



## Stroke and Peripheral Vascular Disease (PVD) Iceberg phenomenon in patients undergoing CABG for coronary artery disease: A Retrospective research study.

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**Abstract:** Iceberg phenomenon is an epidemiological concept that highlights how an illness from preclinical stages progress to its obvious clinical manifestations and presents with challenges in identifying the unreported or otherwise hidden yet potential risks which can cause significant morbidity or resultant mortality in the community seeking professional health care if not well addressed. **Objective** our research study was retrospective review analysis done for studying iceberg phenomenon in patient undergoing preoperative evaluation colour Doppler study that were already diagnosed with coronary artery disease and were planned for CABG (Coronary Artery Bypass Grafting) by CVTS surgeon. **Results** Our study reveals significant burden of future stroke and PVD risks in patients who underwent carotid and peripheral arterial Doppler study during routine preop evaluation for patients planned for CABG for CAD. **Conclusion** The Iceberg phenomenon of stroke & PVD with risk factors presents as significant future burden in community of high risk group class of patients who underwent CABG for CAD. These needs attention by addressing the modifiable risk factors, best medical management, lifestyle modifications, opd followup by both CVTS and IR to addresses the symptomatic population or at risk patients and suggest appropriate vascular interventions and close followup for staged revascularization, further suggest to expand the scope of preoperative evaluation as screening tool in cohort of patients undergoing successful PTCA for CAD.

**Keywords:** Stroke, Peripheral Vascular Disease (PVD), Coronary Artery Disease (CAD), C.A.B.G., Iceberg Phenomenon

## INTRODUCTION

Iceberg phenomenon is an epidemiological concept that highlights how an illness from preclinical stages progress to its obvious clinical manifestations and presents with challenges in identifying the unreported or otherwise hidden yet potential risks which can cause significant morbidity or resultant mortality in the community seeking professional health care if not well addressed <sup>[1-5]</sup>.

In current era the colour doppler study is an efficient non-invasive tool with prudent availability in diagnostic radiology setup and vascular interventional radiology clinics which can help both as screening and diagnostic modality having contribution to not only plan an intervention and decide its feasibility but also has its utility in follow up patients who were at high risk but on conservative protocol or post interventional protocol for their re-evaluation.

COLOUR DOPPLER study unveils this ice berg phenomenon by documenting the carotid and peripheral arterial plaque burden, type of plaque and risk association and hemodynamic changes if any (Table 1).

For instances with critical carotid disease diagnosis interdisciplinary discussions were done either for carotid stenting or carotid endarterectomy versus interval carotid stenting sos staged depending on severity or laterality.

However, in cases of severe Peripheral Vascular Disease (PVD), discussion with CVTS for intra operative CABG (Coronary Artery Bypass Grafting) with sos staged bypass and its feasibility evaluated, else followup interval staged endovascular angioplasty was suggested depending upon patient's symptoms or severity after cardiac CABG performed.

Table 1. Coronary artery disease patients undergoing planned CABG

| Carotid Doppler             | Clinical Profile                                                                                                         |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Symptomatic                 | Acute/subacute stroke/ongoing symptomatology                                                                             |
| Asymptomatic                | Old chronic stroke / TIA /past history/ past imaging reveals stroke.                                                     |
| Incidental findings         | No signs or symptoms known or attributable to carotid disease / posterior circulation.                                   |
| Peripheral arterial Doppler |                                                                                                                          |
| Symptomatic                 | Acute or subacute active or non-healed ulcer/PVD/ claudication/ongoing symptomatology/recent amputation within 3 months. |
| Asymptomatic                | Old chronic PVD/healed ulcer/amputation more than 3 months /treated PVD /past history or imaging reveals PVD.            |
| Incidental findings         | No signs or symptoms known or attributable to PVD                                                                        |
| Investigations              |                                                                                                                          |
| Colour doppler              | Carotid and Peripheral study                                                                                             |

#### Material methods:

Our research study was retrospective review analysis done for studying iceberg phenomenon in patient undergoing preoperative evaluation for color Doppler study that were already diagnosed with coronary artery disease and were planned for CABG (Coronary Artery Bypass Grafting) by CVTS surgeon. All cases during past five year (March 2020 to 2025) with availability of data (Table 2) of carotid and peripheral arterial colour doppler findings were included in our study and appropriate statistical methods were applied.

Table 2: spectrum of findings in Coronary artery disease patients undergoing planned CABG

|                                                                       |                               |
|-----------------------------------------------------------------------|-------------------------------|
| Sex wise distribution                                                 | Male or Female                |
| Age wise distribution                                                 | In decades                    |
| Hyperhomocystenemia and its severity                                  | Mild /Moderate/Severe         |
| Addiction                                                             | Smoking / Tobacco / Alcohol   |
| Raised Hba1c values / Diabetes mellitus DM                            | Yes or No                     |
| Significant comorbidities or Past history                             | TIA / STROKE/ DM /HTN / PVD   |
| IVC Distended (D) or Collapsible (C)                                  | D or C                        |
| Additional findings : Ascites , Renal derangement or pleural effusion | Yes or No                     |
| Carotid doppler findings : HD lesion                                  | Yes or No                     |
| Peripheral Doppler findings : HD lesion                               | Yes or No                     |
| USG Fatty liver grade                                                 | I/II/III                      |
| HD : Hemodynamically significant lesion                               | Carotid or Peripheral Doppler |

## RESULT

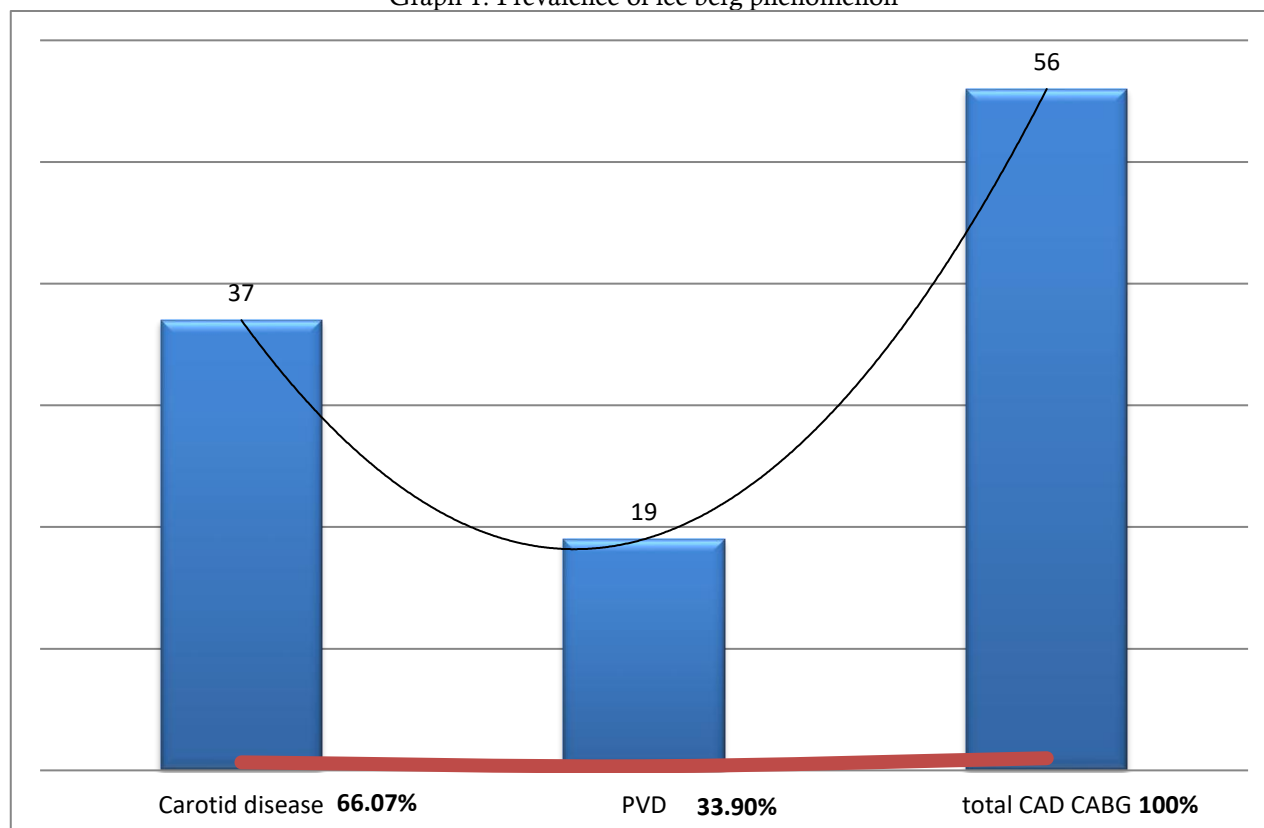
The prevalence (Table 3, Graph1) of ice berg phenomenon in our study was 66.07% for carotid disease and 33.9% for peripheral vascular disease (PVD), in patients (n = 56) who were planned for CABG by CVTS for

symptomatic coronary artery disease (CAD). Thus 37 patients were although asymptomatic for carotid disease and 19 patients asymptomatic for peripheral vascular disease.

Table 3: Prevalence of ice berg phenomenon

| Hidden burden of disease in CABG patients | No. of patients n = 56 | Percentage |
|-------------------------------------------|------------------------|------------|
| Carotid disease                           | 37                     | 66.07 %    |
| PVD                                       | 19                     | 33.9 %     |
| Total CABG CAD                            | 56                     | 100 %      |

Graph 1: Prevalence of ice berg phenomenon



The carotid iceberg group cases six had unilateral carotid involvement while 31 had bilateral involvement. While 8 patients had type I plaque, 19 had type 2 plaque: unstable plaque with risk for thromboembolism; while 21 had mixed type 3 plaque low risk type for thromboembolism, and stable type were found in 3 patients with one third being type 5 and rest two third being type 4.

With percentage stenosis (Table 4) being hemodynamically non-significant in 19 cases while 30 patients in borderline category though being part of ice berg group who requires close monitoring for disease progression and control of risk factors. 19 patients with hemodynamically significant stenosis also formed part of this ice berg who are high risk for stroke and may need depending upon involvement staged interval carotid angioplasty or intervention with due risk during Intraop or post op CABG and require special attention by team for maintaining brain perfusion, hemodynamics and blood pressure.

## INVESTIGATIONS

Table 4: Carotid involvement

| Plaque type                | HICK IMT |  | I | II | III | IV | V |
|----------------------------|----------|--|---|----|-----|----|---|
| <b>carotid involvement</b> |          |  |   |    |     |    |   |
| Unilateral (6)             | 1        |  | 2 | 2  | 1   | 0  | 0 |
| Bilateral (31)             | 16       |  | 6 | 17 | 20  | 2  | 1 |

| % STENOSIS |  | < 50% | 50 to <70 | 0 to < 80 | 0 to < 90 | 90 to 99 | 100 |
|------------|--|-------|-----------|-----------|-----------|----------|-----|
|            |  | 19    | 30        | 14        | 2         | 0        | 3   |

Of all cases (Graph 2) subjected to Preop colour Doppler, 37 were male and 19 were females.

Graph 2: Number of patients

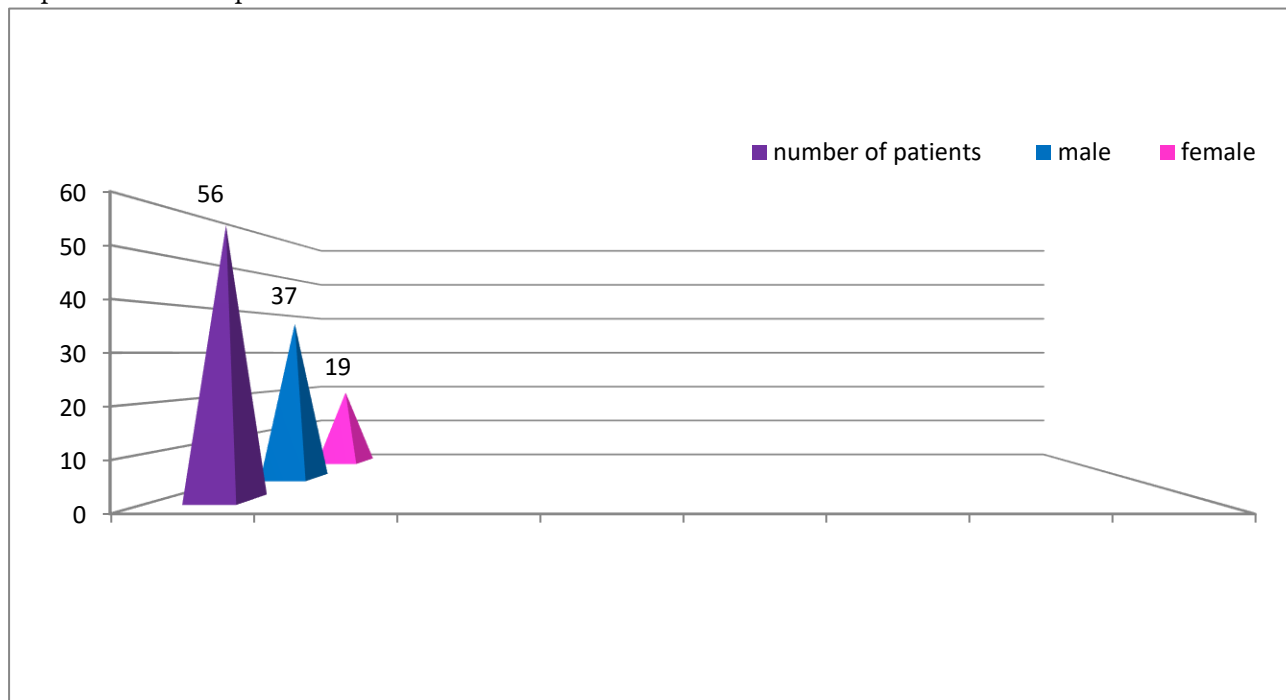
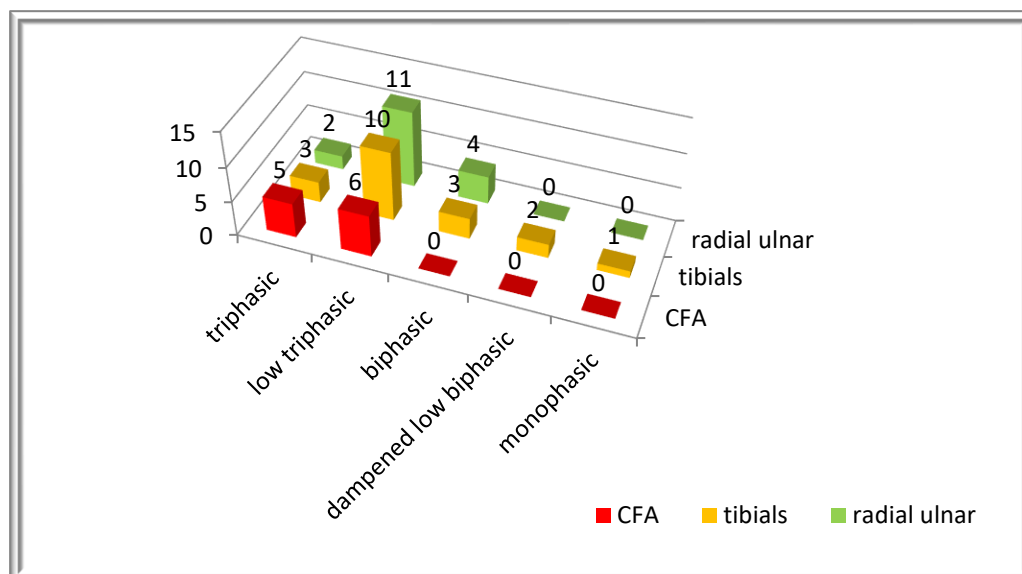


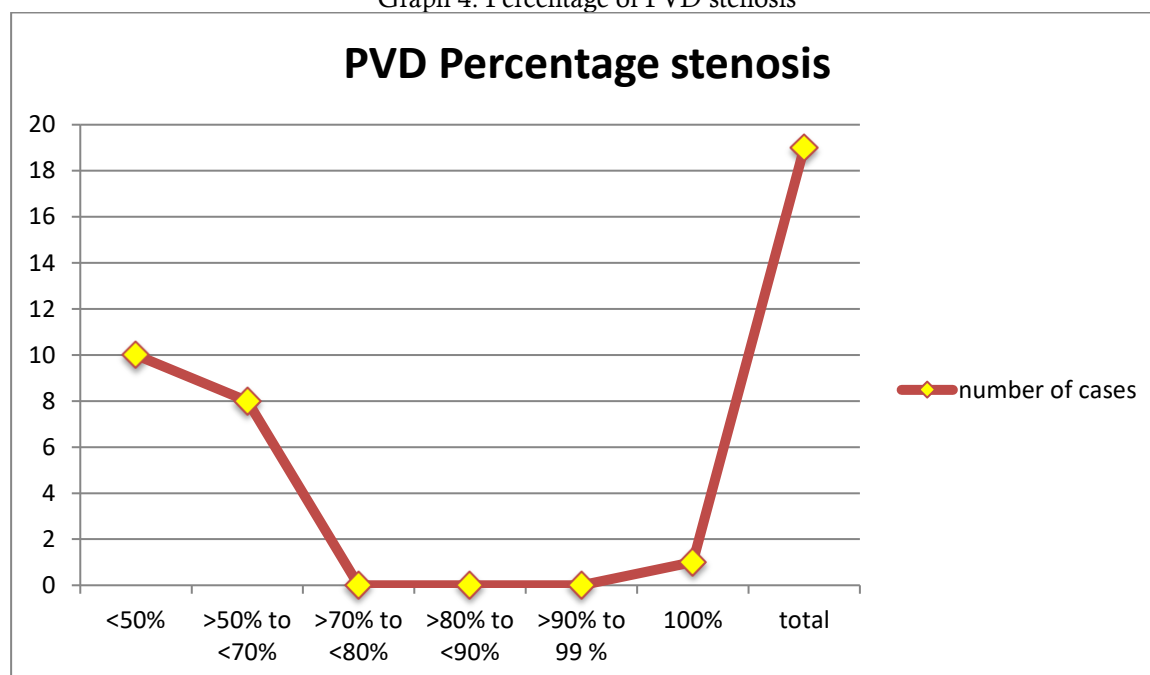
Table 5: PVD % stenosis and waveform types.

| PVD % stenosis      | < 50 %    | 50 % to < 70% | 70% to < 80% | 80 % to < 90%         | 90 to 99%  | 100% occlusion | total |
|---------------------|-----------|---------------|--------------|-----------------------|------------|----------------|-------|
|                     | 10        | 8             | 0            | 0                     | 0          | 1              | 19    |
| Arterial segment    | Triphasic | Low triphasic | biphasic     | Dampened Low biphasic | monophasic |                | total |
| <b>CFA</b>          | 5         | 6             | 0            | 0                     | 0          |                | 11    |
| <b>Tibial</b>       | 3         | 10            | 3            | 2                     | 1          |                | 19    |
| <b>Radial/ulnar</b> | 2         | 11            | 4            | 0                     | 0          |                | 17    |

Graph 3: PVD % Stenosis and waveform types.



Graph 4: Percentage of PVD stenosis



The PVD iceberg cases (Table 5, Graph 3 & 4) out of total 19 cases 10 of them had less than 50% stenosis, 8 of them had 50 to <70% and 1 of them had 100% occlusion.

Depending upon the wave forms out of total 11 common femoral artery 5 had triphasic flow and 6 had low triphasic flow.

In the Tibial artery territory out of 19 cases 3 had triphasic, 10 had low biphasic, 3 had biphasic, 2 had dampened low biphasic and 1 had monophasic flow.

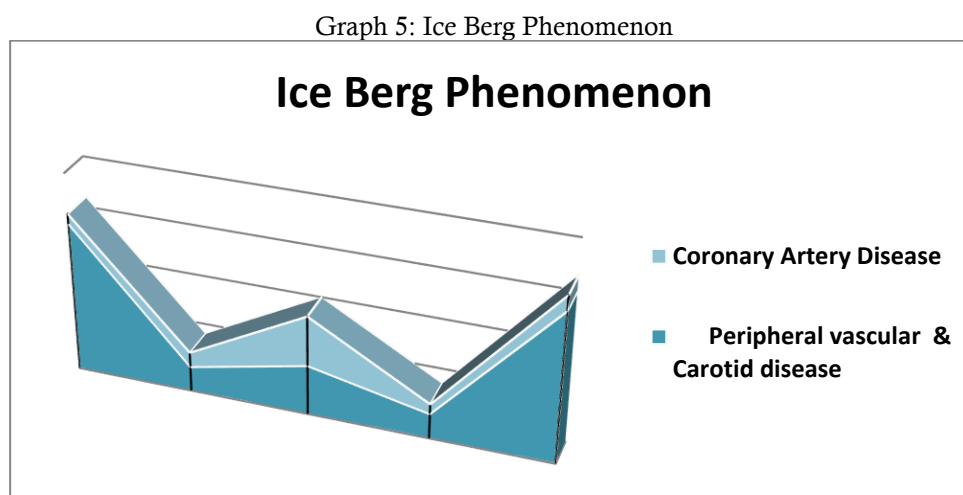
In the Radial and ulnar artery territory– out of total 17 cases 2 had triphasic, 11 had low triphasic and 4 had biphasic flow

With percentage stenosis out of 19 cases 8 and 1 of them have more risk of disease progression

And 1% of the tibial artery has higher risk

So iceberg phenomenon with significant Peripheral Vascular Disease (PVD), for intra operative peripheral saphenous venous (SVG) graft harvest for CABG , depending upon unilaterality and severity of PVD CVTS preferred opposite limb for graft harvest; and in case of bilateral involvement proximal SVG was utilized incase Radial artery was not an option and with sos follow up interval staged endovascular angioplasty or intervention was suggested depending upon patient's symptoms or severity after cardiac CABG was performed.

Thus highlighting preference to carotid disease over PVD for the cohort of patients undergoing CABG.



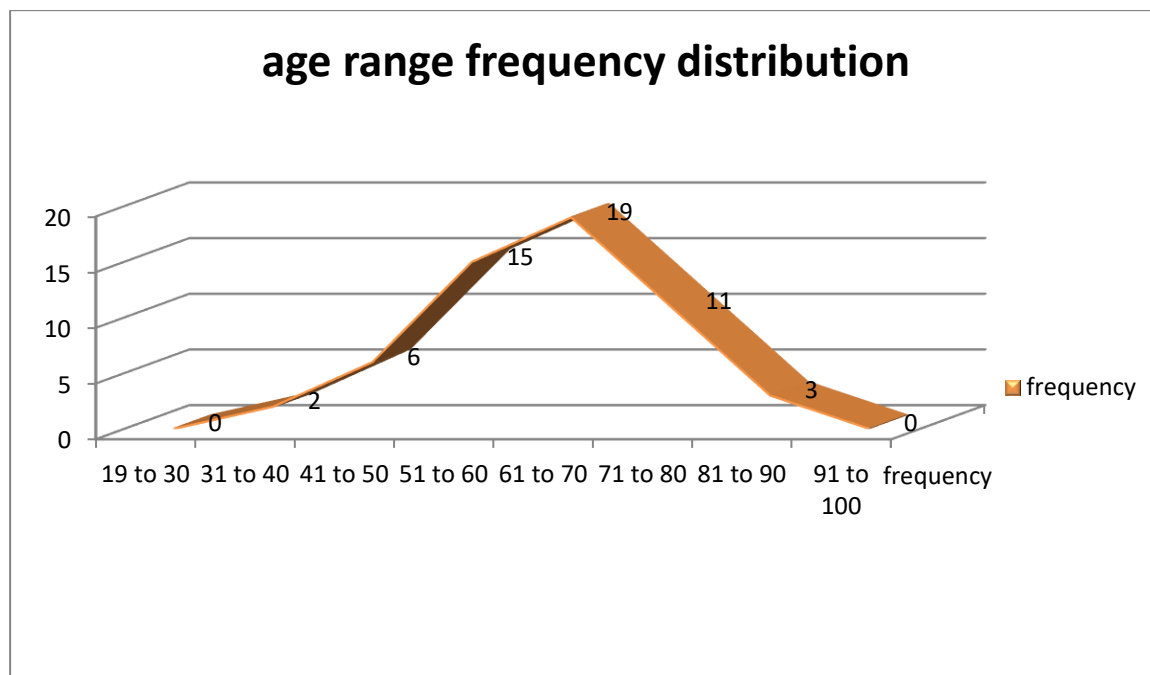
The epidemiological concept illustrated in (graph 5) demonstrate the ice berg phenomenon in a pictographic manner. It shows that a substantial proportion of cases remain in the preclinical stage, represented by the submerged portion of the ice berg, and often go undetected. If these cases are not identified early, they may later present with overt clinical manifestation, forming the visible tip of iceberg. Early detection is crucial in identifying this otherwise hidden but potentially high risk population, which, if missed, may progress to significant morbidity and even mortality. This highlights the challenge of detecting unreported cases within the community and underscores the need for timely and effective professional healthcare intervention.

Age distribution (Table 6, graph 6): although 19 patients (highest frequency) were found in age group range of 61 to 70 years, maximum distribution was noted in age group range between 51 to 80 cohort (total frequency = 45)

Table :6 Age distribution

| Age Range | Frequency |
|-----------|-----------|
| 19 to 30  | 0         |
| 31 to 40  | 2         |
| 41 to 50  | 6         |
| 51 to 60  | 15        |
| 61 to 70  | 19        |
| 71 to 80  | 11        |
| 81 to 90  | 3         |
| 91 to 100 | 0         |

Graph 6: Age frequency distribution.



With comorbidities and risk factor percentage being highest with addictions which needs to be addressed to prevent further damage and complications (Table 7 and 8, Graph 7)

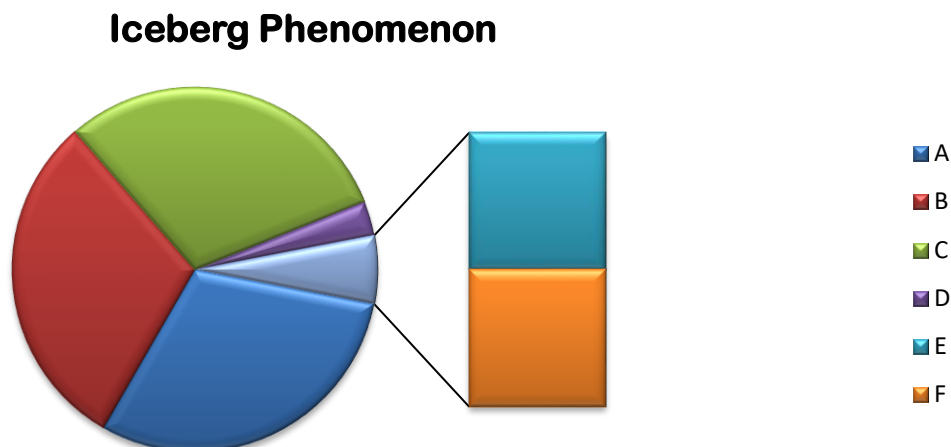
Table 7 Comorbidities & risk factor associations:

| Comorbidities & risk factor associations          | No. of patients | percentage |
|---------------------------------------------------|-----------------|------------|
| Hypertension on treatment                         | 7               | 12.5       |
| Previous PTCA CAD coronary artery disease treated | 5               | 8.9        |
| Hyper homocystenemia                              | 8               | 14.3       |
| Addictions /vices alcohol, tobacco smoking        | 18              | 32.14      |
| Hba1c raised                                      | 6               | 10.7       |
| Previous history of stroke                        | 9               | 16.07      |
| Diabetes mellitus on treatment                    | 9               | 16.07      |

Table 8: ice berg phenomenon

| Legend | Spectrum                                                                                          |
|--------|---------------------------------------------------------------------------------------------------|
| A      | Age, Sex, hyperhomocystenemia, Addictions, DM,HTN,comorbidities                                   |
| B      | Endothelial dysfunction, free radical oxidative stress, inflammation, Virchow's triad stimulation |
| C      | Atherosclerosis, arteriosclerosis, vessel wall calcification, atherothrombosis                    |
| D      | Coronary artery Disease                                                                           |
| E      | Peripheral vascular disease                                                                       |
| F      | Carotid disease                                                                                   |

Graph 7: Distribution of Iceberg Phenomenon



## DISCUSSION:

Iceberg phenomenon depicts the undiagnosed disease burden cohort who were diagnosed with symptoms of coronary artery disease and were referred by cardiologist for CABG in view of advanced coronary artery disease processes warranting bypass surgery; who as per CVTS protocol underwent preoperative evaluation to rule out carotid artery stenosis and PVD as well as to estimate the risk and prognostication along with comorbidities.

In our study, out of the total study population (100%) patients with coronary artery disease we had ice berg phenomenon with reported disease burden of 33.9% patient's newly diagnosed with PVD and 66.07% patient diagnosed with carotid disease.

Thus ice berg phenomenon highlights the increased disease risk burden with risk for developing stroke or PVD related complication and thus helps not only to prognosticate but also to take necessary preventive measures or corrective measures and plan comprehensive strategy for minimizing collateral damage & also help the CVTS surgeon along with the team i.e. perfusionist, cardiac anesthetist and elevate intra op and postop care and formulate strategies in patients undergoing CABG and mitigate complications and due risks; as well council for informed risk consent.

The color Doppler study not only gives the extent and type of stenosis but also type of plaque with its due thromboembolic risk with the iceberg phenomenon revealed with significant study population having more than 50% stenosis with probable stroke and PVD risk and thus help to council and take mitigative measures and to formulate staged stenting or any intervention depending upon severity and suggest follow-up to this

iceberg phenomenon cohort and help to prevent the stroke or gangrene or plan definitive intervention with control of risk factors and comorbidities.

Males are more affected than females in our study and predominantly involving age group above 50 years with sentinel value noted in age group of 61 to 70 years.

Limitations of Our study is relatively smaller sample size as only included to those undergoing CABG under cvts were pre evaluated, by involving those from the angioplasty alone group may help aid in better yield of our study along with further risk stratification and internal control comparison may further help to know better severity and risk burden estimation in angioplasty group versus CABG group and help in patient care and preventive outcomes and comparing our Doppler results with our combined diagnostic approach, along with correlation with MRI Angio in critical stenosis along with counselling and sensitization of preventing a well as planning therapeutic interventions in appropriate patient requiring early interventions or suggest appropriate follow-up and interval intervention with appropriate best medical management strategy and life style modification with control of risk factors, stop vices /addictions if any and physiotherapy and rehabilitations as deemed necessary.

## Conclusion & Recommendations

The Iceberg phenomenon of stroke & PVD with risk factors presents as significant future burden in community of high risk group class of patients who underwent CABG for CAD. These needs attention by addressing the modifiable risk factors, best medical management, lifestyle modifications, opd followup by both CVTS and IR to addresses the symptomatic

population or at risk patients and suggest appropriate vascular interventions and close follow-up for staged revascularization, further suggest to expand the scope of preoperative evaluation as screening tool in cohort of patients undergoing successful PTCA i.e. coronary angioplasty for CAD.

# Special Mention: We would like to thank and extend our gratitude to respected Kadam Family the founders of this institute, Hon. Vice chancellor (Late.) Shri Dr. H M Kadam sir and concerned contemporary contributory management Dr Shahaji V. Deshmukh Sir & Dr Sara Dhanawade Mam and Dr Ajit Joshi Sir & the entire Management & for their unconditional support and foresight for establishment of advanced Vascular Services like Interventional Radiology and CVTS at our tertiary care and referral hospital in Sangli. World Interventional Radiology Day is observed globally on 16th January #WorldIRDay.

Interventional Radiology (IR) stands at the forefront of the future of medicine, seamlessly integrating advanced therapeutics with minimally invasive, image-guided surgical interventions. Its ability to deliver precise, targeted treatments particularly in complex clinical scenarios and life-threatening emergencies & has redefined the scope of modern endovascular surgery. By offering safer procedures, reduced morbidity, and faster recovery, IR has emerged as a cornerstone of advanced, patient-centered healthcare today and is future-ready!



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