STRATIFICATION OF CORONARY ARTERY MORPHOLOGY IN DIABETIC CORONARY ARTERY DISEASE PATIENTS WITH MICROALBUMINURIA

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CERTIFICATE

This is to certify that the dissertation titled "**STRATIFICATION OF CORONARY ARTERY MORPHOLOGY IN DIABETIC PATIENTS WITH MICROALBUMINURIA"** is the bonafide original work of Dr**. R. KANNAN**, in partial fulfillment of the requirements for D.M. Branch-II (CARDIOLOGY) examination of THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY to be held in August 2014.The period of post-graduate study and training was from August 2011 to July 2014.

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DECLARATION

I, **Dr.R.KANNAN**, solemnly declare that this dissertation entitled, "**STRATIFICATION OF CORONARY ARTERY MORPHOLOGY IN DIABETIC PATIENTS WITH MICROALBUMINURIA"** is a bonafide work done by me at the department of Cardiology, Madras Medical College and Government General Hospital during the period 2011 – 2014 under the guidance and supervision of the Professor and Head of the department of Cardiology of Madras Medical College and Government General Hospital, Professor M.S. RAVI M.D.D.M. This dissertation is submitted to The Tamil Nadu Dr.M.G.R Medical University, towards partial fulfillment of requirement for the award of **D.M. Degree (Branch-II) in Cardiology**.

Place: **SIGNATURE OF THE CANDIDATE**

Date:

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CONTENTS

INTRODUCTION

Ancient texts in India mention about the disease "*Madhumeha*" which corresponds to the term "Diabetes mellitus". It suggests that diabetes should have been in India even before 2500 BC. But no evidence is available to know its prevalence.(65)

Diabetes Mellitus is a chronic metabolic disease present throughout the world that leads to increased morbidity and mortality which is major worry for the public health care workers. Inspite of vast developments in the treatment of Diabetes mellitus there is an increased prevalence and complications of this disease.

In 2011 366 million people with diabetes were present throughout the world and it is expected to increase to 552 million in 2030.(61) Most of them live in low- and middle-income countries like India.

These countries are going to have the greatest increase over the next 19 years. The ICMR-INDIAB national studypublished that there are 62.4 million people with type 2 diabetes and 77 million people with pre-diabetes in India. (62)Thesenumbers are expected to increase to 101 million by the year 2030.There are few population based studies on complications of diabetes in India.(63,64) According to those studies the prevalence of diabetic retinopathy was 17.6%, microalbuminuria was 26.9%

neuropathy was 26.1%, coronary disease was 21.4% and peripheral artery disease was 6.3%.

Cardiovascular disease is a major cause for increased mortality in Diabetic patients. The terms Coronary artery disease, Ischemic heart disease are synonymous and they point to a single disease coronary heart disease which is expected to become the most common cause of death around the world by 2020. At present the South East Asian Countries like India, SriLanka, Pakistan , Nepal have an increased incidence of coronary artery disease.

Many Diabetic patients with Coronary disease may not have classical risk factors otherthan diabetes and even the lipid profile will be normal. This led research on newer risk factors for the development of coronary artery disease in Diabetes Mellitus.

Comprehensive research in this field have brought in newer biomarkers and inflammatory markers for coronary artery disease.

They are increased LPa levels, elevated plasma Fibrinogen, Homocysteine, Plasminogen Activator Inhibitor 1, CRP and Microalbuminuria. These risk factors effects are multiplicative rather than additive. People with many risk factors are at more risk. So assessment of a person should be holistic to identify all the risk factors so that modification of these risk factors if possible could alter the incidence of coronary artery disease.

Microalbuminuria is nowadays taken as a risk factor for the Coronary disease among Diabetes as well as in Non Diabetes.

Microalbuminuria is a marker of endothelial and vascular damage and predicts coronary atherosclerosis. Patients with microalbuminuria have an increased mortality rate due to coronary artery disease. Likewise these patients have a more complex and severe form of coronary lesions on angiography when compared to people without microalbuminuria. Many studies have shown the relationship between microalbuminuria and coronary disease in diabetic patients.

Microalbuminuria may be an important indicator of absolute cardiovascular risk to the community. Persistent microalbuminuria also leads to renal disease which again increases morbidity and mortality.

Even microalbuminuria in non diabetes have an increased incidence of coronary artery disease. 50% of the microalbuminuria patients die due to cardiovascular disease even before they reach the stage of end stage renal disease.

Among the elderly more than 60 years ,microalbuminuria leads to coronary artery disease most frequently than other established risk factors for cardiovascular disease. It reflects the presence of an already coexistent coronary artery disease.

A study have shown that microalbuminuria was related to coronary artery disease , dyslipidemia, and hypertension. This indicates that microalbuminuria enhances the risk of coronary artery disease along with other risk factors. Microalbuminuria suggests not only the pressure effect onrenal vessels but significant atherosclerotic disorder in the wholevascular system. Hence microalbuminuria may a marker for the underlying vascular disorder and not alone suggesting a renal disorder.

LITERATURE REVIEW

Diabetes mellitus is a major independent risk factor of coronary heartDisease.(4) The increase in coronary heart disease in diabetes mellitus is due tothe accelerated atherosclerosis, which starts at an early age and advances rapidly to major cardiovascular events in individuals with diabetes than those without it.(1)

American Diabetes Association criteria in the diagnosis of Type 2 diabetes mellitus is(3)

1. Fasting plasma glucose morethan or equal to 126 mg/dl. OR
2. 2 hour plasma glucose more than or equal 200mg/dl after 75 gms Glucose tolerance test. OR
3. Symptoms of hyperglycemia like polyuria, polyphagia with random plasma glucose morethan or equal 200 mg/dl OR
4. HbA1c more than or equal to 6.5 % .

Patients with diabetes mellitus are also prone for arterial thrombosis due to persisting activated thrombogenic pathway and impaired fibrinolysis . This combined arterial disease and prothrombotic state is the major reason for acute ischemic heart disease in diabetes mellitus. Coronary artery disease in diabetes is often diffuse with an increase in the number of vessels affected.

Multivariate analysis with large prospective studies like Framingham study, Multiple Risk Factor Intervention Trial (MRFIT)(5), Nurse Health Study (6) demonstrate that diabetes is associated with 2-5 fold increase in coronary heart disease and cardiovascular disease related death. Multiple factors like systemic hypertension, insulin resistance, dyslipidemia, hypercoaggulable state, inflammatory states also contribute for the cardiovascular disease in diabetics.

Atherosclerosis is a progressive disease of the arterial wall that involves inflammation, lipid deposition, remodelling, fibrosis and thrombosis. Initial atherosclerotic lesion includes lipid deposits in the form of fatty streaks in the intima with increase in the macrophages and foam cells.

These early lesions may be insignificant and may regress or develop into advanced atherosclerotic complex. (7) Intermediate lesions include atheroma which is a focal accumulation of lipid within the neointima along with increased foam cells , origin from macrophages and vascular smooth muscle cells , leading to the formation of a lipid rich plaque core. These intermediate lesions arise from either fatty streaks or pre-existing intimal cell masses. Fibrous plaques are formed as a cap of connective tissue, involving the vascular smooth muscle in collagen and proteoglycan matrix that accumulate between the lipid core and vessel lumen. Thickness of the fibrous cap and its infiltration with macrophages affect the stability of the lipid cap. Thin fibrous cap and increased

macrophage accumulation are rupture prone atheroma. Fibrotic lesions can also develop in lesions that do not have lipid core.(8)

The rupture of a plaque fibrous cap depends on the balance between the forces that impinge on the cap and the integrity of the fibrous cap.Collagen give good integrity for the fibrous cap. Factors leading to disordered metabolism of the collagen may impair the ability to repair the plaque leading to its propensity to rupture. Increased catabolism of the extracellular matrix and increased matrix metalloproteinases from macrophages also lead to weakening of the plaque resulting in its rupture.

A vulnerable plaque is one that has increased propensity to rupture. Characters of such plaque are decreased smooth muscle cells, increased accumulation of macrophages and a large lipid pool. Apoptotic macrophages and smooth muscle cells can produce tissue factor which can lead to thrombosis on plaque rupture.(8)

Cardiac disease is the major cause for morbidity and mortality in diabetic patients. (9)This is most likely due to the macrovasculardisease secondary to atherosclerosis. But mechanism of coronary artery disease in some diabetics have similarities likethose in the kidneys, nephropathy (microvascular disease).

The problem of macrovascular disease is more pronounced in type 2 diabetes rather than type I diabetes . The American Heart Association has made

diabetes a major risk factor for cardiac and vascular disease .Multiple risk factors have been found to contribute to macrovascular disease in diabetes. This has been proved in the United Kingdom Prospective Diabetes Study (UKPDS)(11) . Biochemical mechanisms secondary to the metabolites of glucose affect a number of cellular pathways both intra and extra cellularly leading to adverse effect on the vascular walls. The mechanisms are (2)

1. Increase in non enzymaticglycation of proteins

These glycated products can act on inflammatory agents torelease cytokines or directly lead to vascular dysfunction. Collagen present throughout the body has lysine which has a long biological life and its glycation leads to advanced glycationendproduct(AGE) . These AGE on the wall of vessel lead to excess trapping of LDL cholesterol and its oxidation. There is a correlation between the degree of glycemia and the macrovascular disease.

Activation of Polyol pathway.

Excess glucose enter the vascular endothelial cells and get converted into sorbitol. Excess sorbitol leads to change in redox potential or alter the signal transduction pathway ie activation of Diacylglyceraol and Protein kinace C. These changes affect the permeability, angiogenesis, cytokine activation and leucocyte adhesion of the vascular endothelial cells.

Activation of Protein kinase C and Diacyl glycerol cascade.

Diacyglycerol present in cells are the activators of Protein kinase C.Diacy glycerol is derived from hydrolysis of phosphotidylinositides or denovo synthesis. Persistent hyperglycemia increases the levels of PKC and DAG in tissues likeheart, aorta, retina, glomeruli and liver. Such increase requires persistently elevated hyperglycemia for atleast five days. This elevated DAG PKC cascade leads to a number of intracellular and functional abnormalities in vascular cells. It results in increased release of arachidonic acid and prostaglandin E2 as a result of which there is decreased sodium potassium ATPase activity which inturn affects the cellular integrity, growth and differentiation. PKC increased levels can lead to increased transforming growth factor beta which increases Type IV and Type VI collagen and fibronectins that suppress the proteoglycans in extracellular matrix. Less proteoglycans leads to less lipoprotein lipase and consequent poor clearance of VLDL. These leads to typical dyslipidemia in diabetics . Increased Type IV collagen results in expansion of basement membrane leading to vascular dysfunction.

Oxidative stress

Nonenzymaticglycation is a process that affects proteins like structural proteins, coagulation proteins, lipoproteins or carrier proteins in circulation. Persistent hyperglycemia produces oxygen free radicals and contributes to

increased Advanced Glycation Products (AGP). This increases the oxidative stress in diabetics. This increase in oxidative stress as manifested by increased NADH/ NAD ratio in various cells, also leading to decreased nitrous oxide production in vascular endothelium.

In the vessel they result in depressed LPL activity, decreased insulin action, attenuated fibrinolysis, increased von willibrand factor , defective production of endothelial derived relaxation factor, and increased oxidised LDL. Increased oxidised apoB100 in diabetics mediates excess of receptor uptake of LDL by endothelial cells.

This oxidised LDL molecule is well recognised by the macrophage scavenger receptors , taken up by them and form foam cells inatheromatous lesions. Within the foam cells the degradation of LDL is impaired resulting in further accumulation of Oxidised LDL.Oxidised LDL increases the adhesion of circulating macrophages to the damaged endotheliumin creasing their migration into the intima. Oxidised LDL is more immunogenic stimulates foam cell formation and platelet aggregation. Oxidised LDL increases the affinity for glucose links which in turn increases the oxidative stress on the tissues.

Insulin in physiological levels haveantiatherogenic actions but in insulin resistantce states resulting in hyperinsulinemia it leads to atherosclerosis.(10) At physiological levels insulin leads to increased nitrousoxide levels , retards

migration and growth of smooth muscle cells from subendotheliallayervof vascular wall. In hyperinsulenemic states the vascular wall responds to the mediators and mechanisms rather than to the insulin.Hyperinsulinemia leads to a state of enhancedatherosclerosis through the following mechanisms.

Increased secretion and expression of plasminogen activator inhibitor 1 by endothelial cells and hepatocytes. As PAI 1 is a inhibitor of fibrinolysis, its increase results in increased thrombosis and vascular occlusion. Increased levels of vonwillebrand factor and other procoggulant proteins are increased. Increased levels of fibrinogen which is an acute phase reactant suggest role of acute phase reactants in hyperisulinemia and accelerated atherosclerosis.

Two prospective studies Quebec Cardiovascular Study and British Regional Heart Study revealed that there is a threshold for the macrovascular disease enhancing effect of insulin and an increase in one standard deviation in insulin level increases the cardiovascular risk by 70%.

Abnormal rheology also contributes to accelerated atherosclerosis.(2) This results in increased plasminogen activator inhibitor1 , von willibrand factor, fibrinogen factors VII, VIII, thrombin antithrombin III , protein C,S which have natural antithrombogenic activity are reduced in quantity.

Microvascular complication of diabetes is a major health concern.(12) Four main hypothesis have been postulated for the development of

microvascular complications. They are increased polyol pathway flux, increased advanced glycation products, activation of protein kinase C, and increased hexoxasamine pathway flux. microvascular change leads to various pathophysiological processes in retina, kidney, neurons, basement thickening, increased vascular permeability, and neovascularisation.

Diabetic nephropathy ,a common microvascular disorder of both type1 and type2 diabetes mellitus. It is defined as theoccurence of permanent proteinuria in a diabetic patient usually with retinopathy, elevated blood pressure and declining glomerular function in the absence of urinary tract infection and other renal diseases producing proteinuria and cardiac failure(13).

The incidence of nephropathy in type I diabetes mellitus is 30% and in type 2 diabetes is 20%. But it is commoner to see more number of nephropathy in type 2 diabetes mellitus than in type I due to the increased prevelence of type 2 diabetes. Initially it was thought that renal failure is less common with type 2 diabetes. But nowadays due to better treatment modalities for hypertension and coronary heart disease it is now possible to increase the lifespan of diabetic people sothat we are seeing more number of chronic kidney disease patients among type 2 diabetes mellitus.(12)

Microalbuminuria has been widely accepted as an important marker of diabetic renal disease as well as of early vascular complications. Diabetic

kidney disease is defined as the presence of dipstick positive proteinuria. Microalbiminuria predicts the development of future diabetic renal disease. Further it is associated strongly with cardiovascular risk and coronary heart disease in diabetes.(15)

Condition	24 hr albumin excretion	Overnight urinary albumin excretion rate	Albumin creatinine ratio
Macroalbuminuria	>300mcg/day	>200 mcg/min	>0.2
Microalbuminuria	30- 300 mcg/day	20-200mcg/min	0.02-0.2
Normoalbuminuria	<30mcg/day	<20mcg/min	<0.01

Timed urinary collections 24 hr or overnight remain the gold standard for quantificationof proteinuria. But they are cumbersome for the patients. The use of albumin creatinine ratio in the early morning sample is a convenient and reliable method.(16) Several factors like urinarytract infection, menstruation, exercise, fever can give a false positive result.

The natural history of renal involvement is well defined in type 1 diabetes. The diagnosis of diabetic nephropathy is based on clinical evidence. In the typical course the development of proteinuria is slow.

Initially it is intermittent , then becoming persistent and increasing. The onset of proteinuria is associated with hypertension and declining glomerular function. Usually diabetic retinopathy is associated with diabetic nephropathy. In type 2 diabetes mellitus especially those who do not have diabetic retinopathy 25% of them will be having other renal diseases producing the proteinuria. Both type 1 and type2 diabetes are at risk for developing nephropathy. But only type 1 diabetic has increased risk of progression to end stage renal disease. But due to the increased number of type 2 diabetes there is an increased incidence of chronic renal disease in type2 diabetes.

Stages of kidney involvement in diabetes.(15)

Stage 1 glomerular hypertrophy and hyperfiltration

Stage 2 silent stage ; normal albuminuria but glomerular lesion

Present on histology.

Stage3 microalbuminuria

Stage 4 overt diabetic nephropathy and clinical proteinuria

Stage 5 end stage renal failure.

During the silent phase there is an increased glomerular filtration rate which is increased to about 20% to 40% and is evident in both type 1 and type 2 diabetes mellitus. (17)Hyperfiltration depends on thelevel of glucose control. Good glycemic control can bring back the urine albumin level to normal values.

Epidemiological and other data have shown that microalbuminuria results in raised all cause cardiac mortality, cardiac abnormalities, cerebrovascular diseases, and peripheral vascular disease.

Adverse clinical outcomes in cardiovascular disease have been observed even at values lesser than that for microalbuminuria. (18, 19) the correlationbetween the mortality and microvascular disease is in studies involvinghigh risk patients. In the Heart Outcomes Prevention Evaluation (HOPE) study presence of microalbuminuria increased the cardiovascular risk . The mortality due to all cause in patients with micoalbuminuria was 18.2% and in those without normal albuminuria was 9.4%. A linear relationship was seen among themicroalbuminuria patients for cardiovascular events, with values well below the routine urine microalbumin levels.

In another prospective study with individuals between 50 to 75 yrs, presence ofmicroalbuminuria increased the risk for CV deaths.(20)The

mortality for all cause was more inpatients with microalbuminuria, especially in patients with coexisting hypertension.

The mortality due to all cause can be predicted in the general population in presence of microalbuminuria.(22) This information is seen in the Prevention of Renal and Vascular Endstage Disease (PREVEND) Study.(21)In that study , people of Groningen, Netherlands, aged between28 to 75 yrs had a questionnaire and a bottle to collect an early-morning urine sample for Urine Albumin Excretion measurement.40,548 peoplewere followed for 2.6 yrs. A positive relationship was seen between Urine Albumin Excretion and all-cause, CV, andnoncardiovasculardeath. Thisrelationship was seen at levels of albuminuria that was consideredto be normal.

Prospective and epidemiological studies have shown that microalbuminuria is an independent and seperate among the routine risk factors of all cause and cardiac and vascular mortality and cerebrovascular events in people with diabetes mellitus or hypertension in the general population. National Health and Nutrition Examination survey states that 8.8% US adults have microalbuminuria. Elderly, femalesexand non Hispanics were seen to be associated with increased incidence of Microalbuminuria in presence of diabetes mellitus and hypertension. This prevalence increases with increased duration of the disease.

Microalbuminuria is associated with a number of cardiac disorders and diseases like left ventricle hypertrophy, coronary diseases etc. (24) The Strong Heart Study had shown a significant relationship between microalbuminuria and left ventricle diastolic and systolic dysfunction.(25) The Losartan Intervention for Endpoint reduction in Hypertension Study LIFE confirmed that there is an association between the microalbuminuria and echo evidence of increased Left ventricle mass and hypertrophy among untreated hypertension patients.(26) Another study have shown that there is increased evidence for ischemic heart disease as seen in stress echo, stress ECG in the people withmicroalbuminuria when compared to normal albuminuria.(27) The PREVEND study showed an independent relationship between microalbuminuria and infarct patterns, major and minor ischemia.(28) Further it also identified that the group which had microalbuminuria had a higher cardiovascular mortality than the other groups.In another study which was an population based study conducted by Borch Johnson et all showed that 2.3 fold increased relative risk of ischemic heart disease among people with microalbuminuria even without renal disease or diabetes. This study also showed that the survival free from ischemic heart disease is 97% among normal albumin excreting individuals compared to microalbuminuric individuals who had a survival free period from IHD being 91%. The coronary artery risk associated with other risk factors almost doubled when associated with microalbuminuria.(29)

An angiographic study conducted by Tuttle et all showed a positive correlation between increased urinary albumin excretion angiographic evidence of coronary heart disease. (23)It also showed that these people with excess urinary albumin excretion had more severe coronary artery disease as evidenced as seen by coronary angiography.

The pathophysiology underlying the link between microalbuminuria and coronary artery disease and other cardiovascular diseases are not clear. Microalbuminuria can be a cause of vascular disease or complication of a vascular disease. According to the STENO hypothesiskidneys are the window of vascular system.(31) Hence urinaryalbumin leakage is an expression of vascular damage. So endothelialdysfunction and chronic inflammation are considered as probable underlying causes to associate microalbuminuria with cardiovascularevents.(32)But there are inconsistencies in this theory.

Less grade inflammation may lead to endothelial dysfunction and inflammatory markers have been identified to mark the presence of chronic inflammation in atherosclerosis. Some other studies show that microalbuminuria, chronic inflammation , endothelial dysfunction are linked and they are independent risk factors for cardiovascular death.

Many cross sectional studies have shown that increase urine albumin excretion islinked with many cardiovascular risk factors like increased age, male sex, systemic hypertension, diabetes mellitus , smoking, increased body weight and dyslipidemia. Strategies that are associated with reduction of urinary albumin excretion is said to be cardioprotective as shown in the study conducted by Ibsen et all.(31)- smaller clinical trials have shown the advantage of limiting the progression of microalbuminuria to macroalbuminuria. But whether this advantage could translate to lessened cardiovascular events is not known. In the trials like Irbesartan Diabetic Nephropathy Trial IDNT and Reduction of Endpoints in NIDDM with Angiotensin II Antagonist Losartan RENAAL have shown therapeutic strategies that reduce proteinuria leads to decreased cardiovascular events but less is known whether this reduction can be extrapolated to microalbuminuric patients.

Another theory is that certain individuals have inherently variable levels of vessel function even within their physiologic range and hence can have varying degrees of microalbuminuria. This inherent vascular ability can lead to subsequent end organ damage.(32)

Intensification of blood pressure control, glucose control and better LDL cholesterol control , can normalise the albuminuria which represents a biomeasure of treatment success.

The National Kidney Foundation guidelines say that microalbuminuria screening to be done in patients with diabetes mellitus, systemic hypertension , family history of endstage kidney disease, elderly more than sixty years(34) . The American Diabetes Association says that urine albumin level screening to be done once in every five years in type I diabetes and in type 2 diabetes when during diagnosis.(35A dipstick is a semiquantitative and insensitive method anddetects albumin more than 300 mg/day. Many antibody based technique are present to quantify urine albumin excretion less than 300 mgperday. They include Radioimmunoassay ,Nephelometry, immunotebidometry and Enzyme linked immunosorbent assay. A more modern HPLC method has been devised to detect microalbuminuria (33). sensitive methods to identify albumin excretion at an earlier stage are required to prevent the increased cardiovascular risk.

These methods vary in their sensitivity and measurement times as Follows.(36 – 38)

Method		Time for assay
Single radial immunodiffusion	Mancini et al	1 day

Electroimmuno assay	Laurel 1966	4-6 hours
Immunoturbidometric assay	Teppo 1982	20-30 minutes
RIA	Keen 1963	1-2 days
ELISA	Fielding 1983	5-6 hours
Zone immunoelectrophoresis	Vesterberg	16- 18 hours
Fluorescent immunoassay	Charves 1984	4-6 hours
immunonephalometry	Vasquez 1984	6 hours

The albumin creatinine ratio using a overnight sample or first morning void sample may be used as a screening procedure for detectingmicroalbuminuric patients. But correction to creatine production among the gender should be used.+- Classification of Urine Albumin Excretion (16)

	24 hr albumin mg / day	Overnight Urine Albumin (mcg/ 24 h)	Spot urine Albumin (mg/L)	Spot urine Albumin/Creatinine Ratio mg/g
Normal	< 15	< 10	< 10	Male < 10 Female < 15
High normal	15 - < 30	10 - 20	10 -20	Male 10 – 20 Female 15 - 30
Microalbuminuria	30 – 300	20 - 200	20 - 200	Male 20 – 200 Female 30 – 300

Macroalbuminuria	>300	> 200	> 200	Male > 200 Female > 300

Coronary artery angiography is an investigation for the study of cardiac arteryanatomy. It was usually assessed as a one , two or three vessel diseaseaccording to thethe number of vessels involved and on the amount of stenosis the lesion is producing as 50%, 70% 90% 99% stenosis which was categorised by Oberman et al in 1972(39). This type of categorisation gives an idea of the anatomical stenosis and its hemodynamic significance. But various scoring systems were used in different studies to quantify the lesions in the coronary artery. The various scoring systems utilised for coronary artery anatomy are as follows :

Parker et al in 1966 categorised the coronary angiographic severity and correlated with prior Myocardial infarction , prior symptoms and resting ECG changes.(40)

Oberman et al in 1972 established the correlation of coronary severity to subsequent mortality.

Gould et al made animal studies to correlate the percentage of coronary stenosis to the amount of coronary blood flow reduction.(43)

Gensini Score

The Gensini score was devised by Gensini(44). It takes into consideration the severity of lesions, multiple obstructions, and The amount of myocardium under risk.A score is given to every lesion based on the amount of lumen diameter. A multiplier is given to each lesion depending on lesion location in the coronary tree that in turn depends on the significance of the area supplied by that segment. It also considers the collateral factor and vesselsuitability for revascularisation. The final score is the total of the lesion scores.

Kalbfleisch et al in 1977 made a landmark pathologic study to determine the amount of myocardium supplied by each coronary vessel and categorised the heart into their vascular type , left coronary type, right coronary type , normal types .(45)

Coronary Artery Surgery Study Score

The Coronary Artery Surgery Study (CASS) score was done by Ringqvist et al.The major three coronary vessels with more than 70% stenosis is 1 point; stenosis of more than 50% in the left main coronary artery is taken as a 2-vessel disease and given 2 points. The total score is the sum of all points and is similar to one, two-, or three-vessel disease in the coronary tree.

Duke Jeopardy Score

The Duke Jeopardy Score was usedby Dash et al[47] and improved by Califf et al(50). The coronary artery anatomy is divided into six segments: the Left Anterior Descending , diagonal branches of the LAD, septal perforating branches, thecircumflex artery, obtuse marginal artery, and the posterior descending artery. Each segment with ≥70% stenosis is given 2 points. The maximum possible points is 12.

Duke Coronary Artery Disease Severity Index

The Duke Coronary Artery Disease Severity Index was used by Mark et al. The score ranges from 0 to 100 with higher weightage given to number of involved vessels and severity of LAD stenosis. The more proximal the disease higher is the weightage.

Friesinger Score

The Friesinger Score was developed by Friesinger in 1970[41]. It tries to correlate the anatomical severity to outcome .The score is between 0 to 5. High scores indicate increased severity.

Sullivan Scores

The Sullivan Scores has three scoring systems developed by Sullivan et al[49]. It tries to apply the different aspects of atherosclerotic burden. The score

is from 0 to 3 and represents the number of vessels with more than 70% stenosis; left main stenosis is considered as a one vessel disease. The Lesion score similar to Gensini score. The Extent score is the proportion of each vessel involvement by the atherosclerotic plaque, seen as luminal irregularity, and multiplied by a factor that represents the vessel's functional significance. The total score is out of 100. It represents the percentage of atherosclerotic plaque on the coronary intimal surface.

Jenkins Score

In the Jenkins score[46] the coronary artery anatomy is divided into eight segments and a score is given to each segment depending on the degree of stenosis in that segment. The points for each lesion are totalled to get the finalscore . It reflects the extent and severity of disease in the proximal coronary vessels.

Leamann et al in1981 designed a scoring system that takes into account lesion severity and amount of myoacardium at risk. It grades the lesion stenosis and the Left ventricle weightage factor depending on the amount of blood flow to that part of ventricle from that vessel.(48)

SYNTAX score (51)

The SYNTAX (SYNergy between PCI with TAXUS and Cardiac Surgery) study is a study done to assess the revascularisation strategy needed in multivessel disease. The scoring system used in this study is the SYNTAX score. It utilises scores such as ACC/AHA coronary segment classification, ACC/AHA lesion classification, Leamann sore, DUKE/ICPS bifurcation classification system, total occlusion classification system and experts opinions. It is a computer designed tool. scores are assigned based on the dominance of left or right coronary artery, number and site of the lesion, presence of total occlusion, its characteristics , bifurcation lesion its characteristics, trifurcation

lesion, its characteristics, associated aortoostial lesion, tortuosity, calcification, thrombus and diffuse disease.

SYNTAX score calculation

1. Dominance of the coronary artery
2. Number of lesions in the coronary segments
3. Number of segments involved per lesion

   Lesion characters
4. Total coronary occlusion

   Number of segments involved with coronary total occlusion

   total occlusion > 3 months

   Blunt stump of the occlusion

   Bridging collaterals near the occlusion

   First segment beyond occlusion seen due to collaterals

   Side branch involved or not

5. Trifurcation lesion – number of segments with trifurcation.

6. Bifurcation lesion as classified by Dukes and ICPS classification

   Type

   Angulation less or more than 70 degrees

7. Aortoostialdisease

8. Severe tortuosity one or more bends more than 90 degrees or three or more bends between 45 – 90 degrees.

9. Length of lesion more than 20 mm

10. Multiple persistent calcification

11. Thrombus containing lesion

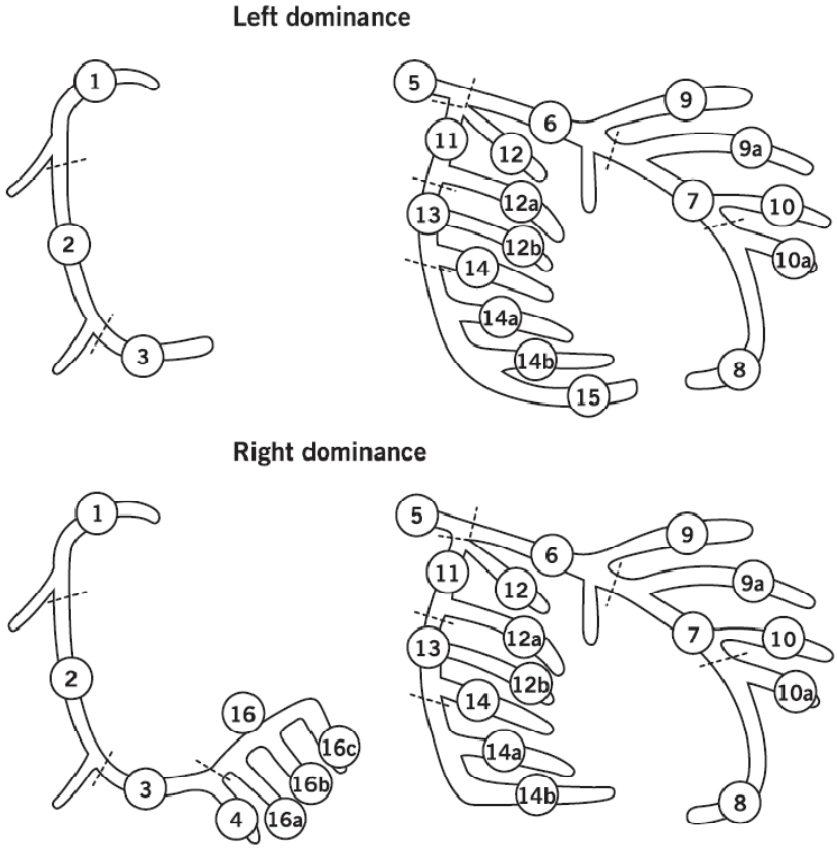
12. Diffuse disease/ small vessels

    Number of segments with small vessels.

The SYNTAX score was developed to prospectively assess the coronary vessels with respect to the number of lesions and their functional significance, site of lesion, and its complexity.

Higher the SYNTAX scores, more complex is the coronary lesion.

The coronary tree segments were defined based on the classification of the American Heart Association (48) and which was modified for the ARTS I and IITrials (52). In this classification the coronary artery is divided into 16 segments and has been used as such in the SYNTAX score.



The 'Leaman score' is based on severity of luminal narrowing and weighed according to the blood flow to the leftventricle in each vessel or vessel segment. A right dominant system means, the right coronary artery (RCA) is supplying approximately 16%and the left coronary artery (LCA) is supplying 84% of the flow to the left ventricle (LV). This 84% is contributed as 66% bythe left anterior descending artery (LAD), and as 33% by the left circumflex coronary artery (LCX). Therefore , the Left Main artery (LMCA) supplies approximately 5 times, the LAD approximately 3.5 times and the circumflex 1.5 times of blood to the left ventricle. In a left dominant system the Right

Coronary Artery does not contribute to the bloodsupply of the left ventricle. Thus the LMCA supplies 100% blood to the LV. The RCA contribution of blood to the LV is now supplied by the LCX. Therefore the LAD supplies 58% (weighing factor 3.5) and the LCX 42% (weighing factor 2.5) of the total blood flow to the LV. Using this principle of relative blood supply to the LV ,the coronary segments are given a weighing factor according to their functional significance. The contribution by the coronary segment to the amount of blood flow to the LV is used as a multiplication factor for the calculation of the Leaman score and used as such in the SYNTAX score calculation.

Score calculation.

A lesion is defined as significant if it produces>50% decrease in luminal diameter of vessels more than 1.5 mm size by visual assessment. Less severe lesions< 50% are not included in the SYNTAX score calculation.

Total occlusive disease (100% diameter stenosis) and non occlusive (50-99% diameter stenosis) disease are made out. The lesion is multiplied by 2 for non-occlusive lesions and by 5 for occlusive lesions. All otheradverse lesions in the coronary artery segments have additive value.

Segment weighing factors.

Segment No		Right dominance	Left domina
1	RCA proximal	1	0
2	RCA mid	1	0
3	RCA distal	1	0
4	Posterior descending artery	1	n.a.
16	Posterolateral branch from RCA	0.5	n.a.
16a	Posterolateral branch from RCA	0.5	n.a.
16b	Posterolateral branch from RCA	0.5	n.a.
16c	Posterolateral branch from RCA	0.5	n.a.
5	Left Main	5	6
6	LAD proximal	3.5	3.5
7	LAD mid	2.5	2.5
8	LAD apical	1	1
9	First diagonal	1	1
9a	First diagonal[a]	1	1
10	Second diagonal	0.5	0.5
10a	Second diagonal[a]	0.5	0.5
11	Proximal circumflex artery	1.5	2.5
12	Intermediate/ anterolateral artery	1	1
12a	Obtuse marginal[a]	1	1
12b	Obtuse marginal[b]	1	1
13	Distal circumflex artery	0.5	1.5
14	Left posterolateral	0.5	1
14a	Left posterolateral[a]	0.5	1
14b	Left posterolateral[b]	0.5	1
15	Posterior descending	n.a.	1

Adverse lesions scoring system

Diameter reduction*		
- Total occlusion		x5
- Significant lesion (50-99%)		x2
Total occlusion (TO)		
- Age >3months or unknown		+1
- Blunt stump		+1
- Bridging		+1
- First segment visible beyond TO		+1/ per non-visible segment
- Side branch (SB)	- Yes, SB <1.5mm**	+1
	- Yes, both SB < & ≥ 1.5mm	+1
Trifurcations		
- 1 diseased segment		+3
- 2 diseased segments		+4
- 3 diseased segments		+5
- 4 diseased segments		+6
Bifurcations		
- Type A, B, C		+1
- Type D, E, F, G		+2
- Angulation <70°		+1
Aorto ostial stenosis		+1
Severe tortuosity		+2
Length > 20mm		+1
Heavy calcification		+2
Thrombus		+1
"Diffuse disease"/small vessels		+1/ per segment number

x: multiplication
+: addition

Lesions less than three vessel diameter reference (tandem lesion) are

taken as single lesion. But if multiple lesion separated by more than three vessel diameter reference taken as separate lesions.

Total occlusion is when no antegrade flow is visible distally or filled by bridging collaterals.

Bifurcation lesion is lesion at junction of a main vessel and a side branch with a diameter more than 1.5mm.

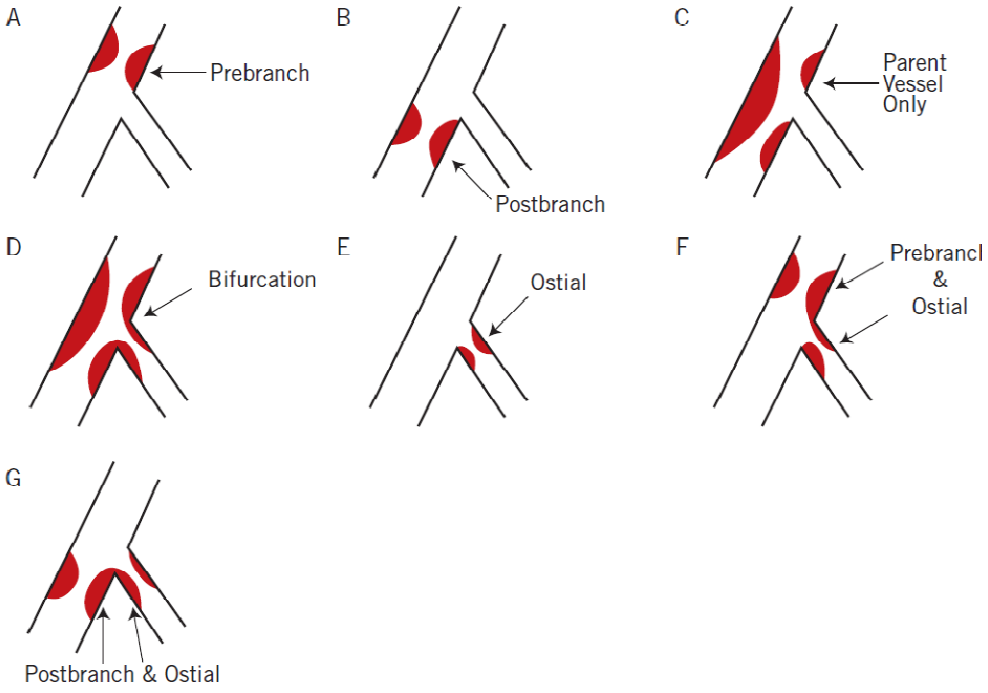
Trifurcation lesion are lesions at junction of one main vessel and two side branches more than 1.5 mm diameter.

Small vessels means when more than 75% of the segment distal to the lesion is less than 2 mm in diameter.

Thrombus ovoid irregular intraluminal filling defect or translucency surrounded on three sides by contrast present distal to or within a lesion in multiple views.

The syntax score calculator is a computer program that calculates the score based on certain sequential interactive questions.

Bifurcation lesion classification Type A,B,C,D,E,F,G.



OBJECTIVE AND AIM OF THE STUDY

To stratify the coronary angiographic characteristics in Type2

Diabetes Mellitus patients with Microalbuminuria suspected of having Ischemic Heart Disease.

MATERIALS AND METHODS

This is a cross sectional prospective study done during the period between December 2013 to febraury 2014. Consecutive diabetes mellitus type 2 patients who were suspected of ischemic heart disease but with no history of myocardial infarction who under went coronary angiography at the department of cardiology Rajiv Gandhi Government General Hospital, Chennai during this period were selected for the study.

All patients were diagnosed to have diabetes mellitus according to WHO criteria. Inclusion criteria was the same as above with consecutive diabetic patients suspected of coronary artery disease undergoing coronary angiography during the period between December 2013 – febraury 2014.

Exclusion criteria

1. Not willing for angiography.
2. h/o underlying renal disease
3. elevated serum creatinine > 2mg/dl
4. h/o active urinary tract infection
5. h/o malignancy.

6. h/o prior myocardial infarction / heart failure
7. h/o macroalbuminuria

Clinical characteristics of the patients were recorded. Patient's age, sex ,body mass index , systemic systolic and systemic diastolic blood pressure , smoking status , h/o hypertension, vital signs with routine cardiac clinical evaluation were done. Blood pressure was measured with a standard sphygmomanometer having mercury at rest. Systemic hypertension was defined as blood pressure more than 140 mmHg / 90 mmHg or have been using antihypertensive drugs.

Measurement of microalbuminuria:

Overnight or early morning urine samples were obtained for measurement of urine albumin creatinine ratio. It was done as a single spot specimen.

Diagnostic kit was used to quantify urine creatinine (Jaffe technique) and albumin was checked by Bromocresol green method. The apparatus used in the evaluation was Alcyon, 3001 and autoanalyser system.

Lab tests:

Blood was collected 12 hours after fasting. It was sent for measurement of Blood Sugar, Lipid levels includes Total Cholesterol, Serum Triglycerides, Serum LDL, HDL and serum Creatinine.

Coronary angiography

Coronary angiography was done by a cardiologist with the Thoshiba system. Modified Seldingers technique was used when right femoral artery was used as the route and Seldingers technique was used for the radial artery route. Various catheters were used depending on the aortic size, route of procedure . Local anesthesia with 2% xylocaine was used for the procedure. Pressure of the aorta was noted during the catheterisation.

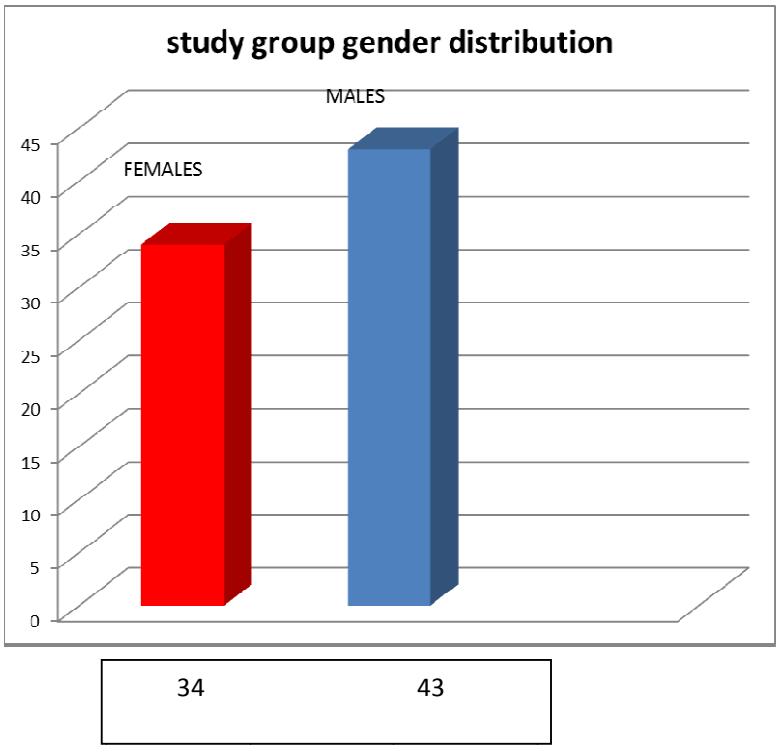
Various views were taken to get a good analysis of the lesions in the coronary arteries. Selective left and right coronary angiograms were done. Heparin 2500 units for femoral route and 5000 units for the radial route was used. All the images were recorded and analysis was made. Syntax score analysis was made using the online syntax score calculator.

Statistical analysis was made with Microsoft Excel 2010 by using QI Macros software. Data were analysed in terms of average, standard deviation

for quantitative variables. Comparison of groups was done with Chi square test . Value less than 0.05 was taken as statistically significant for the P value.

OBSERVATION AND RESULTS

In this study 77 patients with type2 diabetes mellitus suspected of ischemic heart disease underwent coronary angiography during the period between December 2013 and Febraury 2014 at the Department of Cardiology, Rajiv Gandhi Government General Hospital , Chennai. Of them 34 (44%) were females and 43 (56%) were males.

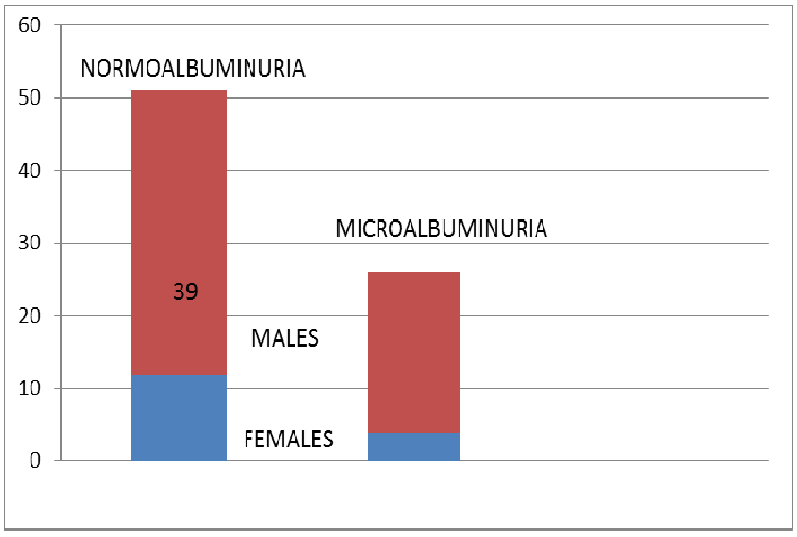


Among the 77 patients 16 (21%) patients had microalbuminuria and 61 (79%) patients had normoalbuminuria.

Among the 16 patients who had microalbuminuria 12 were men and 4 were women. A significant significance was noted betweenthe two groups regarding prevalence of microalbuminuria.

Odds Ratio M/F 5.3; 95% confidence interval 1.53-18.5 ; Pvalue < 0.005.

Among the 61 patients who had normoalbuminuria 39 were male and 22 were females .



The age among the normoalbuminuria group ranged between 44 years and 72 years and the average age 59.4 years.

Standard deviation 6.81; P value more than 0.05 which was not statistically significant.

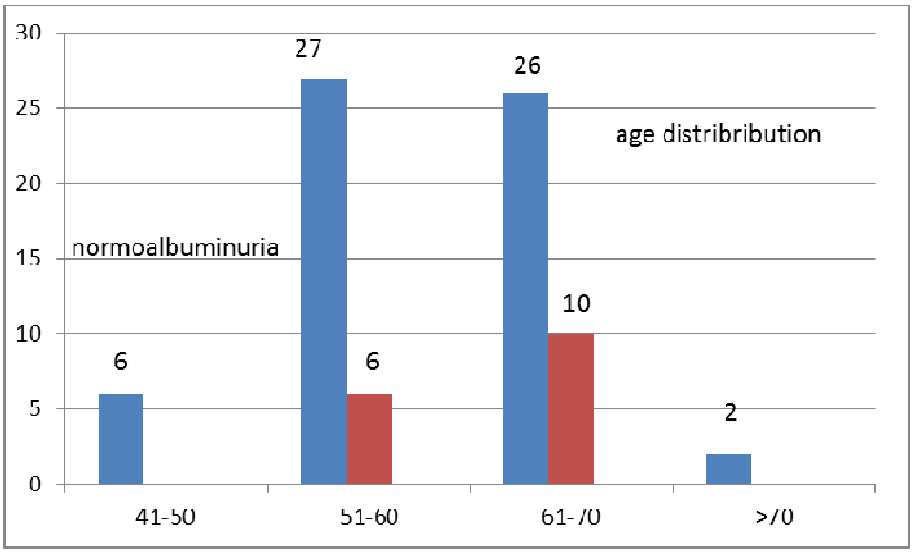
The age among the microalbuminuriaranged between 51 years and 72 years and the average age 60.4 years . standard deviation 2.42; Pvalue more than 0.5 was not statisticallysignificant.

But comparing the two groups showed a statistical significance with a P value <0.04 and a standard deviation of 0.707.

The age distribution among the study population is as follows:

Age	Normoalbuminuria N = 61	%	Microalbuminuria N= 16	%
41-50 yrs	6	7%	0	
51-60 yrs	27	35%	6	7%
61- 70 yrs	26	33%	10	13%
>70yrs	2	2%	0	

Histogram showing age distribution of the study group.



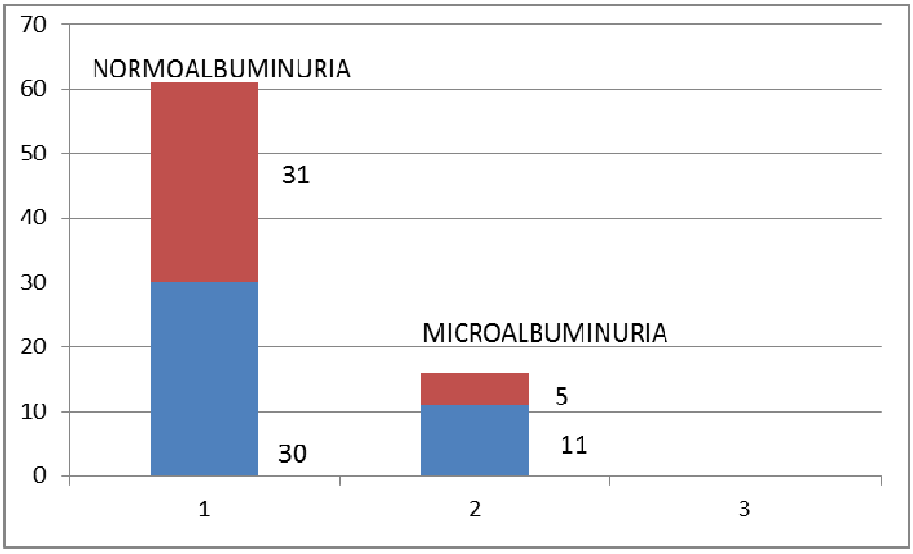
Normalbuminuria

Microalbuminuria

Among the normoalbuminuria group 30 of the 61 patients had systemic hypertension and were under treatment with antihypertensive drugs. 11 of the 16 patients in the microalbuminuria group had hypertension.

The average SBP is 136.5 mmHg and it ranged between 110 – 176 mmHg ; the diastolic Blood Pressure ranged between70- 106 mmHg and the average DBP was 85.24 mmHg.

Chart showing the distribution of hypertension and non hypertension among the study group.



The duration of diabetes mellitus varied between 4 years to12 years.

All patients were on oral hypoglycemicdrugs . 27 of the 61 patients (44%) of the normoalbuminuria group did not have adequate control of blood sugar at the time of the study. 8 of the 16 (50%) of the microalbuminuria patients did not have adequate glycemic control at the time of the study. The mean fasting blood sugar in the normoalbuminuric group was 105.3 mg/dl and in the microalbuminuric group was 106.5 mg/dl.

The HDL Cholesterol in the normoalbunuric group varied between 32-44 mg/dl and the mean value 38.22 mg/dl. In the microalbuminuric group it ranged between 30 – 40 mg/dl and the mean value 36.12 mg/dl. Comparing the

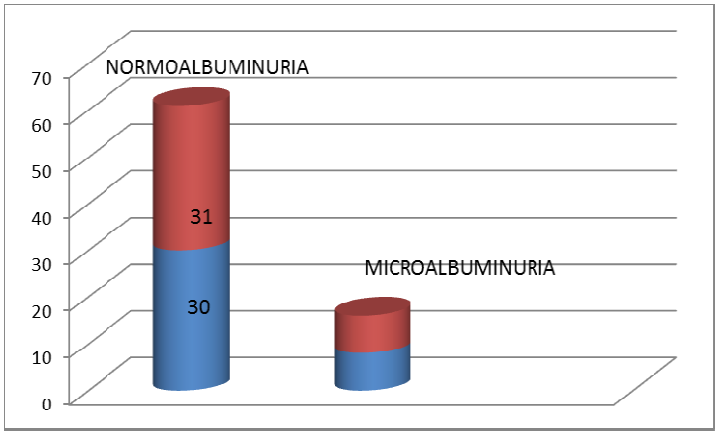
two values using the paired T test for means showed statistical significance with a P value of 0.025 (< 0.05).

The LDL Cholesterol in the normoalbuminuric group ranged between 122 – 172 mg/dl and the mean value 148.93 mg/dl ; among the microalbuminuric group it was between 144 – 174 mg/dl and the mean value 157.75 mg/dl. Comparing the two average didnot show any statistical significance P value more than 0.5.

The triglycerides in the normoalbuminuric group ranged between 142 - 210 mg/dl and the mean value 161.39 mg/dl ; in the microalbuminuric group it ranged between 146 – 210mg/dl and the average value 165.62 mg/dl. Comparing the two values did notshow any statistical significance P value was 0.5.

There were no smokers among the female group in the study population. But among men in the normoalbuminuria group 30 out of 61 patients (49%) were smokers either currently smoking or had been reformed smokers. Among the microalbuminuriagroup 8 out of the 16 patients were smokers.

SMOKERS IN STUDY GROUP.



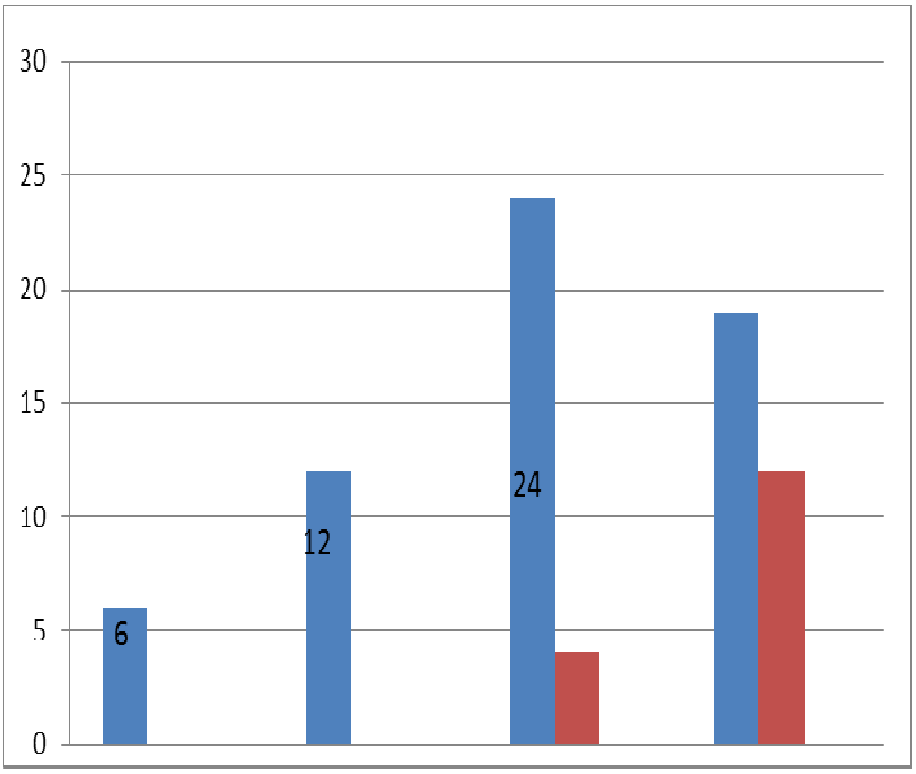
Coronary angiographic profile was analysed between the normoalbuminuric and microalbuminuric group.

The normoalbuminuric group had 6 patients with normal coronary angiography and no patient had normal coronary angiography in the microalbuminuric group.

The normoalbuminuric group had 12 patients with one vessel disease and no patient had one vessel disease in the microalbuminuric group. Two vessel disease was seen in 24 of the normoalbuminuria group and 4 of the microalbuminuria group. Three vessel disease was seen in 19 of the normoalbuminuria group and 12 of the microalbuminuria group.

8 patients of the normoalbuminuria group and 6 patients of the microalbuminuria group had diffuse disease with thin vessels not suitable for CABG.

Chi square 5.066 ; p value 0.05 ; the difference between the two group is statistically significant



SYNTAX score was applied to the coronary angiographic profile of the study group and were classified according to the severity.

Score< 22 less severe

22 – 32 intermediate

>32 severe .

Score	Severity
<22	Less

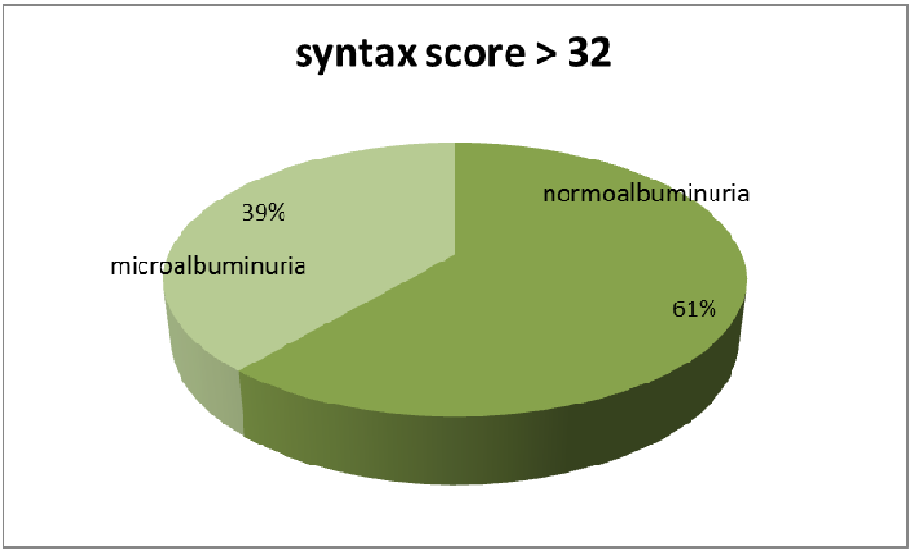
22 – 32	Intermediate
>32	Severe

In the normoalbuminuria group 10 patients had Syntax score less than 22 and no patient in the microalbuminuria group had this score.

26 patients of the normoalbuminuria group and 4 patients of the microalbuminuria group had a syntax score of intermediate severity between 22 – 32.

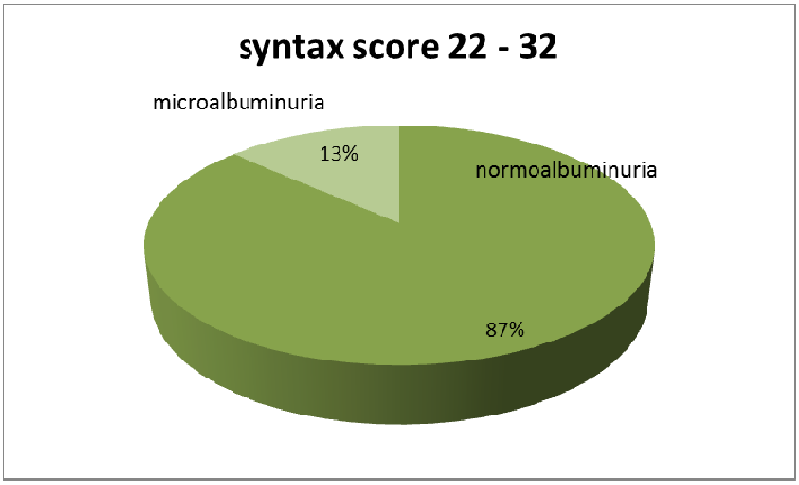
Among the normoalbuminuria, 19 patients and in the microalbuminuria , 12 patients had syntax score > 32 signifying severe lesion.

Syntax score	Normoalbuminuria N=61	Microalbuminuria N =16
< 22	10 (16%)	0
22- 32	26 (42%)	4 (25%)
>32	19 (31%)	12 (75%)



Comparing the two groups with intermediate to severe lesion shows a statistically significance in their values.

Syntax score	Chi square	P value
22 - 32	3.38	0.05
>32	10.13	0.001



Comparing the smokers with the severity of coronary lesion, the following were theobservation. There were no smokers in the female group. Among the males 30 patients were either current smokers or reformed smokers.

Among the 30 smokers, 23 patients had a syntax score of more than 22(ie) intermediate to severe lesion. Chi square 0.194 ; P value 0.65 ; not significant.

Among the 30 smokers 16 patients had a syntax score of more than 32 , signifying a more severe coronary lesion.

Chi square 5.96 ; P value 0.01 ; statistically significant.

Among the microalbuminuria patients 7 patients were smokers and 9 patients were non smokers.

Among them the 7 smokers and 5 of the non smokers had a syntax score of more than 32.

Remaining 5 nonsmokers had a syntax score of less than 32.

This comparison was statistically significant with a chisquare 4.14 and a P value of 0.04.

It shows that among the microalbuminuric patients the smokers had severe and complex coronary lesions.

smokers and CAD in the study group.

Syntax score	Normoalbumin	microalbumin
22 - 32	7	0
>32	16	7

In this study , in the microalbuminuria group 5 patients had thin vessels with diffuse disease with vessels not suitable for CABG and 4 patients with normoalbuminuria had thin vessels . this difference was statistically significant.

Chi square 5.16 ; P value 0.02.

DISCUSSION

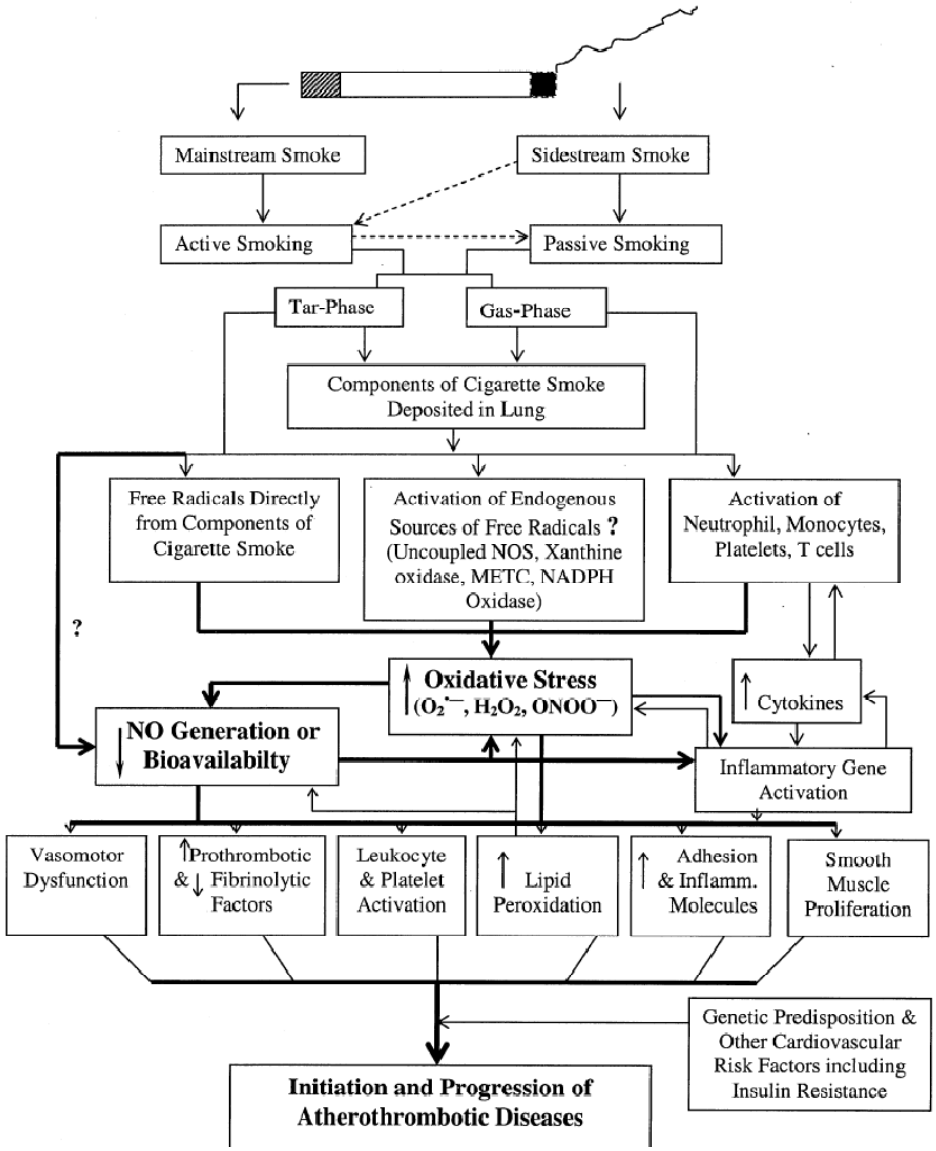
In this study the microalbuminuria was higher in men than in women which was significant. This finding correlated with the other studiesdone by Guo et al.(54) and Luo et al.(55) and Amir farhang et al.(53).

In this study increased aging was associated with microalbuminuria and severe coronary disease as calculated by syntax score. This was in consistency with the other studies done by El Sherif et al. (56) and Guo et al and Amir farhang et al where elderly people were associated with severe coronary artery disease.

In this study there was a significant correlation between severity of coronary artery disease and smoking . This was incorrelation with previous studies of Gou et al and Luo et al. Nakaishi Ret al but differed with Amir farhang et al.

Smoking leads to platelet dysfunction , alteration of antithrombotic and prothrombotic factors , alteration in the tissue factor and tissue factor pathway inhibitor – 1 leading to increased thrombogenic potential. Further there is decreased release of tPA which leads to reduced natural fibrinolysis. The oxidativestress due to free radicals is an important step in development of atherosclerosis. (59) The interreaction between free radicals like superoxide and the nitrous oxide , decreases nitrous oxide but also produces peroxy nitrite that

further rises the oxidative stress in the cells. Elevated oxidative stressand decrease of nitrous oxide leads to proatherogenicity and prothrombotic state.



Potential pathways and mechanisms of smoking related cardiovascular diseases. The bold boxes signify the main mechanisms.

The severity of coronary disease and microalbuminuriadid not find any relationship to HDL Cholesterol levels, LDL Cholesterol levels, systemic Systolic Blood Pressure and Diastolic Blood Pressure and Body Mass Index . This observation in this study differed with the previous studies of Guo et al and Luo et al but correlated with that of Amir farhang et al. This difference could be due to the smaller sample size, ethnicity, drugs ,and geographical factors.

In this study there was a statistical significant correlation betweenmicroalbuminuria and the severity of coronary artery disease. 12 patients of the microalbuminuria group had a syntax score of more than 32 signifying severe coronary artery disease which had a statistically significance. This was in correlation with otherstudies of Devici et al(58) , Sukhija et al (57), Sherif et al(56), Guo et al, Amir farhang et al.

The pathological changes that occur in microalbuminuria and in premature atherosclerosis is almost the same. Decreased heparin sulphate in the endothelial cells of the vasculature leads to reduced Lipoprotein Lipase which in turn causes decreased clearance of VLDL and leads to dyslipidemia. Dysfunction of endothelial and less grade inflammation are more common in people with microalbuminuria.(60)

This study also shows a significant correlation of microalbuminuria with intermediate severity of coronary artery disease. There is a statistically

significant finding that coronary lesions with intermediate severity with syntax score between 22 – 32 were associated with the microalbuminuria group.

This study also shows that patients with microalbuminuria had a statistically significant result in having thin vessels with diffuse disease; vessels being not suitable for CABG.

CONCLUSION

The following conclusions are made from this study.

1. IN Type 2 Diabetes mellitus presence of micoalbuminuria predicts a severe form of coronary disease with complex and severe coronary lesions.

2. Elderly with Type2 Diabetes Mellitus with microalbuminuria have severe form of coronary disease.

3. There were increased males having microalbuminuria than females.

4. The smokers with diabetes had an increased severity of coronary Artery disease and especially in the patients with microalbuminuria.

5. People with microalbuminuria had significant diffuse disease with thin vessels unsuitable for revascularisation.

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PATIENT CONSENT FORM

Study Details **:STRATIFICATION OF CORONARY ARTERY MORPHOLOGY IN DIABETIC CAD PATIENTS WITH MICROALBUMINURIA**

Study Centre **:** **Department of Cardiology**
Madras Medical College and
Rajiv Gandhi Government General Hospital,
Chennai - 600 003.

Patient may check (✓) these boxes:

I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction. ☐

I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected. ☐

I understand that the investigator of the clinical study, others working on his behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study. ☐

I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well being or any unexpected or unusual symptoms. ☐

I hereby give permission to undergo complete clinical examination . ☐

I hereby consent to participate in this study. ☐

Signature / Thumb impression: Place: Date:

Patient Name and Address:

Signature of Investigator: Place: DateStudy
(Investigator's Name:

DETAILS OF THE PROJECT PROPOSAL

Title	STRATIFICATION OF CORONARY ARTERY MORPHOLOGY IN DIABETIC CAD PATIENTS WITH MICROALBUMINURIA
Aims and Objective	To analyse the clinical characters and coronary anatomy by angiography among diabetics with and without microalbuminuria
Design of the study duration of study	Prospective observational study
Ethical clearance	Applied
Consent	An informed consent will be obtained from all the patients
Material/ selection of subjects	Diabetic patients undergoing coronary angiography between December 2013 and Febraury 2014 at the department of Cardiology, RGGGH, Chennai.
Exclusion criteria	Not willing for angiography; allergic to contrast underlying chronic kidney disease, urinary tract infection
Methods/ Analysis	Detailed history and cardiovascular examination will be done. Routine investigations and details of angiography will be Noted .
Conflicts of interest	Nil
Financial support	Nil
Participant: Primary investigator	Dr. R. Kannan, Postgraduate in Cardiology, Department of Cardiology, Madras Medical College& Rajiv Gandhi Govt. General Hospital, Chennai - 600003
Supervisor & Guide	Prof. Dr. M.S.Ravi M.D; D.M Professor of Cardiology, Department of Cardiology, Madras Medical College& Rajiv Gandhi Govt. General Hospital, Chennai - 600003.\
	Prof. G.Ravishanker M.D; DM

Co Guides	Associate Professor of Cardiology Department of Cardiology Madras Medical College& Rajiv Gandhi Govt. General Hospital, Chennai - 600003. Dr.S.Venkatesan M.D; D.M Senior Assisstant Professor Department of Cardiology Madras Medical College& Rajiv Gandhi Govt. General Hospital, Chennai - 600003

Information sheet

- We are conducting a study on the "**STRATIFICATION OF CORONARY ARTERY MORPHOLOGY IN DIABETIC CAD PATIENTS WITH MICROALBUMINURIA**''at the Department of Cardiology, Rajiv Gandhi Govt. General Hospital, Chennai.The purpose of this study is to analysethe Angiographic profile of coronary artery disease among diabetics and non diabetic patients undergoing angiography during the period December 2013 to Feb 2014.

- The privacy of the patients in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

- Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time. Your decision will not result in any loss of benefits to which you are otherwise entitled.

- The results of the study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment.

Signature of the investigator **Signature of the participant**

Date:

STRATIFICATION OF CORONARY ARTERYMORPHOLOGY IN

DIABETIC CAD PATIENTS WITH MICROALBUMINURIA

PROFORMA

NAME AGE/SEX

IP / OP NO. ADDRESS

DURATION OF DIABETES ; DRUGS TAKEN +- INSULIN

HYPERTENSION Y/N

CAD ANGINA / MI

HF

PVD

SMOKER

ALCOHOLIC

MENSTRUAL STATUS

FAMILY H/O CAD

VITALS

HT WT BMI WAIST/ HIP RATIO

CLINICAL FEATURES

ECHO

TMT

LIPID PROFILE

B.SUGAR B. UREA S.CREATININE

URINE SPOT ALBUMIN CREATININE RATIO

CAG SVD

DVD

TVD

TYPE OF LESION A B C

SYNTAX SCORE

LMCA DISEASE

MINIMAL CAD

NORMAL

COLLATERALS

MASTER CHART

name	age	sex	dura dm	hype r-ten	smo ker	bmi	dbp	lvsd	sbp	hd l	ldl	tgl	b sugar	micro alb. Mcg/ mg	svd	dvd
dathaiyan	62	male	10	y	y	23.4	96	normal	164	37	132	177	116	7.5		
nallakannu	64	male	9	y	y	25.4	102	normal	160	35	135	159	138	8.5		
thayalnayaki	68	female	12	n	n	26.3	90	normal	130	39	142	156	98	5	y mid LAD Tandem	
ravichandran	46	male	9	n	y	22.3	88	normal	124	40	152	180	124	7.5	y LAD cutoff	
sankaran	65	male	14	y	n	23.4	84	normal	130	33	128	210	168	6	y LCx	
sampath	58	male	12	y	y	24.3	106	normal	164	37	127	169	142	7		LAD,LCX
jayasundari	50	female	6	n	n	22.5	70	normal	132	39	137	162	120	5.5		
barani	59	male	13	n	y	20.3	90	mild	150	38	138	190	110	9	y RCA	
doss	52	male	10	n	n	19.6	80	normal	120	38	139	152	116	12		
jaya	50	female	7	n	n	23.4	88	mild	122	41	148	179	90	11.5		
kasthri	58	female	6	y	n	29.9	86	normal	132	40	148	170	110	6.5		LAD,RCA
backiam	62	female	8	y	n	24.6	80	normal	126	39	147	152	90	7.5		LADRCA
selvam	56	male	11	y	y	22.6	96	normal	146	35	154	164	96	11.5	mid LAD	
kala	59	female	5	y	n	25.5	100	normal	150	39	178	180	96	14.5		LADLCX
kamala	67	female	4	y	n	23.5	80	mild	120	38	122	192	120	11		LADLCX
kalyani	60	female	10	n	n	25.4	80	mild	120	40	138	158	124	13		
gayathri	65	female	11	n	n	23.5	80	normal	130	39	152	158	98	8.5	mid LAD	
vasu	59	male	9	y	y	23	90	normal	130	37	160	172	172	9		LADRCA
banumathy	63	female	16	y	n	24.6	70	normal	120	33	130	182	128	6		LADRCA
dhanam	61	female	10	y	n	25.5	60	normal	120	36	138	158	114	10	DISTAL LAD	
murugesan	69	male	9	y	y	24.6	96	normal	146	42	158	158	118	14.5		LADRCA
raja	53	male	11	n	y	25.5	100	normal	150	41	138	174	124	11.5	mid LAD	
nalan	49	male	9	y	y	23.6	106	normal	164	38	138	182	120	8.5		
kannan	52	male	10	n	y	24.4	96	normal	130	39	142	192	182	6.5		LADLCX
dharani	58	female	6	y	n	23.4	80	mlid	120	42	152	178	100	7	y RCA	
kannan k	46	male	12	y	y	24.4	70	mild	120	32	142	181	98	7	y RCA	
kamala	52	female	8	y	n	23.4	96	normal	166	38	166	172	118	8.5		

dyaneswar	44	male	6	y	y	22.3	102	normal	156	37	172	168	124	9		LADRCA
selvam	68	male	12	y	y	24.6	100	mild	176	42	144	174	144	12		RCALCX
mani	52	male	4	n	n	22.2	86	normal	130	36	142	158	86	13.5	y LCX	
koteeswaran	62	male			y	23.4	94	normal	146	38	148	156	98	6.5		LADLCX
nagammal	58	female			n	22.2	80	normal	120	42	138	140	86	7.5		
lashmi	56	female			n	25.5	84	normal	124	38	148	156	112	7.5		
sarala	65	female		y	n	27.5	80	normal	120	36	160	158	100	8.5		LADLCX
deviammal	69	female			n	24.5	70	normal	110	42	154	140	86	11.5		
rajendiran	72	male		y	n	23.5	70	normal	114	34	166	158	88	12		LADRCA
mohana	61	female			n	26	80	normal	110	42	146	166	110	11.5		LADRCA
ravichandran	64	male			n	25.5	74	normal	120	34	166	148	88	10.5		
raji	58	female		y	n	23.6	68	normal	100	38	148	134	86	6.5		LADRCA
renuka	57	female			n	22.3	80	normal	116	36	168	144	78	8		
raja	65	male			y	25.5	94	normal	148	38	156	140	88	9.5		
rajeswari	52	female			n	27.6	80	normal	120	38	158	154	100	9		
lakshmi	60	male			y	24.6	102	normal	172	32	168	180	100	6.5		
moovendan	65	male			y	25.9	100	normal	160	38	166	158	88	7.5		LADLCX
devi	51	female			n	27	80	normal	130	42	148	158	86	8		
rajam	53	female			n	24.4	88	normal	120	42	138	148	80	8		LADRCA
mary	66	female		y	n	23	80	mild	132	40	146	150	84	9.5		
kannan	68	male			n	25.5	84	normal	126	44	138	146	110	8		
rangan	67	male			y	20.4	96	normal	146	36	166	158	102	7		LADRCA
karthikeyan	61	male		y	y	22.3	86	normal	120	38	154	144	78	6.5		LADRCA
fathima	59	female		y	n	24.5	80	normal	120	40	166	146	80	9.5		
raja	64	male			y	20.5	100	normal	146	34	158	158	88	10.5		LADLCX
sheela	55	female		y	n	24.5	86	normal	120	38	166	154	80	11		
peter	66	male		y	y	22	88	normal	120	36	166	154	74	12.5		
ranganayagi	52	female			n	20.8	80	normal	130	38	144	142	100	9.5		
muhammed	63	male		y	n	29.5	76	normal	120	36	166	158	84	9.5		
hameed	69	male		y	n	24	80	normal	120	38	148	152	124	7.5		
manickam	72	male			n	23.5	70	normal	110	42	138	144	80	8		LADLCX
kaliammal	55	female			n	24.3	74	normal	110	40	140	142	98	8.5		
maryammal	52	female			n	22.4	78	normal	118	40	138	152	94	11	mid LAD	

meenakshi	59	female			n	25	70	normal	120	42	136	150	90	11		LADRCA
								MAU								
nellaiyappan	62	male		y	y	24.6	104	mild	166	34	172	180	124	22.5		LADRCA
dathaiyan	61	male		y	y	25.3	108	normal	170	32	166	162	118	21.5		LADLCX
nallakannu	61	male		y	y	26.4	96	normal	150	30	174	182	114	23.5		
babu	62	male			n	22.4	86	normal	120	36	146	152	142	22		LADRCA
sabari	60	male		y	n	21.5	80	mild	130	40	152	142	90	25.5		
ravichandran	61	male			y	24.3	104	mild	160	38	156	158	86	21.5		LADLCX
muniswari	57	female			n	26.5	76	normal	110	38	144	152	80	23.5		LADLCX
rangan	55	male			y	22.4	98	normal	148	36	152	184	98	27		LADRCA
sivabalan	59	male		y	y	21.6	100	mild	150	36	164	174	100	22.5		
ravi	62	male		y	n	25.5	104	normal	160	34	172	158	86	21.5		LADRCA
muniappan	61	male		y	y	22.6	80	normal	120	34	164	210	154	24		LADRCA
vedappan	65	male		y	n	24.6	76	mild	110	38	146	152	124	23		LADRCA
safana	62	female		y	n	25.7	70	normal	110	40	146	152	78	21.5		
virudeeswari	63	female		y	n	24.8	80	normal	120	38	158	182	114	25.5		LADLCX
vellammal	60	female		y	n	25.4	90	normal	140	36	158	164	110	23		LADRCA
vetrivelan	58	male			n	23.5	84	normal	120	38	154	146	86	22.5		LADRCA

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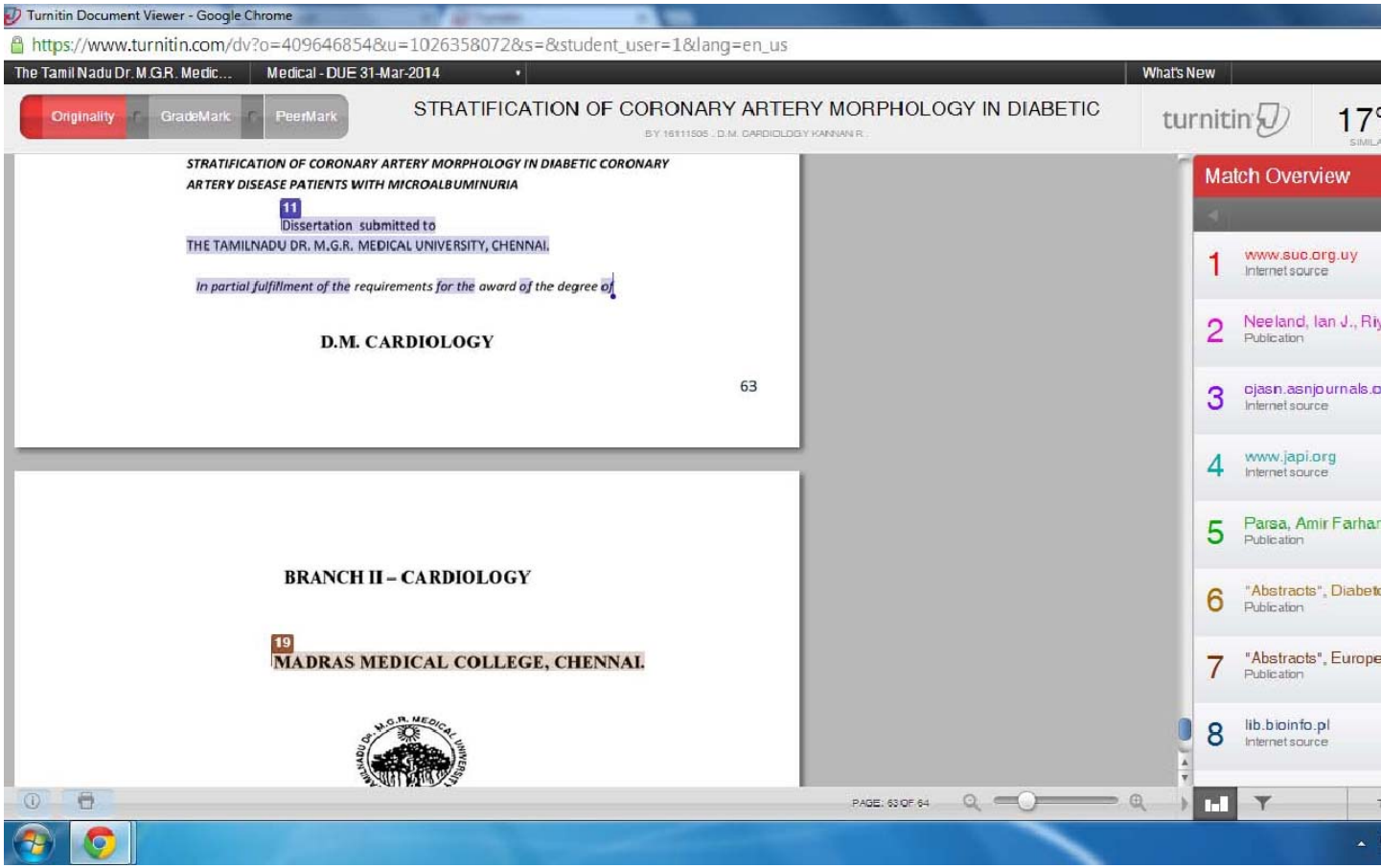
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