Original Article

# *Angiographic Profile of Coronary Artery Disease in Patients of Heart Failure Attending in BPKIHS, Nepal*

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**Keywords:** *Coronary Artery Disease; Heart Failure; Coronary Angiography.*



## Abstract

**Introduction:** Coronary Angiography in heart failure is one of the diagnostic modalities that acts as complementary tool in the management. Very few studies are conducted in Nepal regarding prevalence of CAD in HF. CAD has been one of the etiologies in 18% patients of Heart failure.[1] On categorizing heart failure patients into ischemic and non-ischemic groups and knowing any anomalous anatomy would be feasible to intervene as essential and decrease in recurrent hospital admissions and improve quality of life. Our current study aimed to evaluate various characteristics and profiles of Coronary Arteries in the heart failure subjects after Coronary Angiography.

**Methods:** It was a single center hospital based descriptive cross-sectional study conducted at BPKIHS from October 2022 to October 2023 in heart failure patients who underwent CAG. Heart failure patients were selected based on Framingham criteria.

**Results:** Out of total 78 patients 64.15 were males and mean age was 62.4±13.69 years. There were 47.4% patients with HFrEF, 28.2% with HFmrEF and 24.4% were having HFpEF. Significant CAD was found in 70.5%, normal Coronary artery was present in 2.8%, 2.5% had anomalous coronary artery, minor CAD was found in 2.6% while 5.1% had moderate CAD. Prevalence of significant CAD was found in 70.3% patients with HFrEF, 68.2% in HFmrEF whereas HFpEF had significant CAD in 73.7% subjects. Significant CAD in males and females were 48.7% and 70.5% respectively. Smoking was the most common risk factor present in our study population. Most common presentation were Basal Lung Crepitations, Raised JVP, Hepatomegaly and Leg Swelling.

**Conclusion:** Our result suggests higher prevalence of CAD in HFpEF (73.7%) followed by HFrEF (70.3%) and HFmrEF (68.2%). Coronary anomaly was seen in 2.5% while angiographic profile revealed abnormal coronary artery to be more frequent in HF subjects which was quite comparable to other similar studies of Heart failure.

## Introduction

The concept of heart disease is based on the works of cardiac catheterization laboratory for the past eighty years as mentioned by Andre Cournand in a lecture on December 11, 1956 AD where he addressed cardiac catheter as "key in the lock". According to him cardiac catheterization was first performed by Claude Bernaurd in 1844. Werner Forssmann is credited of first angiography on himself at twenty five years of age while receiving a clinical.[2]

The Framingham Heart study defined heart failure based on 2 major or 1 major plus 2 minor criteria. The **Major Criteria were**: 1. Paroxysmal Nocturnal dyspnea 2. Neck veinous distension 3. Basal crepitations of unexplained dyspnea 4. Cardiomegaly in chest x -ray or increasing heart size 5. Acute pulmonary edema 6. Ventricular gallop 7. CVP >16cm of water 8. >24 seconds arm to tongue circulation time 9. Hepatojugular reflux 10. Autopsy showing pulmonary edema, visceral congestion, and cardiomegaly. **Minor criteria were:** 1. Ankle edema 2. Nocturnal cough 3. Dyspnea on ordinary exertion 4. Hepatomegaly 5. Pleural effusion 6. Decreased vital capacity by one third from maximum records 7. Tachycardia (≥120 beats per minute). Minor or major: weight loss ≥4.5kg in 5 days. A diagnosis of 'Definite heart failure' was made if the patient had two major, or one major plus two minor criteria concurrently. This criteria is 100% sensitive and 78% specific for identifying patients of CHF.[3]

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The Proposed Universal Definition of 2021 describes HF as a clinical syndrome with symptoms and/or signs caused by a structural and/or functional cardiac abnormality and corroborated by elevated natriuretic peptide levels and/or objective evidence of pulmonary or systemic congestion. HF stages have been revised to emphasize symptomatic nature of HF as a clinical syndrome: At risk for HF (Stage A), Pre–HF (new) (Stage B), Symptomatic HF (Stage C) and Advanced HF (Stage D). Classification of HF according to LVEF now includes: 1. HFrEF: symptomatic HF with LVEF ≤40%. 2.HFmrEF: symptomatic HF with LVEF 41-49%. 3.HFpEF: symptomatic HF with LVEF ≥50%. 4.HFimpEF: symptomatic HF with a baseline LVEF ≤40%, a ≥10-point increase from baseline LVEF, and a second measurement of LVEF >40%.[4]

Selective coronary angiography was introduced by Mason Sones in 1958 AD, which stands as a milestone in decision making in cardiology. Analysis of severity of Coronary Artery Lesion is often done by a visual estimate obtained from simple inspection of the angiogram and is taken by many operators to be their reference standard.[5] In Coronary Angiogram, following parameters are evaluated:1.Extension and localization of the lesion, 2. Severity of the stenosis, 3.Morphologic characteristics of the lesion, 4. Evaluation of the downstream flow, 5.Presence of collateral blood vessel circles, and 6. Changes compared with previous angiograms, if available.[6] Up to around 2017 AD, Cardiologists did not know when and why patients with heart failure should undergo coronary angiography.[7]

According to the Framingham Heart Study, CAD is an emerging risk factor in heart failure. A similar study named as Survival and Ventricular Enlargement (SAVE) trial showed presence of significant CAD in patients having heart failure.[8]

In our study we have assessed angiographic results in heart failure patients with specific reference to HFrEF as it is the most common HF observed in Clinical practice. Coronary diseases are one of the major risk factors for the incidence and progression of heart failure. Prevention of both hypertension and coronary disease is important for eliminating heart failure risk.[9]

Data regarding prevalence of heart disease in Nepal are nominal. In a study Shrestha et al had described the profile of HF in the western regions and reported CAD as etiology in 29% of 274 HF patients. Overall data says two third of patients with HFrEF have CAD which seems important contributor to morbidity and mortality.[1]

Without angiography HF cases may be left untreated and impose significant challenge to care givers and treatment recipients.[10]

Echocardiography represents the "gold standard" in the assessment of LV systolic dysfunction. It is available easily at our institute with additional importance to consider the advantage of zero radiation exposure in situations, such as heart failure, when serial assessment seems to be done.[16]

Both the American and European practice guidelines recommend a diagnostic strategy largely based on symptoms and clinical presentation, patient history, and the likelihood that revascularization may be necessary. There is general agreement that patients with heart failure, severe LV dysfunction, and severe angina should be referred to coronary angiography provided the patient is otherwise suitable for revascularization.[6]

Similar study on Coronary arteries done by Arques Stephane in 2019 on left heart failure with reference to heart failure with preserved and mid-range ejection fraction found that coronary angiography should be performed to establish coronary disease. It also investigated prevalence of heart failure to be one of the manifestation of CAD.[11]

Kosyakovsky et al. in their study had found that heart failure (HF) was a major global health burden, impacting 26 million people worldwide and still rising in prevalence. Coronary artery disease (CAD) is a key risk factor for the development of HF and was identified as the primary etiology in 66% of cases. The presence of CAD in HF displays worse prognosis, which can be stratified by the severity of the underlying CAD. Many available guidelines suggests considering ischemic etiology in any episode of acute HF, however there is no standard approach for identifying patients requiring investigation.[12]

Coronary angiography shall come up as a necessary element for the management of patients in whom coronary revascularization is likely to be beneficial because of a high risk for complications with medical therapy alone.[13]

A study conducted by Najmy et al. on similar objective was also a hospital based, cross-sectional observational study carried out at Shahid Gangalal National Heart Centre, Kathmandu, Nepal from June 2018 to June 2019 with aim of studying CAD in patients on HFrEF along with with spectrum in other phenotypes of heart failure. Similar studies are needed to be conducted in our institute too which can aid to further researches regarding performance of angiography in heart failure patients.[1]

A study done in 2019 by John JE et al claimed that coronary artery disease (CAD) was a potent risk factor for heart failure with reduced ejection fraction (HFrEF), and had been a common comorbidity in HF with preserved EF (HFpEF). It is thus rationale to study patients having heart failure and find out coronary anatomy with emphasis on stenosis that might lead to etiological diagnosis and hence temporal intervention can be implemented.[14]

A similar study conducted in 2012 concluded that 1–2% of the adult population in developed countries has HF, with the prevalence rising to ≥10% among persons 70 years of age or older. At least half of patients with HF had a low EF (HFrEF). HFrEF was the best understood type of HF in terms of pathophysiology and treatment, and was the focus of the guidelines of those time. Coronary artery disease (CAD) was the cause of approximately two-thirds of cases of systolic HF, although hypertension and diabetes were probable contributing factors in many cases.[15]

Coronary artery disease (CAD) contributes significantly to the development of Heart failure in both developed and developing countries. Recognition of CAD in these patients significantly alters the management strategy. A similar study was conducted to assess the prevalence of coronary disease in the patient with Left Ventricular systolic dysfunction of unknown cause. The term ischemic cardiomyopathy has been used to describe significantly impaired left ventricular function that results from coronary artery disease.[16]

Patients with heart failure are considered as having ischemic etiology when they have a history of myocardial infarction, revascularization procedure, or angiographic evidence of obstructive coronary artery disease.[17]

In Nepal, Coronary Artery Disease (CAD) is one of the common cardiovascular diseases seen by physicians in their hospital and private practice. Notable national data on incidence and prevalence of CAD in Nepal is not available due to lack of proper studies in reference to etiology and significant need for angiography for heart failure. In a Study by Ashok Adhikari KBS, it was mentioned that cardiovascular diseases account for around one out of every three deaths worldwide.[18]

A similar study was conducted by Trevisan lory et al in 2018 which aimed to determine the prevalence and characteristics of CAD using a prospective systematic coronary angiography approach found the prevalence of CAD was similar for HFpEF and HFmEF. The left main coronary artery presented a significant stenosis in 6.5% of cases and 39% of patients had a two- or three-vessel disease.[19]

## Methods

This was A single center hospital based descriptive cross-sectional study. One year conducted at BPKIHS from October 2022 to October 2023. Heart failure patients who underwent CAG at BPKIHS were enrolled in study. Detailed history and echocardiographic findings were obtained and angiographic findings were noted.Detail history, echocardiographic and angiographic finding were recorded in history sheet. The clinical data recorded were demographic data and symptomatology of the patients having heart failure.Data were analyzed using SPSS (version 20) and Chi-square test. Heart failure was diagnosed by the Framingham Congestive Heart Failure criteria.[20]

Echocardiographic assessment and chamber quantification would be done with a Philips ultrasound system as per American Society of Echocardiography (ASE) recommendation.[21] Measurements of LV volumes and ejection fraction would be done by manual tracing of an endocardial border from apical 4- and 2-chamber views using the disk summation method.[22]

Arteriograms of the right and left coronary arteries was performed and the best projection, representing stenosis of the lesion with progression, was selected and examined for percentage diameter stenosis by use of a cardiovascular measurement system which is Philips Medical Imaging Systems named Allura Xper FD20 in accordance with standard guidelines.[23]

Coronary stenosis was analyzed by visual assessment and confirmed by QCA i.e. Quantitative Coronary angiographic technique which is a software based technique that quantifies coronary stenosis by comparing the diameter of the stenosis with reference diameter of the guiding catheter.[24]

Coronary arteriograms were reviewed by the principal investigator and one independent observer experienced in angiographic interpretation and blinded to the clinical data. The degree of coronary artery obstruction was expressed as the % diameter stenosis, by comparing the diameter of the site of greatest narrowing (minimal lumen diameter) to an adjacent segment assumed to be free of disease. Lesion in an epicardial coronary artery was considered significant in ≥ 70% stenosis of the examined vessel or ≥ 50% of Left Main Coronary Artery (LMCA).

### Lesion severity was also classified as:

1. Minimal / minor CAD: <50% stenosis
2. Moderate- 50 to 70% stenosis
3. Significant- >70% stenosis.[6]

### Heart failure screening:

Patients with HF would be categorized into the heart failure with reduced ejection fraction (HFrEF) [LVEF ≤40%) or heart failure with mid- range ejection fraction (HFmrEF) (LVEF=41 to 49%) and heart failure with preserved ejection fraction (HFpEF) (LVEF >50%) groups.[4] Heart failure patients who underwent CAG were eligible for the analysis.

### Ethical Consideration:

This was taken as per guidelines of BPKIHS.

### Work Plan:

- Protocol development of the study was done
- Data collection tool was prepared.
- Protocol presentation was done in the department.
- Submission to IRC.
- Ethical approval was taken.
- Data entry and analysis
- Report preparation and submission

### Sample Size:

Sample calculation was based on following equation of qualitative study considering the prevalence of two-third approximately 60% of CAD in heart failure having LV systolic dysfunction.[1]

Sample calculation:

N= Z2 x p x q/e2

=3.84x60x40/ 25

= 368.64

Where, N = Sample Size

p = prevalence of CAD in HF = 60%.

q=100-p=100-60=40

Z= Confidence level at 95%= 1.96

e = margin of error = 5%

Therefore, corrected sample size has estimated based on the followings.

- Calculated sample size = 369
- Estimated heart failure individuals approached during one year period = 99 (departmental record)

According to the corrected sample size estimation formula:

$$n = \frac{\text{Calculated sample size}}{\left(1 + \frac{\text{Calculated sample size}}{\text{estimated population}}\right)}$$

$$n = \frac{369}{(1 + 369/99)}$$

N=78.17(25)

Hence, a total of 78 individuals who fulfil the criteria of enrolment will be enrolled under the study.

## Results

A total of 78 patients were enrolled in this study with 64.1% males and 35.9% females. The age group of patients was between 25 to 91 years with a mean age of 62.4 ± 13.69 years. The Median age was 62.5 years. The minimum age was 25 years and maximum was 91 years with a range of 66 years. There were 57.7% (45) patients in age group ≤65 years while 42.3% (33) were in the age group > 65 years.

**Table 1:** Demographic profile of the study participants (n = 78)

| Variables | Frequency |
|---|---|
| Age (years) (mean ± SD) | 62.4 ± 13.69 |
| Age (median, IQR) | 62.5 (53.75 – 73.25) |
| Minimum age | 25 years |
| Maximum age | 91 years |
| Male | 50 (64.1%) |
| Female | 28 (35.9%) |
| Age≤65 years | 45 (57.7%) |
| Age>65 years | 33 (42.3%) |

Table no. 1 shows there were more males than females, patients in the age group ≤65 years were in higher number than age group >65 years.

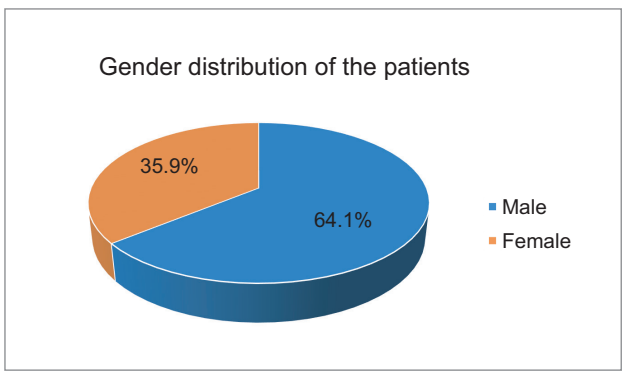


***Figure 1:*** *Gender distribution of the patients of the study population.*

**Table 2:** Table showing Signs and symptoms of the study group (N=78).

| Sign and Symptoms | Frequency | Percent |
|---|---|---|
| Basal crepitations in lung | 4 | 5.1 |
| Rasied JVP | 4 | 5.1 |
| Cardiomegaly | 2 | 2.6 |
| Tender Hepatomegaly | 3 | 3.8 |
| Cough | 13 | 16.7 |
| Basal crepitations, raised JVP, Cardiomegaly, Tender Hepatomegaly and Cough | 14 | 17.9 |
| Basal crepitations and leg swelling | 9 | 11.5 |
| Raised JVP, Tender hepatomegaly, Leg swelling, | 17 | 21.8 |
| Leg swelling, Chest pain | 5 | 6.4 |
| Dyspnoea and leg swelling | 2 | 2.6 |
| Dyspnoea | 5 | 6.4 |
| Total | 78 | 100.0 |

Table No. 2 showed raised JVP and Tender Hepatomegaly along with leg swelling was found in 21.8%[17] and these were most common presentations of the study group and cough was the second most common complaint found in 16.7%[13] patients.

**Table 3:** Table showing frequency of risk factors in the study population (N=78)

| Risk factors | Frequency | Percent |
|---|---|---|
| Smoking | 15 | 19.2 |
| HTN | 5 | 6.4 |
| DM | 6 | 7.7 |
| DM, HTN | 6 | 7.7 |
| Dyslipidemia | 14 | 17.9 |
| HTN, DM, Dyslipidemia | 12 | 15.4 |
| HTN, Dyslipidemia | 12 | 15.4 |
| DM, dyslipidemia | 8 | 10.3 |
| Total | 78 | 100.0 |

Table No. 3 shows Smoking was present in 19.2%[15] and was the most common risk factor in the study population and Dyslipidemia was the second most common risk factor found in 17.9%[14] patients. Three risk factors: HTN, DM and Dyslipidemia were found in 15.4%[12] of the heart failure patients.

**Table 4:** Angiographic profile of Coronary Arteries in the study population (N=78).

| Coronary Artery Profile | Frequency | Percentage |
|---|---|---|
| Minor CAD | 2 | 2.6 |
| Moderate CAD | 4 | 5.1 |
| Normal Coronary | 17 | 21.8 |
| Significant CAD | 55 | 70.5 |
| Anomalous Coronary artery | 2 | 2.5 |

Table No. 4 shows 21.8% (17) had normal coronary artery and 2.5% (2) had coronary anomaly whereas 70.5% patients had significant CAD. The percentage of minor and moderate CAD was 2.6 and 5.1 respectively. The total heart failure subjects with ischemic etiology was 70.5% (55) whereas 7.6% (6) patients showed insignificant CAD. 29% of patients with heart failure had Non-ischemic etiology.

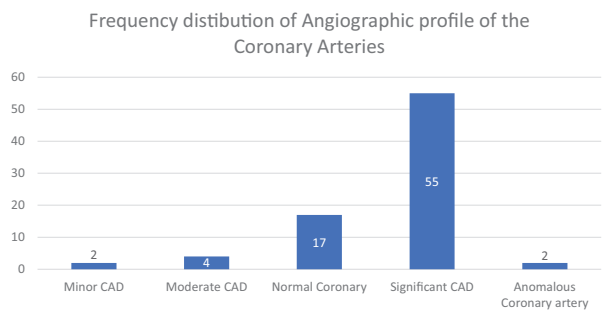


***Figure 2:*** *Chart showing Angiographic profile of Coronary Arteries of the study participants.*

**Table 5:** Distribution based on severity of lumen stenosis of coronary artery in the study patients (N=78)

| Severity of coronary artery lesion | Frequency of patients | Percentage of patients |
|---|---|---|
| Minor (50% stenosis) | 2 | 2.6 |
| Moderate (50 to 70% stenosis) | 4 | 5.1 |
| Significant (>70% stenosis) | 55 | 70.5 |
| No stenosis | 17 | 21.7 |
| Total | 78 | 100 |

Table No. 5 shows frequency distribution of participants based on degree of luminal stenosis of coronary artery. There were 70.5% patients that had ≥ 70% stenosis. Only 21.7% had no stenotic lesion, 2.6% had minor and 5.1% had moderate stenosis respectively.

**Table 6:** Percentage distribution of Echocardiographic findings in the participants (N=78)

| Echocardiography | Frequency | Percentage |
|---|---|---|
| Normal | 21 | 26.9 |
| LV Global wall hypokinesia | 29 | 37.2 |
| RWMA | 28 | 35.9 |

Table No. 6 shows RWMA was found in 37.2%, Out of the total subjects 26.9% had normal finding and 37.2% showed LV global wall hypokinesia.

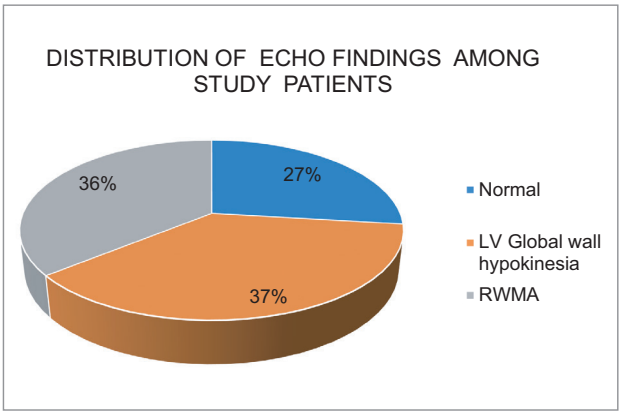


***Figure 3:*** *Pie Chart showing echocardiographic distribution.*

**Table 7:** Distribution based on types of heart failure of the study patients (n=78).

| Types of Heart Failure | Number | Percentage |
|---|---|---|
| HFrEF (≤40%) | 37 | 47.4 |
| HFmrEF (41 to 49) | 22 | 28.2 |
| HFpEF (≥50%) | 19 | 24.4 |
| Total | 78 | 100 |

Table no. 7 contains data where 47.4% of heart failure patients were HF with reduced ejection fraction, 28.2% had Mid-range ejection fraction while 24.14% had preserved ejection fraction.

**Table 8:** Types of heart failure based on distribution of CAD (n=78)

| Types of heart failure | No CAD | Significant CAD | Insignificant CAD |
|---|---|---|---|
| HFrEF | 27.0% (10) | 70.3% (26) | 2.7% (1) |
| HFmrEF | 18.2% (4) | 68.2% (15) | 13.6 % (3) |
| HFpEF | 15.8% (3) | 73.7% (14) | 10.5% (2) |

*(P value =0.195)*

Table No. 8 shows significant CAD in 70.3% patients of HFrEF, 68.2% of HFmrEF and 73.7% of HFpEF patients. Among heart failure patients with reduced ejection fraction 28.9% had normal coronary artery and 2.7% showed insignificant CAD. Patients with HFmrEF had 18.2% normal CAD and 13.6% had insignificant CAD. Similarly HFpEF patients had normal coronary artery in 15.8% and 5.6% had insignificant CAD. There was no statistical significance (P value=0.195)

**Table 9:** Prevalence of Significant CAD in different types of heart failure.

| Types of heart failure | Prevalence of CAD | Frequency |
|---|---|---|
| HFrEF | 70.3% | 26 |
| HFmrEF | 68.2% | 15 |
| HFpEF | 73.7% | 14 |

Table No. 9 shows significant CAD was prevalent in HFrEF(70.3%), HFmrEF had 68.2% while HFpEF had 73.7%. Almost similar distribution of CAD was observed in this study population.

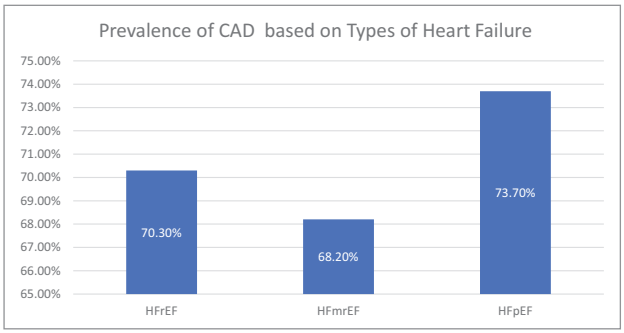


***Figure 4:*** *Bar diagram showing Prevalence of CAD in different Types of Heart Failure Patients.*

**Table 10:** Percent Gender distribution of CAD in HFrEF (N=38).

| Gender | >70% Coronary stenosis | ≤70% Coronary stenosis | No CAD |
|---|---|---|---|
| Male | 48.7% | 2.6% | 12.8% |
| Female | 70.5% | 7.7% | 21.8% |

*(P value=0.195)*

Table No. 10 shows females were having less CAD than female counterpart however association was not statistically significant. (P value= 0.195)

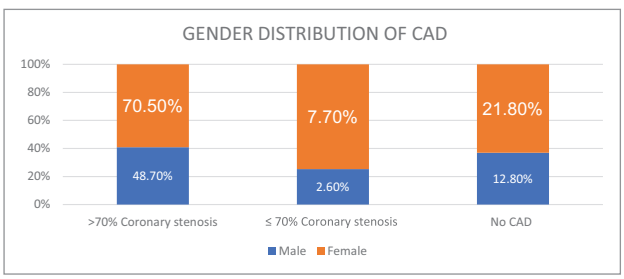


***Figure 5:*** *Bar diagram of gender distribution of CAD in the study population*

**Table 11:** Percentage distribution based on Number of Significant Coronary vessels involved in the corresponding heart failure groups (N=78).

| Types of Heart Failure | SVD | DVD | TVD |
|---|---|---|---|
| HFrEF | 29.7% | 21.6% | 18.9% |
| HFmrEF | 36.4% | 36.4% | 4.5% |
| HFpEF | 42.1% | 10.5% | 21.1% |

*(P Value=0.395)*

Table No.11 shows out of total Patients of HFrEF, 29.7% had SVD, 21.6% had DVD and 18.9% had TVD. In HFmrEF, 36.4% had SVD, 10.5% subjects had DVD with 4.5% having TVD. HFpEF showed 42.1% having SVD, 10.5% had DVD and 21.1% had TVD. There was no statistical significance between the type of Heart Failure based on EF and Number of Significant Coronary Vessel Disease involved (The p value=0.395).

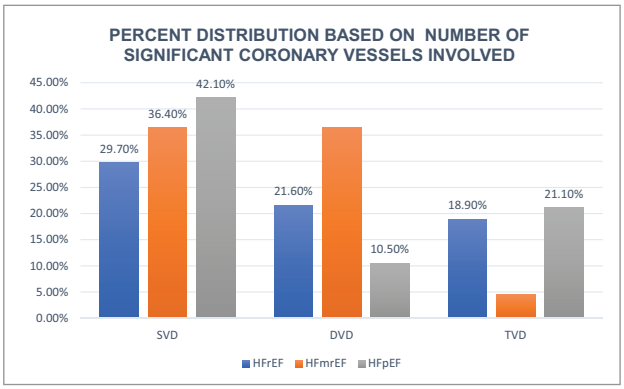


***Figure 6:*** *The bar diagram showing the number of coronary vessels and types of heart failure.*

**Table 12:** Percentage distribution of CAD based on age group of the study participants(N=78).

| Age group | Minor (<50% stenosis) | Moderate (50 to 70% stenosis) | Significant (>70% stenosis) | No stenosis |
|---|---|---|---|---|
| ≤65years | 1.3 %[1] | 3.8%[3] | 41%[32] | 11.5%[9] |
| >65years | 1.3 %[1] | 1.3%[1] | 29.5%[23] | 10.3%[8] |

Table No. 12 shows significant coronary artery stenosis in age group >65 years was 29.5%, no stenosis was found in 10.3% and in age group ≤65 years significant stenosis was present in 41% patients and no stenosis was found in 11.5%.

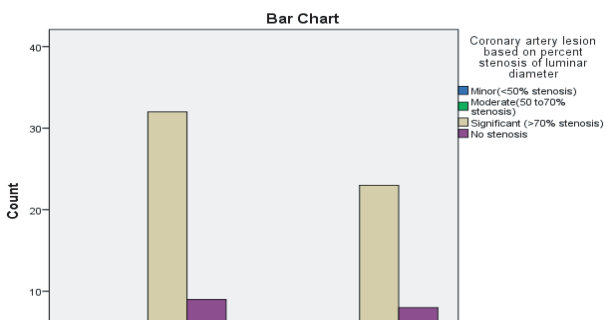


***Figure 7:*** *Bar diagram showing percentage distribution of CAD based on age group of the study participants.*

## Discussion

CAD has been the most common cause of heart failure in developed countries. The presence of HF in coronary artery disease is fairly common and is associated with poor outcomes. CAD is frequently found in both HF with reduced ejection fraction and HF with preserved ejection fraction. As occurrence of IHD is increasing every now and then affecting mankind and dismantling quality of life and well-being, research on such issues needs utmost attention.[26]

In our current study of angiographic profile, out of total 78 enrolled, 50 were males and 28 were females with 47.4 % of total were HFrEF and significant CAD in HFrEF was present in 70.3% cases. while 28.2% had HfmrEFand 23.1% had HFpEF. This showed CAD to be most commonly found etiology in all types of heart failure. SVD was most commonly seen in 29.7% patients of HFrEF, DVD was found

in 21.6% and only 18.6% had TVD. Two patients had anomalous coronary artery. There were 70.5%(55) showing ischemic etiology while 29.5%[23] had non-ischemic causes of heart failure. Coronary artery disease is prevalent both in the developed and developing countries and is a leading cause of mortality despite recent advances in diagnostic facilities and treatment modalities. Most common mode of presentation of heart failure in our study was raised JVP, tender hepatomegaly and leg swelling. Similarly, Smoking, Dyslipidemia and Diabetes were noticeable risk factors in our study participants.

A study conducted in 2020 by Said et al found that between 13% and 24% of patients with HF had HFmrEF, between 40% and 60% of patients with HF had diastolic dysfunction, and more than 50% of HF were HFpEF. The prevalence of HFpEF is increasing, and researchers expected that by 2020, patients hospitalized for HF would have HFpEF of 65%.[27]

Khandelwal L et al in their study have found coronary artery disease (CAD) as the most common etiology of heart failure with reduced ejection fraction (EF) Sixty-four patients had no CAD and 36 patients had CAD, of which 34 and 26 patients had significant CAD and severe CAD, respectively. 41.7% patients had double vessel disease followed by 33.3% and 25% patients having triple-vessel disease and single-vessel disease, respectively. This study emphasized angiography should be considered in HF with systolic dysfunction. Our study had found SVD in 42.15% of HF patients which was quiet remarkable in this institute.[28]

Angiographic profile of the study population done by Imran et al in 145 patients with heart failure, coronary artery disease was found in 38(26.2%) of cases. Significant coronary artery disease to cause LV systolic dysfunction was seen in 15(10.3%) of the study population. This is lower than that of our study where more than 70.5 % case had CAD, 21.8% had no CAD at all.[16]

CAD is present in patients with HFpEF and is associated with increased mortality and greater deterioration in ventricular function. Revascularization may be associated with preservation of cardiac function and improved outcomes in patients with CAD. Given the paucity of effective treatments for HFpEF, prospective trials are urgently needed to determine the optimal evaluation and management of CAD in HFpEF.[29] In our study 24.4% had HFpEF. Among them 73.7% had significant CAD with 42.1% having SVD, 10.5% had DVD and 21.1% showed TVD.

A similar study on HFrEF by Najmy et al, prevalence and characteristics of CAD showed that Obstructive CAD (≥ 70 coronary stenosis) was present in 31(33%) while 26 (27%) had minor CAD with < 50% coronary stenosis and only five (5%) had moderate stenosis of ≥50 to < 70% stenosis. Most common pattern of CAD was TVD (48%), followed closely by SVD (39%). In clinical practice it is challenging for all patients with systolic HF of unclear etiology to undergo coronary angiography, hence we thought to study total heart failure subjects and classified them unto various phenotypes based on EF. We did CAG and tried to seek status of CAD in those populations assess CAD as a cause of systolic HF. In our study CAD was significantly more common in patients with age less than 65 years. Prevalence of CAD in our study was 70.3%, SVD was present in 29.7% and TVD was found in 18.9% cases and the data obtained was closer to the analysis done in this study.[1]

A study corroborating prevalence and CAD status "The Get With The Guidelines-HF" (GWTG-HF) registry of hospitalized HF has revealed data and provided the largest study participants till date characterizing HFmEF. Kapoor et al. described 99,825 patients hospitalized for HF from 305 hospitals across all regions of the United States between 2005 and 2013, of whom 48,950 (49%) had HFrEF, 12,819 (13%) had HFmEF, and 38,056 (38%) had HFpEF. Our study comparatively showed 47.7% having HFrEF, Patients with HFmrEF were 28.2% and HFpEF were 24.4%. Among the HF participants of Mid-range EF, 78.2% had significant CAD. This study also emphasizes increased mortality in patients with ischemic etiology. This study paved the way for further evaluation of CAD in HF subjects and thus need to conduct CAG to rule out IHD.[30]

A study was conducted in 2022 AD by John JE et al for etiology of HFpEF and showed that CAD was present both in HFpEF and HFrEF. The CAD was observed with subsequent incident HFpEF and HF with reduced ejection fraction. Over 13-year follow-up, incident CAD developed in 892 participants and 178 subsequently developed HF (86 HFrEF, 71 HFpEF). Risk of HFrEF and HFpEF were both greatest early after the CAD event. At >1 year post-CAD event, presence of HFrEF and HFpEF were similar. Our study also had relatively higher presence of significant CAD which was 70.5%. This study showed relatively similar data and proved ischemia as major contributor in heart failure.[31]

A study conducted in 2023 in HFrEF, mentioned normal CAG findings in 60.8% of patients and significant CAD was found in 24.1% cases. Among them 63% had more than 70% coronary artery stenosis. Likewise in our study 70.3% of HFrEF had significant CAD. Thus, ischemic etiology contributes to all range of heart failure and HFrEF is commonly associated with obstructive coronary lesion. CAG need to be applied to heart failure subjects whenever feasible.[32]

In the last several years many studies have looked at the prevalence of angiographically significant CAD in patients with HF with reduced EF. A retrospective study conducted by Silva et al, found that out of a total of 168 patients being followed in a HF clinic, CAD was the etiology of HF with reduced EF in one-third of the patients without angina and no prior cardiac events.[33]

Doukky et al studied 124 consecutive patients who had undergone coronary angiography with a primary diagnosis of systolic HF of unclear etiology. It was found that 27% had CAD, including 15% with severe CAD. The early detection and treatment of CAD may help delay cardiomyocyte death, adverse ventricular remodeling, and the onset of Stage D HF. In addition, diagnosing a patient with heart disease changes long-term treatment goals because optimal medical therapy then includes high-dose statins and aspirin in addition to the standard goal-directed HF medications. Ischemic heart disease in today's new life style scenario is the number one reason for systolic HF.[34]

However, there is a paucity of evidence for early invasive evaluation and revascularization of CAD in acute HF. Consequently, there are no clear guidelines regarding the selection of patients for coronary angiography nor there are studies clearly demonstrating the benefits of early testing. A study of hospitalized heart failure patients, early coronary angiography was associated with reduced mortality. Thus our study showing larger number of patients having CAD might benefit if revascularized earlier.[35]

Similarly, Trevisan L et al found that of the 164 patients with HFpEF or HFmEF who underwent angiography, median age was 79 years, 54% were women and 46% men. In their analysis, 64% of patients had significant coronary stenosis corresponding to a global CAD prevalence of 80%. The prevalence of CAD was similar for HFpEF and HFmEF. They have found higher prevalence of Significant CAD as in our study where it was 77.35 for HFmrEF and 61.1% for HFpEF.[19]

In the current study, prevalence of significant CAD of 70.3% in HFrEF closely matches with the other descriptive studies from Nepal suggesting one third of HFrEF are likely ischemic in our population. In clinical practice, systematic coronary angiography is not always

possible in all patients admitted for heart failure, but potential survival benefit of revascularization is still there so an approach for coronary artery angiography should be promoted in patients having heart failure.[35, 1]

## Conclusions

The study enrolled total 78 patients with mean age of 62.4 ± 13.69 years. Among them, 64.1% were males and 35.9% females. There were 57.7% (45) patients in age group ≤65 years while 42.3% (33) were in the age group > 65 years (Table 1). Common signs and symptoms found in the study group were raised JVP, tender hepatomegaly and leg swelling, Cough was present in 16.7% cases (Table 2). Smoking and Dyslipidemia were common risk factors present along with HTN and DM (Table 3). Occurrence of HFrEF was most common with 47.4%, patients with HFmrEF were 28.2% and HFpEF were 24.4%. Angiographic profile revealed 70.5% cases with significant CAD, patients with normal coronary artery were 24.4%, whereas 2.6% (2) patients had anomalous coronary artery in which right coronary artery had origin from posterior part of the sinus and 2.6% patients had insignificant CAD. The ischemic etiology was found in 70.5% (55) subjects while 29.5% (23) had non-ischemic etiology (Table 4). TVD was present in 18.9%, DVD in 21.6% and SVD in 29.7% of HFrEF (Table 11). The prevalence of significant CAD in HFrEF was 70.3%, and this was the most common type of heart failure in our study (Table 9). Significant CAD by gender distribution revealed 48.7% males and 70.5% females (Table 10). Echocardiography showed LV global wall hypokinesia in 37.2% which was most common finding, 35.9 % showed RWMA while 26.9% had normal study (Table 6). One reason for the higher occurrence of CAD might be more RWMA findings associated with heart failure in our study.

Our study showed higher prevalence of CAD (70.5%) in Heart failure patients however statistical significance could not be reached, nevertheless this study would be a set mark for further researcher and protocol developers with reference to our scenario of patients having genetic, racial and environmental differences when compared to western population.

## Limitations of The Study

Our study was a single-center study with relatively small sample size, therefore, our findings should be cautiously generalized to the other set of population. Multi-center studies adopting the same protocol and including a larger number of patients are needed for the final conclusions. The study lacked follow -up and complications. In documenting coronary artery stenosis, Coronary angiography have limitations if compared to other newer modalities of diagnosing coronary artery disease like OCT and IVUS.

Similarly, selection bias while patient enrollment by history may have come into play despite meticulous history taking.

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