Original Article

A Clinical Correlation of EEG Changes in Relation to Ischaemic Stroke on its Prognosis as per Location

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Background : Stroke is a common, potentially devastating disease with potential high morbidity and mortality. EEG (Electro-encephalogram), functional representation of electrical activity of brain, changes are closely tied to CBF (Cerebral Blood Flow). Thus EEG is useful to establish the location of Ischaemic CVA (Cerebro-vascular accident). It can also prognosticate Ischaemic stroke.

Aims & Objectives : (1) To assess the grade and severity of clinical manifestations in acute ischaemic stroke patients by clinical scoring following admission. (2) To obtain EEG findings of ischaemic stroke patients following admission and after 1 month. (3) To assess the morbidity of ischaemic stroke patients by Modified Rankin Scale after 1 month. (4) To correlate EEG changes according to the clinical outcome and according to the site of involvement of ischaemic stroke.

Materials and Methods : 90 Patients were selected during the study period as per the inclusion and exclusion criteria. Clinical scoring was done by NIHSS (National Institute of Health Scoring System). CT (Computed Tomography) scan of brain and MRI (Magnetic Resonance Imaging) Brain with DWI (Diffusion Weighted Image) extension was done. EEG findings on admission of morbidity was done by Modified Rankin Score on follow up after 1 month was noted. EEG findings after 1 month was noted on follow up. Assessment Clinical correlation was compared with EEG changes. All the data were collected and analysed by statistical software SPSS version 20.

Results : The mean MRS (Modified Rankin Score) after 1 month for abnormal EEG on admission was 4.50 in comparison to score of 3.36 in case of normal EEG. The p value of this association was 0.003 and was considered significant.

Conclusions : Normal EEG and focal slowing of EEG was mostly noted in MCA (Middle Cerebral Artery) and PCA (Posterior Cerebral Artery) infarcts involving the cortical region. Those with normal EEG findings had good clinical outcome in comparison to those with abnormal findings in EEG.

Stroke is a common disease with potential high morbidity and mortality, requiring accurate diagnosis rapidly. EEG, representation of electrical activity of neuronal network of brain, is closely related to changes in Cerebral Blood Flow. Thus EEG is closely related to changes in Cerebral Blood Flow. Thus EEG is important in establishing the site and prognostication of Ischaemic CVA.

AIMS AND OBJECTIVES

Our aims and objectives were grading the severity of clinical manifestations in acute ischaemic stroke patients by clinical scoring and to obtain EEG findings

following admission. Then to assess the morbidity by Modified Rankin Scale (MRS) and obtain EEG of them after 1 month. Lastly to correlate EEG changes according to the clinical outcome and according to the site of involvement of ischaemic stroke.

MATERIALS AND METHODS

It was an institution based descriptive study done at Medicine Ward at CNMCH, Kolkata for a period of 18 months. 90 haemodynamically stable patients, without existing neurological diseases and metabolic encephalopathy, from the age group of 18-95 years with signs of ischaemic stroke, NIHSS>4 and supportive neuro-imaging were selected. EEG findings of these patients were noted during admission and during follow up after 1 month. During follow up

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morbidity was assessed by MRS. All the data were collected and tabulated. Categorical variables are expressed as Number of patients and percentage of patients and compared across the groups using Pearson's Chi Square test for Independence of Attributes/ Fisher's Exact Test as appropriate. Continuous variables are expressed as Mean, Median and Standard Deviation and compared across the groups using Mann Whitney U test/Kruskal Wallis Test as appropriate. The statistical software SPSS version 20 has been used for the analysis. An alpha level of 5% has been taken, ie, if any p value is less than 0.05 it has been considered as significant.

ANALYSIS AND RESULTS

In our study most of the patients were in the age group of 61-70 years (45.6%), followed by the 51-60 years age group. Range of age was 51-85 years. Females were 44.4% and Males were 55.6% of the study-population. MRI of Brain with DWI extension revealed - 63.3%, 14.4%, 4.4% of the cases had MCA territory infarction, Multi-infarct state, ACA territory involvement respectively. On admission, 58.9%, 18.9%, 14.4%, 7.8% of the cases showed Normal EEG, Focal, Diffuse slowing and Multifocal slowing respectively. During follow up at 1 month, 91.8% of the cases showed Normal EEG, Focal and Diffuse slowing was noted in 4.1% cases each. The mean MRS after 1 month for abnormal and normal EEG on admission was 4.30 and 3.68 respectively, p value being 0.024 (significant). Among the abnormal EEG on admission the mean values of MRS were 3.29±0.59 and 5.77±0.44 in cases with focal slowing and diffuse slowing respectively, with p value of <0.001 (significant). The mean values of MRS were 3.36±0.8, 4.0±0, 5.0±0 in cases with normal EEG, focal slowing and diffuse slowing of EEG on follow up, with the p value of 0.006 (significant). In our study all Normal EEG on admission were focal lesions. Among abnormal EEG findings 64.86% and 35.14% were with focal lesions and Multi-infarct state respectively with p value being <0.001 (significant). During follow up all of the normal EEG was of patients with Focal lesions and abnormal EEG findings were equal among focal lesions and multi-infarct state with p value of <0.001 (significant). Our study shows 73.58% and rest of normal EEG on admission were with Subcortical lesions and Unifocal lesions respectively. Among the abnormal EEG 66.67%, 4.17% and rest were of unifocal, subcortical and multifocal lesions respectively, with p value <0.001 (significant). Our study showed 96.43% of cases with MCA territory infarct had normal EEG after 1 month in comparison to

68.42% on admission, which was statistically significant. Also 3.57% of cases with MCA infarct showed EEG with focal slowing after 1 month against 19.3% on admission, which was also considered significant. Significant improvement was also found in case of multifocal slowing of EEG in MCA territory infarct. 90.0% of PCA territory infarct showed normal EEG after 1 month against 54.55% on admission, with a significant p value. 10% of them had focal slowing after 1 month in comparison to 45.45% on admission, which was statistically significant. 91.67% of cortical lesions showed normal EEG after 1 month in comparison to 37.84% on admission with p value of <0.001 (significant). 8.33% of them showed focal slowing after 1 month in comparison to 43.24% on admission, which was statistically significant. Significant improvement change in multifocal slowing of EEG in them was also found. This study showed good clinical outcome in patients with ACA, MCA and PCA infarct. Whereas, Pontine infarct and those with Multi-infarct state showed very poor clinical outcome with high mortality. The p value of this correlation was found significant. The mean MRS after 1 month for ACA, MCA, PCA, Multi-infarct and pontine infarct respectively were 3±0, 3.44±0.91, 3.73±1.19, 5.77±0.44, 6±0. Multi-infarct state was associated with high mortality rate, whereas, cortical or subcortical lesion showed good clinical outcome according to MRS after 1 month which for cortical, subcortical and multi-infarct state respectively were 3.54±0.77, 3.7±1.34, 5.77±0.44. The p value of this study was also significant (Tables 1 & 2).

DISCUSSION

The patients in our study was between 44 to 85 years of age, with maximum patients in the group of 61-70 years (45.6% of the patients). In our study there were 55.6% males and 44.4% females. A previous study[1] showed prevalence of stroke for individuals older than 80 years is more than that of individuals of 60-79 years of age. Other studies[2,3] showed that stroke is commoner in men and most common age group was 61-70 years. In our study MCA territory infarct was commonest followed by Multi-infarct state, PCA infarct and Pontine infarct. Previous studies[4,5] revealed MCA territory was most frequently involved. On admission normal EEG was commonest finding followed by focal slowing and diffuse slowing. But in previous studies[6,7], the most common EEG finding was focal slowing (43.5%). 91.8% cases showed normal EEG on follow up, similar to a previous study[8]. In our study Abnormal EEG findings significantly decreased from 41.1% on admission

Table 1 — *Comparison of EEG findings on admission and after 1 month according to site of infarct*

		NORMAL EEG			FOCAL SLOWING			DIFFUSE SLOWING			MULTIFOCAL SLOWING		
		On Admission	After 1 month	p Value	On Admission	After 1 month	p Value	On Admission	After 1 month	p Value	On Admission	After 1 month	p Value
MRI FINDINGS	ACA INFARCT	3(75)	4(100)	0.248	1(25)	0(0)	0.248	0(0)	0(0)	NA	0(0)	0(0)	NA
	MCA INFARCT	39(68.42)	54(96.43)	<0.001	11(19.3)	2(3.57)	0.007	0(0)	0(0)	NA	7(12.28)	0(0)	0.005
	PCA INFARCT	6(54.55)	9(90)	0.046	5(45.45)	1(10)	0.046	0(0)	0(0)	NA	0(0)	0(0)	NA
	MULTI-INFARCT	0(0)	0(0)	NA	0(0)	0(0)	NA	13(100)	3(100)	1.000	0(0)	0(0)	NA
	PONTINE INFARCT	5(100)	0(0)	NA	0(0)	0(0)	NA	0(0)	0(0)	NA	0(0)	0(0)	NA

Table 2 — *Comparison of EEG findings on admission and after 1 month according to site of lesion*

		NORMAL EEG			FOCAL SLOWING			DIFFUSE SLOWING			MULTIFOCAL SLOWING		
		On Admission	After 1 month	p Value	On Admission	After 1 month	p Value	On Admission	After 1 month	p Value	On Admission	After 1 month	p Value
Lesions/ Site	Cortical	14(37.84)	33(91.67)	<0.001	16(43.24)	3(8.33)	<0.001	0(0)	0(0)	NA	7(18.92)	0(0)	0.003
	Subcortical	39(97.5)	34(100)	0.311	1(2.5)	0(0)	0.311	0(0)	0(0)	NA	0(0)	0(0)	NA
	Multiinfarct	0(0)	0(0)	NA	0(0)	0(0)	NA	13(100)	3(100)	1.000	0(0)	0(0)	NA

to 8.2% after 1 month Among all the cases discharged, 17 patients died before follow-up. The mean MRS after 1 month for abnormal EEG on admission was 4.50 that is significantly more than a score of 3.36 in normal EEG. There was significant improvement in EEG findings on follow up in comparison to that on admission in cases with MCA and PCA territory infarct. Cortical lesions also showed significant improvement in EEG findings after 1 month. Clinical outcome determined by MRS after 1 month also showed significant correlation with territory and site of infarct corroborating EEG findings. Patients with ACA, MCA and PCA infarct showed better prognosis than those with Pontine infarct and with Multi-infarct state. Simple EEG study can give an idea about the site of Simple EEG study can give an idea about the site of infarct as well as the clinical outcome. Though neuroimaging have taken an important place in determination of site of ischaemia, EEG can be used as a contemporary measure to diagnose and prognosticate this. Neuroimaging needs expensive apparatus and infrastructure whereas EEG can be done with portable machines in the remotest corners in our country. With proper training reporting can also be done locally or with the help of Telemedicine. Thus we can prognosticate cerebral infarct in a cost effective way in a resource poor country like ours.

CONCLUSION

Patients with normal EEG had better clinical outcome. Normal EEG and focal slowing of EEG was mostly noted in MCA and PCA infarcts involving the cortical region. Hence an idea about the site and vascular territory of the lesion can be determined.

Limitations of the study : As the study used small population group, it may not simulate other studies. Simple EEG recordings were done instead of Continuous EEG or Quantitative EEG. As the study was done in a tertiary care centre it may not represent the community, as mainly patients with poorer condition presents here.

REFERENCES

1 Soler EP, Ruiz VC — Epidemiology and risk factors of cerebral ischemia and ischemic heart diseases: similarities and differences. Curr Cardiol Rev 6: 2010: 138-49.

2 Appelros P, Stegmayr B, Terént A — Sex differences in stroke epidemiology. A systematic review: *Stroke* 2009; **40:** 1082–90.

3 Vaidya CV — A retrospective study of clinical profile of stroke patients from GMERS Medical College and Hospital, Gandhinagar, Gujarat: *International Journal of Clinical Trials* 2014; **1(2):** 62-6.

4 Paciaroni M, Silvestrelli G, Caso V, Corea F, Venti M, Milia P, *et al* — Neurovascular territory involved in different etiological subtypes of ischemic stroke in the Perugia Stroke Registry. *Eur J Neurol* 2003; **10(4):** 361-5.

5 Chung JW, Park SH, Kim N — Trial of ORG 10172 in Acute Stroke Treatment (TOAST) classification and vascular territory of ischemic stroke lesions diagnosed by diffusion-weighted imaging. *J Am Heart Assoc* 2014; 3(4).

6 Wolf ME — The use of routine EEG in acute ischemic stroke patients without seizures: generalized but not focal EEG pathology is associated with clinical deterioration. *Int Journal of Neuroscience* 2017; **127(5):** 421-6. Epub 2016 Jun 1.

7 Jennifer Wu — Utility of EEG measures of brain function in patients with acute stroke. *Journal of Neurophysiology*, 115(5).

8 Giaquinto S, Cobianchi A — EEG recordings in the course of recovery from stroke. *Stroke* 1994; **25(11):** 2204-9.