Scholars Journal of Applied Medical Sciences (SJAMS) **ISSN 2320-6691 (Online)**
Sch. J. App. Med. Sci., 2016; 4(7C):2492-2495 **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com DOI: 10.36347/sjams.2016.v04i07.039

Original Research Article

Study of Pulse Wave Velocity and Ankle Brachial Index in different age-groups and their role in assessment of early atherosclerotic risk

Dr. Ranjana Mandal[1], Dr. Sankar Palchowdhury[2], Dr. A.B.S. Mahapatra[3]
[1]Associate Professor, Department of Physiology, College of Medicine & Sagore Dutta Hospital, Kolkata, West Bengal, India
[2]Professor, Department of Cardiology, R.G. Kar Medical College, Kolkata, West Bengal, India
[3]Professor and Head of Department of Physiology, R.G. Kar Medical College, Kolkata, West Bengal, India

***Corresponding author**
Dr. Ranjana Mandal
Email: guptasomarusa@yahoo.com

Abstract: A total of 240 subjects of different age groups were studied for detection of early atherosclerotic risk by measuring their Pulse Wave Velocity (PWV) and Ankle Brachial Index (ABI) with the help of Vascular Profiler (VP-1000). It is a non invasive, vascular screening device for early detection of arteriosclerosis and atherosclerosis using "Waveform Analysis and Vascular Evaluation" WAVE Technology. The VP 1000 assesses arteriosclerosis by PWV – an index of arterial wall stiffness and by ABI an index to assess arterial occlusion by a single operation and displays the results in a two-dimensional graph. Statistical analysis of the data, obtained was done to evaluate the association between different parameters. In our study, statistically significant changes have been observed in PWV values in Ischaemic Heart Disease (IHD) and Non Ischaemic Heart Disease (Non IHD) group (P Value 0.003). There were no statistically significant changes in the value of ABI in IHD and non IHD groups.
Keywords: PWV (Pulse Wave Velocity), ABI (Ankle Brachial Index), IHD (Ischaemic Heart Disease), PVD (Peripheral Vascular Disease), CAD (Coronary Artery Disease)

INTRODUCTION

There is a witticism "A man is as old as his arteries". Human blood vessels become stiffer and aging in the process of growing old. Senile changes emerge as vessel wall stiffens, loses its elasticity, deteriorates and blocks up - so called arteriosclerosis. Bottom line to remain in healthy condition is to keep elasticity of the arteries – that is to keep the blood vessels soft [1].

As living standards improve, the incidence of some diseases like hypertension, obesity, Diabetes Mellitus, hyperlipidaemia etc., which are closely related to life-style, increases progressively. Arteriosclerosis is known to be a major complication associated with the diseases and can lead to cardiovascular diseases and stroke. So the need for early detection and early treatment of arteriosclerosis is becoming apparent.

Arteriosclerosis and the consequent atherosclerosis progress through a series of structural and functional changes taking place in the vessel-wall culminating into manifest cardiovascular disease. Long latent phase of atherosclerosis provides us with ample opportunity to identify this process at an early stage. Moreover, Vascular Profiler 1000 is a non invasive vascular screening device which can detect arteriosclerosis and atherosclerosis early enough in asymptomatic patients using WAVE technology.

PWV is the speed of blood pressure wave to travel a given distance between two sites of the artery system. PWV is determined by elasticity and other properties (eg Wall thickness) of the artery and also on blood density. PWV correlates well with arterial distensibility and stiffness and is a useful non invasive index to assess Arteriosclerosis. High velocity corresponds to higher arterial stiffness and lower distensibility. Clinically it is a marker of atherosclerotic load or coronary vascular risk [2]. Arterial stiffness is increased with age, in subjects with hypertension, DM, atherosclerosis, end stage renal disease [3].

Aortic PWV is strongly associated with the presence and extent of atherosclerosis and a forceful marker and predictor of cardiovascular risk in

hypertensive patients. Identification of these patients will lead to better and earlier risk stratification and more cost-effective prevention therapy.

$$PWV = \frac{\text{Distance between two sites}}{\text{Pulse Wave Transmit time (PPT)}}$$

Brachial ankle Pulse wave velocity (baPWV) is Delay time from ascending point of right brachial PVR (Pulse volume Recorder) to ascending point of each ankle PVR.

There is a high correlation between baPWV and aortic PWV from heart to femoral artery. In clinical studies 9 m/sec of aortic PWV is defined as a threshold value for high-risk cardiovascular diseases and is equivalent to 1400 cm/sec of baPWV [4].

PWV in different segments helps in the early detection of co-existent subclinical peripheral vascular Disease (PVD) in patients with high CAD risk [5, 6].

$$ABI = \frac{\text{Ankle systolic Blood Pressure}}{\text{Brachial systolic Blood Pressure}}$$

ABI correlates well with degree of stenosis in lower extremity arteries and is widely used to assess Peripheral arterial diseases. Low ABI reading indicates possible presence of severe stenosis [7].

The interpretation of ABI is as follows:

(0.91 to 1.30) → Normal Value
(0.91 to 0.99) → Gray Zone
< 0.90 → Suspected PVD
< 0.80 → Confirmed PVD
> 1.30 → high lower limb arterial stiffness

Peripheral arterial disease is a manifestation of atherosclerotic process. Patients with lower-extremity arterial disease have significantly increased risk of stroke, MI, Cardiovascular death. This has prompted the suggestion that measurement of ABI be included screening physical examination in patient over the age of 55 yrs [8].

Recent data suggest that almost 30% of patients in at risk population have PAD [9-11].
In this backdrop the present study intends to see

1) The relation of PWV and ABI with respect to age.
2) As it has been seen that increased PWV is associated with increased cardiovascular mortality and morbidity risk, the study intends to reveal whether high cardiovascular risk (Conventional risk factors) has got any relationship with PWV and ABI.

MATERIALS AND METHODS

The case control study was undertaken in the dept. of Cardiology, NRS Medical College, Kolkata in collaboration with the dept. of Physiology of same institute. The study period was from January 2013 to Dec 2013. The study was approved by Institutional Ethics Committee.

Selection of Study Subjects

A total of 240 subjects from in-Patient and out-patient-Department (Cardiology) of the Institute were included in the study. Informed consent was obtained from all subjects. Detailed History was taken and thorough were clinical examination done in each case.

5ml of blood was collected from all the subjects and plasma was used to estimate Lipid Profile and Fasting blood glucose.

1 ml of blood was collected after 2 hrs of 100 g of oral glucose intake and plasma was used to estimate Post prandial glucose estimation. All the tests were done in Central Laboratory of the Institute by Auto analyser. The study population was divided into different groups as follows:

Group I: Subjects having Coronary artery disease

The criteria of inclusion in this group are:
Prior documented evidence of Myocardial Infarction

i) Post CABG and post angioplasty
ii) Typical angina by history
iii) Non invasive test eg stress ECG Test positive

The non CAD group comprised of age-matched individual without any evidence of CAD.

Group II : Coronary Risk Equivalent

The criteria of inclusion in this group are:

i) Subjects having Diabetes Mellitus Fasting Blood sugar level 126 mg/dl, postprandial >=200 mg/dl
ii) Subjects having Peripheral Artery Disease
iii) Other risk factors
   - Male > 45 yrs & Female > 55 yrs.
   - Family History of CAD
   - Cigarette Smoking
   - Hypertension (140/90 mmHg)
   - Low HDL (<40 mg/dl]

Group III: Normal Subjects who gave none of the above findings.

PWV / ABI measurements were done with VP 1000 device in all study subjects.

The Normal reference values which were adopted were provided by Colin Corporation (12).

STATISTICAL ANALYSIS

Statistical analysis of data (the Parameters, PWV, ABI) obtained were expressed as Mean ± Standard Deviation using the software package. Analysis was performed to evaluate whether there is any significant change in the said parameters among different groups by using student's t test. Values of $P<0.05$ was considered to indicate statistical significance.

RESULTS

A total of 240 subjects were enrolled for the study. Among them, number of subjects in Group I, i.e. patients with IHD was 76; Subjects with Coronary Risk Equivalent, i.e. in Group II were 66 whereas subjects in group III (Normal) were 98.

Table 1 shows the estimation of value of ABI & PWV in IHD (Group I) and Non IHD group (Group III). There was statistically significant change in PWV value in IHD when compared to non IHD group. However, no significant change was observed in ABI value. Hence PWV is considered as more important parameter for screening and was used to find out whether it differs among cases with Coronary risk equivalent (Group II) and normal (Group III) subjects (table 2). Statistically significant change was observed in PWV values in these 2 groups.

Table 1: Estimation of value of ABI & PWV in IHD and Non IHD group

Parameter	IHD (n=76)	Non IHD (n=98)	P Value	Significant or Non-Significant
ABI	1.11±0.12	1.1±0.09	0.31	NS
PWV	1889.77 ±426.04	1709.31±521.79	0.003	S

All values are expressed in Mean ± SD

Table 2: Estimation of value of PWV in Coronary Risk equivalent and Normal Subjects

Parameter	Coronary Risk equivalent (n=66)	Normal Subjects (n=98)	P Value	Significant or Non-Significant
PWV	1709.31±521.79	1290± 150	0.0009	Significant

All values are expressed in Mean ± SD

DISCUSSION

Prevention is better than cure. VP-1000 is able to detect the ill-health of the arteries supplying the heart, brain, limbs in a non invasive manner. So any individual above 35 years of age should get themselves screened every year for health check-up. Also patients with risk factors should get screened. Both PWV and ABI are good inductors of cardiovascular health.

Arteriosclerosis is a natural ongoing process in every individual and hence arterial stiffness gradually increases with age. There is an established range of baPWV for specific age groups. The threshold value for baPWV is 1400 cm/sec. An ABI value is in the range of 0.90 – 1.30.

More than Ten epidemiologic studies have shown the validity and reproducibility of baPWV 7,8. Our study is concordant with the finding of Yamashina A. *et al* [13] and Kingwell BA *et al*. [14].

Paul E Norman *et al*. [15] opined that patients with PVD have mortality rate over healthy age study, we have not obtained statistically significant relation in the ABI values between IHD and non IHD group.

CONCLUSION

In order to evaluate the morbidity and mortality even among the young individuals and to reduce the incidence of acute events like acute myocardial infarction with associated complications-conventional risk factors and emerging risk factors should be taken care of through specific policies including public education program.

LIMITATIONS

1) Relatively small study with heterogenous population.
2) Time limited to one year. So we could not assess prospectively whether PWV could be a sole indicator of Atherosclerotic burden.

ACKNOWLEDGEMENT

The authors acknowledge the help from Prof. A.K. Mondol, Principal NRS Medical College, Mr. N. Bhattacharya Nicholas Piramal India Ltd. for providing the instrument vascular Profiler 1000 without which this work would not have been possible and Dr. N. Mondol of Dept. of PSM for statistical analysis part. The support of the West Bengal University of Health Sciences is also duty acknowledged.

REFERENCES

1. Libby P; Current concepts of the pathogenesis of the acute coronary syndrome. Circulation, 2001; 104(3): 365 – 72
2. Lehman ED, gosling RG; Lowering of Blood Pressure and artery stiffness. Lancet, 1997; 349: 318 – 20.
3. Blacher J; Aortic Pulse wave velocity a marker of cardiovascular risk. Hypertension, 1999; 33(5): 1111 – 7.
4. Yasuda H, Kamide K, Takiuchi S, Matayoshi T, Hanada H , Kada A, Yang J, Miwa Y, Yoshii M, Horio T, Yoshihara F, Nakamura S, Nakahama H,

Tei C, Miyata T, Kawano Y; Association of single nucleotide polymorphisms in endothelin family genes with the progression of atherosclerosis in patients with essential hypertension. Journal of Human Hypertension, 2007; 21: 883–892.

5. Yamashina A, Tomiyama H, Takeda K, Tsuda H, Arai T, Hirose K; Validity reproducibility and clinical significance of noninvasive brachiated ankle pulse wave velocity measurement. Hypertension, 2002; 25(3): 359 – 64.
6. Pereira T, Correia C, Cardoso J; Novel Methods for Pulse Wave Velocity Measurement. J Med Biol Eng., 2015; 35(5): 555–565.
7. Lisa KCKR, Simon GA, John SW, Graham D, Ray GG; Aortic Pulse wave velocity and its relationship to mortality in Diabetes and glucose Tolerance. Circulation 2002, DOI: http://dx.doi.org/10.1161/01.CIR.0000033824.02722.F7 LHG Henskens. Increased Aortic pulse wave velocity is associated with silent cerebral small vessel Disease in Hypertensive Patients. Hypertension, 2008; 52(6):1120-6.
8. Hirsch AT, Criqui MH; Peripheral arterial disease detection, awareness and treatment in primary care. JAMA, 2001; 286: 1317 – 24
9. Asmar RG, Benetos A, Topuchain J; Assessment of arterial compliance by automatic PWV measurements. Validation and clinical application studies. Hypertension, 1995; 26: 485 – 90.
10. Nichols WW, O' Rowike MF (eds): McDonald's Blood flow in arteries : Theoretical, experimental and clinical principles, Fourth edition London, Arnold, 1998; 347 – 401.
11. O'Rourke M; Arterial stiffness, Systolic Blood Pressure and logical treatment of arterial hypertension. Hypertension 1990; 15: 339 – 347.
12. Website url: www.colin-bp.co.jp
13. Yamashima A, Tomiyama H, Takeda K; Validity, reproducibility and clinical significance of noninvasive brachial – ankle pulse wave velocity measurement. Hypertens Res., 2002; 25: 359 – 364.
14. Kingwell BA, Waddell TK, Medley TL, Cameron JD, Dart AM; Large Artery Stiffness Predicts Ischemic Threshold in Patients With Coronary Artery Disease. J Am Coll Cardiol., 2002; 40(4):773-9.
15. Paul E Norman, Eikelboom JW, Hankey GJ; Peripheral arterial disease: prognostic significance and prevention of atherothrombotic complications. MJA, 2004; 181 (3): 150 – 154.