Section: General Medicine

Original Research Article

STUDY OF RISK FACTORS, CLINICAL FEATURES, ANGIOGRAPHIC PROFILE, MANAGEMENT OUTCOMES IN YOUNG PATIENTS WITH ACS IN CORRELATION WITH NT-PRO-BNP, HS-TROP I AND APO-B LEVELS PRESENTING TO A TERTIARY CARE HOSPITAL

Seshagiri Raju Dondapati[1], Kota Sabarigirish[2], Shaik Vahida[3], John Richards Lingam[4]

[1]Consultant Cardiologist, KTCT Hospital, Attingal, Trivandrum, India.
[2]Chief Cardiologist, Dr Anjireddy Super Speciality Hospitals, Narasaraopeta, Andhra Pradesh, India.
[3]Assistant Professor, Department of General Medicine, Government Medical College, Markapuram, Andhra Pradesh, India.
[4]Associate Professor, Department of General Medicine, Government Medical College, Markapuram, Andhra Pradesh, India.

Received *: 20/04/2024*
Received in revised form *: 03/06/2024*
Accepted *: 19/06/2024*

Corresponding Author:
Dr. John Richards Lingam
Associate Professor, Department of General Medicine, Government Medical College, Markapuram, Andhra Pradesh, India.
Email: richizse@gmail.com

DOI: 10.5530/ijmedph.2024.2.148

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2024; 14 (2); 770-776

ABSTRACT

Background: To study the risk factors, clinical features in young patients presenting with ACS to Cardiology department at tertiary care hospital, in South India.

Material and Methods: Prospective Observational study. It was carried out during From December2020 to 31stDecember2021. Hundred Patients with primary diagnosis of ACS will be subjected to thorough medical history taking, full clinical examination, Baseline laboratory investigations, ECG, ECHO, NT-pro-BNP, Hs-Trop I level, Apo B levels, Angiographic data will be attained. Admission clinical data, risk factors, angiographic data, NT-pro-BNP levels, Hs-Trop I level, Apo B levels, Management options taken accordingly, outcomes as in-hospital and one month later MACE will be recorded. Independent predictors of outcome will be identified by logistic regression analysis and incorporated in to study prediction tool.

Results: This study showed the role dyslipidemia as most important modifiable risk factor has its pivotal role due to changing food habits and increasing sedentary life style, a more focused and early detection of dyslipidemia in young can prevent deleterious consequences. Common form of ACS in young is STEMI and commonly present with single vessel disease involving LAD causing AWMI, if managed in time young ACS patients have better in hospital to one-month prognosis, further longer duration studies are needed to prognosticate the longer outcomes in young population. There is significant role of Hs Trop I in assessment of the disease burden, progression of the disease and optimizing the treatment options to cut short the course of disease progression according its levels.

Conclusion: The present study concluded that there is significant role of Hs Trop I in assessment of the disease burden, progression of the disease and optimizing the treatment options to cut short the course of disease progression according its levels.

Keywords: CAD, Hs Trop I, Atherosclerosis, STEMI, ACS.

INTRODUCTION

Coronary artery disease (CAD) is regarded as the most commonnon communicable disease around the world, CAD manifests in two major forms Acute coronary syndrome (ACS) and Chronic coronary syndrome (CCS). ACS forms the life-threatening manifestation of CAD. ACS is classified into three types namely,

- ST elevation myocardial infarction (STEMI)

- Non-ST elevation myocardial infarction (NSTEMI), and
- Unstable Angina (UA)

CAD has been common disease of older population with prevalence of 19.8% inindividuals greater than 65 years of age according to centre for disease control data for the year 2010, and it continues to increase with age.

Younger men and women being affected with CAD and ACS has been on rise. Coronary arterial disease in the form of coronary atherosclerosis occurring in individuals less than 45 years of age is termed as young CAD. Individuals of age less than 40-45 years in western world comprise of 4 to 10% of all Myocardial infarction (MI) patients and women make toone tenth of is total (5.6to11%). In Indian subcontinent several studies have shown earlier occurrence of CAD in men and women by a decade compared with western world, ethnic wise south Asians especially Indians are more vulnerable to have CAD in young age group with a prevalence of 5% to 10%.[1,2]

Though an uncommon disease of the young, CAD in them proves to be limiting disease of their active life style and associated with significant morbidity and mortality.

The well-known traditional risk factors such as Smoking, Diabetes, Hypertension, Obesity and Family history seems to be as important as in older CAD subjects. But the prevalence of these risk factors seems to vary in younger subjects like Cocaine and Marijuana usage in both men and women in the western world and OCpillusage in women, Psychosocial factors, Hypo-estrogenic phase of menstrual cycle, where as the Indian data has showed greater association of smoking to betheetiology, next in the lineare diabetes and hypertension.[3,4] In spite of low diabetic prevalence, it has been associated with high risk, and untreated hypertension is at alarming rates in young individuals of India.

Though there is abundant literature on younger individuals with CAD and ACS, no one has corelated the association of ACS as disease entity like clinical features, risk factors, angiographic profile, management strategies with commonly used biomarkers in ACS like high sensitivity troponin I (Hs Trop I), Apo B and NT-pro-BNP over outcomes along with above mentioned factors. Hs Trop I is recommended by recent guidelines for early rule in/rule out in patients with suspected ACS, added to this its role has been proven in assessment of the disease burden, progression of the disease, risk assessment of major adverse cardiac events (MACE) and optimizing the treatment options to cut short the course of disease progression according its levels.

Aim and Objectives

Aim: To use NT-pro-BNP levels, Hs-Trop I and Apo B levels to correlate with risk factors, clinical features, management outcomes of ACS in young and to find out the use of NT-pro-BNP levels, Hs-Trop I and Apo B levels in defining the outcomes of ACS in young.

Objectives

Primary objective: To studythe risk factors, clinical features in young patients presenting with ACS to emergency department at Apollo Main Hospitals, Chennai.

Secondary objective: To obtain NT-pro-BNP, Hs-Trop I and Apo B levels in these patients and correlate these values with patient risk factors and clinical features with management outcomes of the patients.

MATERIAL AND METHODS

Study design: Prospective Observational study.

Study duration: From December2020 to 31stDecember2021

Sample size: 100

Inclusion Criteria

Male Patients under the age of 45 years and female under the age of 55 years presenting with ACS to the hospital.

Willing and ability to provide history, baseline blood samples within 24 hours of onset of symptoms, consent for angiography and further management.

Exclusion Criteria

Patients not willing for study

Patients with other illnesses and comorbidities that likely to elevated levels of NT-pro-BNP levels, Hs-Trop I and Apo B levels apart from ACS.

Methodology

Hundred Patients with primary diagnosis of ACS will be subjected to thorough medical history taking, full clinical examination, Baseline laboratory investigations, ECG, ECHO, NT-pro-BNP, Hs-Trop I level, Apo B levels, Angiographic data will be attained.

Admission clinical data, risk factors, angiographic data, NT-pro-BNP levels, Hs-Trop I level, Apo B levels, Management options taken accordingly, outcomes as in-hospital and one month later MACE will be recorded. Independentpredictorsofoutcomewillbeidentifiedbylogisticregressionanalysisandincorporatedintostudy prediction tool.

RESULTS

After statistical evaluation, calculated sample for our study was 100. In view of COVID -19 pandemic and lockdown in the country there occurred slow recruitment of cases for the study and in view of completion of study period the number cases recruited at time of completion has been projected to observation and results.

In this study, we had total of60 patients presenting with ACS at our tertiary care hospital fulfilling the criteria of male patients under the age of 45 years and female under the age of 55 years.

Sex distribution of the study population

In this study, a majority of 66.7% were males and 33.3% were females.

Cumulatively majority are under the age group of 41 to50 years, with 46.7 percent and least number were under the age group of 30 years with a percentage of6.7 percent, youngest in the study was19-year-oldmaleand eldest of the study was 54-year-old female. overall, the mean age is 42.40 with standard deviation of 7.386.

In this study majority of the patients presented with primary complaint of chest pain and were 71.67%, next common complaint in the patients was chest discomfort followed by left shoulder pain and giddiness, least common of the complaints was dyspnea as presentation. [Table 2]

In this study 40% of patients were known diabetics, 60% of the females were diabetics and 32.5% of males were diabetics.

In this study 28.33% of patients were known hypertensive, 36 % of the females were hypertensive and 20 % of males were hypertensive.

In this study 33.33% of patients had strong family history of CAD, and 28.33% patient's father had CAD while 5% patients' mother had CAD. In study 10% patients were smoker and 90% non-smokers, all female patients were non-smokers. In study 8.33% patients were alcoholics, 91.67% were non alcoholics and none of the female patients were alcoholics.

In this study baseline lipid profile was done in 46 patients and 40 patients were dyslipidemia, abnormal total cholesterol was seen in 30% patients, abnormal LDL was seen in56.7% patients, abnormal triglycerides were seen in 46.7%patients, abnormal HDL was seen in 63.3% patients, abnormal NHDL was seen in55% patients, abnormal TC/HDL was seen with 60% patients. [Table 3]

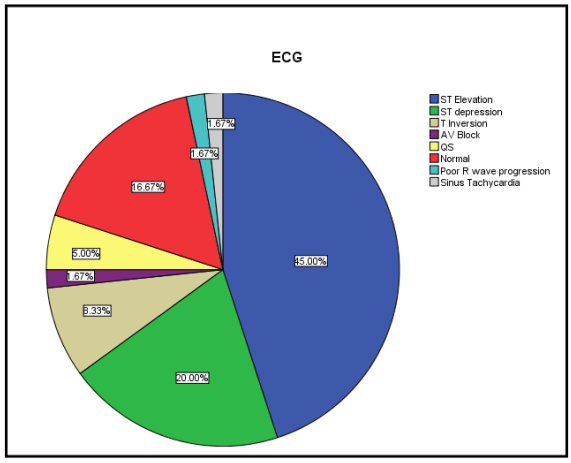

Figure 1: ECG pattern distribution in study Subjects.

In this study 45% patients presented with ST elevation, 20% presented with ST depression, 16.67% patients had normal ECG, 8.33% presented with T wave inversion, 5% patients presented with QS complex, 1.67% patients presented with AV block, Poor R wave progression, and Sinus tachycardia.

In this study regional wall motion abnormality (RWMA) in echocardiography was seen with 71.7%, 28.3% were without any wall motion abnormality. A majority of 61.7% had normal LV ejection fraction (> 55%), 21.7 % patients had mild LV dysfunction (54-45%) and moderate LV dysfunction was seen in 16.7% patients, none of the patients had severe LV dysfunction (30%).

Distribution of ACS in the study population

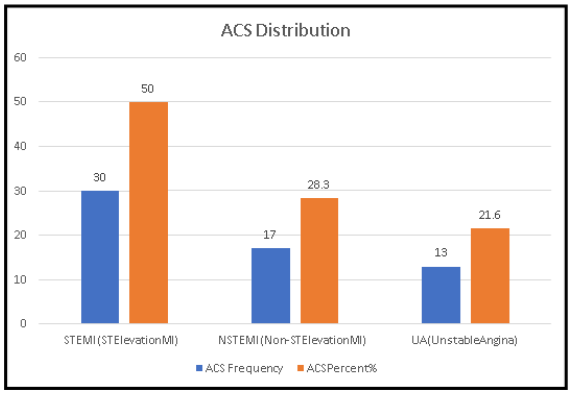

Figure 2: ACS distribution in study subjects

In this study 50% presented with STEMI, 28.33% presented with NSTEMI, and 21.66% presented with UNSTABLEANGINA.30% patients presented with Anterior wall MI (AWMI), 16.7% patients presented withinferior wall MI (IWMI), 3.3% patients presented with inferio-posterior wall MI.

In this study majority of 76.67% patients presented with KILLIP class I, 11.67% presented with KILLIP class II, 6.67% patients presented with KILLIP class III, 5% patients presented with KILLIP class IV

Distribution of HS TropI levels in the study population

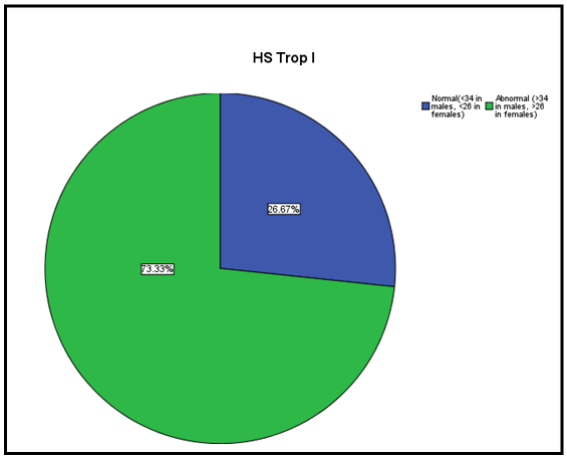

Figure 3: HS Trop, Ilevels distribution in study Subjects. In study 73.33% patients were having elevatedHSTropIlevelsand26.67%patientsdidn'tshowelevatedHS Trop I levels.

Distribution of NT-pro-BNP value in the study population

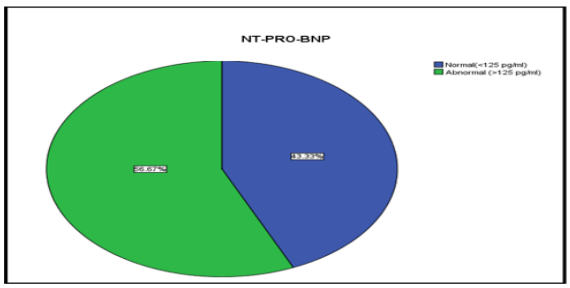

Figure 4: NT-pro-BNP value distribution in study Subjects

In study 56.67% patients were having abnormally elevated NT-pro-BNP levels and 43.33% patients didn't show elevated NT-pro-BNP levels

Distribution of Apo B values in the study population

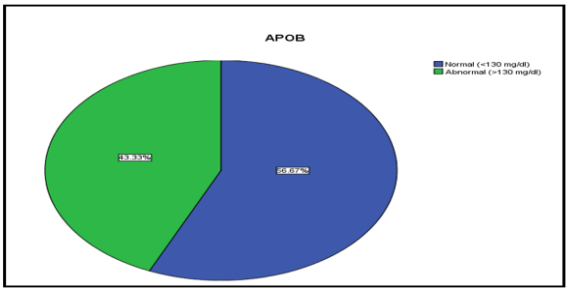

Figure 5: Apo B value distribution in study Subjects.

In study 43.33 % patients were having abnormally elevated Apo-B levels and 56.67 % patients didn't show elevated Apo-B levels

TIMI risks core was calculated in NSTEMI and UA patients, low TIMI risks core (0-2,5-8% risk of MACE for 14 days) was seen 45% patients and 5% patients were into intermediate TIMI risk score (3-4, 13-20% risk of MACE for 14 days).

TIMI risk index (TRI) calculated in STEMI patients for 30-day mortality risk there were maximum of 26.7% patients with risk index score of <12.5 with estimated risk of 5% and a minimum of 3.3% patients with risk index score of 22.5-30 with estimated risk of 13.6%.

Distribution of Coronary Angiogram Pattern (CAG) in the study population

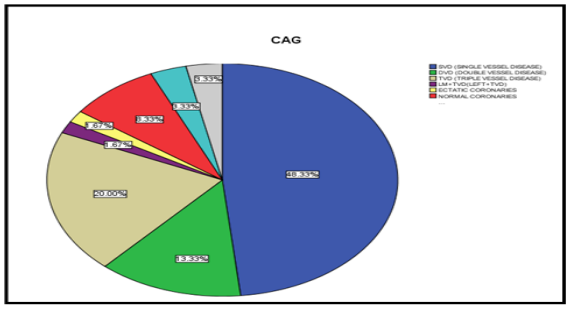

Figure 6: CAG pattern distribution in study Subjects.

Coronary angiogram done in this study group 48.33% patients had single vessel disease, followed 20% were having triple vessel disease, 13.33%patients had double vessel disease, 8.33%had normal coronaries, 1.67% showed coronary ectasia, 1.67% showed LM+TVD.

Distribution of door to balloon time in STEMI patients who underwent PCI

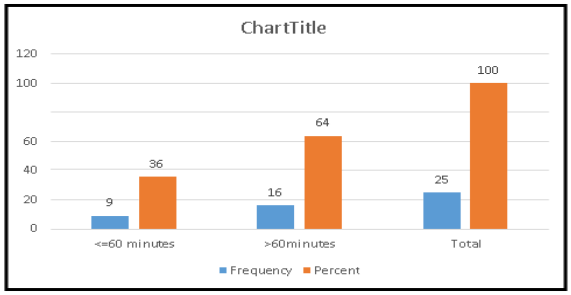

Figure 7: Door to balloon time distribution in STEMI patients.

Out of 50 STEMI patients 25 underwent PCI of which 9 patients were with door to balloon time of<60 minutes and 16 patients were with door to balloon time of > 60 minutes.

Distribution of Management in the study population

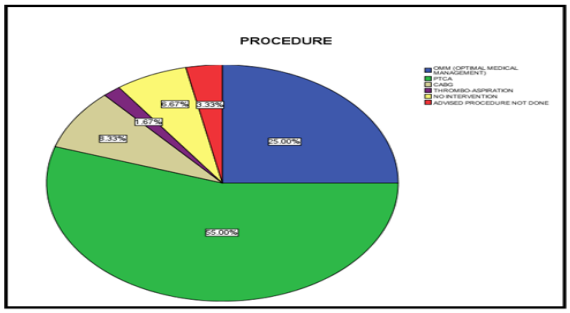

Figure 8: Management distribution in study Subjects.

In this study 55% underwent PTCA plus Stenting, 25% needed optimal medical management, 8.33% patients underwentCABG,1.67% patients underwent thrombus-aspiration, no intervention was done in 6.67%patients,

3.33% patients didn't undergo advised intervention.

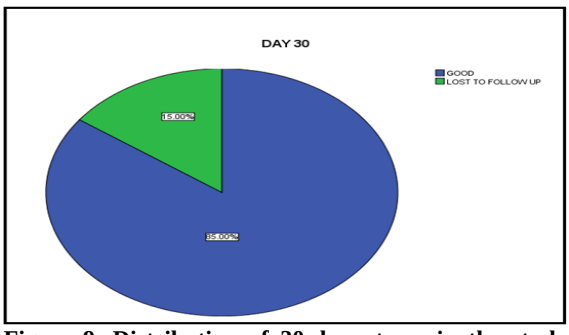

Figure 9. Distribution of 30-dayoutcomein the study population

In this study had no adverse outcomes at 7thdayand after 30 days, while15% patients were lost to follow up.

Table 1: Showing sex distribution of study population

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	40	66.7	66.7	66.7
	Female	20	33.3	33.3	100.0
	Total	60	100.0	100.0	

Table 2: Showing Age distribution of study population

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<=30 years.	4	6.7	6.7	6.7
	31-40years.	20	33.3	33.3	40.0
	41-50years.	28	46.7	46.7	86.7
	51-60years.	8	13.3	13.3	100.0
	Total	60	100.0	100.0	

Table 3: Distribution of various elements in the study population

PARAMETER	PRESENT %/ ABNORMAL % Of total patients	ABSENT %/ NORMAL% of Total patients
DIABETESMELLITUS	40	60
HYPERTENSION	28.33	71.67
F/H/OCAD	33.33	66.67
SMOKING	10	90
ALCOHOLISM	8.33	91.67
DYSLIPIDEMIA	86.95(of46patients)	13.04(of46patients)
TOTALCHOLESTROL	30	70
LDL	56.7	43.3
TRIGLYCERIDES	46.7	53.3
HDL	63.3	36.7
NHDL	55	45
TC/HDL	60	40

Table 4: Descriptive statistics various study elements with minimumvalue, maximum value and mean value

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	60	19	54	42.40	7.386
TC	45	105	299	189.80	47.775
LDL	45	55	243	136.87	45.011
TGL	45	52	1351	215.87	209.807
HDL	45	9	62	32.71	8.753
NHDL	45	72	266	157.09	47.160
TC/HDL	45	2.8	12.3	6.087	1.9778
HR	60	64	140	87.27	17.733
SYSTOLICBP	60	90	230	134.83	22.810
DIASTOLICBP	60	50	115	80.42	13.093
HS TropI	60	1.1	130007.0	14012.155	30798.6022
NT-PRO-BNP	60	10	7719	954.35	1531.625
APOB	60	52	228	119.23	38.150
SerumCreatinine	60	.5	4.5	.927	.5194
GRACE	60	28	145	75.47	24.389
ValidN(listwise)	45				

Table 5: Symptoms in ACS of young were co-related with HST ropIlevels

			HS TropI		Total
			Normal (<34in males,<26in females)	Abnormal (>34 in males,>26 in females)	
SYMPTOMS	Chest Pain	Count	9	34	43
		% Among SYMPTOMS	20.9%	79.1%	100.0%
		%Between HSTropI	56.2%	77.3%	71.7%
	Chest discomfort	Count	4	4	8
		% Among SYMPTOMS	50.0%	50.0%	100.0%
		%Between HS TropI	25.0%	9.1%	13.3%
	Dyspnea	Count	0	1	1
		% Among SYMPTOMS	.0%	100.0%	100.0%
		%BetweenHSTropI	.0%	2.3%	1.7%
	Giddiness	Count	3	1	4
		% Among SYMPTOMS	75.0%	25.0%	100.0%
		%BetweenHSTropI	18.8%	2.3%	6.7%
	Left shoulder pain	Count	0	4	4
		% Among SYMPTOMS	.0%	100.0%	100.0%
		%Between HS TropI	.0%	9.1%	6.7%
Total		Count	16	44	60
		% Among SYMPTOMS	26.7%	73.3%	100.0%
		%Between HS TropI	100.0%	100.0%	100.0%

DISCUSSION

Young MI can leave devastating experience and dire consequences for the patient and the family if not managed in time. In our study due to COVID 19 pandemic there occurred slow recruitment of patients and 60 young patients were included in study who presented as ACS and study elements were assessed and analyzed.

There is lack of consensus on defining the young in young MI, multiple studies have young or premature CAD in ranging < 35 years to < 60 years (3), this study has taken males < 45 years and females < 55 years as young.[5,6,7]

Assessing the clinical profile in this study majority of the patients presented with chest pain, followed by chest discomfort as complaints. 70% of the both male and female patients presented with chest pain as major complaint, while in a study done by Alappatt,et.al, there were 83% males and 46% females presenting with chest pain. Ourstudy showed correlation the presenting symptoms and Hs trop I level with a p value of 0.049.

In our study individuals with history of smoking presenting with ACS were only 10%, while other similar studies like CADY registry showed 39%, Van Loon et.al showed 38%, Kumbalkar SD et.al showed 17.1%, Michele Doughty et.al showed 76.5%, J A Fournier et.al showed 94.5%, Soumya G et.al showed 30%, and Tamrakar R et.al showed64.3% of individuals history of smoking, Presence of tobacco chewing was present with 3.33% patients in our study group this differences could beduetoourstudybeingconductedinamajorcityofIndia ,and increasing awareness on adverse effects of smoking, majority of them being educated and no female patient was a smoker.

In our study diabetes and hypertension was present in 40 % and 28.3% respectively in young MI patients, comparing with previous studies hypertension correlated with majority of previous studies, while various previous studies showed different percentages of young patients being diabetic and presenting with ACS with average of less than20%,ourstudyhad comparablepercentageofdiabeticpatientswithCADYr egistry,thiscouldduetodaybyday increasing stress levels and changing food habits and life style.

Family history CAD, defined as manifesting CAD in first degree relative before the age of 55 – 60 years is reported in 41 to 71% young ACS patients5 our study a presence of 33.3% probably due to low number of patients recruited for study.

In our study diabetes had correlation with NT-pro-BNP levels with a p value of 0.019.Though lipid profile was taken up in 46 percent patients, dyslipidemia and all components of lipid profile had correlation with Hs TropI, except for HDL levels with Apo B with significant p value, the percentage of patients with dyslipidemia in this study was comparatively higher with 66.67% than previous studies probably due to low number of cases recruited and further low number patients tested for lipid profile.

This study showed a majority of 50% patients presenting with STEMI, NSTEMI were 28.3% and Unstable Angina of 21.6% patients, though STEMI patients were high the percentage was comparatively low with previous and this study little higher percent of unstable stable angina patients this due to all patients with working diagnosis of ACS in young were consecutively recruited in the study this resulted comparably higher percent of unstable angina and comparable low number of STEMI patients. In a paper by ShahNetal5reported that up to two-thirds of ACS of young patients will presented with NSTEMI and around one third presented with STEMI, our study had one half patients presenting with STEMI.

Percentage of patients presenting with good, moderate left ventricular ejection fraction (LVEF) were comparable with previous studies (table-38), while our study showed comparably higher percent of patients with poor LVEF of 16.7%, probably as majority of 71.7% showed wall motion abnormality in all three forms of ACS (STEMI, NSTEMI, UA) in our study.

Accordingtoastudyin youngACSpatient'ssinglevesseldiseasewasmorecom monthanolderpatients65and LADarterywasmostcommonlyaffectedartery.[13]Singl evesseldiseasewaspredominantinthisstudypopulation with percentage of 58.3 % which was comparable with 57.1% of J A FOURNIER et.al,[2] LAD disease was seen in with 28.3%whichwascomparablewith27.6%ofTAMRAK ARRet.al8.Previousstudiesshowedlowinvolvemento fLeft main disease,[8,9] accordingly our study showed 3.33% patient with left main disease.

In youngpatientswithSTEMItheadvantageofprimaryang ioplastyoverthrombolysiswasasgoodasinolder patients,[10] none of the patients undergo thrombolysis at our center, as our center being well equipped tertiary care center, a majority of 55% percent underwent primary angioplasty including patients with STEMI, NSTEMI and UA, which corroborates with percentage of patients in study done by Doughty M et.al,[1] with a percent of 56.2%.

The percentage of patients who underwent CABG in this study are 8.3% while other studies showed a percentage of 4.6 to10.4% (table-40).In this study certain patients with no angioplasty or CABG done were patients with insignificant CAD, patients with occluded SVD with collaterals, patients with coronary ectasia, patients with critical TVD not amenable for PCI and CABG, patients with recanalized SVD, patients with thrombotic SVD who were treated with Gp IIb/IIIa inhibitors, patients with branch vessel disease and patient normal coronaries were managed with onlyoptimal medical management and all thesepatients madeup

to 25%. While patients with advised CABGandwerenotreadytoundergotheprocedurewere 3.3%, one among these patients had LVclot and these were sent with optimal medical management advising regular follow up.

Whilein-hospital and short-term out comes were more favorable for young ACS patients, previous studies have shown an in-hospital and 6-month mortality as 0.7% and 3.1%,[11] and other comparative studies showed a mortality ranging from1.7to3%, our study didn't show any MACE probably as majority patients were managed early with angioplasty, number of patients taken study is low and follow period is less compared to other studies.

The newer part of this study is that as we tried correlating the elements of the studylike clinical features, risk factors, angiographic profile, management strategies and outcomes with Hs Trop I, Apo B, NT pro BNP, though not with outcomes the scope ofHs-Trop Iis far beyond the use of triaging patients with chest pain, particularly in young patients as it positively correlated with symptoms of presentation, dyslipidemia, STEMI, anterior wall motion abnormality, LAD involvement and primary angioplasty. Further an oriented study on Hs Trop I with these elements may lead to a favorable result. While the scope of Apo B can be more in primordial and primary prevention of CAD and ACS as per its correlation with dyslipidemia and emerging evidences on Apo B,[12] further Apo B correlated with TIMI risk score and KILLIP score with P value with 0.04. while NT-pro-BNP showed obvious positive correlation with ACS and regional wall motion abnormality.

Limitations

The study's limitations are this study contained relatively low number of patients; greater number of patients would have projected a different result. There is no comparative group in this study to compare the results with like elderly age group, the study is conducted in short period of time and follow up period was only for 1 month, and as study is conducted in a tertiary care hospital of a major metropolitan city of the country where people of all socioeconomic classes were unable to get recruited. Other risk factors like Lp(a), Homocysteine levels were not included in to the study criteria. While what could have impacted the study was a low percent of 3.3% patients didn't undergo advised procedure, 35.7% of unstable angina patients didn't undergo CAG, and 15% patients have lost to follow up, and would have drawn a different result.

CONCLUSION

Young patients with ACS as in comparison with previous studies presented most commonly with complaints of chest pain, while unusual complaints like giddiness and isolated left shoulder too should be considered in young patients with ACS.

Although the presence of traditional risk factors like diabetes, hypertension, smoking, obesity, family history of CAD, dyslipidemia have their impact on etiopathogenesis of ASCVD and ACS, this study showed the role dyslipidemia as most important modifiable risk factor has its pivotal role due to changing food habits and increasing sedentary life style, a more focused and early detection of dyslipidemia in young can prevent deleterious consequences. Common form of ACS in young is STEMI and commonly present with single vessel disease involving LAD causing AWMI, if managed in time young ACS patients have better in hospital to one-month prognosis, further longer duration studies are needed to prognosticate the longer outcomes in young population. There is significant role of Hs Trop I in assessment of the disease burden, progression of the disease and optimizing the treatment options to cut short the course of disease progression according its levels.

Conflict of Interest: None

Funding Support: Nil.

REFERENCES

1. Doughty M, Mehta R, Bruckman D, Das S, Karavite D, Tsai T, Eagle K. Acute myocardial infarction in the young—The University of Michigan experience. American heart journal. 2002 Jan 1;143(1):56-62.
2. FournierJA, SanchezA,QueroJ,Fernandez, Cortacero JA,González-BarreroA.Myocardial infarction in men aged 40 years or less: A prospective clinical- angiographic study. Clinical cardiology. 1996 Aug;19(8):631-6.
3. Aggarwal A, Srivastava S, Velmurugan M. Newer perspectives of coronary artery disease in young. World journal of cardiology. 2016 Dec 26;8(12):728.
4. Sniderman AD, Furberg CD. Age as a modifiable risk factor for cardiovascular disease. TheLancet.2008May 3;371(9623):1547-9.
5. vanLoonJE, deMaat MP,DeckersJW,vanDomburgRT,LeebeekFW.Prognostic markers in young patients with premature coronary heart disease. Atherosclerosis. 2012 Sep 1;224(1):213-7.
6. Zimmerman FH, Cameron A, Fisher LD, Grace NG. Myocardial infarction in young adults: angiographic characterization, risk factors and prognosis (Coronary Artery Surgery Study Registry).Journal of the American College of Cardiology. 1995 Sep;26(3):654-61.
7. Arnett DK, Blumenthal RS, Albert MA, Buroker AB, Goldberger ZD, Hahn EJ, Himmel farb CD, Khera A, Lloyd-Jones D, McEvoy JW, Michos ED. 2019 ACC/AHA guideline on the primary prevention of cardiovascular disease: are port of the American College of Cardiology/American Heart AssociationTaskForce onClinicalPracticeGuidelines.JournaloftheAmericanCollegeofCardiology.2019Sep10;74(10):e177-232.
8. Mishra BK, Sawhney JP, Manchanda SC, Khanna PK. Coronary artery disease in young women less than 50 years of age. Indian Heart J. 2008; 60:401.
9. ChrisJ, JaiShankarK, JaiswalPK, NayarPG,ThomasJM,MeenakshiNA.Evaluationofriskfactorprofilein acute coronary artery syndrome in the young. Indian Heart J. 2006; 58:394-410.
10. Holmes DR, White HD, Pieper KS, Ellis SG, Califf RM, Topol EJ. Effect of age on outcome with primary angioplasty versus thrombolysis. Journal of the American College of Cardiology. 1999 Feb;33(2):412-9.
11. Incalcaterra E, Caruso M, Lo Presti R, Caimi G. Myocardial infarction in young adults: risk factors, clinical characteristics and prognosis according to our experience. Clin Ter. 2013 Jan 1;164(2):e77-82.
12. Marston NA, Giugliano RP, Melloni GE, Park JG, Morrill V, Blazing MA, Ference B, Stein E, Stroes ES, Braunwald E, Ellinor PT. Association of Apolipoprotein B–Containing Lipoproteins and Risk of Myocardial Infarction in Individuals with and Without Atherosclerosis: Distinguishing Between Particle Concentration, Type, and Content. JAMA cardiology. 2021 Nov 13.