

**Role of Duplex as a prognostic value for favorable outcome in patients with Acute Ischemic Stroke**

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**Abstract: Background and Purpose:** To determine the distribution of steno-occlusive arterial disease in patients with stroke using Doppler and to show their impact on applying the guidelines for care and consequently to show their role in predicting the stroke prognosis and outcome. **Aim Of Work:** To describe the prevalence and severity of steno-occlusive disease of the extracranial arteries and intracranial arteries as well as the collaterals in Egyptian patients with stroke using Duplex and study their reflection on complications, clinical state and stroke prognosis and outcome and to provide an insight about the prognostic value of Duplex in outcome prediction of acute stroke patients. **Methods:** patients will be admitted in neurology department of Al-Azhar University Hospitals (Al-Hussein and Bab-Al Sharea Hospitals), during the study period from march 2016 to May 2017, with diagnosis of acute cerebrovascular stroke, they will be subjected to full clinical assessment with history and examination and NIHSS score and MMSE score at time of admission, radiologic assessment by computerized tomography, Duplex and reevaluation after 15 days. **Results:** analysis of prognosis using NIHSS values and MMSE values in different groups presenting with acute ischemic cerebrovascular stroke correlated well with sonographic findings and better prognosis could be predicted in the presence of normal sonographic findings. **Conclusion:** the outcome of acute cerebrovascular stroke can be predicted by duplex and associated risk factors and the premorbid condition of the patient.

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**Keywords:** Role; Duplex; prognostic; value; patient; Acute; Ischemic; Stroke

## 1. Introduction

Stroke is the third most common cause of disability and second most common cause of death worldwide. According to the current World Health Organization stroke is “rapidly developing clinical signs of focal or global disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin”, (1,2).

Clinicians are often asked to predict outcome after stroke by the patient, the family, other healthcare workers, and insurance providers. A wide variety of factors influence stroke prognosis, including stroke severity, age, stroke mechanism, infarct location, comorbid conditions, clinical findings, and related complications. In addition, interventions such as thrombolysis, stroke unit care, and rehabilitation can play a major role in the outcome of ischemic stroke, (3, 4).

Both the National Institutes of Health Stroke Scale (NIHSS) and Folstein Mini-Mental State Examination (MMSE) are used in describing recovery, NIHSS and MMSE are used for screening

cognitive impairment within 24 hours of the symptoms onset and at 10-15 days as a predictor for prognosis, (3, 5-14).

The presence of acute occlusion of the cervical internal carotid artery, basilar artery or a large intracranial artery is associated with an increased risk of poor outcome. It follows that involvement of total anterior circulation or posterior circulation is also of poor prognosis these are to be considered among the predictors of stroke prognosis. Patients with symptomatic ICA occlusion are at a high risk of adverse outcomes that is as severe, if not worse, than any other degree of ICA stenosis in the short term (15-21).

Transcranial doppler and transcranial color coded duplex are non - invasive, non - ionising, inexpensive, portable and safe techniques for assessment of intracerebral blood flow (22-25 & 26-29).

Knowledge of the status of the extracranial and intracranial arteries will thus be helpful in predicting the stroke prognosis, and complications.

**Aim Of Work**

This study is intended to provide an insight about the prognostic value of ultrasound techniques (TCD and TCCS) in predicting the outcome of acute stroke patients relative to the prevalence and severity of steno-occlusive disease of the extracranial arteries and intracranial arteries in Egyptian patients with stroke and TIA. This may guide future treatment decisions in the acute stage and study their reflection on clinical state and complications.

**2. Patients and Method**

The present study was performed at Al Azhar University hospital, during the study period from March 2016 to May 2017 on 60 patients who are known to be hypertensive, diabetic, presenting with Stroke.

**Inclusion criteria:**

Male and female patients with TIA or stroke; aged above 45, with their collective data will be included.

All were subjected to the following;

1. Personal history taking including age, sex, occupation, residence, smoking, education and marital status.

2. General medical examination including blood pressure measurement, temperature and heart rate.

3. Cardiac assessment including electrocardiogram and echocardiography.

4. Neurological examination and assessment of stroke prognosis using the National Institutes of Health Stroke Scale (NIHSS), which measures neurologic impairment using a 15-item scale.

NIHSS scores will be obtained within 24 hours of the symptoms onset and at 10-15 days as a predictor for stroke outcome.

5. Folstein Mini-Mental State Examination MMSE will be used as a screening tool for cognitive impairment within 24 hours of the symptoms onset and at 10-15 days as a predictor for prognosis.

6. Ultrasound Doppler techniques using a GE Voluson E8 Ultrasound System and Ge Model 46-284127g1 Ultrasound Probe:

a) Duplex examination of the extracranial carotid arteries.

Both systems will be analyzed for:

a) Bilaterality.

b) Severity.

1) 0-49 non-significant.

2) 50 -99 significant.

3) Total occlusion.

b) Transcranial Doppler and Transcranial Color Coded Duplex examination of the intracranial arteries.

7. Computed Tomography (CT) scan will be applied via a Philips Brilliance 16 CT Scanner within 12 hours of the onset of symptoms and 72 hours later for the exclusion of hemorrhagic strokes and detection of the size and location of ischemic lesions.

Results will be correlated and analyzed.

**Exclusion criteria:**

Patients with cerebral hemorrhage will be excluded.

**Statistics:**

How to calculate the mean value for NIHSS, MMSE.

Example of NIHSS.

Nihss Value	0	1-4	5-9	10-20	21-24
Number Of Patients	-	1	4	7	1

**A) Frequency and midpoint:**

1) First column: Frequency (f) = 1

Midpoint =  $1 + 4 = 5/2 = 2.5$

2) Second column: f = 4

Midpoint =  $5 + 9 = 14/2 = 7$

3) Third column: f = 7

Midpoint =  $10 + 20 = 30/2 = 15$

4) Fourth column: f = 1

Midpoint =  $21 + 24 = 45/2 = 22.5$

**B) Midpoint (m) X Frequency (f):**

$2.5 + 28 + 105 + 22.5 = 158$

**C) Sum of (f):**

$1 + 4 + 7 + 1 = 13$

D) Sum of ( midpoint X frequency) / sum of frequency = Mean value

$158 / 13 = 12.15$

**3. Results**

Table (1) Analysis of prognosis using (a) NIHSS values and (b) MMSE values in 39 male patients with ischemic cerebrovascular stroke showing either normal or abnormal sonographic findings:

Group	Total Number Of Patients	Nihss Value					Mean Value	
		0	1-4	5-9	10-20	21-24		
Patients With Nomral Sonographic Findings	22	Initial	-	6	7	6	3	10.1
		After 15 Days	3	6	6	5	2	8
Patients With Abnormal Sonographic Findings	17	Initial	-	3	3	4	7	14.3
		After 15 Days	1	2	4	6	4	12.6

From table (a)

1- The first group was significantly responding with NIHSS mean value initially 10.1 and after 15 days was around 8 with a decline of 2.1.

2- The second group was less significantly responding with NIHSS mean value initially 14.3 and after 15 days was around 12.6 with a decline of 1.7.

3- The initial NIHSS values were higher in the second group who presented with abnormal sonographic findings.

This supports that better prognosis could be predicted in the presence of normal sonographic findings.

c) Analysis of prognosis using MMSE values in 39 male patients with ischemic cerebrovascular stroke showing either normal or abnormal sonographic findings.

Group	Total Number Of Patients	Mmse Value					
		0-10	11-20	21-25	26-30	Mean Value	
Patients With Nomral Sonographic Findings	22	Initial	3	7	10	2	18.6
		After 15 Days	2	7	4	9	21
Patients With Abnormal Sonographic Findings	17	Initial	8	2	7	-	13.6
		After 15 Days	8	2	4	3	14.5

From table (b)

1- Definitive incline of MMSE is seen in the first group.

2- The first group was significantly responding with MMSE mean value initially 18.6 and after 15 days was around 21 with an incline of 2.4.

3- The second group was less significantly responding with MMSE mean value initially 13.6 and after 15 days was around 14.5 with an incline of 0.9.

This supports that better prognosis could be predicted in the presence of normal sonographic findings.

Table (2) Analysis of prognosis using (a) NIHSS values and (b) MMSE values in 21 female patients with ischemic cerebrovascular stroke showing either normal or abnormal sonographic findings:

a)

Group	Total Number Of Patients	Nihss Value					Mean Value	
		0	1-4	5-9	10-20	21-24		
Patients With Nomral Sonographic Findings	11	Initial	-	3	6	1	1	8
		After 15 Days	1	4	4	2	-	6.1
Patients With Abnormal Sonographic Findings	10	Initial	-	1	1	4	4	16
		After 15 Days	1	-	1	4	4	15.6

From Table (a)

1- Definitive decline of NIHSS was seen in both groups.

2- The first group was significantly responding with NIHSS mean value initially 8 and after 15 days was around 6.1 with a decline of 1.9.

3- The second group was less significantly responding with NIHSS mean value initially 16 and after 15 days was around 15.6 with a decline of 0.4.

4- The initial NIHSS values were higher in the second group who presented with abnormal sonographic findings.

This supports that better prognosis could be predicted in the presence of normal sonographic findings.

b) Analysis of prognosis using MMSE values in 21 female patients with ischemic cerebrovascular stroke showing either normal or abnormal sonographic findings:

Group	Total Number Of Patients	Mmse Value					
		0-10	11-20	21-25	26-30	Mean Value	
Patients With Nomral Sonographic Findings	11	Initial	1	3	5	2	20.2
		After 15 Days	1	2	3	5	22.3
Patients With Abnormal Sonographic Findings	10	Initial	5	3	2	-	11.7
		After 15 Days	5	3	1	1	12.3

From table b)

1- Definitive incline of MMSE is seen in the first group.

2- The first group is significantly responding with MMSE mean value initially 20.2 and after 15 days is around 22.3 with an incline of 2.1.

3- The second group is less significantly responding with MMSE mean value initially 11.7 and after 15 days is around 12.3 with an incline of 0.6.

4- The initial MMSE values were lower in the second group who presented with abnormal sonographic findings.

This supports that better prognosis could be predicted in the presence of normal sonographic findings.

Table (3) Analysis of both initial and after 15 days using (a) NIHSS values and (b) MMSE values in 60 patients with different extra and intracerebral sonographic findings:

Group		Total Number Of Patients	Nihss Value					
			0	1-4	5-9	10-20	21-24	Mean Value
Patients With Normal Sonographic Findings	Initial	33	-	9	13	7	4	9.4
	After 15 Days		4	9	11	7	2	7.5
Patients With Abnormal Sonographic Findings Extracranial And Intracranial	Initial	18	-	1	3	4	10	17
	After 15 Days		-	1	4	6	7	15.5
Patients With Normal Extracranial Sonographic Findings And Abnormal Intracranial Sonographic Findings	Initial	9	-	3	1	4	1	10.7
	After 15 Days		2	1	1	4	1	10.2

a) From table (a)

1- Definitive decline of NIHSS was seen in all groups.

2- The first group representing patients with normal sonographic findings was significantly responding with NIHSS mean value initially 9.4 and after 15 days was around 7.5 with a decline of 1.9.

3- The second group representing patients with abnormal sonographic findings extra and intra was less significantly responding with NIHSS mean value initially 17 and after 15 days is around 15.5 with a decline of 1.5.

4- The third group representing patients with normal sonographic findings extra and abnormal intra

was less significantly responding with NIHSS mean value initially 10.7 and after 15 days is around 10.2 with a decline of 0.5.

5- The initial NIHSS values were higher in the second group who presented with abnormal sonographic findings extracranial and intracranial.

This supports that better prognosis could be predicted in the presence of normal sonographic findings.

b) Analysis of both initial and after 15 days using MMSE values in 60 patients with different extra and intracerebral sonographic findings:

Group		Total Number Of Patients	Mmse Value				
			0-10	11-20	21-25	26-30	Mean Value
Patients With Normal Sonographic Findings	Initial	33	4	9	16	4	19.3
	After 15 Days		3	8	8	14	21.6
Patients With Abnormal Sonographic Findings Extracranial And Intracranial	Initial	18	10	4	4	-	11.3
	After 15 Days		10	3	3	2	12.3
Patients With Normal Extracranial Sonographic Findings And Abnormal Intracranial Sonographic Findings	Initial	9	3	2	4	-	15.3
	After 15 Days		3	2	2	2	16.5

From table (b)

1- Definitive incline of MMSE is seen in all groups.

2- The first group representing patients with normal sonographic findings was significantly responding with MMSE mean value initially 19.3 and after 15 days was around 21.6 with an incline of 2.7.

3- The second group representing patients with abnormal sonographic findings extra and intra was the least significantly responding with MMSE mean value initially 11.3 and after 15 days was around 12.3 with an incline of 1.

4- The third group representing patients with normal sonographic findings extra and abnormal intra was less significantly responding with MMSE mean value initially 15.3 and after 15 days was around 16.5 with an incline of 1.2

This supports that better prognosis could be predicted in the presence of normal sonographic findings.

Table (4) Analysis of prognosis using (a) NIHSS values and (b) MMSE values in 35 patients; smokers with ischemic cerebrovascular strokes showing either normal or abnormal sonographic findings:

a)

Group		Total Number Of Patients	Nihss Value					
			0	1-4	5-9	10-20	21-24	Mean Value
Patients With Normal Sonographic Findings	Initial	17	-	2	6	5	4	12.3
	After 15 Days		1	3	5	6	2	10.5
Patients With Abnormal Sonographic Findings	Initial	18	-	2	3	3	10	16.4
	After 15 Days		-	2	3	6	7	16

From Table (a)

1- Definitive decline of NIHSS was seen in both groups.

2- The first group was significantly responding with.

NIHSS mean value initially 12.3 and after 15 days was around 10.5 with a decline of 1.8.

3- The second group was less significantly responding with NIHSS mean value initially 16.4 and after 15 days was around 16 with a decline of 0.4.

This supports that better prognosis could be predicted in the presence of normal sonographic findings.

b)

Group		Total Number Of Patients	Mmse Value				
			0-10	11-20	21-25	26-30	Mean Value
Patients With Normal Sonographic Findings	Initial	17	5	4	6	2	16.5
	After 15 Days		4	5	3	5	18
Patients With Abnormal Sonographic Findings	Initial	18	10	3	5		11.8
	After 15 Days		9	4	3	2	12.8

From table (b)

1- Definitive incline of MMSE is seen in both groups.

2- The first group was significantly responding with MMSE mean value initially 16.5 and after 15 days was around 18 with an incline of 1.5.

3- The second group was less significantly responding with MMSE mean value initially 11.8 and after 15 days was around 12.8 with an incline of 1.

4- The initial MMSE values were lower in the second group who presented with abnormal sonographic findings.

This supports that better prognosis could be predicted in the presence of normal sonographic finding.

Table (5) Analysis of prognosis using (a) NIHSS values and (b) MMSE values in 25 non-smokers with ischemic cerebrovascular stroke showing either normal or abnormal sonographic findings:

a)

Group		Total Number Of Patients	Nihss Value					
			0	1-4	5-9	10-20	21-24	Mean Value
Patients With Normal Sonographic Findings	Initial	16	-	7	7	2	-	6.1
	After 15 Days		3	7	5	1	-	4
Patients With Abnormal Sonographic Findings	Initial	9	-	2	1	5	1	12.2
	After 15 Days		2	-	1	5	1	11.5

From table (a)

1- Definitive decline of NIHSS was seen in both groups.

2- The first group was significantly responding with NIHSS mean value initially 6.1 and after 15 days was around 4 with a decline of 2.1.

3- The second group was less significantly responding with NIHSS mean value initially 12.2 and after 15 days was around 11.5 with a decline of 0.7.

4- The initial NIHSS values were higher in the second group who presented with abnormal sonographic findings.

This supports that better prognosis could be predicted in the presence of normal sonographic findings.

b)

Group		Total Number Of Patients	Mmse Value				
			0-10	11-20	21-25	26-30	Mean Value
Patients With Normal Sonographic Findings	Initial	16	-	4	10	2	21.7
	After 15 Days		-	2	5	9	24.7
Patients With Abnormal Sonographic Findings	Initial	9	3	3	3	-	14.5
	After 15 Days		3	3	1	2	15.6

From table (b)

1- Definitive incline of MMSE is seen in both group.

2- The first group was significantly responding with MMSE mean value initially 21.7 and after 15 days was around 24.7 with an incline of 3.

3- The second group was less significantly responding with MMSE mean value initially 14.5 and after 15 days was around 15.6 with an incline of 1.1.

4- The initial MMSE values were lower in the second group who presented with abnormal sonographic findings.

This supports that better prognosis could be predicted in the presence of normal sonographic findings.

Table (6) Analysis of prognosis using (a) NIHSS values and (b) MMSE values in 23 patients with ischemic cerebrovascular stroke and IHD showing either normal or abnormal sonographic findings:

a)

Group		Total Number Of Patients	Nihss Value					
			0	1-4	5-9	10-20	21-24	Mean Value
Patients With Normal Sonographic Findings	Initial	6	-	2	-	3	1	13.7
	After 15 Days		2	-	-	4	-	11.2
Patients With Abnormal Sonographic Findings	Initial	17	-	2	1	4	10	17
	After 15 Days		1	1	2	6	7	15.5

From table (a)

1- Definitive decline of NIHSS was seen in both groups.

2- The first group was significantly responding with NIHSS mean value initially 13.7 and after 15 days was around 11.2 with a decline of 2.5.

3- The second group was less significantly responding with NIHSS mean value initially 17 and after 15 days was around 15.5 with a decline of 1.5.

4- The initial NIHSS values were higher in the second group who presented with abnormal sonographic findings.

This supports that better prognosis could be predicted in the presence of normal sonographic findings.

b)

Group		Total Number Of Patients	Mmse Value				
			0-10	11-20	21-25	26-30	Mean Value
Patients With Normal Sonographic Findings	Initial	6	3	1	1	1	13.5
	After 15 Days		2	1	2	1	16.5
Patients With Abnormal Sonographic Findings	Initial	17	10	3	4	-	11
	After 15 Days		10	3	2	2	11.6

From table (b)

1- Definitive incline of MMSE is seen in both groups.

2- The first group was significantly responding with MMSE mean value initially 13.5 and after 15 days was around 16.5 with an incline of 3.

3- The second group was less significantly responding with MMSE mean value initially 11 and after 15 days was around 11.6 with an incline of 1.7.

4- The initial MMSE values were lower in the second group who presented with abnormal sonographic findings.

This supports that better prognosis could be predicted in the presence of normal sonographic findings.

Table (7) Analysis of prognosis using (a) NIHSS values and (b) MMSE values in 27 patients with ischemic cerebrovascular stroke presenting with abnormal intracranial sonographic findings; terminal ICA stenosis/occlusion, Proximal and Distal MCA stenosis/occlusion.



Table (a)

Group	Total Number Of Patients	Nihss Value					Mean Value	
		0	1-4	5-9	10-20	21-24		
Patients With Terminal Ica Stenosis/Occlusion	14	Initial	-	-	2	6	6	17
		After 15 Days	-	-	3	7	4	15.4
Patients With Distal Mca Occlusion/Stenosis	5	Initial	-	1	1	2	1	12.4
		After 15 Days	1	-	2	2	-	8.8
Patients With Proximal Mca Occlusion/Stenosis	8	Initial	-	2	-	2	4	15.6
		After 15 Days	1	1	-	3	3	14.3

From table (a)

1- Patients with terminal ICA stenosis/occlusion was less significantly responding with NIHSS mean value initially 17 and after 15 days was 15.4 around with a decline of 1.6.

2- Patients with distal MCA occlusion/stenosis was significantly responding with NIHSS mean value initially 12.4 and after 15 days was around 9 with a decline of 3.4.

3- Patients with proximal MCA occlusion/stenosis was less significantly responding with NIHSS mean value initially 15.6 and after 15 days was 14.3 around with a decline of 1.3.

This indicated that patients with distal middle cerebral artery (MCA) occlusion are likely to have a better outcome when compared to patients with proximal MCA occlusion and patients with terminal ICA occlusions.

b)

Group	Total Number Of Patients	Mmse				Mean Value	
		0-10	11-20	21-25	26-30		
Patients With Terminal Ica Stenosis/Occlusion	14	Initial	6	6	2	-	12
		After 15 Days	6	6	1	1	12.4
Patients With Distal Mca Occlusion/Stenosis	5	Initial	2	-	3	-	15.8
		After 15 Days	2	-	1	2	17.8
Patients With Proximal Mca Occlusion/Stenosis	8	Initial	5	1	2	-	10.8
		After 15 Days	5	1	1	1	11.4

From table (b)

1. The first group was less significantly responding with MMSE mean value initially 12 and after 15 days was around 12.4 with an incline of 0.4.

2. The second group responding with MMSE mean value initially 15.8 and after 15 days was around 17.8 with an incline of 2.

3. The third group responding with MMSE mean value initially 10.8 and after 15 days was around 11.4 with an incline of 0.6.

This indicated that Patients with distal middle cerebral artery (MCA) occlusion are likely to have a better outcome when compared to patients with proximal MCA occlusion and patients with terminal ICA occlusion.

**4. Discussion**

In this study analysis of prognosis using mean NIHSS values and mean MMSE values in 39 male patients and 21 female patients with ischemic cerebrovascular stroke support that better prognosis could be predicted if the initial sonographic findings are normal, we found a higher stroke incidence in

males over females in the three age groups which is consistent with the Oxford Vascular Study that showed lower ischemic stroke incidence for women than men aged 55–74 years (4). We also found that male patients have a better outcome when compared to female patients which is in agree with studies that have been done with the primary objective of examining sex differences in functional outcomes after stroke; these studies include those from Europe (30,31,32,33) and North America (34,35,36).

In our study, the analysis of NIHSS mean values and MMSE mean values in 60 patients with different extracranial and intracranial sonographic findings showed that patients with normal sonographic findings were significantly responding and have a better outcome when compared with patients with abnormal sonographic findings involving both extracranial vessels and intracranial vessels or intracranial vessels only which was previously published by Lei C et al. in 2014 where they studied the risk factors and clinical outcomes associated with intracranial and extracranial atherosclerotic stenosis and they found that Poor functional outcome and

mortality were significantly more frequent patients with intracranial stenosis and patients with both intracranial and extracranial stenosis than in the non-stenotic patients (37).

Our study also shows that better prognosis outcome could be predicted using mean NIHSS and MMSE values in non-smokers compared to smokers whether with normal or abnormal sonographic findings which is in a agree with 3 previous studies stating that smoking was not associated with a good functional outcome and that long-time smoking had a negative effect on functional outcome at discharge and mortality at 1 year which does not support the (smoking paradox) which is paradoxical benefit of smoking on functional outcome following acute ischemic stroke (38,39,40).

In this study, the analysis of prognosis using NIHSS values and MMSE values in 23 patients with ischemic cerebrovascular stroke and IHD with normal sonographic findings showed a favorable outcome while those with abnormal sonographic findings showed higher NIHSS mean values and lower MMSE values therefore both NIHSS and MMSE mean values support that better prognosis could be predicted if the initial sonographic findings are normal, also the risk for intracranial artery stenosis was significantly increased in middle-aged subjects with Coronry artery calcification compared with that in those without Coronary artery calcification (41) which was also proven by our study as 75% of patients with IHD had abnormal sonographic findings.

In our study using mean NIHSS values and MMSE values in 27 patients with ischemic cerebrovascular stroke presenting with different abnormal intracranial sonographic findings; including terminal ICA stenosis/occlusion, Proximal and Distal MCA stenosis/occlusion. It was found that patients with distal middle cerebral artery (MCA) occlusion are likely to have a better outcome when compared to patients with proximal MCA occlusion and patients with terminal ICA occlusions which is consistent with a study by Friedrich B et al. where 136 with acute stroke and MCA occlusion confirmed by CT angiography were retrospectively included in this study. The distance from the carotid T to the thrombus (DT) on coronal maximum intensity projection images and the thrombus length were measured. The correlation between DT and the modified Rankin Scale score at 90 days was analyzed. In acute stroke with MCA occlusion confirmed by CT angiography and DT <16 mm, the likelihood of a good clinical outcome after treatment with IVT was exponentially <50% (42).

## Conclusion

Early duplex findings can be very useful for prognosis in patients presenting with acute ischemic stroke and the outcome of acute cerebrovascular stroke can be predicted by duplex and associated risk factors and the premorbid condition of the patient.

Transcranial doppler and transcranial color coded duplex are non - invasive, non - ionising, inexpensive, portable and safe techniques for assessment of intracerebral blood flow.

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