

Incidence of Carotid Artery Atherosclerosis in Patients with Coronary Artery Disease in a Tertiary Care Hospital

Dr. Balaji Varaprasad Mallula¹, Dr. Sandeep Nagare², Dr. Prashanth Kumar KS^{2*}

¹Associate Professor, Department of Radiology, Kamineni Academy of Medical Sciences and Research Center, Lb Nagar Hyderabad, India

²Director and Chief Radiologist, Me division Diagnostic Centre, Ahmed Nagar, Maharashtra, India

Original Research Article

*Corresponding author
Dr. Prashanth Kumar KS

Article History

Received: 16.02.2018

Accepted: 26.02.2018

Published: 20.03.2018

DOI:

10.21276/sjams.2018.6.3.7



Abstract: The burden of coronary artery disease (CAD) continues to rise globally, including India, due to adopting of sedentary lifestyles. Stroke and myocardial infarction are clearly interrelated events. Determine the incidence of carotid artery atherosclerosis by carotid Doppler ultrasonography in patients with coronary artery disease in a tertiary care hospital. This prospective study was done at kamineni hospitals, l.b. nagar, hyderabad, during june 2012 to March 2014 over 70 patients. The overall incidence of Carotid artery atherosclerosis measured in terms of increased IMT, the presence of plaques, the presence of hemodynamically significant stenosis in carotid and vertebral artery. Increased IMT found in 65.715, plaques in 62.85%, carotid artery stenosis in 14.28%, and carotid and vertebral artery stenosis in 22.85% cases. Incidence of increased IMT, plaques and hemodynamically significant stenosis in the carotid and vertebral artery is more common in TVD patients than SVD patients. However, there is no such association between SVD & DVD and DVD & TVD patients.

Keywords: Coronary artery disease, the intima-medial thickness of carotid artery, plaques in the carotid artery, hemodynamically significant stenosis in carotid and vertebral artery.

INTRODUCTION

Cardiovascular diseases are the most common cause of death and disability in industrialized countries and emerging as the major cause of death and disability in developing countries like India. The burden of coronary artery disease (CAD) continues to rise globally, as developing nations, including India, are adopting to lifestyle changes with the predisposition to cardiovascular diseases (CVD) [1].

In India, incidences of CAD have doubled over the last three decades. By 2015, CVDs alone would amount to 1.5 million deaths, including 34% of male and 32% of female global deaths [2].

Atherosclerosis is the formation of fibro-fatty plaques in the intima, resulting in narrowing of the lumen of blood vessels. Atherosclerosis is the main factor leading to myocardial infarction or Stroke [3]. The natural history of coronary artery disease (CAD) is often complicated by cerebrovascular accidents.

There is an increased incidence of Transient Ischemic Attack (TIA) and stroke in patients undergoing Coronary Artery Bypass Grafting (CABG) surgery [4]. The risk of stroke is increased in patients with significant carotid artery stenosis. Because most of the patients with significant carotid stenosis are asymptomatic, it is mandatory to screen the status of carotid arteries prior to CABG [5]. Just like the general

population there is not enough attention paid by medical fraternity to look into the status of other vessels in patients with significant coronary artery disease.

There are many methods to diagnose the carotid artery disease. They are Doppler ultrasound, CT angiogram, MRI angiogram, cerebral angiography. There are different positive and negative aspects of each diagnostic tool. Among all, the most accurate test is carotid angiogram which is invasive and expensive. Doppler ultrasound has been widely accredited as the best screening tool with accuracy comparable to carotid angiogram in 93% of cases [6]. Intimo-medial thickness (IMT) is a measure of the combined thickness of intima and media layers of a carotid artery, most commonly assessed by B-mode ultrasound. Increase in carotid intima-media thickness (CIMT) may result from hypertrophy of intimal or medial layers or both because cellular/molecular mechanisms that increase CIMT are also the factors responsible for development and

progression of atherosclerosis [7]. Arterial IMT measurement is an independent predictor of atherosclerotic Events [8].The progression of common carotid IMT is a useful surrogate marker for coronary and other atherosclerotic events [8,9].The presence of carotid plaque is associated with an increased risk of cardiovascular events in patients with CAD regardless of the treatment strategy (medical therapy alone or myocardial revascularization). The presence of obstructive carotid plaques is associated with increasing risk of cerebrovascular events by aeroembolism, as the severity of the stenosis increases [10] and increased risk of cardiac death and myocardial infarction [11].

AIMS AND OBJECTIVES

Aims

To determine the incidence of carotid artery atherosclerosis by carotid Doppler ultrasonography in patients with coronary artery disease in a tertiary care hospital

Objectives

To investigate

- Relation between intima-medial thickness in carotid arteries and extent of coronary artery disease
- Type, site and nature of plaque.
- Severity of stenosis in carotid arteries.

MATERIALS AND METHODS

This prospective study was done at Kamineni Hospitals, L.B. Nagar, Hyderabad, during June 2012 to March 2014 over 70 patients.

Inclusion criteria

All patients with coronary artery disease (those proved by coronary angiography) symptomatic or asymptomatic for carotid artery disease

Exclusion criteria

Hemodynamically unstable patients

Methods

After taking informed consent, detailed clinical history collected. Carotid Doppler ultrasonography was performed on the PHILIPS HD 11. Scanning was performed with a 7.5 MH mechanical sector. Scanner Probe and pulsed-Doppler-sound spectral analysis were

be used to detect flow disturbances. Following findings were recorded as per the case record form.

***Intima-medial thickness**

For the far (posterior) wall of the carotid artery, this index was measured by ultrasound as the distance between the leading edge of the luminal echo (first bright line) and the leading edge of the media-adventitia echo (second bright line).

For the near (anterior) wall, IMT was measured as the distance between the trailing edge of the first bright line and the trailing edge of the second bright line (23;70) An IMT was measured in common carotid and internal carotid arteries on both sides. An IMT of 0.8 mm was considered as an upper limit of normal for both men and women (DH).

***Carotid plaques**

Site, thickness and type of plaques if any are recorded in the bilateral common carotid artery, carotid bulb and internal carotid artery.

***Severity of stenosis**

% of hemodynamically significant stenosis is recorded as per criterion is given by Grant EG *et al.* [12].

*** Vertebral artery**

PSV, EDV and spectral waveform are recorded on each side.Any abnormality in velocities and spectral waveform is recorded.

RESULTS

A total number of 70 patients with Coronary artery disease, those proved by Coronary angiography either Single vessel disease, double vessel disease or Triple vessel disease were studied by carotid Doppler ultrasonography over a period of June 2012 to March 2014, in the Department of Radiology, Kamineni hospital, LB Nagar, Hyderabad.

Mean age of the study population was 58.57 years (range: 41 years – 78 years).Among them 57 (81.42 %) are males and 13 (18.57%) are females. Majority of the patients (45) were between the ages of 50- 70 years, which included 38 (84.44 %) males and 7 (15.15%) females. 64.28 % of the population included in this study was in between 50 to 70 years of age, the majority of which were males.

Table-1: Age and Sex Distribution of Studied Patients

| SR.NO. | AGE GROUP | NO.OF PATIENTS | MALE | FEMALE |
|--------|-----------|----------------|------|--------|
| 1 | <50Yr | 16 | 13 | 3 |
| 2 | 50- 70yr | 45 | 38 | 7 |
| 3 | >70yr | 9 | 6 | 3 |
| | Total | 70 | 57 | 13 |

Out of the 70

Patients of Coronary artery disease, 21 (30%) are of single vessel disease, 20 (28.57%) are of double vessel disease and 29 (41.43 %) are of triple vessel disease.

In the study population, 39 (55.71 %) patients had diabetes, 41 (58.57%) patients had hypertension, 27 (38.57%) patients had the history of smoking and 20 (28.57%) patients had the history of

alcoholism. Most of the patients 69 (98.57 %) are asymptomatic for carotid artery disease while only one patient was symptomatic of carotid artery disease.

Intima medial Thickness

Increased IMT was seen in 46 (65.71%) of the patients, the common carotid artery is more common than an internal carotid artery. The incidence of increased IMT was as follows.

Table-2: Incidence of Increased Int of Common Carotid and Internal Carotid Artery in Cad Patients

| Carotid Artery Disease | Number of patients with increased IMT out of 70 | Percentage |
|------------------------|---|------------|
| Right CCA | 46 | 65.71% |
| Left CCA | 46 | 65.71% |
| Right ICA | 34 | 48.57% |
| Left ICA | 34 | 48.57% |

Average IMT in these patients was 1.1043 mm in right common carotid artery, 1.1017 mm in the left common carotid artery, 0.9461 mm in right internal carotid artery and 0.9450 mm in the left internal carotid artery.

Increased IMT was seen in 10 (47.61 %) patients out of the 21 patients of SVD, 13 (65%) patients out of the 20 patients of DVD and 23 (79.31%) patients out of the 29 patients of TVD.

Table-3: Association of Severity of Cad and Incidence of Increased It in Carotids by Fisher's Exact Test

| Association | P Value by Fisher's Exact test[13,14] | Statistical significance |
|-------------|---------------------------------------|--------------------------|
| SVD X TVD | 0.0334 | Significant |
| SVD X DVD | 0.3499 | Not significant |
| DVD X TVD | 0.3314 | Not significant |

Plaques

The plaque was identified in 44 (62.85 %) patients out of the 70. Plaques were identified in 8

(38.09 %) patients out of the 21 patients of SVD, 13 (65%) patients out of the 20 patients of DVD and 23 (79.31%).

Table-4: Incidence of Plaques: Side and Territory Wise Distribution in Carotids

| Carotid artery | Incidence of plaques in 70 patients | Total number of plaques | Calcified plaques | Hypochoic plaques | Echogenic plaques |
|----------------|-------------------------------------|-------------------------|-------------------|-------------------|-------------------|
| Right CCA | 24(34.28%) | 27 | 16 | 7 | 4 |
| Left CCA | 22(31.42%) | 22 | 7 | 8 | 7 |
| Right ICA | 21(30 %) | 23 | 14 | 5 | 4 |
| Left ICA | 16(22.85%) | 17 | 8 | 5 | 4 |
| | Total | 89 | 45(50.56%) | 25(28.08%) | 19(21.34%) |

Table-5: Association of Severity of Cad and Incidence of Plaques by Fisher's Exact Test

| Association | P Value by Fisher's Exact test [13,14] | Statistical significance |
|-------------|--|--------------------------|
| SVD X TVD | 0.007 | Significant |
| SVD X DVD | 0.1215 | Not significant |
| DVD X TVD | 0.3314 | Not significant |

Haemodynamically significant stenosis in carotids

It is found in 10 (14.28%) patients out of 70. 1(4.76%) patient of SVD, 2 (10%) patients of DVD and 7 (24.13 %) patients of TVD. The overall incidence of haemodynamically significant stenosis in carotids is 14.28 % (10/70). TVD is relatively more commonly

associated with haemodynamically significant carotid stenosis. The incidence of haemodynamically significant carotid and vertebral artery stenosis is 22.85 % (16/70). TVD is relatively more commonly associated with haemodynamically significant carotid and vertebral artery stenosis.

Table-6: Association of severity of cad and incidence of haemodynamically significant carotid artery stenosis

| Association | P Value by Fisher's Exact test[13,14] | Statistical significance |
|-------------|---------------------------------------|--------------------------|
| SVD X TVD | 0.1167 | Not Significant |
| SVD X DVD | 0.6060 | Not significant |
| DVD X TVD | 0.2771 | Not significant |

DISCUSSION

A total number of 70 patients with Coronary artery disease, those proved by Coronary angiography either Single vessel disease, Double vessel disease or Triple vessel disease were included for carotid Doppler ultrasonography over a period of June 2012 to March 2014 in the present study.

Overall incidence of Carotid artery atherosclerosis measured in terms of increased IMT, presence of plaques, presence of haemodynamically significant stenosis in carotid and vertebral artery is as follows in the present study

| Increased IMT | Plaques | Haemodynamically significant stenosis in carotid artery | Haemodynamically significant stenosis in carotid & vertebral artery |
|---------------|--------------|---|---|
| 65.71%(n-46) | 62.85%(n-44) | 14.28 % (n-10) | 22.85 % (n-16) |

Value of Normal Cut off And Average Increased Imt In Comparison With Other Studies

| Study | Normal cut off in mm | Average increased IMT in common carotids in mm |
|----------------------------------|----------------------|--|
| Present study | ≤ 0.8 | 1.1030 |
| Hansa <i>et al.</i> [15] | ≤0.8 | 0.82 |
| Visona A <i>et al.</i> [16] | 0.87 ± 0.1 | 1.45 ± 0.95 |
| Komorovsky <i>et al.</i> [17] | ≤ 1 | - |
| Shiran Shetty <i>et al.</i> [18] | 0.689 | 0.923 |

An IMT of 0.8 mm was considered as an upper limit of normal for both men and women in common carotid and internal carotid artery in the present study. Average IMT in these patients was 1.1043 mm in right common carotid artery, 1.1017 mm in the left common carotid artery, 0.9461 mm in right internal carotid artery and 0.9450 mm in the left internal carotid artery.

To determine whether carotid intima-media thickness is associated with coronary artery disease and cardiovascular risk factors in the Indian population, Hansa and colleagues [15] measured carotid intima-media thickness using high-resolution B-mode ultrasonography in 101 patients with coronary artery disease and 140 control subjects. Intima-media thickness was significantly higher in the coronary disease group compared to the controls (1.02 vs. 0.80 mm). The average intima-media thickness was also

significantly higher in the coronary disease group (0.82 vs. 0.67 mm). In the present study, we did not include controls. Visona and colleagues [16] showed that common carotid artery IMT in CAD patients (1.45 ± 0.95 mm) was significantly higher than in controls (0.87 ± 0.1 mm; $p < 0.005$). Komorovsky *et al.*[17] proposed that carotid artery disease, even in its preclinical stage (intima-media thickness [IMT] ≥ 1 mm has been associated with CAD and an increased risk of cardiovascular events. Shiran Shetty *et al.*[18] measured IMT IN 70 documented cases of coronary artery disease and 30 controls. The mean carotid IMT in the study group was 0.923 ± 0.123 and in control group, it was 0.689 ± 0.051 ($P=0.001$). The mean carotid intima thickness was significantly high in the case group as compared with the control, and the P-value was highly significant. In the present study, we did not include controls.

Incidence of Increased Imt In Comparison With Other Studies

| Study | Incidence in % | Study population |
|------------------------------------|----------------|------------------|
| Present study | 65.71(n-46) | 70 |
| M. Sanei Taheri <i>et al.</i> [19] | 22.50(n-79) | 352 |

The incidence of increased IMT in the present study is 65.71% (n-46). Incidence of increased IMT is as follows: Right and left common carotid artery 46 patients (65.71%). Right and left internal carotid artery 34 patients (48.57%)

In the present study, symmetrical involvement is seen in bilateral common carotid arteries. In a study done by M. Sanei Taheri *et al.* [19] an increase in IMT was observed in 79 (22.5 %) patients. 72 (20.5%) had bilateral and 7 (2%) had unilateral disease.

Incidence of Plaques in Individual Carotid Artery In Comparison With Other Studies

| Study | Study population | Incidence of plaques in % | | | |
|----------------------------------|------------------|----------------------------|------------|---------------------------|---------------|
| | | Right CCA and carotid bulb | Right ICA | Left CCA and carotid bulb | Left ICA |
| Present study | 70 | 34.28% (n-24) | 30% (n-21) | 31.42% (n-22) | 22.85% (n-16) |
| Waseem Akhtar <i>et al.</i> [20] | 176 | 48% (n-85) | 36% (n-64) | 50% (n-88) | 35% (n-61) |

Incidence of Plaques on Either Side in Comparison with other Studies

| Study | Study population | Incidence of plaques in % | |
|------------------------------------|------------------|---------------------------|-----------------|
| | | Right side | Left side |
| Present study | 70 | 64.28 % (n-45) | 54.28 % (n-38) |
| Waseem Akhtar <i>et al.</i> [20] | 176 | 84.65 % (n-149) | 84.65 % (n-149) |
| M. Sanei Taheri <i>et al.</i> [21] | 352 | 32.4 % (n-114) | 30.1 % (n-106) |

The overall incidence of plaques in CAD patients was 62.85 % (n-44) in the present study. Incidence of plaques is higher in right common carotid artery and carotid bulb, followed by left common carotid artery and carotid bulb in present study, however, incidence of plaques is higher in higher in left common carotid artery and carotid bulb, followed by right common carotid artery and carotid bulb in a study done by M. Sanei Taheri *et al.* [19]. There is no much difference between the incidence of plaques on right, 64.28 % (n-45) and left, 54.28 % (n-38) side in the present study. This result correlates with the other studies. The incidence of plaques is same on either side in a study done by Waseem Akhtar *et al.* [19]. The

incidence of plaque on right is 32.4 % (n-114) and on left is 30.1 % (n-106) side in a study done by M. Sanei Taheri *et al.*[19]. One limitation is that Waseem Akhtar *et al.* [20] and M. Sanei Taheri *et al.* [19] included the patients undergoing CABG in their study while present study included all the CAD patients either SVD, DVD, TVD irrespective of their medical or surgical management.

Overall 89 plaques were identified out of which incidence of calcified plaques was highest ie. 45 (50.56 %) followed by hypochoic plaques which were seen in 25 (28.08 %) patients and then echogenic plaques are seen in 19 (21.34 %) patients.

Incidence of Hemodynamically Significant Carotid Artery Stenosis in Comparison with other Studies

| S. No | Study | Study population | Incidence of haemodynamically significant stenosis |
|-------|--------------------------------------|------------------|--|
| 1 | Present study | 70 | 14.28% (n-10) |
| 2 | M. Sanei Taheri <i>et al.</i> [19] | 352 | 7.4% (n-26) |
| 3 | Waseem Akhtar <i>et al.</i> [20] | 176 | 19.88% (n-35) |
| 4 | Valerio Sanguigni <i>et al.</i> [21] | 184 | 27.7% (n-51) |
| 5 | Kallikazaros <i>et al.</i> [22] | 197 | 18.78% (n-37) |
| 6 | Angelopoulos <i>et al.</i> [23] | 18050 | 1.7% (n-313) |
| 7 | T. Sumalatha <i>et al.</i> [24] | 200 | 17% (n-34) |

The overall incidence of hemodynamically significant carotid stenosis in the present study is 14.28 % (n-10). The average age of these 10 cases is 63.8 years (range: 47-78 years) and all are males. Total 29 plaques were identified in these 10 cases; out of which incidence of calcified plaques is high 44.82% (13/29) followed by hypochoic plaques 31% (9/29) and then echogenic plaques 24.13% (7/29). Out of these 10 cases

8 had diabetes, 7 had hypertension, 5 had the history of smoking and 4 had the history of alcoholism.

In the present study, we also showed the incidence of hemodynamically significant vertebral artery stenosis in patients of the CAD. This incidence is 8.57% (n-6) and the overall incidence of haemodynamically significant carotid and vertebral artery stenosis is 22.85% (n-16). To the best of our

knowledge, this is the first study which showed the incidence of hemodynamically significant stenosis in both carotid and vertebral artery in patients of the CAD.

In a study done by M. Sanei Taheri *et al.* [19], out of 352 patients studied Overall, 26 (7.4%) patients had at least one stenosis >50%. 82.1% (n-289) patients were ≥ 60 years old. The prevalence of carotid stenosis and atherosclerotic plaques in these patients was higher than in patients aged <60 years. Valerio Sanguigni *et al.* [21] found a significant carotid stenosis in 51 patients (27.7 %), 40 men and 11 women, with the average age of 62.3 years. Twenty-one subjects were classified as symptomatic on the basis of what was defined as general symptoms (dizziness, vertigo, lipothymia, etc),

while 30 subjects were completely asymptomatic. This study highlighted the fact that half of the patients (47.1 1 %), with carotid stenosis greater than 75 % were asymptomatic. In the present study out of the 10 cases of hemodynamically significant stenosis, only 1 is symptomatic. Recent Indian study done by T. Sumalatha *et al.* [24] showed that out of the 200 patients 82% are males and 18% are females. The percentage of males with carotid stenosis (34) cases was 85.3% and that of females was 14.7%. The mean age of study population was 57.5 years. The incidence of carotid stenosis among patients with age <55 years was 10.1% and that among patients with age >55 years was 21.5%.

Association of Haemodynamically Significant Carotid Artery Stenosis and Severity of Coronary Artery Disease In Comparison With Other Studies

| S. No | Study | Number of patients with haemodynamically significant stenosis in carotids | Incidence of haemodynamically significant stenosis in carotids in % | | |
|-------|---------------------------------|---|---|--------------|---------------|
| | | | SVD | DVD | TVD |
| 1 | Present study | 10 | 10 % (n-1) | 20% (n-2) | 70% (n-7) |
| 2 | Kallikazaros <i>et al.</i> [22] | 37 | 8.10% (n-3) | 18.91% (n-7) | 72.97% (n-27) |
| 3 | T. Sumalatha <i>et al.</i> [24] | 34 | 0% (n-0) | 20.6% (n-7) | 79.4% (n-27) |

The overall incidence of haemodynamically significant stenosis in carotids in the present study is 14.28% (n-10). Out of these 10 cases, 7 patients are of TVD. Other studies (Kallikazaros *et al.* [22] and T. Sumalatha *et al.* [24]) also showed the same association. This suggests that incidence of haemodynamically significant stenosis in carotids is higher in patients with TVD.

CONCLUSIONS

A total number of 70 patients with CAD, those proved by Coronary angiography either SVD, DVD, TVD were studied with carotid Doppler ultrasonography.

The most common age group was 50-70 years. The male preponderance was noted with the male: female ratio of 4.3:1. Most of the patients was asymptomatic for the carotid artery disease. The incidence of increased thickness of IMT was 65.71 % (n-46). Simultaneous involvement of bilateral Common carotid artery is more common than the internal carotid artery. TVD patients are more commonly associated with increased thickness of IMT. The incidence of plaques of was 62.85 % (n-44). Overall 89 plaques were identified out of them incidence of calcified plaques is more followed by hypoechoic plaques and then echogenic plaques. The incidence of plaques is more common in TVD patients. The incidence of

hemodynamically significant stenosis in carotids was 14.28% (n-10). Incidence is high in patients with TVD. The incidence of hemodynamically significant stenosis in vertebral artery was 8.57% (n-6). Incidence is high in patients with TVD. The incidence of increased IMT, plaques and hemodynamically significant stenosis in the carotid and the vertebral artery is more common in TVD patients than SVD patients. However, there is no such association between SVD & DVD and DVD & TVD patients.

REFERENCES

1. Sharma M, Ganguly NK. Premature coronary artery disease in Indians and its associated risk factors. Vascular health and risk management. 2005 Sep;1(3):217.
2. Enas EA. Coronary artery disease epidemic in Indians: a cause for alarm and call for action. Journal of the Indian Medical Association. 2000 Nov;98(11):694-5.
3. American Heart Association. Heart and stroke statistical update. Dallas: American Heart Association; 2001.
4. Furlan AJ, Craciun AR. Risk of stroke during coronary artery bypass graft surgery in patients with internal carotid artery disease documented by angiography. Stroke. 1985 Sep 1; 16(5):797-9.
5. Halliday A. MRC Asymptomatic Carotid Surgery Trial (ACST) Collaborative Group: Prevention of

- disabling and fatal strokes by successful carotid endarterectomy in patients without recent neurological symptoms: randomized controlled trial. *Lancet*. 2004; 363:1491-502.
6. Langsfeld M, Lusby RJ. The spectrum of carotid artery disease in asymptomatic patients. *The Journal of cardiovascular surgery*. 1988;29(6):687-91.
 7. Stein JH, Korcarz CE, Hurst RT, Lonn E, Kendall CB, Mohler ER, Najjar SS, Rembold CM, Post WS. 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. *Journal of the American Society of Echocardiography*. 2008 Feb 29;21(2):93-111.
 8. Mohan V, Deepa R, Ravikumar R. Role of carotid intimal medial thickness in assessment of Pre-clinical Atherosclerosis. *Indian heart journal*. 2000;52:395-9.
 9. Ridker PM. Evaluating novel cardiovascular risk factors: can we better predict heart attacks?. *Annals of internal medicine*. 1999 Jun 1;130(11):933-7.
 10. North American Symptomatic Carotid Endarterectomy Trial Collaborators. Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. *N engl j Med*. 1991 Aug 15;1991(325):445-53.
 11. Held C, Hjemdahl P, Eriksson SV, Björkander I, Forslund L, Rehnqvist N. Prognostic implications of intima-media thickness and plaques in the carotid and femoral arteries in patients with stable angina pectoris. *European Heart Journal*. 2001 Jan 1;22(1):62-72.
 12. Grant EG, Benson CB, Moneta GL, Alexandrov AV, Baker JD, Bluth EI, Carroll BA, Eliasziw M, Gocke J, Hertzberg BS, Katanick S. Carotid artery stenosis: gray-scale and Doppler US diagnosis—Society of Radiologists in Ultrasound Consensus Conference. *Radiology*. 2003 Nov; 229(2):340-6.
 13. Fisher RA. On the interpretation of χ^2 from contingency tables, and the calculation of P. *Journal of the Royal Statistical Society*. 1922 Jan 1; 85(1):87-94.
 14. Fisher RA. *Statistical methods for research workers*. Genesis Publishing Pvt Ltd; 1925.
 15. Hansa G, Bhargava K, Bansal M, Tandon S, Kasliwal RR. Carotid intima-media thickness and coronary artery disease: an Indian perspective. *Asian Cardiovascular and Thoracic Annals*. 2003 Sep;11(3):217-21.
 16. Visona A, Pesavento R, Luciani L, Bonanome A, Cernetti C, Rossi M. Intimal medial thickening of the common carotid artery as the indicator of coronary artery disease. *Angiology* 1996;47:61–6
 17. Komorovsky R, Desideri A. Carotid ultrasound assessment of patients with coronary artery disease: a useful index for risk stratification. *Vascular health and risk management*. 2005 Jun;1(2):131.
 18. Shetty S, George P, Venkatesha BM, Alva J. A study to correlate carotid intima thickness by B-mode ultrasonography in patients documented with coronary artery disease. *Heart views: the official journal of the Gulf Heart Association*. 2011 Oct; 12(4):157.
 19. Saneei Tm, Haghightakhah Hr, Hasantash S, Bakhshian Kr, Shakiba M, Jalali Ah. The prevalence of carotid artery disease in candidates of coronary artery bypass graft.
 20. Akhtar W, Sabih A, Ali A, Aslam M, Ahmad N. Carotid artery disease in patients undergoing elective coronary artery bypass surgery. *Journal of the College of Physicians and Surgeons Pakistan*. 2009;19(12):759.
 21. Sanguigni V, Gallù M, Strano A. Incidence of carotid artery atherosclerosis in patients with coronary artery disease. *Angiology*. 1993 Jan;44(1):34-8.
 22. Kallikazaros I, Tsioufis C, Sideris S, Stefanadis C, Toutouzas P. Carotid artery disease as a marker for the presence of severe coronary artery disease in patients evaluated for chest pain. *Stroke*. 1999 May 1;30(5):1002-7.
 23. Evagelopoulos N, Trenz MT, Beckmann A, Krian A. Simultaneous carotid endarterectomy and coronary artery bypass grafting in 313 patients. *Cardiovascular surgery*. 2000 Jan;8(1):31-40.
 24. Sumalatha T, Sreelatha T, Rajasree K and T. Sivaprasad.' Asymptomatic carotid artery stenosis and correlation with coronary artery disease among 200 patients undergoing CABG'. *IJBR* (2013) 04 (06).