group.

MATERIAL AND METHODS

This case control study was carried out at Aarupadai Veedu Medical College & Hospital, Pondicherry from September 1st 2016 to August 31st 2018 (2years) with total of 100 cases (50 patients and 50 controls).

Equipment used

1. Voluson S6 colour Doppler Ultrasound (A 7 to 12 MHz Multi-frequency probe is used).
2. Biochemical assessment by Mindray Autoanalyser BS -330E

Inclusion criteria

1. Patients diagnosed with hypertension.
2. Age of patients above 50 years.
3. Both sexes included.

Exclusion criteria

1. Patients with diabetes mellitus.
2. Patients with malignant hypertension.
3. Patients with cerebrovascular accident.
4. Patients with cardiac disease.

Method of data collection

Ultrasound evaluation of carotid artery

Both carotid arteries were evaluated by Voluson S6 colour Doppler ultrasound unit using a high frequency linear probe (7-12 MHz).

Doppler measurements are obtained in the stenotic portion of the carotid lumen. Parameters measured included:-

1. Peak systolic velocity (PSV)
2. Peak end diastolic velocity (EDV)
3. Resistive index (RI)
   RI= PSV– EDV/PSV

History and Biochemical parameters recorded

A detailed medical history, duration of hypertension, family history of hypertension is elicited from the patient. Biochemical parameters like fasting blood sugar, total cholesterol and triglycerides are taken as a part of diagnostic work up of the patients.

RESULTS

Out of 100 cases, we selected 50 hypertensive patients aged above 50 years and 50 normotensive subjects of same age group. Table 1 shows relative distribution of subgroups. Out of total 62 (62%) were males and 38 (38%) of them were females.

In normotensives, 25 (50%) of patients were between 55-60 years, 19 (38%) of them were less than 55 years and 6 (12%) of patients were more than 60 years and in hypertensives, 26 (52%) of patients were between 55-60 years. Majority of patients had hypertension for 5-10 years (38%). There were 16 (32%) of patients had 11-15 years, 8 (16%) of them had less than 5 years and 7 (14%) of patients had more than 15 years of hypertension (table-2).

The table-3 and figure-1 shows the effect of hypertension on right CCA Intima Media Thickness (IMT). The result shows that the mean of right CCA Intima Media Thickness (IMT) was significantly higher in hypertensive patients when

Subgroup	Frequency	Percentage
Normotensive	50	50%
Hypertensive	50	50%

Table-1: Relative distribution of various subgroups

Age (years)	Normotensive	Hypertensive
50-55 years	19 (38%)	12 (24%)
56-60 years	25 (50%)	26 (52%)
>60 years	6 (12%)	12 (24%)

Table-2: Age distribution in study group

IMT	Normotensive	Hypertensive	'P' Value (ANOVA)
Right CCA	0.454±0.121	0.923±0.043	<0.001*
(*-Significant)			

Table-3: Effect of hypertension on right CCA Intima Media Thickness (IMT)

IMT	Normotensive	Hypertensive	'P' Value (ANOVA)
Left CCA	0.492±0.057	0.942±0.033	<0.001*
(*-Significant)			

Table-4: Effect of hypertension on left CCA Intima Media Thickness (IMT)

RI	Normotensive	Hypertensive	'P' Value (ANOVA)
Doppler (mean RI)	0.552±0.075	0.678±0.062	<0.001*
(*-Significant)			

Table-5: Effect of hypertension on mean CCA Resistive Index (RI)

Plaque	Normotensive	Hypertensive
Soft Plaque	Nil	1
Hard Plaque	Nil	1

Table-6: Prevalence of plaque in various subgroups

Biochemical parameters	Normotensive	Hypertensive	'P' Value (ANOVA)
TC	146.22±3.871	168.26±4.552	<0.001*
TG	115.74±3.148	165.34±6.548	<0.001*
LDL	66.76±1.492	71.18±3.061	<0.001*
HDL	51.36±2.693	48.96±2.618	<0.001*
(*-Significant)			

Table-7: Effect of hypertension on biochemical parameters

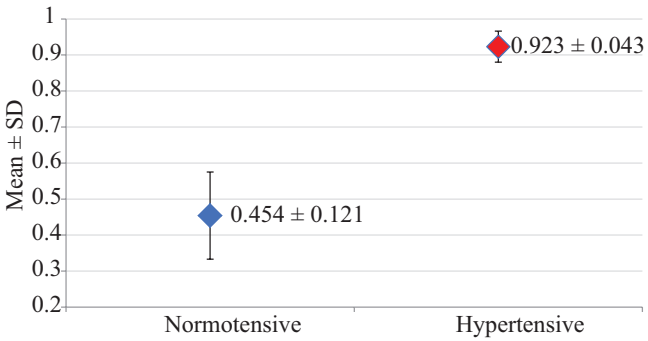

Figure-1: Effect of hypertension in right CCA intimal media thickness

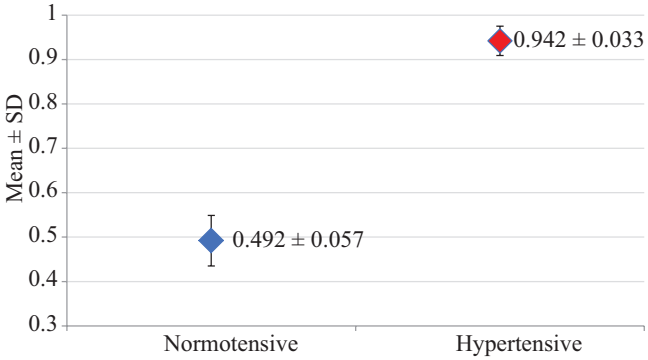

Figure-2: Effect of hypertension in left CCA intimal media thickness

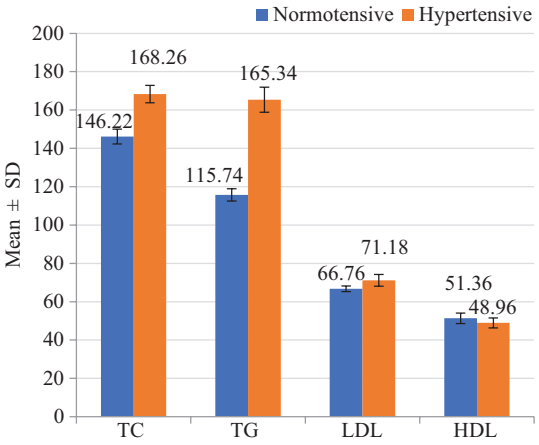

Figure-3: Effect of hypertension on biochemical parameters

comparing to normotensive patients.

Table 4 shows the effect of hypertension on left CCA Intima Media Thickness (IMT). The result shows that the mean of left CCA Intima Media Thickness (IMT) was significantly higher in hypertensive patients when comparing to normotensive patients.

The mean CCA Resistive Index (RI) was significantly higher in hypertensive patients when comparing to normotensive patients (figure 2; table-5).

The table-6 shows the prevalence of plaque in subgroups. It shows that none of the normotensive patients had plaque whereas 1 hypertensive patient had soft plaque and other 1 patient had hard plaque.

Table-7, figure-3 shows the mean TC was significantly higher in hypertensive patients when comparing to normotensive patients. Similarly the mean TG was significantly higher in hypertensive patients when comparing to normotensive patients. Also the mean LDL was significantly higher in hypertensive patients when comparing to normotensive patients. The mean HDL was significantly lower in hypertensive patients when comparing to normotensive patients.

DISCUSSION

We examined bilateral common carotid arteries of all patients with duplex sonography and IMT and RI were assessed. By measuring IMT and RI, we assessed both morphological and hemodynamic changes.

Although, some authors have found an even better correlation with the degree of atherosclerosis when using IMT values for combination of ICA and CCA values, we have restricted ourselves to the determination of IMT in the CCA. Because IMT measurements in the ICA have a massive scatter and IMT measurement of CCA is easier to obtain, more reliable, and have been proved by many studies. We found the mean IMT and RI to be 0.923±0.043mm and 0.678±0.062 respectively in the hypertensive group whereas in the normotensive group the corresponding values were 0.454±0.121mm and 0.552±0.075. The results obtained were analyzed statistically. The results of our study indicate highly significant relationship between hypertension and increase in IMT and RI (P<0.01) of CCA in hypertensive. The normotensive group however did not show any such increase in IMT and RI.

The results of our study closely correlates with the results of the previous Indian study done by M Adaikkappan et al in 2002.[9] They studied IMT of 260 hypertensive patients over a period of three years and compared with seventy normotensive patients. They also studied the associated Doppler parameter changes along with IMT. They concluded that IMT is significantly elevated in hypertensive compared with normotensives. The mean value of IMT in hypertensive in their study was around 1.01 mm and 1.09 mm for the Right and Left sides respectively (P value of <0.001). In our study the mean IMT measurement in hypertensive was 0.92 mm and 0.94 mm (P value of <0.001), which is indicative of highly significant relationship. Our study showed significantly higher LDL cholesterol, total cholesterol and triglycerides levels in hypertensive, which was also seen in their study.

The role of hypertension in the development of LDL cholesterol and triglycerides mediated atherosclerosis measured by Common carotid artery IMT was confirmed by the study of Sun et al in 2000.[10] They observed that elevated LDL cholesterol and triglycerides were associated with increased IMT in higher blood pressure after adjustment for the other risk factors. This supports the response-to-injury model of hypertension-induced atherosclerosis. Another explanation for the IMT thickening along with increased LDL cholesterol and triglyceride levels occurring in hypertensive was suggested to be adaptive thickening of the intima and the media.[11] Such thickening is characterized

by remodeling to counteract the rise in wall tension observed as medial hypertrophy in the presence of hypertension. Massimo Puatoet al. also found that in grade I hypertensive subjects, both mean IMT and mean of maximum IMT were significantly higher compared with baseline values. Compared with normotensive subjects, both mean IMT and maximum IMT increased significantly (at least P<0.01) in each carotid artery segment. The increase in cumulative IMT was 3.4 fold for mean IMT and 3.2 fold for mean of maximum IMT.[12]

The Plavnik et al. also showed intima media complex (IMC) of common carotid artery and femoral artery to be thicker in hypertensive patients than in normotensive subjects.[13] Similar results were obtained earlier by Jiang et al.[14] and Labrova et al.[15] in their studies. Mechanisms by which hypertension predisposes to atherosclerosis may include endothelial dysfunction, hyperinsulinemia, hemodynamic stress, and multiple metabolic alterations. Impaired production of endothelium-derived relaxing factors and increased activity of endothelium-derived contractile substances have been demonstrated in hypertensive patients, preceding overt atherosclerotic disease.[16]

CONCLUSION

High-resolution sonography is a simple, safe, quick, accurate and non-expensive method of investigation of vessel wall changes in atherosclerosis. Thus High frequency ultrasound and Color Doppler can be effectively used to study both IMT and RI of CCA together.

REFERENCES

1. Kannel WB. Blood pressure as a cardiovascular risk factor: prevention and treatment. JAMA. 1996; 275: 1571–76.
2. Longo, Fauci et al. Hypertensive Vascular Disease. Harrison's principles of internal medicine. 18th ed., The McGraw-Hill Companies, Inc., 2012, Chapter-247.
3. Patel V, Chatterji S, Chisholm D, Ebrahim S, et al. diseasesand injuries in India, Lancet 2011;377:413-28.
4. Palmer AJ, Bulpitt CJ, Fletcher AE, Beevers G, Coles EC,Ledingham JG, et al. Relation between blood pressure and stroke mortality. Stroke 1992;20:601–605.
5. Poli A, Tremoli E, Colombo A. Ultrasonographic measurement of the common carotid artery wall thickness in hypercholesterolemic patients: a new model for the quantification and follow up of preclinical atherosclerosis in living human subjects. Atherosclerosis1988; 70:253–61.
6. Touboul PJ, Labreuche J, Vicaut E, Amarenco P. Genic Investigators. Carotid intima-media thickness, plaques, and Framingham risk score as independent determinants of stroke risk. Stroke 2005;36:1741-45
7. Gnasso A, Irace C, Mattioli PL, Pujia A. Carotid intima-media thickness and coronary heart disease risk factors. Atherosclerosis 1996; 119:7–15.
8. Stein JH, Korcarz CE, Hurst RT, Lonn E, Kendall CB, Mohler ER et al. Use of carotid ultrasound to identify subclinical vascular disease and evaluate cardiovascular disease risk: a consensus statement from the American Society of Echocardiography Carotid Intima-Media Thickness Task Force. Endorsed by the Society for Vascular Medicine. J Am Soc Echocardiogr. 2008;21:93-111; quiz 89-90.
9. M Adaikkappan, R Sampath, AJW Felix, S Sethupathy Evaluation of carotid atherosclerosis by B'mode ultrasonographic study in hypertensive patients compared with normotensive patients. IJRI Vascular 2002;12:365-368.
10. Sun P, Dwyer KM, Merz CNB, Sun W, Johnson CA, Shircore AM et al. Blood pressure, LDL cholesterol, and intima-media thickness. A test of the "response to injury" hypothesis of atherosclerosis. Arterioscler Thromb Vasc Biol 2000;20:2005-2010.
11. Chopanian AV. Corcoran lecture: adaptive and maladaptive responses of the arterial wall to hypertension. Hypertension 1990;15:666-674.
12. Massimo Puato, Paolo Palatini et al. Increase in Carotid Intima-Media Thickness in Grade I Hypertensive Subjects.Am Heart Assoc, 2008;51:1300-1305.
13. FL. Plavnik, SAjzen, et al. Intima-media thickness evaluation by B-mode ultrasound. Correlation with blood pressure levels and cardiac structures. Brazilian Journal of Medical and Biological Research 2000;33: 55-64.
14. Jiang YN, Kohara K, Hiwada K. Alteration of carotid circulation in essential hypertensive patients with left ventricular hypertrophy. J Hum Hypertension 1998;12:173-9.
15. Labrova R, Honzikova N, Madirova E et al. Age dependent relationship between the carotid intimamedia thickness, baroreflex sensitivity, and the interbeat interval in normotensive and hypertensive subjects. PhysiolRes 2005;54:593-600.
16. Touboul PJ, Elbaz A, Koller C et al.Common carotid artery intima-media thickness and brain infarction: the Etude du ProfilGénétique de l'Infarctus Cérébral (GENIC) case control study. The GENIC Investigators. Circulation 2000;102:313-8.

Source of Support: Nil; **Conflict of Interest:** None

Submitted: 28-08-2019; **Accepted:** 05-10-2019; **Published:** 18-10-2019