INTRODUCTION

This study aims to correlate the relationship between metabolic syndrome and ischemic stroke based on its severity and morbidity after a period of 60 days.

Metabolic syndrome is in itself an independent risk factor for the development of stroke, coronary artery disease, peripheral vascular diseases, carotid plaques and so on. There are studies that correlate risk of development of ischemic stroke and metabolic syndrome and recently a study showed that there was no significant correlation between metabolic syndrome and ischemic stroke.

Stroke as we all know is one of the leading causes of morbidity and mortality that our country is suffering from now, recent data suggests that the overall reported cases of stroke in our country exceed 1 lakh per year. Hence it is very important that we understand the risk factors that are associated with stroke. The known risk factors of stroke are age, gender, diabetes mellitus, hypertension, elevated BMI. Hence there are modifiable and un-modifiable risk factors for stroke. Hence lifestyle changes are of core importance in management of stroke. A study done by Safarzadegan showed there was no significant correlation between lifestyle modification and metabolic syndrome.

Hence this study not only aims to correlate the severity of stroke in patients with metabolic syndrome, but also the morbidity it ensues after a period of 60 days by the scaling system that are available to us.

REVIEW OF LITERATURE

As stroke is one of the most leading causes of mortality and morbidity in our country ,there is a need to assess the risk factors, management and efficacy of treatment not only at the scale of the patient but also with respect to the clinical trials that we can do. Hence in this respect it is of great importance that for patients who are recovering from stroke there are more important end points rather than death and the recurrence of stroke. And since stroke is a long term morbid condition we have to take into account the functional well-being of the patients as well. And it is for this purpose that the NATIONAL INSTITUTE OF STROKE SCALE (NIHSS), THE MODIFIED RANKIN (mRS) and the BARTHEL INDEX was developed. As with all scales these scales also have their limitations and their strengths of which we shall discuss in great detail later. And as mentioned earlier it is not only the severity of stroke that has to be looked into but also the functional impairment that the patient suffer from for example a patient who has a lower score in a NIHSS score scale might have a higher score in his quality of life measures. Hence it is important that we look into both these scaling systems for stroke. In this study we would be using the NIHSS scale and the MRS scale to assess the severity of stroke at presentation and the morbidity faced by these patients after a period of 60 days and to assess if metabolic syndrome in itself is a reversible factor which can be modified.

National Institute of Health Stroke Scale

As to all scaling system NIHSS scale has its strengths and its limitations. It incorporates a 15 item scale which is part of the basic neurological examination, where it pays specific attention to those aspects that are more affected by stroke. The 15 item scale examines ones language, speech, motor function, consciousness, eye movements, cerebellar function, neglect, visual fields, neglect and so forth. The scoring system of NIHSS scale is from 0-42, with 0 being no stroke and 42 being very severe stroke. A score greater than 21 in itself is considered as severe stroke. To assess level of consciousness there is a standard approach on scaling these patients who are not able to respond to oral commands.

The history of NIHSS scale starts as far as 1980 where it was used as a consistent tool for research purposes for reporting neurological deficits in patients with acute stroke. This was used in trials of intervention in stroke as in case of thrombolysis and in case where neuroprotective agents were used. The scale was derived from previous scales that were existent in Canada and other parts of Europe. And at present it is one of the most widely used scaling system in acute stroke in clinical trials as well as in management of cases in wards.

On the basis of this a modified NIHSS scale was made with the purpose that it would be much faster to perform, and it has an 11 point scoring system. But since NIHSS in itself took only 6 minutes to complete the importance of the mNIHSS has reduced and is not in use even in trials and in management of cases in ward.

Coming to the advantages of this widely used scoring system is that

1. It is easy to perform.

2. It’s not time consuming, taking about 6 min to perform the whole test.

3. There are no instruments that are required.

4. It has been proven with various clinical studies of its efficacy.

5. It helps to assess the clinical improvement or deterioration of the patient, a change of score even by 2 is significant.

6. There are no major changes even when it’s used by trained non-medical personal.

7. It can even be used by non-neurologist.

8. Its validity even holds when used via telemedicine.

9. There are training apps even online, DVD, and mobile phones which can be used to high degree of accuracy.

10. There is clinical correlation that is obtained with NIHSS and the ones obtained by imaging in the form of CT brain or MRI brain.

11. It has great predictive ability in not only assessing acute stroke but also the hospital stays and the morbidity of patients over a period of 90 days.

12. With respect to the other scaling system like the mRS and the BI, this system has greater sensitivity and specificity even when the sample size is small.

LIMITATIONS OF NIHSS SCALE

1. It is more biased to the dominant hemisphere, with non-dominant hemisphere validity being less.
2. A lower core in NIHSS does not mean the patient has less disability as discussed before. A score of 1 in NIHSS means the patient as mild stroke, but this might be a visual field defect which hampers his quality of life to a great extent.
3. Posterior territory stroke has less validity with respect to other stroke like anterior circulatory stroke.
4. NIHSS scale gives less importance to cranial nerve examination.
5. With respect to quantifying the volume of infarct size, it is noted that for the same score the right sided non dominant stroke has greater volume

with respect to the left sided dominant stroke. Indirectly implying the fact that, there is a bias for this scale towards the dominant hemisphere.

6. The quality of life index and the NIHSS scale does not correlate in certain instances as described earlier. Hence a low score in the NIHSS scale does not mean that the functional disability is less which is amply clear from the example before.

Category	Score/Description		Date/Time Initials	Date/Time Initials	Date/Time Initials	Date/Time Initials	Date/Time Initials
1a. Level of Consciousness (Alert, drowsy, etc.)	0 = Alert 1 = Drowsy 2 = Stuporous 3 = Coma						
1b. LOC Questions (Month, age)	0 = Answers both correctly 1 = Answers one correctly 2 = Incorrect						
1c. LOC Commands (Open/close eyes, make fist/let go)	0 = Obeys both correctly 1 = Obeys one correctly 2 = Incorrect						
2. Best Gaze (Eyes open - patient follows examiner's finger or face)	0 = Normal 1 = Partial gaze palsy 2 = Forced deviation						
3. Visual Fields (Introduce visual stimulus/threat to pt's visual field quadrants)	0 = No visual loss 1 = Partial Hemianopia 2 = Complete Hemianopia 3 = Bilateral Hemianopia (Blind)						
4. Facial Paresis (Show teeth, raise eyebrows and squeeze eyes shut)	0 = Normal 1 = Minor 2 = Partial 3 = Complete						
5a. Motor Arm - Left **5b. Motor Arm - Right** (Elevate arm to 90° if patient is sitting, 45° if supine)	0 = No drift 1 = Drift 2 = Can't resist gravity 3 = No effort against gravity 4 = No movement X = Untestable (Joint fusion or limb amp)	Left					
		Right					
6a. Motor Leg - Left **6b. Motor Leg - Right** (Elevate leg 30° with patient supine)	0 = No drift 1 = Drift 2 = Can't resist gravity 3 = No effort against gravity 4 = No movement X = Untestable (Joint fusion or limb amp)	Left					
		Right					
7. Limb Ataxia (Finger-nose, heel down shin)	0 = No ataxia 1 = Present in one limb 2 = Present in two limbs						
8. Sensory (Pin prick to face, arm, trunk, and leg - compare side to side)	0 = Normal 1 = Partial loss 2 = Severe loss						
9. Best Language (Name item, describe a picture and read sentences)	0 = No aphasia 1 = Mild to moderate aphasia 2 = Severe aphasia 3 = Mute						
10. Dysarthria (Evaluate speech clarity by patient repeating listed words)	0 = Normal articulation 1 = Mild to moderate slurring of words 2 = Near to unintelligable or worse X = Intubated or other physical barrier						
11. Extinction and Inattention (Use information from prior testing to identify neglect or double simultaneous stimuli testing)	0 = No neglect 1 = Partial neglect 2 = Complete neglect						
	TOTAL SCORE						

MODIFIED RANKIN SCALE

The Rankin scale is named after the Scottish physician John Rankin, who made the scale in in view to assess the disability of the patient with specific reference to the mobility of the patient. Initially this scale was made to assess the patients who suffered from stroke to assess the global disability of these patients which was later modified to be used in clinical trials and hence the name modified Rankin scale.

The modified Rankin scale was used initially in a study in Great Britain for patients suffering from transient ischemic attack. After this the scale has gained popularity and now is widely used to assess the functional outcome of patients who suffer from stroke. There are various variations of the mRS scale but are not used in clinical purpose or for trials. As in the case of NIHSS scale the mRS scale has its strengths and its limitations some of them are as follows.

STRENGTHS OF mRS SCALE

1. It is easy to perform

2. It takes about 5 min to perform

3. It is in close correlation with other stroke scales like the NIHSS scale and the BI.

4. The volume of infarct correlates well with the imaging findings of patients with stroke.

5. It has a 6 point score which correlates well with the outcome of patients.

6. As in the case of NIHSS scale there are various mobile phone apps, DVD , online certificate courses for learning this scale.

LIMITATIONS OF THE mRS SCALE

1. Since there are only 6 point score it is less probable to change than other stroke scales.

2. The specificity of the scale is less.

3. Inter observer variability is high with respect to this scale.

4. Detailed training in scripted interviews is required to improve the reliability and the consistency of this scale.

There are various modifications for the mRS scale of noteworthy to mention is the use of proxies to assess the patients and to assess prestroke score for mRS.

1. Since these patients have various disabilities in the form of comprehension, aphasias, it is valuable that an informant who is close to the patient completes the scale. And these are proxies that are used to complete the scaling system. But the reliability of these scoring systems is less than those in which there are no proxies.

2. The use of prestroke modified Rankin score is used mainly in clinical trials as an exclusion criteria when the prestroke is greater than 2. And this has moderate reliability and validity.

MODIFIED RANKING SCORE

SCORE	DESCRIPTION
0	No symptoms at all
1	No significant disability despite symptoms; able to carry out all usual duties and activities
2	Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance
3	Moderate disability; requiring some help, but able to walk without assistance
4	Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance
5	Severe disability; bedridden, incontinent and requiring constant nursing care and attention
6	Dead

BARTHEL INDEX

The history of the Barthel index starts as early as the 1960s, and was developed for a simple index to assess the improvement in patients in rehabilitation and how independent they are in their day to day activities and to plan discharges in patients with stroke admitted in rehabilitation centres. The scale was pioneered by Mahoney and Dorothea Barthel. In the following years the scale has been accepted as a good scale even for assessing the geriatric population. The BI is the most commonly used scale to assess functional improvement in the rehabilitation setting and the second most used index in patients suffering from acute stroke to assess their functional disability after the mRS scale. The scale uses mainly activities of daily living and uses a 10 tasks, and the tasks are graded to a score of zero to hundred. This scale tests the independence of the patient suffering from stroke during the acute phase and also during the rehabilitation phase of these patients. The higher the score in the BI it indicates the patient is recovering and has greater independence to his activities of daily living. So a patient with a score of 50 is less independent when compared to a patient with a score of 80, and a score of greater than 80 is taken as one who can be discharged and sent home as he can manage his activities of daily living.

STRENGTHS OF THE BARTHEL INDEX

1. It is well validated.

2. Good prognostic tool.

3. Predicts recovery of patients.

4. Duration of rehabilitation required.

5. Co relates well with other indexes mentioned earlier.

6. Inter observer variability is good in this scale.

LIMITATIONS OF THE BARTHEL INDEX

1. The cognitive impairment's and impairments due to speech are not calculated.

2. Stroke mortality is not well represented.

3. The floor and ceiling effect of the BI, indicates that a patient with severe morbidity following discharge may be high on a scale, and a patient who has improved significantly in the ICU setting will still score low and hence the response to the clinical change in patients is low, it is due to this fact that the BI is more widely used in the rehabilitation centre than in intensive care management.

The BI is one of the earliest scales made to assess the independence of patients following which emerged much more complex indices to assess the activity of daily living, of noteworthy to mention are E-ADL, Lawton I-ADL, Nottingham Extended ADL and so forth. The strengths of these scales are the fact that the limitation of the BI is taken into account and adjusted to as in the case of the ceiling effects as described earlier.

ACTIVITY	BARTHEL SCORE			
	0	5	10	15
Feeding	Unable	Some help required e.g. needs help cutting, spreading butter etc.	Independent	
Bathing	Dependent	Can use a bath tub, shower or take a complete sponge bath unassisted		
Grooming	Needs help with personal care	Independent face/hair/ teeth/shaving (implements provided)		
Dressing	Dependent	Needs help but can do at least half unaided	Independent (including buttons, zips, laces etc.)	
Bowels	Incontinent (or need to be given enemas)	Needs help with an enema or suppository	Can use enema or suppository independently	
Bladder	Incontinent or catheterised and unable to manage alone	Occasional accidents or can not wait for the bed pan/get to the toilet in time	Can control bladder day and night	
Toilet use	Dependent	Needs some help, but can do some things alone	Independent (can get on and off, dress and wipe unassisted)	
Transfer (bed to chair and back)	Unable, no sitting balance	Major help (can sit up alone but needs to be lifted out of bed)	Minor help or supervision	Independent
Mobility (on level surfaces)	Immobile or <50 yards	Wheelchair independent, including corners; ≥50 yards	Walks with little help; ≥50 yards	Independent (but may use an aid, e.g. walking stick); ≥50 yards
Stairs	Unable	Needs help or supervision	Independent	

METABOLIC SYNDROME

As described earlier metabolic syndrome is one that can be modified based on life style modification, and in recent times is one of the most important public health hazard in view of the lifestyle that is prevalent in our modern cities the excess calorie intake the sedentary life style that is prevalent not only among the aged but also the youth of our community. And with the exploding population it is one which should be dealt with swiftly and aggressively. Metabolic syndrome is associated with major health hazards our community faces such as

1. Metabolic syndrome itself increases the risk of type 2 diabetes by 4 fold.
2. Metabolic syndrome increases the risk of coronary artery disease by 3 fold.
3. Metabolic syndrome increases the risk of heart attacks by 3 fold.
4. Metabolic syndrome increases the risk of stroke by 4 fold.

Metabolic syndrome is in itself a risk factor for atherosclerosis and its complication and hence it should be investigated for as it directly correlates with the long term mortality and morbidity for patients suffering from this.

The history of metabolic syndrome started in the early parts of the 19 century when a physician demonstrated diabetes, hypertension and gout in the same patient. It was nearly 20 years hence that it was noticed that

patients who suffer from diabetes and cardiovascular disease also had increased abdominal circumference due to adipose deposition. And 20 years following this hypertension was also added into the mix in a conference in Europe for diabetes which comprised of diabetes, hypertension, and obesity. It was not until late 1980 when a scientist by the name of Raven introduced the concept of insulin resistance and it is he who named it as SYNDROME X. Later on in the 1990's it was renamed as a insulin resistance syndrome. Following its clinical implication various diagnostic criteria's have come into being .Some of them are

1. The WHO criteria
2. The EGIR criteria
3. NCEP ATP 11
4. AACE criteria
5. IDF criteria.

Diagnostic criteria proposed for the clinical diagnosis of the MetS.

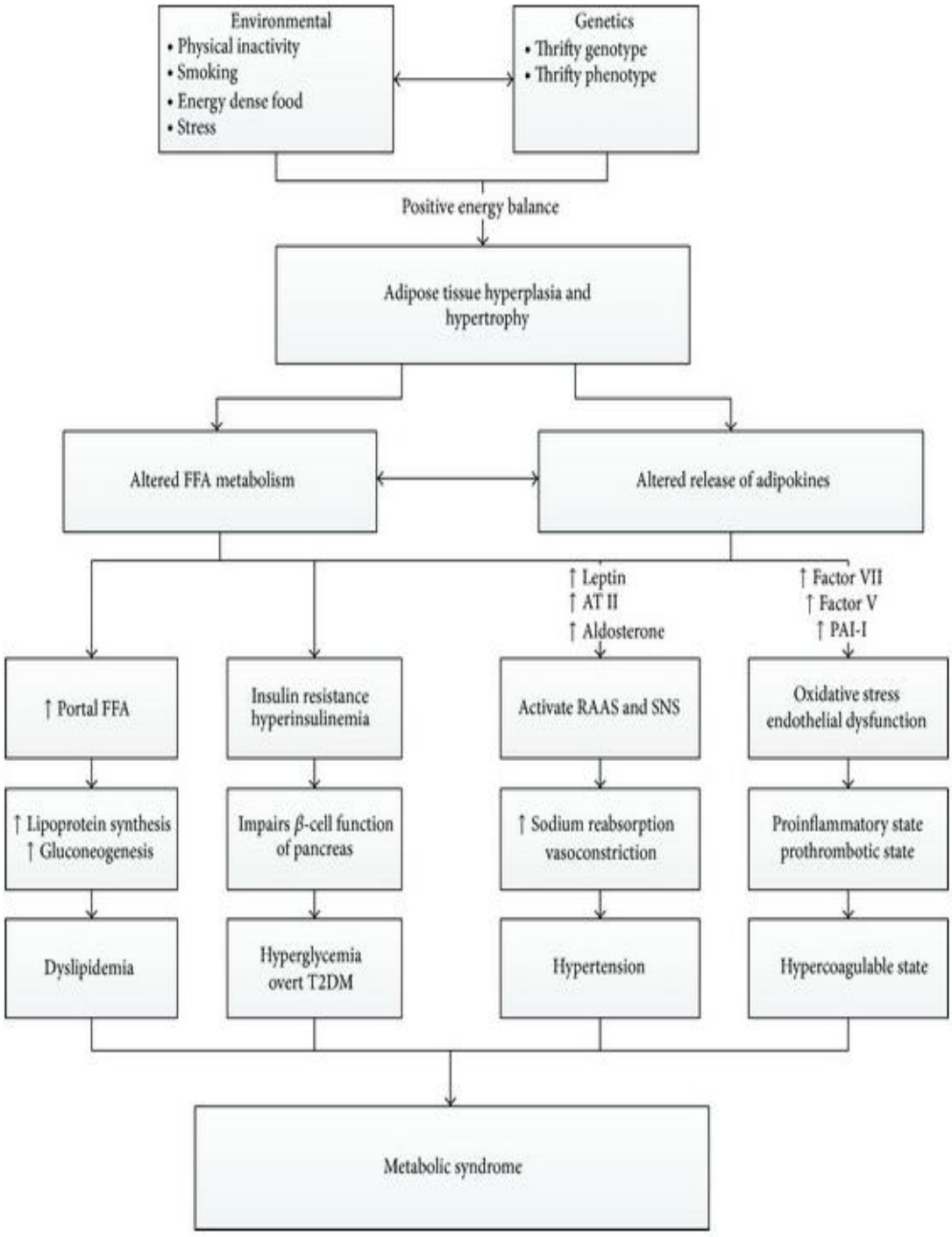
Clinical measures	WHO (1998) [5]	EGIR (1999) [6]	ATPIII (2001) [7]	AACE (2003) [8]	IDF (2005) [9]
Insulin resistance	IGT, IFG, T2DM, or lowered insulin Sensitivity[a] **plus any 2 of the following**	Plasma insulin >75th percentile **plus any 2 of the following**	**None, but any 3 of the following 5 features**	IGT or IFG **plus any of thefollowing based on the clinical judgment**	None
Body weight	Men: waist-to-hip ratio >0.90; women: waist-to-hip ratio >0.85 and/or BMI > 30 kg/m^2	WC ≥94 cm in men or ≥80 cm in women	WC ≥102 cm in men or ≥88 cm in women	BMI ≥ 25 kg/m^2	Increased WC (population specific) **plus any 2 of the following**
Lipids	TGs ≥150 mg/dL and/or HDL-C <35 mg/dL in men or <39 mg/dL in women	TGs ≥150 mg/dL and/or HDL-C <39 mg/dL in men or women	TGs ≥150 mg/dL HDL-C <40 mg/dL in men or <50 mg/dL in women	TGs ≥150 mg/dL and HDL-C <40 mg/dL in men or <50 mg/dL in women	TGs ≥150 mg/dL or on TGs Rx. HDL-C <40 mg/dL in men or <50 mg/dL in women or on HDL-C Rx
Blood pressure	≥140/90 mm Hg	≥140/90 mm Hg or on hypertension Rx	≥130/85 mm Hg	≥130/85 mm Hg	≥130 mm Hg systolic or ≥85 mm Hg diastolic or on hypertension Rx
Glucose	IGT, IFG, or T2DM	IGT or IFG (but not diabetes)	>110 mg/dL (includes diabetes)	IGT or IFG (but not diabetes)	≥100 mg/dL (includes diabetes)[b]
Other	Microalbuminuria: Urinary excretion rate of >20 mg/min or albumin: creatinine ratio of >30 mg/g.			Other features of insulin resistance[c]	

PREVALENCE OF METABOLIC SYNDROME

The prevalence of metabolic syndrome is estimated to be one in every 4 as estimated by the international diabetes federation. There are genetic and non-genetic factors that are responsible for the prevalence of metabolic syndrome. Some of the associations of metabolic syndrome are genetic, smoking, alcohol consumptions, family history, sedentary lifestyle, obesity and so forth. There are multiple studies that correlate with the development of metabolic syndrome in patients with the above associations such as Framingham's study, parks study, IDF.

PATHOLOGY OF METABOLIC SYNDROME

Metabolic syndrome pathology is multifactorial ranging from insulin resistance, genetic causes, hypertension, chronic stress, and low grade of underlying inflammation .It is the interplay with these factors that are the factors responsible for the development of metabolic syndrome. A graphical representation of the same is given below.


Environmental
• Physical inactivity
• Smoking
• Energy dense food
• Stress
Genetics
• Thrifty genotype
• Thrifty phenotype
Positive energy balance
Adipose tissue hyperplasia and hypertrophy
Altered FFA metabolism
Altered release of adipokines
↑ Leptin
↑ AT II
↑ Aldosterone
↑ Factor VII
↑ Factor V
↑ PAI-I
↑ Portal FFA
Insulin resistance hyperinsulinemia
Activate RAAS and SNS
Oxidative stress endothelial dysfunction
↑ Lipoprotein synthesis
↑ Gluconeogenesis
Impairs β-cell function of pancreas
↑ Sodium reabsorption vasoconstriction
Proinflammatory state prothrombotic state
Dyslipidemia
Hyperglycemia overt T2DM
Hypertension
Hypercoagulable state
Metabolic syndrome

The various components of Metabolic syndrome are

1. Abdominal obesity

2. Insulin resistance

3. Dyslipidemia

4. Hypertension

ABDOMINAL OBEISITY

An increase in the prevalence of abdominal girth is markedly due to the life style changes that we as a human race have come across, with more prevalence in the western world and in urban areas than the rural indirectly indicating that it may be due to sedentary life style, cheap high calorie intake of food items. It is an epidemic in its own way. The excess calorie that is present in the body gets converted to adipose tissue which is constellation of cells like the adipocytes, immune mediated cells, blood vessels, and with further nutrient excess there is both hypertrophy of each adipocytes and hyperplasia of the cells as well. It is this adipocytes that serve as a medium for production of inflammatory mediators when it comes in contact with stimulants like hypoxia .It is this low level of inflammation that is the cause of increased atherosclerosis and its varied complication. There are various waist circumference cut off depending on

the ethnicity and some of them have been listed

Table 2

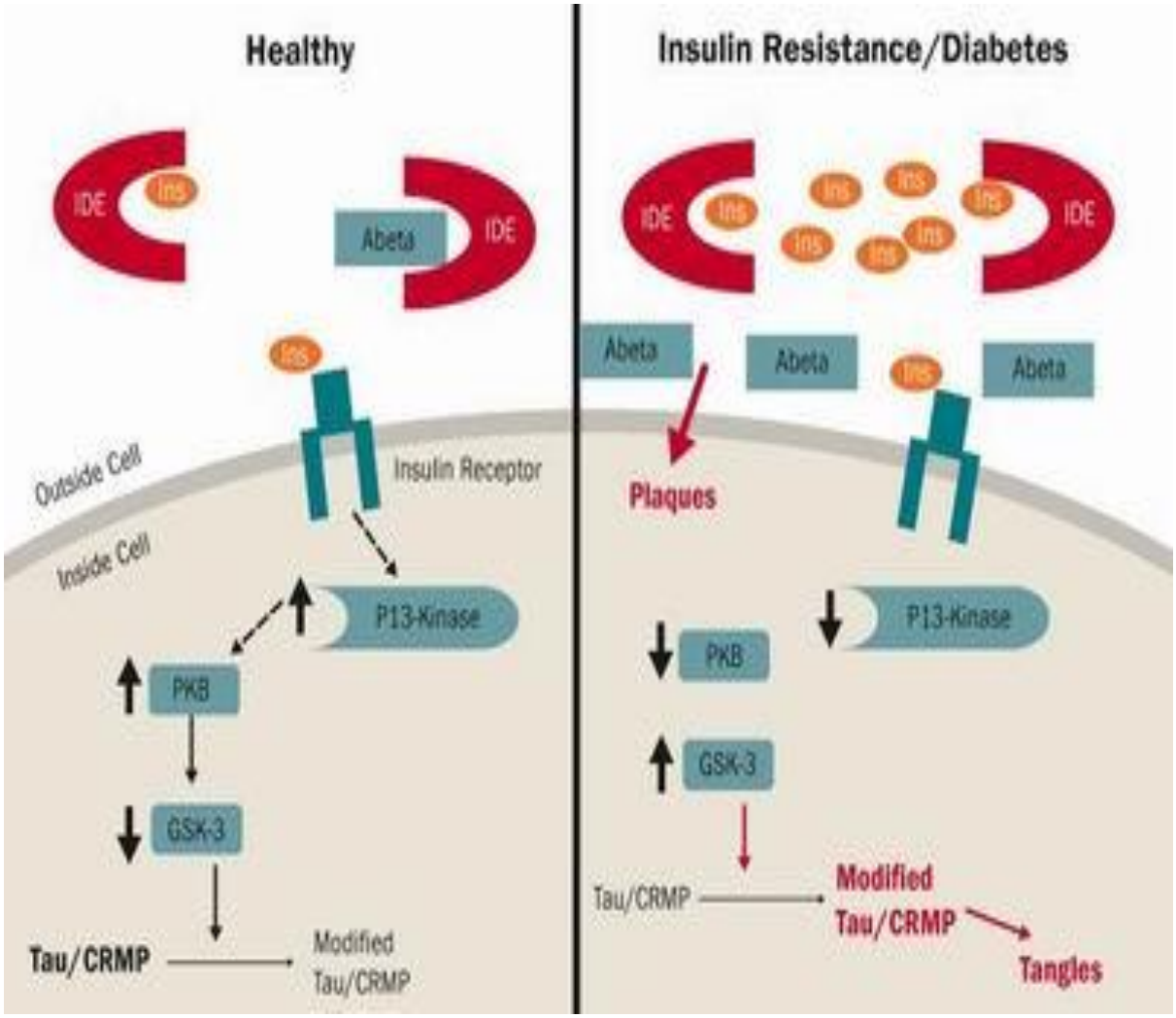
Gender and age-specific waist circumference cut-offs [1].

Country/ethnic group	Waist circumference cut-off	
	Male (cm)	Female (cm)
Europids	≥94	≥80
In USA, the ATPIII values (102 cm males; 88 cm females) are likely to continue to be used for clinical purposes.		
South Asians	≥90	≥80
Based on a Chinese, Malay, and Asian-Indian population.		
Chinese	≥90	≥80
Japanese	≥90	≥80
Ethnic South and Central Americans	Use South Asians recommendations until more specific data are available.	
Sub-Saharan Africans	Use European data until more specific data are available.	
Eastern Mediterranean and Middle East (Arabs) population	Use European data until more specific data are available.	

INSULIN RESISTANCE

Insulin resistance is described as the condition in which normal amount of insulin concentration does not produce the response it is supposed to, due to this the beta cells of pancreas produce more amount of insulin because of the persistent hyperglycemia. This hyper insulinemia compensates for the hyperglycemia and makes the person normoglycemic. But due to this resistance there is an overexpression of the insulin receptors. Due to this there are some actions insulin that are accentuated and some that are not due to the insulin resistance, it is this mixture of over activity and under activity that is the cause of metabolic syndrome in a patient with insulin resistance.

In due time the pancreas cannot produce extra insulin needed due to the insulin resistance and a burn out of the pancreatic islets happen ,during this phase leads to sever hyperglycemia and overt diabetes. Although an increased waist circumference is the norm for insulin resistance it can also be seen in patients with normal waist circumference with abnormal adipose distribution. But classically it is the upper body adipose deposition that strongly correlates with the development of metabolic syndrome.


Healthy
Insulin Resistance/Diabetes
IDE
Ins
Abeta
Outside Cell
Inside Cell
Insulin Receptor
P13-Kinase
PKB
GSK-3
Tau/CRMP
Modified
Tau/CRMP
Plaques
Tangles

DYLIPIDEMIA

Dyslipidemia is a condition characterised by the elevation of lipids in our body. There is elevation of plasma cholesterol, triglycerides, and lipoproteins with reduced HDL and elevated LDL. The most common to elevate is the cholesterol level. There are various causes for dyslipidemia some of them are diabetes , PCOD , Cushing's syndrome , hypothyroidism and so on.

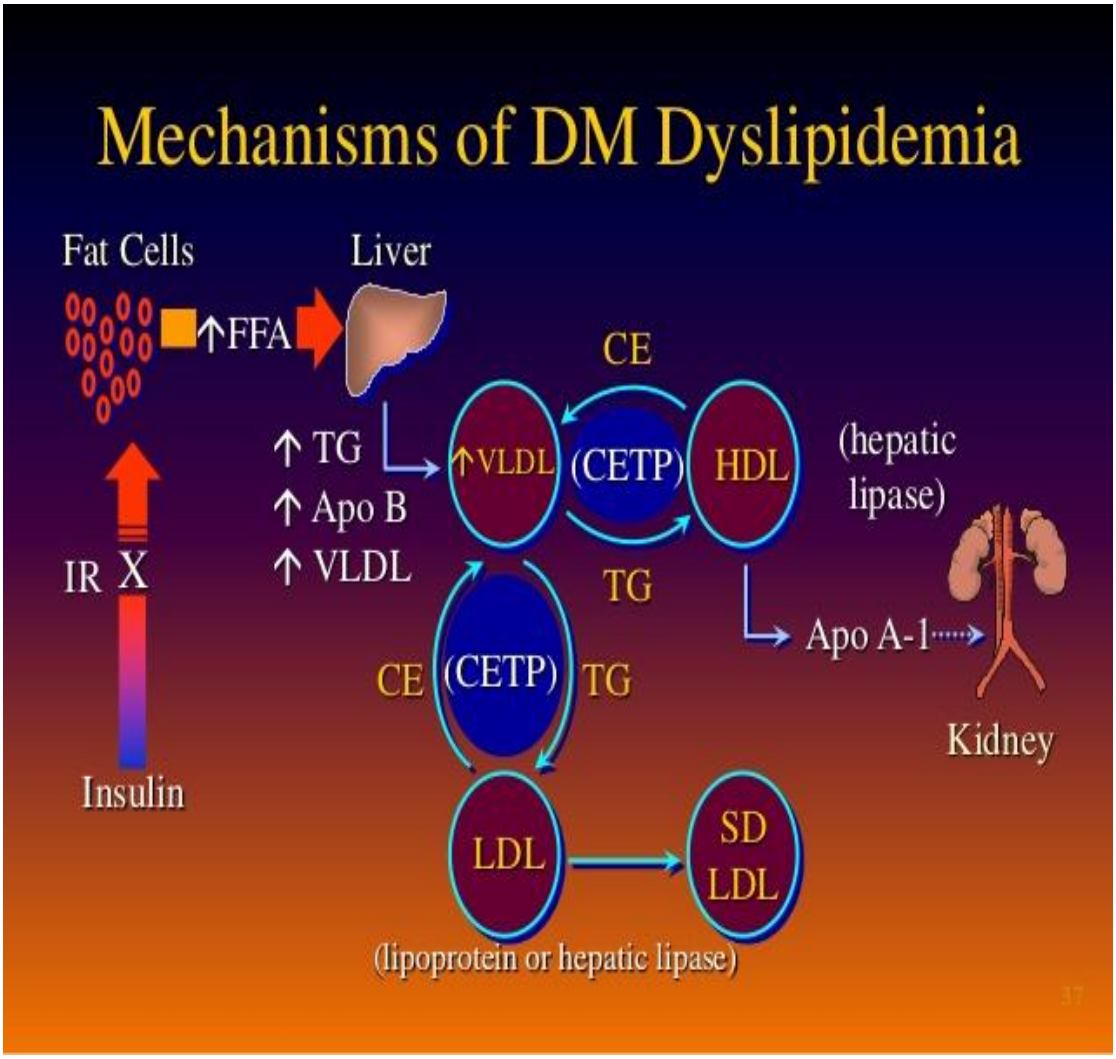
The pathogenesis behind dyslipidemia in a patient with insulin resistance are multiple.

1. Insulin functions normally to supress lipid metabolism and hence in a condition where there is sufficient insulin resistance this is inhibited causing lipolysis and the release of these free fatty acid into circulation thereby causing dyslipidemia

2. Insulin normally functions in the degradation of apo protein B via PI3K pathway, and hence insulin resistance produces increased level of very low density lipoprotein .

3. Insulin also regulates other enzymes which metabolises VLDL like the lipo-protein lipase. This enzyme is the rate limiting enzyme in the metabolism of VLDL. Hence insulin not only acts via the PI3K pathway

it also acts via the LPL pathway in its metabolism whereby increasing its concentration in serum.


Mechanisms of DM Dyslipidemia
Fat Cells
Liver
↑FFA
CE
↑ TG
↑ Apo B
↑ VLDL
↑VLDL
(CETP)
HDL
(hepatic lipase)
IR X
TG
Apo A-1
CE
(CETP)
TG
Kidney
Insulin
LDL
SD LDL
(lipoprotein or hepatic lipase)

HYPERTENSION

Hypertension is the term used to describe elevated blood pressure. The causes of hypertension can be varied from primary cause or secondary causes. Some of the causes of secondary hypertension include OSAS, CKD, Reno vascular hypertension, endocrine causes of hypertension like hyperthyroidism, pheochromocytoma, diabetes, Cushing's syndrome.

While essential hypertension can be genetic it is often associated with metabolic syndrome. The pathology behind metabolic syndrome producing hypertension is the fact that hyperinsulinemia, hyperglycemia activate the renin angiotensin aldosterone system, which in turn results in hypertension via

1. Increased angiotensin level

2. Kidney reabsorbs more amount of sodium

3. Increased cardiac output.

4. Adipose tissue is postulated to produce aldosterone in the presence of increased angiotensin levels.

Management of hypertension based on JNC 8 is as follows.

JNC 8 Recommendations

Patient Subgroup	Target SBP (mm Hg)	Target DBP (mm Hg)
≥ 60 years	<150	< 90
< 60 years	<140	< 90
> 18 years with CKD	<140	<90
> 18 years with diabetes	<140	<90

CKD = chronic kidney disease; DBP = diastolic blood pressure; SBP = systolic blood pressure

James PA, et al. *JAMA*. 2013 Dec 18. [Epub ahead of print]

Diagnosis of metabolic syndrome

Over a period of time there has been a strive to define and diagnose metabolic syndrome. Following which there has been different criteria for the diagnosis of metabolic syndrome brought about by various organisations like the IDF, NCEP, WHO, AACE. For the purpose of this study the IDF guidelines are followed. The criteria's are as follows:

	WHO (1999)	NCEP (2001)	IDF (2005)
Required	Insulin resistance*		WC† ≥ 94 cm in men or ≥ 80 cm in women
No. of abnormalities	≥ 2 of:	≥ 3 of:	≥ 2 of:
Obesity	WHR > 0.9 in men or > 0.85 in women; BMI ≥ 30 kg/m^2	WC ≥ 102 cm in men or ≥ 88 cm in women	
Triglycerides	≥ 150 mg/dL	≥ 150 mg/dL	≥ 150 mg/dL
HDL cholesterol	< 40 mg/dL in men or < 50 mg/dL in women	< 40 mg/dL in men or < 50 mg/dL in women	< 40 mg/dL in men or < 50 mg/dL in women
Hypertension	≥ 140/90 mmHg	≥ 130/85 mmHg	≥ 130/85 mmHg
Glucose		≥ 110 mg/dL‡	≥ 100 mg/dL
Microalbuminuria	Albumin/creatinine ratio > 30 mg/g; Albumin excretion rate > 20 mcg/min		

TREATMENT OF METABOLIC SYNDROME

The treatment of metabolic syndrome winds around the concept of making lifestyle modifications.

1. Exercise: Exercise is one of the most important life style modifications to be made. It helps to reduce weight, lower blood pressure, and increase peripheral absorption of glucose, glycemic control, reduces dyslipidemia, and improves insulin resistance.

2. Healthy diet: In this new age of ours eating healthy is an important corner stone in the management of metabolic syndrome. It helps in reducing weight, improve cholesterol levels, improve insulin resistance, reduce the risk of cardiovascular disease, stroke.

3. Weight reduction: It is a by-product of exercise and healthy diet. Weight loss as a single entity reduces all aspects of metabolic syndrome

4. Alcohol abstinence and cessation of smoking:

5. Pharmacological treatment: medication revolves around control of diabetes with OHA or insulin, antihypertensive, statins for dsylipidemia. It is important

to note that medication along with life style modification provides the greatest benefit in the management of metabolic syndrome.

AIMS AND OBJECTIVES

Primary Objective

1. To examine the association of the metabolic syndrome and its components on acute ischemic stroke.

Secondary Objective(s)

1. To find the association of metabolic syndrome and the severity of ischemic stroke.
2. To evaluate the effects of Metabolic Syndrome and its components on the short-term (60day) prognosis of patients with acute ischemic stroke.

MATERIALS AND METHODS:

In the following Hospital based study for the **A Study to find the association of Metabolic Syndrome and its components in Ischemic Stroke** 100 patients who were in-patient at the department of Medicine were evaluated for metabolic syndrome and its severity of which 50 were cases and 50 were controls.

Period of study: april2016 to september2016

Study design: case control study.

Study conducted: Madras medical college hospital, Chennai.

Sample size : 100 subjects. 50 were cases and 50 were control.

INCLUSION CRITERIA:

1. All the subjects presented clinical characteristics of acute ischemic stroke WITHIN 7 DAYS OF ONSET, confirmed by cranial computed tomography and/or magnetic resonance imaging/angiography.

EXCLUSION CRITERIA:

1. Criteria for exclusions were patients who experienced the onset of stroke more than 7 days before hospitalization.

2. Patients with cerebral haemorrhage, subarachnoid haemorrhage, brain tumor or other central nervous system disorders were also excluded.

3. Those not willing to give consent were also excluded.

IDF Criteria for metabolic syndrome

1. Central or abdominal obesity (measured by waist circumference :)in men > 102cms and in women >88 cms
2. Triglycerides > or equal to 150 mg/dl or using cholesterol medication/
3. HDL Cholesterol: men < 40 mg/dl, women <50 mg/dl or using cholesterol medication.
4. Blood pressure > or equal to 130/ 85 mmHg or on anti-hypertensive
5. Fasting glucose > or equal to 100 mg/dl or on anti-diabetic drugs

The presence of any three of the following five risk components.

Data collection and Methods

Data collection was performed by using a standardized questionnaire based on an extensive manual and follow up information.

- Patients were classified into two groups at baseline based on whether or not the diagnostic criteria for MetS were met.
- Data collection was performed by using a standardized questionnaire based on an extensive manual and follow-up information.
- Initial severity of stroke in cases will be measured by the NIHSS scale. Level of stroke severity is measured as 0(no stroke) ; 1-4 (minor stroke) ; 5-15 (moderate stroke) ; 15-20 (moderate to severe stroke) and 21-42 (severe stroke).
- The patients would be followed up and stroke severity assessed at 1st week and 1 month post stroke. The functional outcome is measured by modified Rankin scale 60 days post stroke. Patients who died scored 6 in the mRS. and mRS =3 were used as cut-off scores to defined poor outcome.
- Patients will be followed up with hospital visits during the first and 6 months after the stroke event. Patients who were unable to attend the scheduled visits or had migrated from the city will be contacted by

telephone. In case of death, dates and causes were registered by gathering information from relatives.

Product / Procedure / Investigation Details

1. Fasting plasma glucose
2. Fasting lipid profile
3. BP record
4. Anthropometric tests (height, weight, BMI , waist circumference)
5. CT brain/MRI brain

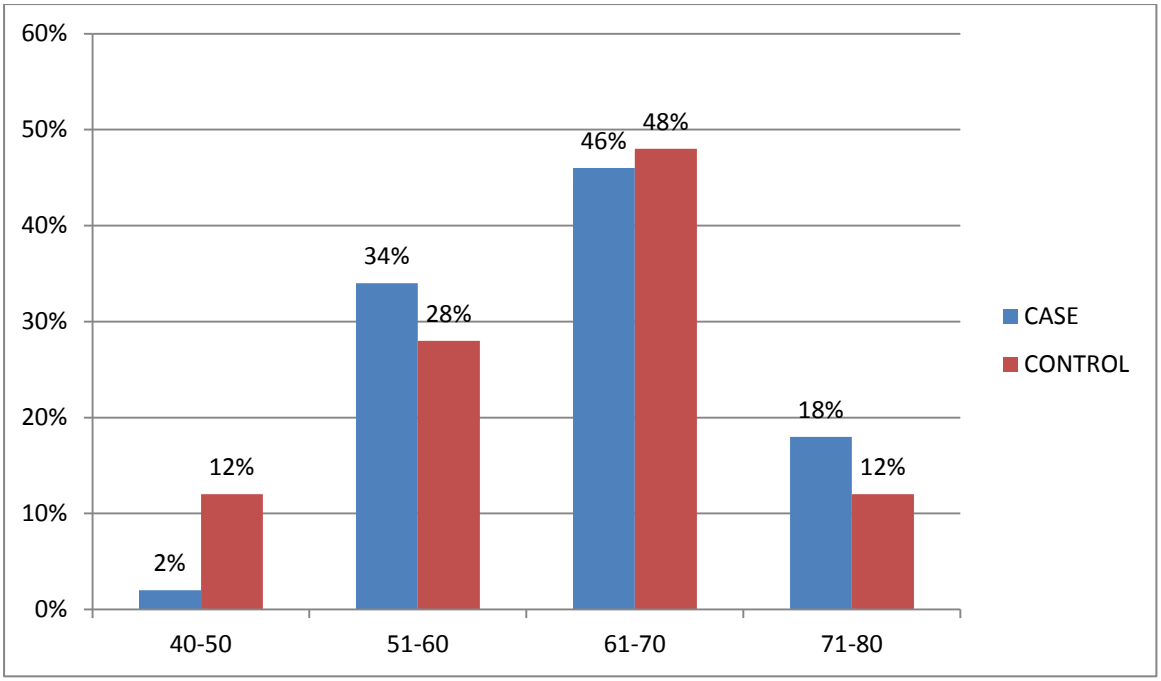
RESULTS

This study group included total number of 100 subjects ,among these 50 were cases and 50 control.

ANALYSIS OF CASE AND CONTROL WITH RESPECT TO AGE.

			Age group				Total
			40-50	51-60	61-70	71-80	
group	case	Count	1	17	23	9	50
		% within group	2.0%	34.0%	46.0%	18.0%	100.0%
	control	Count	6	14	24	6	50
		% within group	12.0%	28.0%	48.0%	12.0%	100.0%
Total		Count	7	31	47	15	100
		% within group	7.0%	31.0%	47.0%	15.0%	100.0%

Pearson Chi-Square=4.483 p= 0.214

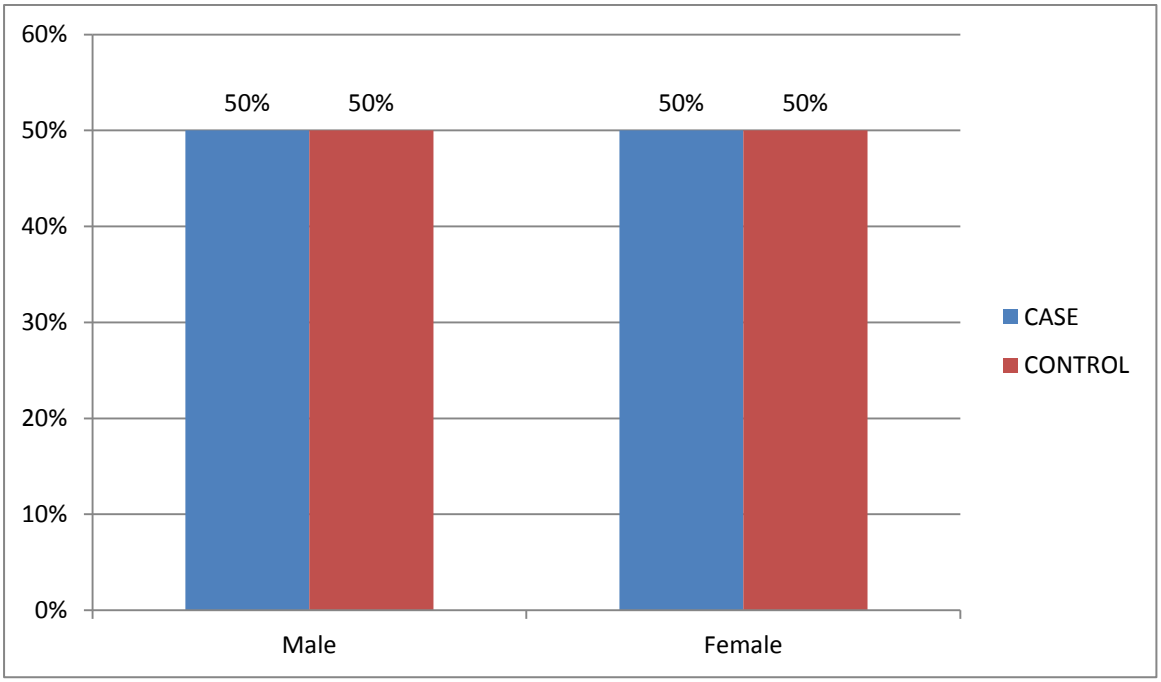


The age of the study population ranged from 40 onwards to 80, With the peak incidence of stroke from the age group of 60-70.The study showed a p value of 0.214, and hence the study was independent of age.

ANALYSIS OF CASE AND CONTROL WITH RESPECT TO SEX.

			SEX		Total
			Male	Female	
group	case	Count	25	25	50
		% within group	50.0%	50.0%	100.0%
	control	Count	25	25	50
		% within group	50.0%	50.0%	100.0%
Total		Count	50	50	100
		% within group	50.0%	50.0%	100.0%

Pearson Chi-Square=0 p=1

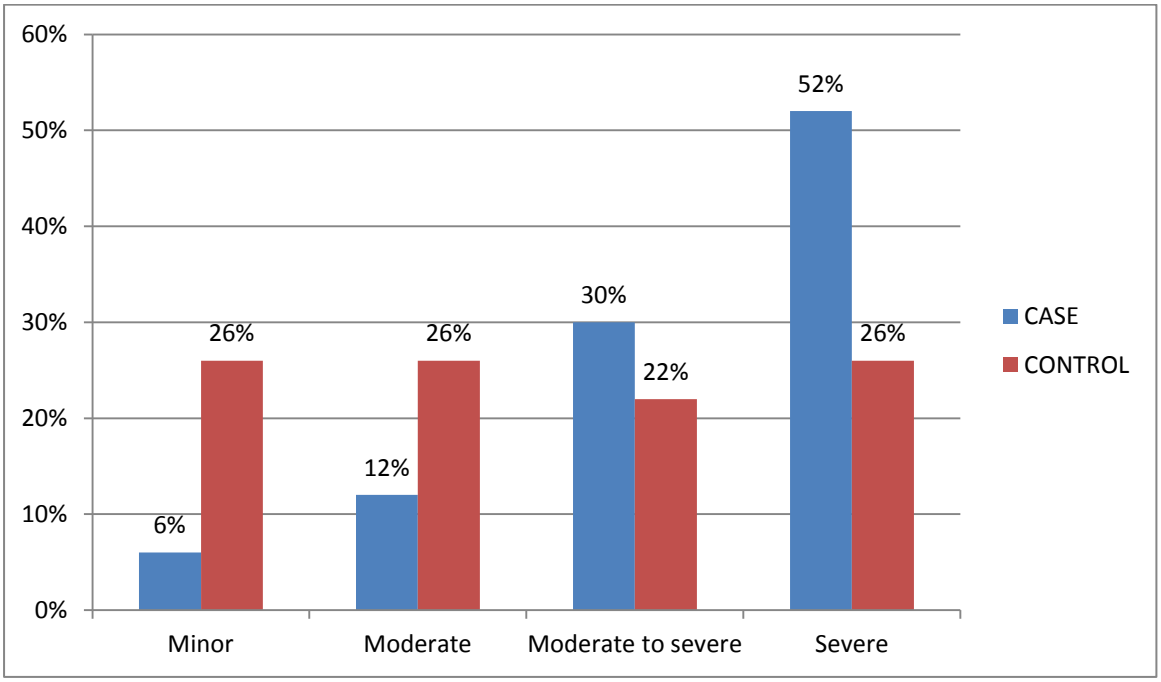


Both case and control had equal proportion of male and female in the study. And the study had a p value of 1, indicating that there was no significant difference in the sex in the study with respect to the case and control.

ANALYSIS OF CASE AND CONTROL WITH RESPECT TO NIHSS SCORE.

		NIHSS class				Total
		Minor	Moderate	Moderate to severe	Severe	
group	case	Count	3	6	15	26	50
		% within group	6.0%	12.0%	30.0%	52.0%	100.0%
	Control	Count	13	13	11	13	50
		% within group	26.0%	26.0%	22.0%	26.0%	100.0%
Total		Count	16	19	26	39	100
		% within group	16.0%	19.0%	26.0%	39.0%	100.0%

Pearson Chi-Square=13778 *p= 0.003



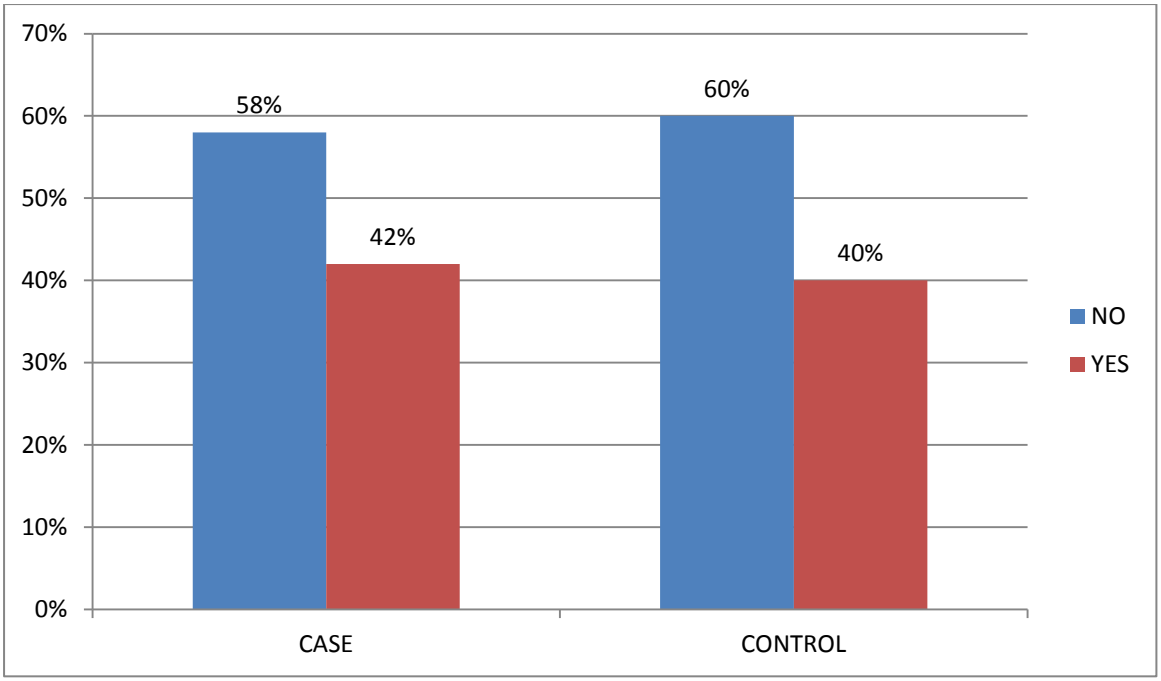
Analysis of NIHSS scale with respect to the case and control revealed more than 50% of cases to be severe while control was evenly distributed between the various severity of the NIHSS scale. The analysis revealed a statistically significant relation between cases and control with respect to the NIHSS scale. Thereby confirming a significant relation between the severity of ischemic stroke and metabolic syndrome.

ANALYSIS OF CASE AND CONTROL WITH RESPECT TO ALCOHOL INTAKE.

Crosstab

			Alcohol intake		Total
			no	yes	
group	case	Count	29	21	50
		% within group	58.0%	42.0%	100.0%
	control	Count	30	20	50
		% within group	60.0%	40.0%	100.0%
Total		Count	59	41	100
		% within group	59.0%	41.0%	100.0%

Pearson Chi-Square=0.041 p= 0.839

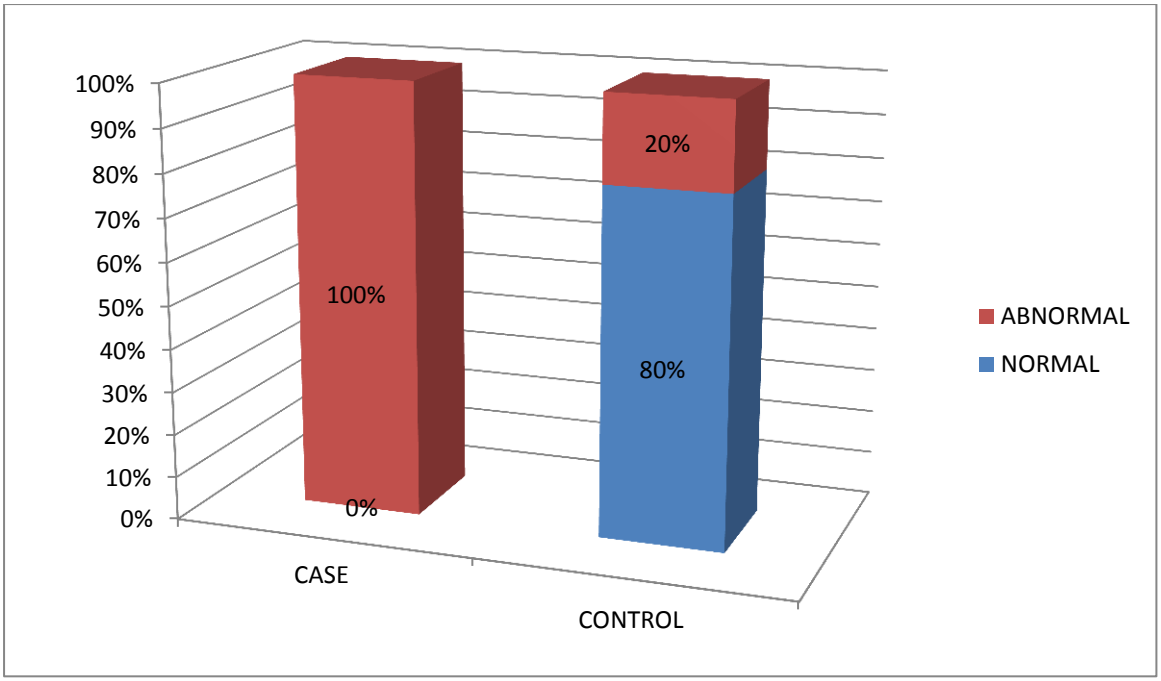


Analysis of the alcohol intake with the incidence of stroke within case and control did not yield a statistically significant relation between them.

ANALYSIS OF CASE AND CONTROL WITH RESPECT TO HYPERTENSION.

			HYPERTENSIVE		Total
			NO	YES	
group	case	Count	0	50	50
		% within group	0.0%	100.0%	100.0%
	control	Count	40	10	50
		% within group	80.0%	20.0%	100.0%
Total		Count	40	60	100
		% within group	40.0%	60.0%	100.0%

Pearson Chi-Square=66.667* $p<0.001$ significant

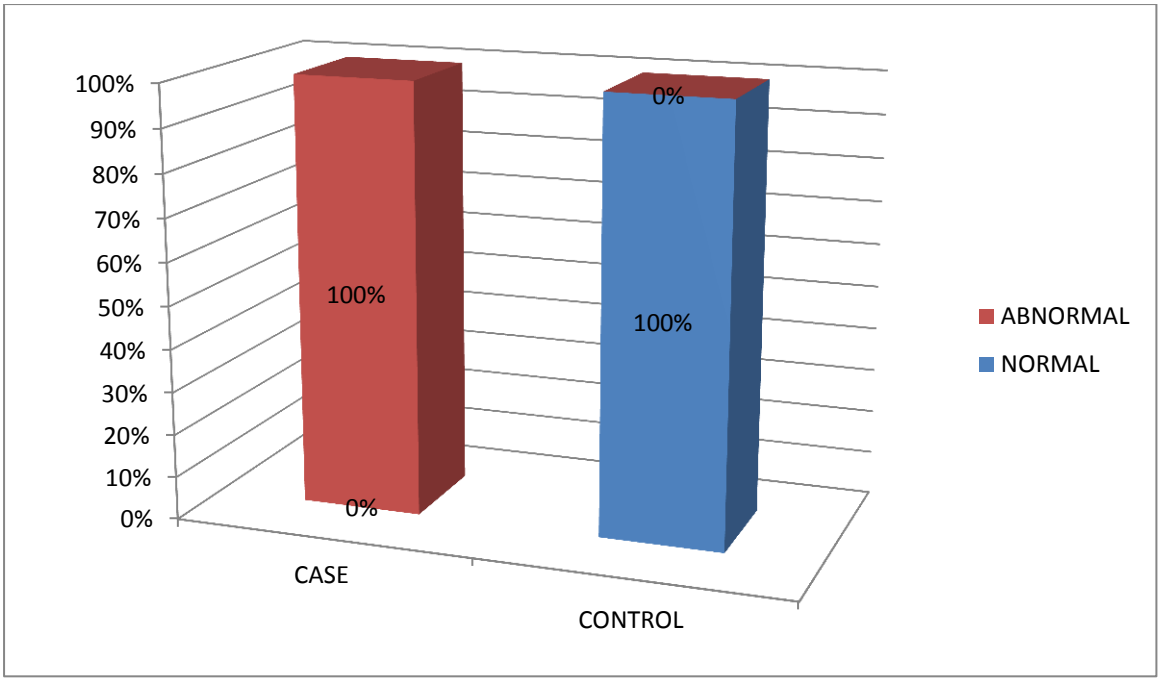


Analysis of the data for the incidence of stroke in case and control with respect to hypertension revealed that there was a statistically significant relation between them.

ANALYSIS OF CASE AND CONTROL WITH RESPECT TO DIABETES MELLITUS.

			DM		Total
			NORMAL	ABNORMAL	
group	case	Count	0	50	50
		% within group	0.0%	100.0%	100.0%
	control	Count	50	0	50
		% within group	100.0%	0.0%	100.0%
Total		Count	50	50	100
		% within group	50.0%	50.0%	100.0%

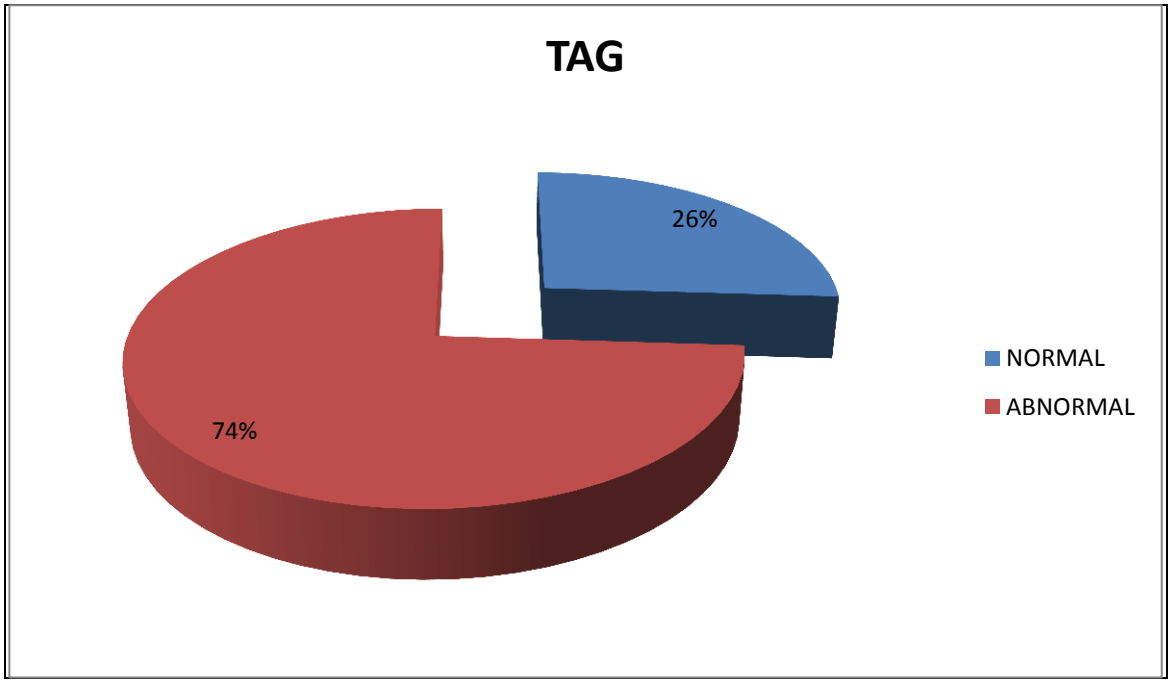
Pearson Chi-Square=100.00* p<0.001 significant



Analysis of the data for the incidence of stroke in case and control with respect to diabetes mellitus revealed that there was a statistically significant relation between them.

ANALYSIS OF CASE AND CONTROL WITH RESPECT TO TAG.

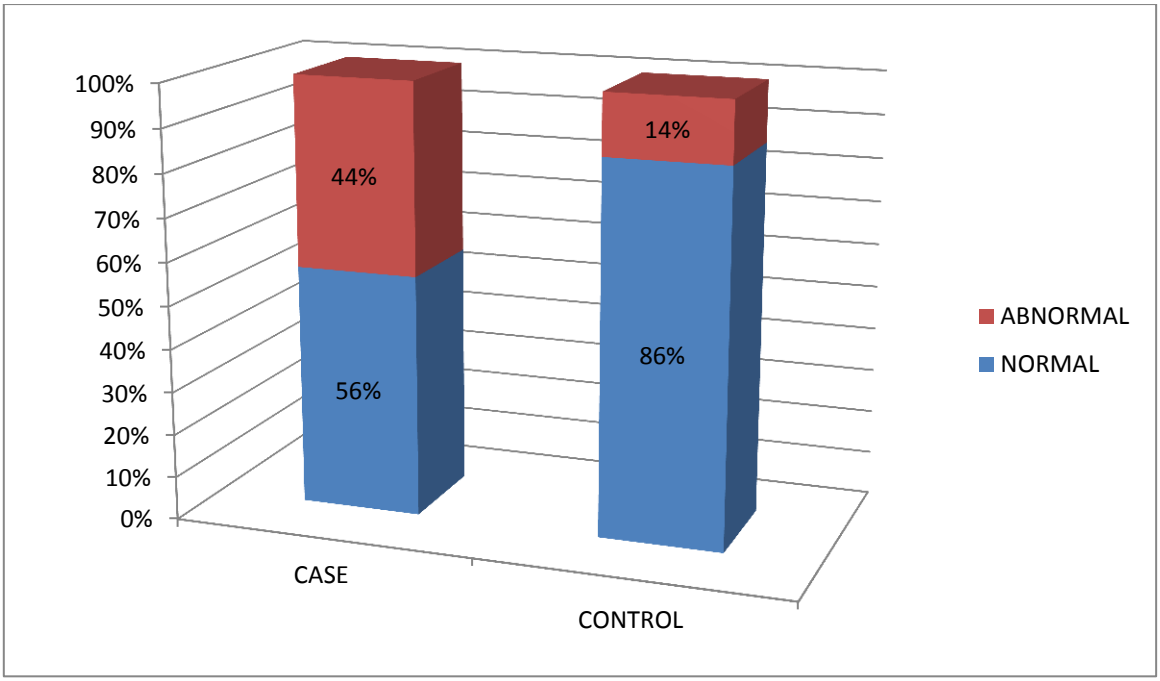
		TAG		Total
		NORMAL	ABNORMAL	
Case group	Count	13	37	50
	% within group	26.0%	74.0%	100.0%
Total	Count	13	37	50
	% within group	26.0%	74.0%	100.0%



ANALYSIS OF CASE AND CONTROL WITH RESPECT TO HDL.

			HDL		Total
			NORMAL	ABNORMAL	
group	case	Count	28	22	50
		% within group	56.0%	44.0%	100.0%
	control	Count	43	7	50
		% within group	86.0%	14.0%	100.0%
Total		Count	71	29	100
		% within group	71.0%	29.0%	100.0%

Pearson Chi-Square=10.928* p<0.001 significant



Analysis of the data for the incidence of stroke in case and control with respect to HDL revealed that there was a statistically significant relation between them.

ANALYSIS OF CASE AND CONTROL WITH RESPECT TO ABDOMINAL CICUMFERENCE

			ABD CIRCUMFERENCE		Total
			NORMAL	ABNORMAL	
group	case	Count	21	29	50
		% within group	42.0%	58.0%	100.0%
	control	Count	19	31	50
		% within group	38.0%	62.0%	100.0%
Total		Count	40	60	100
		% within group	40.0%	60.0%	100.0%

Pearson Chi-Square=0.167 p=0.683

Analysis of the abdominal circumference with the incidence of stroke within case and control did not yield a statistically significant relation between them.

ANALYSIS OF CASE AND CONTROL WITH RESPECT TO PACK YEARS.

			PACK YEARS		Total
			0-10	10-30	
group	case	Count	3	18	21
		% within group	14.3%	85.7%	100.0%
	control	Count	6	17	23
		% within group	26.1%	73.9%	100.0%
Total		Count	9	35	44
		% within group	20.5%	79.5%	100.0%

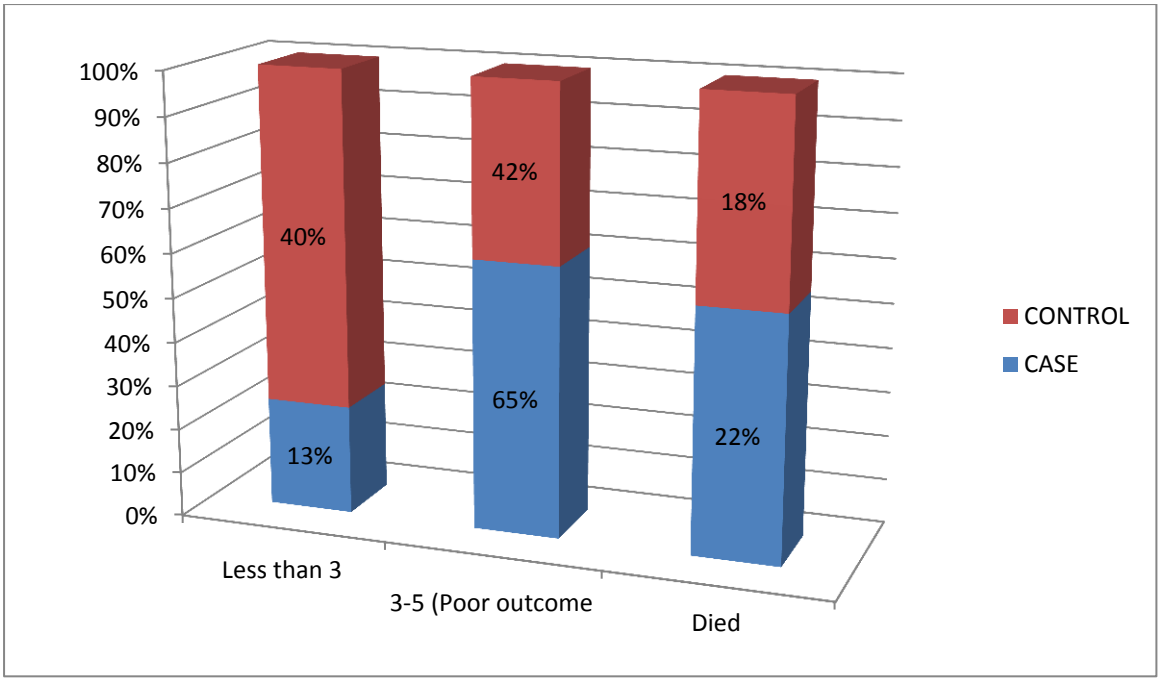
Pearson Chi-Square=0.940 p= 0.332

Analysis of pack years with the incidence of stroke within case and control did not yield a statistically significant relation between them.

ANALYSIS OF CASE AND CONTROL WITH RESPECT TO mRS SCALE

			MRS scale			Total
			Less than 3	3-5 (Poor outcome	Died	
group	case	Count	6	30	10	46
		% within group	13.0%	65.2%	21.7%	100.0%
	control	Count	18	19	8	45
		% within group	40.0%	42.2%	17.8%	100.0%
Total		Count	24	49	18	91
		% within group	26.4%	53.8%	19.8%	100.0%

Pearson Chi-Square=8.682* p= 0.013

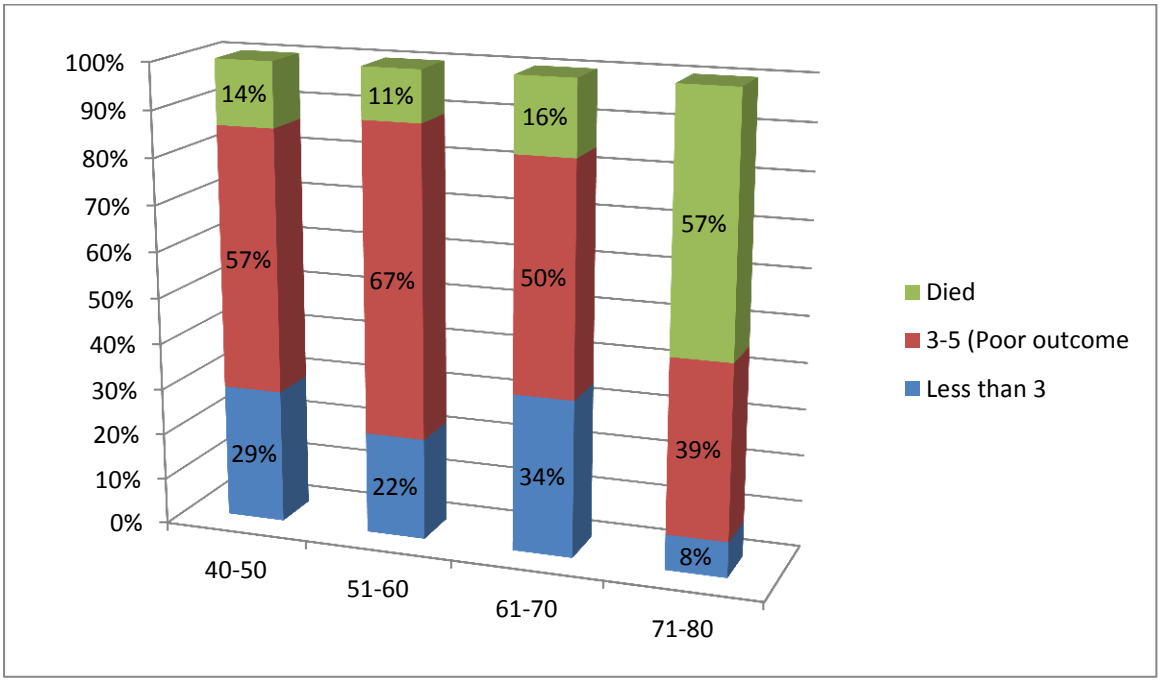


The study showed significant correlation between the mRS scale and the severity of stroke after a period of 60 days in patients with metabolic syndrome.

CORRELATION BETWEEN mRS SCALE AND AGE

			mRS scale			Total
			less than 3	3-5 (poor outcome	died	
Age group	40-50	Count	2	4	1	7
		% within age group	28.6%	57.1%	14.3%	100.0%
	51-60	Count	6	18	3	27
		% within age group	22.2%	66.7%	11.1%	100.0%
	61-70	Count	15	22	7	44
		% within age group	34.1%	50.0%	15.9%	100.0%
	71-80	Count	1	5	7	13
		% within age group	7.7%	38.5%	53.8%	100.0%
Total		Count	24	49	18	91
		% within age group	26.4%	53.8%	19.8%	100.0%

Pearson Chi-Square=13.527 * p= 0.035

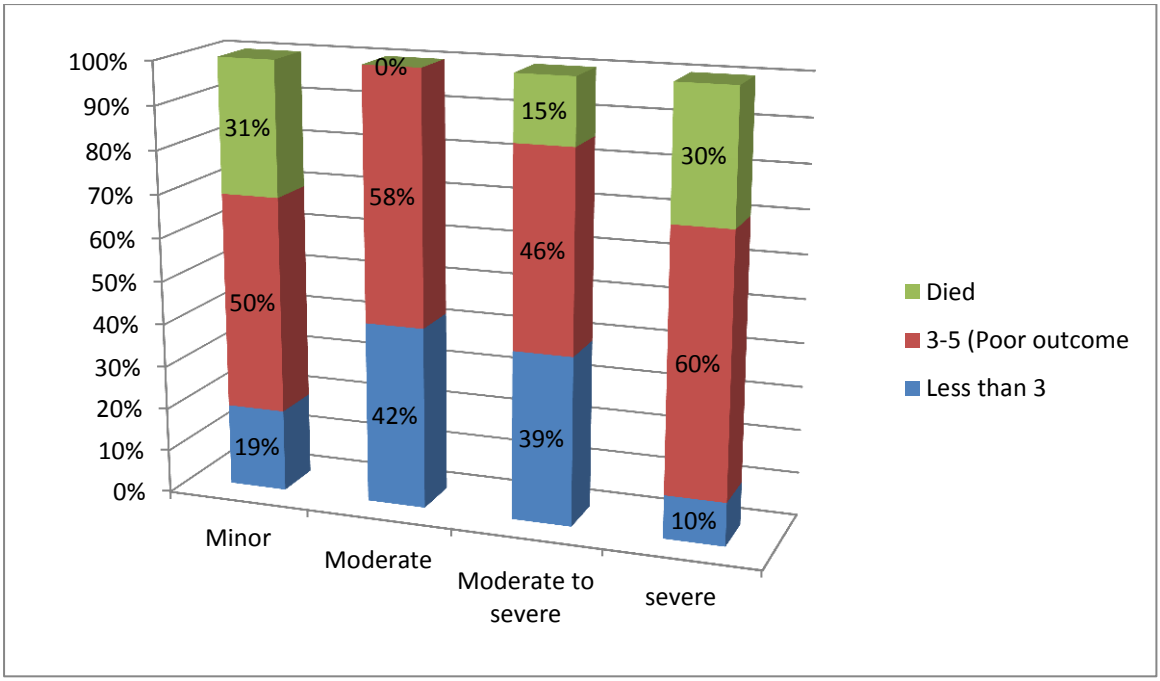


The study showed statistical significance between mRS scale and the age of the patients within the case and he control group. Indicating that age is a risk factor in patients with metabolic syndrome for severity of stroke.

CORRELATION BETWEEN NIHSS SCALE AND mRS SCALE

			MRS scale			Total
			less than 3	3-5 (poor outcome	Died	
NIHSS SCALE	Minor	Count	3	8	5	16
		% within NIHSS scale	18.8%	50.0%	31.2%	100.0%
	Moderate	Count	8	11	0	19
		% within NIHSS scale	42.1%	57.9%	0.0%	100.0%
	Moderate to severe	Count	10	12	4	26
		% within NIHSS scale	38.5%	46.2%	15.4%	100.0%
	Severe	Count	3	18	9	30
		% within NIHSS scale	10.0%	60.0%	30.0%	100.0%
Total		Count	24	49	18	91
		% within NIHSS scale	26.4%	53.8%	19.8%	100.0%

Pearson Chi-Square=13.884* p= 0.03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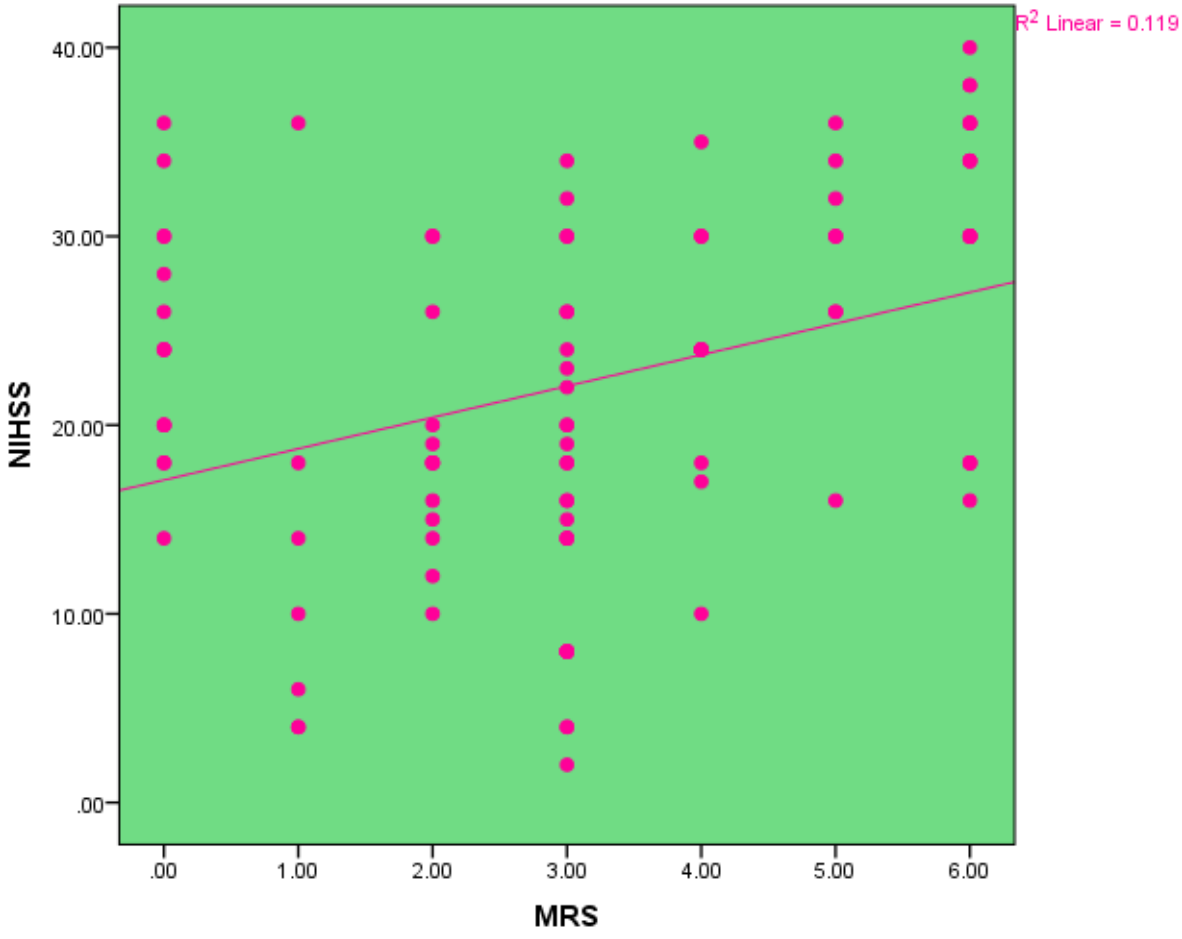
R2 Linear = 0.119
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MRS

Correlations

		NIHSS	
MRS	Correlation	.302****	
	Sig. (2-tailed)	P<0.01	
	N	100	

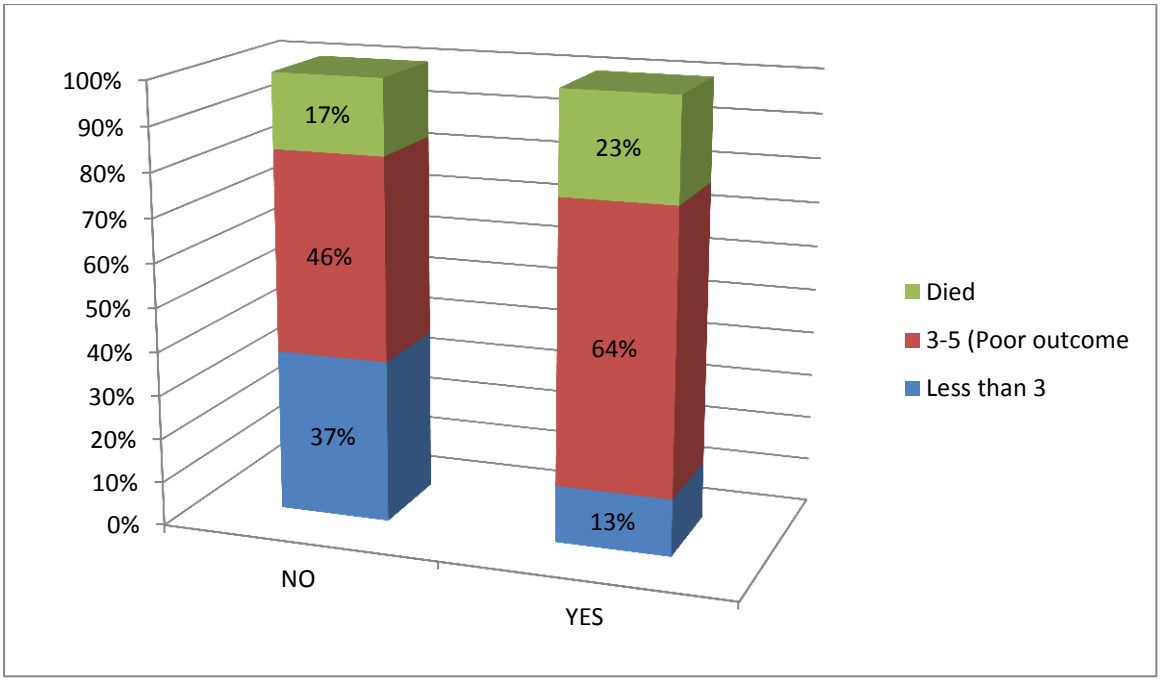
**. Correlation is significant at the 0.01 level (2-tailed).

The above analysis correlates between the NIHSS scale and the mRS scale and it shows a statistically significant relation between them, indicating that a high score in the NIHSS scale correlates with a high score in the mRS scale.

CORRELATION BETWEEN mRS SCALE AND ALCOHOL INTAKE.

			MRS scale			Total
			less than 3	3-5 (poor outcome	died	
Alcohol intake	no	Count	19	24	9	52
		% within alcohol intake	36.5%	46.2%	17.3%	100.0%
	yes	Count	5	25	9	39
		% within alcohol intake	12.8%	64.1%	23.1%	100.0%
Total		Count	24	49	18	91
		% within alcohol intake	26.4%	53.8%	19.8%	100.0%

Pearson Chi-Square=6.462* p= 0.040

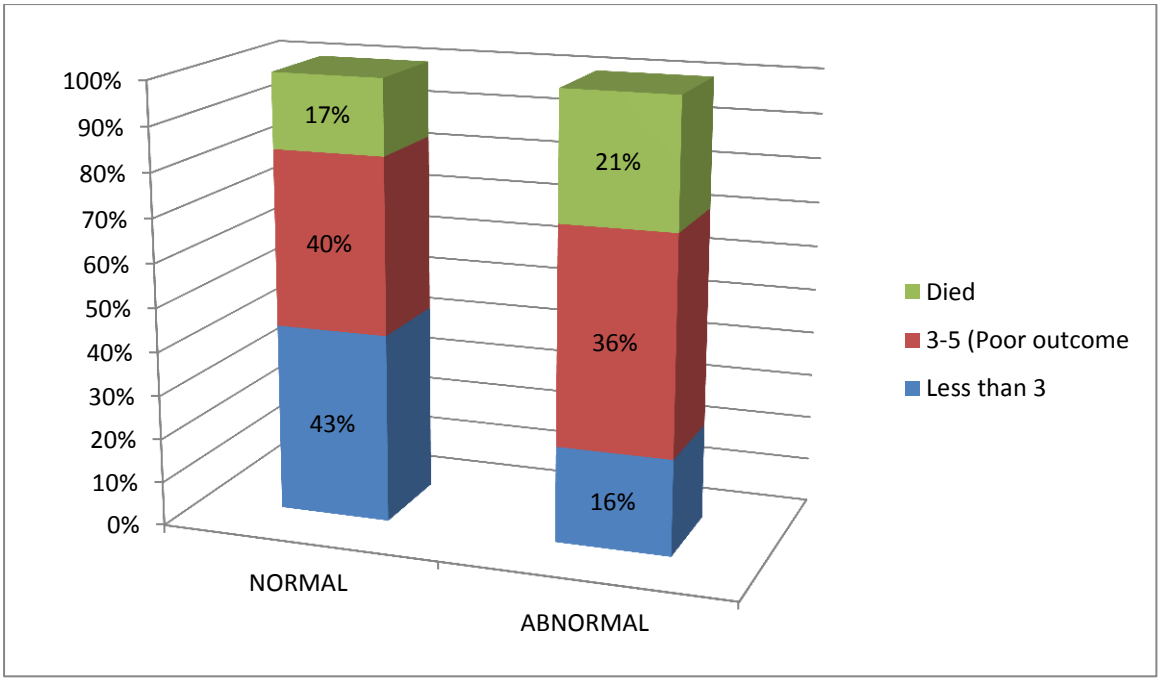


The study shows significant correlation with respect to alcohol intake in patients with metabolic syndrome with respect to their functional disability as seen by their higher mRS score.

CORRELATION BETWEEN HYPERTENSION AND mRS SCALE

			mRS SCALE			Total
			less than 3	3-5 (poor outcome	died	
	NORMAL BP	Count	15	14	6	35
		% within	42.9%	40.0%	17.1%	100.0%
	HYPERTE-NSIVE	Count	9	35	12	56
		% within	16.1%	62.5%	21.4%	100.0%
Total		Count	24	49	18	91
		% within BP	26.4%	53.8%	19.8%	100.0%

Pearson Chi-Square=8.084* p= 0.018

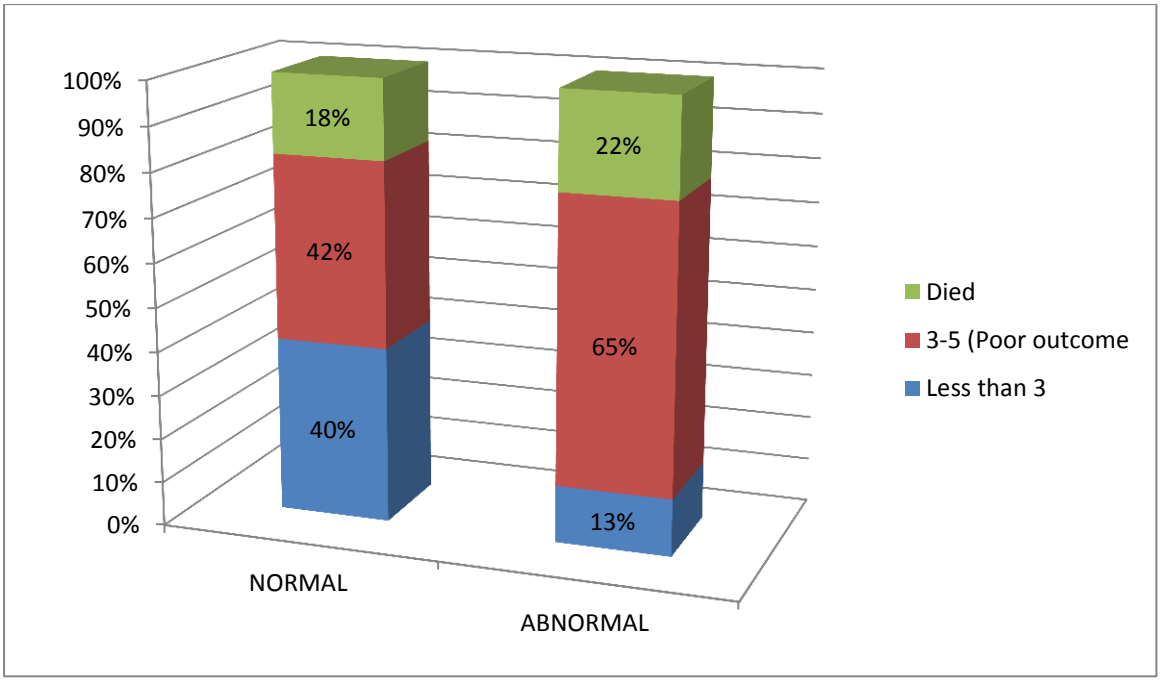


The study showed significant statistical correlation with respect to hypertensive's and the severity of stroke which was evident by the higher mRS score for this sub group of patients.

CORRELATION BETWEEN DIABETICS AND mRS SCALE

			MRS grade			Total
			less than 3	3-5 (poor outcome	died	
	Non diabetic	Count	18	19	8	45
		% within	40.0%	42.2%	17.8%	100.0%
	Diabetics	Count	6	30	10	46
		% within	13.0%	65.2%	21.7%	100.0%
Total		Count	24	49	18	91
		% within DM	26.4%	53.8%	19.8%	100.0%

Pearson Chi-Square=8.682* p= 0.013



The study showed significant correlation in the subgroup of patients with diabetes mellitus with respect to the severity of stroke as evident by the higher mRS score.

CORRELATION BETWEEN TAG AND mRS SCALE

			mRS SCALE			Total
			less than 3	3-5 (poor outcome	died	
	NORMAL TAG	Count	3	5	3	11
		% within	27.3%	45.5%	27.3%	100.0%
	ABNORMAL TAG	Count	3	25	7	35
		% within	8.6%	71.4%	20.0%	100.0%
Total		Count	6	30	10	46
		% within TAG	13.0%	65.2%	21.7%	100.0%

Pearson Chi-Square=3.314 p= 0.191

The study did not show any statistical correlation between the severity of stroke based on the mRS score and the level of TAG in patients.

CORRELATION BETWEEN HDL LEVELS AND mRS SCALE

			MRS SCALE			Total
			less than 3	3-5 (poor outcome	died	
	NORMAL HDL	Count	20	32	13	65
		% within	30.8%	49.2%	20.0%	100.0%
	ABNORMAL HDL	Count	4	17	5	26
		% within	15.4%	65.4%	19.2%	100.0%
Total		Count	24	49	18	91
		% within HDL	26.4%	53.8%	19.8%	100.0%

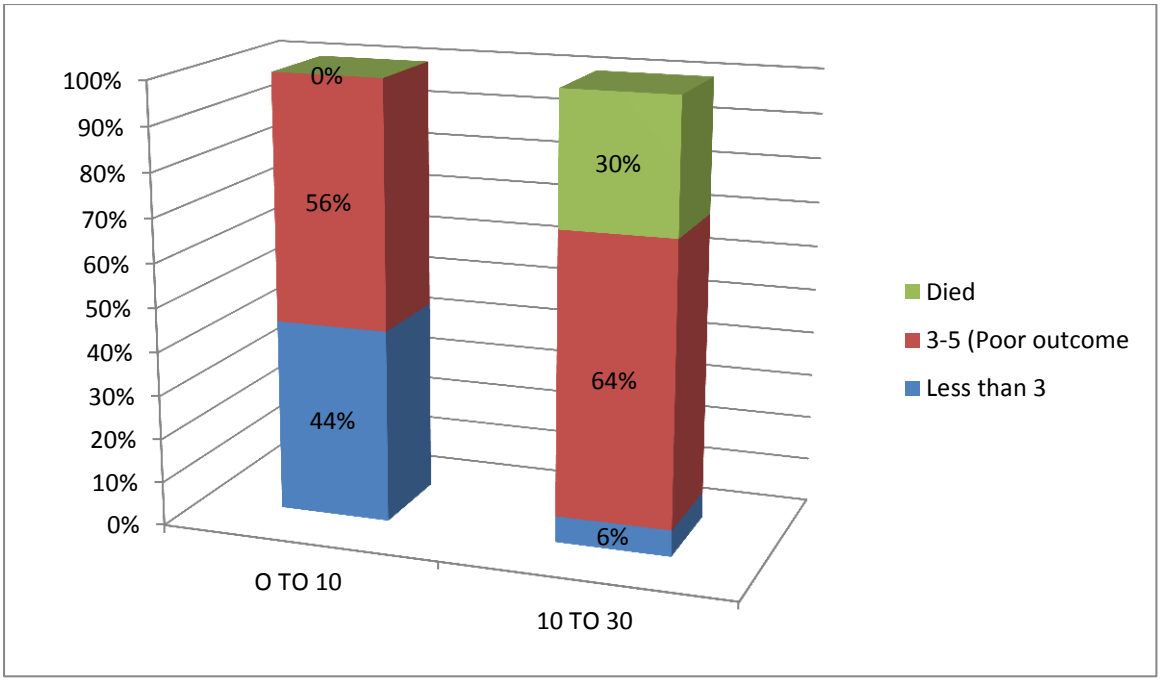
Pearson Chi-Square=2.572 p= 0.276

The study did not show any significant correlation with respect to the severity of stroke and the HDL level of patients

CORRELATION BETWEEN PACK YEARS AND mRS SCALE

		mRS SCALE			Total
		less than 3	3-5 (poor outcome	died	
0-10 PACK YEARS	Count	4	5	0	9
	% within	44.4%	55.6%	0.0%	100.0%
10-30 PACK YEARS	Count	2	21	10	33
	% within	6.1%	63.6%	30.3%	100.0%
Total	Count	6	26	10	42
	% within PACK	14.3%	61.9%	23.8%	100.0%

Pearson Chi-Square=10.095* p= 0.006

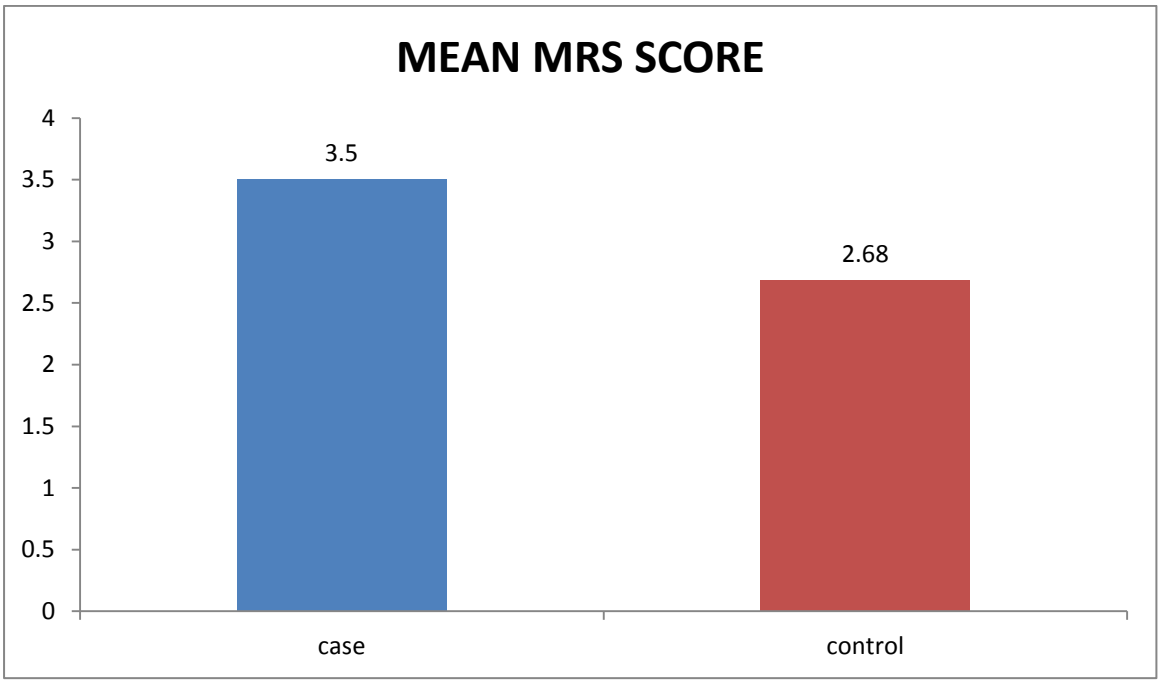


The study showed significant correlation with respect the pack years the patient smoked and the severity of stroke for this subgroup as evident by the higher mRS scale for these patients.

Group Statistics

	group	N	Mean	Std. Deviation	Std. Error Mean
MRS	case	50	3.5000	1.87628	.26535
	control	50	2.6800	1.97370	.27912

t value= 2.129*P=0.036



When the mean mRS scale was done for the subgroup of patients with metabolic syndrome and those without metabolic syndrome, that is the case and control it is evident that those with metabolic syndrome had mean mRS score higher than the control group with a p value of 0.036 indicating its statistical significance.

DISCUSSION

The study was conducted with a sample size of 100 patients ,with an intention to correlate the severity as well as the 60 day functional morbidity in patients who suffered from ischemic stroke by using scaling system such as the NIHSS and the mRS scale

The study divided the patients into a set of control and cases with 50 patients in each set. The findings of the study are as such.

The significance of age, sex, was not evident between patients with and without Metabolic Syndrome. While systemic hypertension, diabetes mellitus, and HDL levels showed statistical significant correlation with respect to the development of stroke. Implying that the components of Metabolic syndrome that is, diabetes, hypertension, HDL levels do correlate with the incidence of stroke. With the chi –square values of the same being 66.67,100,10.92 respectively.

The NIHSS scale when compared with both the population , that is those with metabolic syndrome and those without metabolic syndrome, we get a statistical significant data ,in which a large subset of the population presents with severe stroke ,which is measured by a score greater than 21 in the NIHSS scale. 83 % of cases had moderate to severe stroke when compared with control which had only 26 %.

When modified rankin scale was used to identify the functional disability after a period of 60 days which yielded a significant correlation. When different subsets were used in relation to the mRS scale it was well evident that age, sex, alcohol consumption, systemic hypertension, diabetes mellitus, pack years of cigarettes smoked showed significant correlation. Implying that these factors increased both the severity and the functional disability of patients. Age had a chi square value of 13.52,sex a value of 6.617,alcohol consumption a value of 6.462, hypertensive a value of 8.084 and diabetics a value of 8.682.

One interesting analysis that was obtained was that although the amount of pack years did not show any correlation for the incidence of strokes in patients with and without metabolic syndrome. Once stroke had developed, those with a greater pack years, had a higher score in the mRS scale indicating that, the functional disability of smokers with stroke was far more than those without stroke. It should also be noted that the males had a significantly higher score when compared to females. This could be attributed to fact that there are confounding factors like smoking and alcohol abuse which are more prevalent in the former subgroup.

When mean of the mRS scale was calculated for both the control and the case group it was evident that patients with metabolic syndrome showed significant worse outcome than those without metabolic syndrome.

LIMITATION OF THE STUDY

1. The size of the sample is small
2. The data collected was from a single centre
3. Loss of cases to attrition was present
4. mRS scale was obtained from relatives in patients with severe stroke.

CONCLUSION

It was the findings of the study, that patients with metabolic syndrome have a more severe disease when it comes to the acute presentation of stroke and also after a period of 60 days were there was greater functional disability in patients with metabolic syndrome.

Patients who are smokers did not have any significant rise in incidence of stroke among those with metabolic syndrome and those without metabolic syndrome .There was a significant correlation with this functional disability ,that is those patients with metabolic syndrome had a worse mRS scale than those without metabolic syndrome. Indicating that metabolic syndrome affected the quality of life and suffering of patients were much greater than the control group.

Individual risk factors like age, smoking ,alcohol consumption significantly affected patients with metabolic syndrome, whereby the patients fared worse in the mRS scale ,hence as an individual risk factor patients with metabolic syndrome had a worse functional outcome if they were elderly smoker or an alcoholic .

The study thus concludes and affirms that Metabolic Syndrome is a risk factor for severity of stroke and an independent risk factor for severity of

stroke and an independent risk factor for functional disability. Other risk factors like alcoholism also increased the severity of stroke.

The limitation of the study was that the total sample size was 100 cases and the data collected was from a single institution. Loss of patients to attrition and the fact that the mRS scale was obtained from relatives for patients with severe stroke are other short falls of the study.