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ORIGINAL PAPER

Clinical and Radiological profile of stroke in children

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ABSTRACT

***IIntroduction:** Stroke in children although relatively rare, needs to be addressed separately as it frequently results in a lack of recognition and a delay in its diagnosis. The various fundamental developmental differences, varied etiological factors and multiple risk factors co-existing make the recognition and treatment of stroke in children different when compared with adults. **Method:** A prospective analysis of 82 cases of stroke in children aged between 1 month to 18 years was undertaken. Stroke was categorized into ischemic (arterial or venous) and intracerebral hemorrhage (ICH). Trial of Org 10172 in Acute Stroke Treatment (TOAST) criteria and ICH location was used to classify and stroke severity was assessed using the Pediatric National Institutes of Health Stroke Scale (PedNIHSS) and ICH score respectively. Neuroimaging (CT/ MRI) was done in all cases and were analyzed. **Results:** Hemiparesis was seen in 69 (84.2%), speech disturbance in 31 (37.8%), ataxia in 5 (6.1%) and seizures in 29 (35.4%) cases. Anterior circulation territory was involved in 60 (84.5%), the posterior circulation territory in 7 (9.9%), and both in 4 (5.6%) cases. Infections were the most common cause of stroke noted in 43 (60.6%) cases. **Conclusion:** Intracranial infection is the commonest etiology of stroke in children below 18years presenting to our hospital. Commonest type of stroke is an ischemic stroke. Most patients improve with conservative management and there is a high survival rate in childhood stroke if timely managed.*

***Keywords:** Acute ischemic stroke, stroke in children, PedNIHSS, Infections.*

INTRODUCTION

Stroke is defined by the World Health Organization (WHO) as "a clinical syndrome typified by rapidly developing signs of focal or global disturbance of cerebral functions, lasting more than 24 hours or leading to death, with no apparent causes other than of vascular origin".[1] Haemorrhagic stroke in paediatric population is more common than adults (45% vs. 10%).[2, 3] The recovery is better in pediatric population than in adults with comparable lesion, but there is a lack of a randomized controlled trial in children when compared to adults. Hence, identification of the important risk factors and a targeted clinical approach is required in childhood stroke.

No medical task exists that is more complex, more multifaceted, more important, and potentially more rewarding than caring for a stroke patient. Keeping the above facts in mind, we aim to study the various clinical and radiological profiles, the etiological factors and the outcome in childhood stroke.

METHODS

A prospective analysis of 82 cases of stroke in children occurring in patients aged between 1 month to 18 years[4] who attended Gauhati Medical College and Hospital between 2015 to 2017. The type of stroke was categorized into ischemic (arterial or venous) and ICH:

a) The arterial ischemic stroke (AIS) was defined on the basis of acute focal neurological deficit with corresponding CT or MRI evidence of infarction in an arterial territory.

b) The diagnosis of cerebral venous sinus thrombosis (CVST) was based on MR venography findings with

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evidence of thrombosis in the cerebral venous sinuses or veins.

c) Intracerebral hemorrhage was diagnosed on the basis CT or MRI with corresponding clinical findings.

The AIS was classified according to TOAST criteria.[5] The stroke severity at the time of admission was assessed using the PedNIHSS.[6] ICH score[7] was used to determine the prognosis in hemorrhagic stroke patients. Seizures were sub-classified according to the International League Against Epilepsy (ILEA) 2017.[8] An urgent Non-contrast Computed tomography (CT) scan of the head or MRI-Brain with MRA and MRV was done in all patients.

Outcome and follow-up: The outcome of stroke in children was assessed at the time of discharge from hospital and at 3 months follow-up by using Modified Rankin Scale (MRS) for children.[9]

Statistical analysis: The data collected were analyzed using licensed SPSS software version 21.

RESULTS

Among all the cases of stroke, mean age of presentation was 6.01 years. Approximately one fourth of the study subjects 22, (26.8%) belonged to age group of 6-10 years and 18(22%) cases were noted in 3-6years age group. 50 (61%) cases were males and 32(39%) cases were females with a male: female ratio of 1.6:1. More than 2/3rd (69.5%) cases were residents of rural areas.

Out of 82 cases studied, 71(86.6%) had ischemic stroke, 9(11%) had ICH **(Fig. 4)** and 2(2.4%) had CVST. Focal signs like Hemiparesis (**Table 1**) were seen in 69(84.2%) cases. Seizures were the presenting symptoms in 29(35.4%), of which Generalized Tonic-Clonic Seizures (GTCS) were seen in 26(31.7%) cases.

Anterior circulation territory was involved in 60(84.5%) cases, the posterior circulation territory in 7(9.9%) cases, and both in 4(5.6%) cases. Left Middle cerebral artery distribution was the most common vascular territory involved in ischemic stroke comprising of 26(36.7%) cases. Ischemic stroke severity was graded according to initial PedNIHSS score, 21(30%) cases were between 6-10 years age group, followed by 16(22.5%) cases between 3-6years age group.

Infections (Table 2) were the most common cause of stroke noted in 43(60.6%) cases, Cardioembolic stroke was noted in 9(12.7%) cases, a total of 3(4.2%) cases with arteriopathy were noted, six (8.5%) cases of Moyamoya disease **(Fig. 2A & 2B)**, 9 (12.7%) cases with Leukemia, 3 (4.2%) cases with mineralizing microangiopathy **(Fig.1A & 1B)** were noted.

We found Cardioembolic stroke in 9(12.7%), small vessel occlusion in 22(31%), other determined etiology like arteriopathy **(Fig.3)**, mineralizing microangiopathy, hyperlipidemia, hyperhomocysteinemia in 21(29.6%), in 19(26.8%) cases etiology could not be established because of incomplete evaluation for other inherited thrombotic disorders and genetic testing due to financial constraints. There were no patients with large artery atherosclerosis in our study.

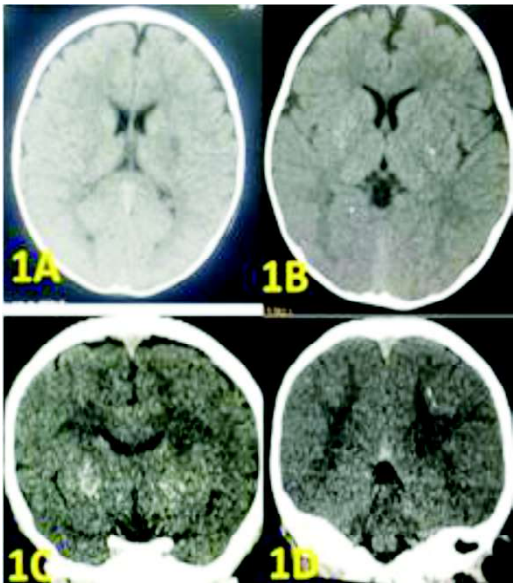

Figure 1 (1A) & (1B) Axial CT brain – hypodense area in left lentiform nucleus suggestive of infarct & punctate hyperdensity in bilateral basal ganglia region. **(1C) & (1D)** coronal reconstruction CT showing linear area of hyperdensities probably related to mineralization of lenticulostriate arteries

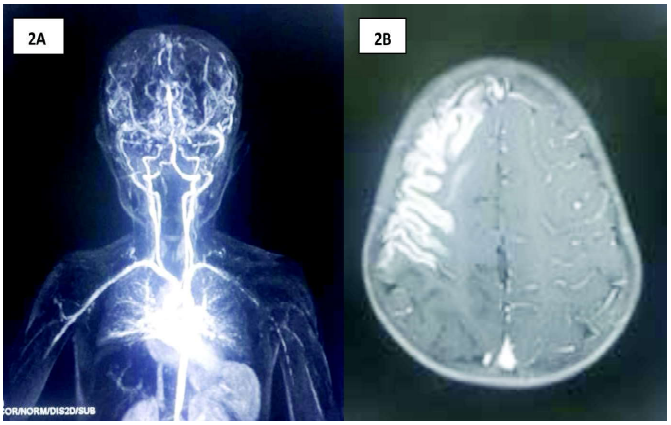

Figure (2A) MR Angiography showing features of occlusion of bilateral ICA (L>R) circulation distal to their clinoid segments with multiple collateral vessels and underlying chronic ischaemic insults. Features are s/o Moya Moya disease. **Figure (2B)** MRI-Brain post-contrast study axial section showing intense gyral enhancement noted along right fronto-temporo-parietal lobar convexity

Laboratory features:

Hemoglobin was <8gm/dl in 10 (12.2%) cases, total leukocyte count <4000 in 17 (20.7%) and >11000 in 29 (35.4%) cases. Platelet count is <20000 in 9 (11%), ESR >20mm AEFR was seen in 30 (36.6%) cases, Anti-nuclear antibody (ANA) by immunofluorescence assay (IFA) was positive in one patient. Serum homocysteine was elevated

Table 1 Analysis of neurological manifestations (n=82)

Neurological manifestations	Types	Cases No.(%)
Level of consciousness	**Conscious** **Altered sensorium**	**68 (82.9)** **14 (17.1)**
speech and language		**31 (37.8)**
Intellectual disability		**34 (41.5)**
Left Hemiparesis Right Hemiparesis Monoparesis Quadriparesis		**25 (30.5)** **44 (53.7)** **9 (11)** **4 (4.9)**
Hemidystonia		**29 (35.4)**
Seizures	Focal motor seizures with impaired awareness	3 (3.7)
	Generalized tonic-clonic seizures (GTCS)	26 (31.7)
Stroke	Hemorrhagic	9 (11)
	Ischemic	71 (86.6)
Headache	18 (22)	
Cranial nerve involvement	33 (40.2)	
Cerebellar signs	6 (7.3)	
Meningeal Signs	3 (3.7)	

Table 2 Etiologic diagnosis by age-wise distribution (n=82)

Etiology category	1month-1year	>1 – 3 years	>3 – 6 years	>6 – 10 years	>10 – 18 years	p-value
Arteriopathy	3 (3.66)	0	0	0	0	0.04
Cardiac illness						
VSD	0	2 (2.4)	1 (1.2)	0	0	0.251
Ebstein anomaly	1 (1.2)	0	0	0	0	0.026
Tricuspid atresia	1 (1.2)	0	0	0	0	0.251
Severe PS	1 (1.2)	0	0	0	0	0.038
DORV	1 (1.2)	0	0	0	0	0.383
Others			1 (1.2)	1 (1.2)		
Hyperhomocysteinemia	0	0	0	1 (1.2)	0	0.748
Hyperlipidemia	0	0	0	0	1 (1.2)	0.362
Infections	12 (14.6)	10 (12.2)	8 (9.8)	9 (11)	4(4.9)	0.043
Leukemia	1 (1.2)	1 (1.2)	2 (2.4)	3(3.7)	2 (2.4)	0.372
Moyamoya disease	0	0	4 (4.9)	2 (2.4)	0	0.044
Mitochondrial cytopathy	0	0	0	1 (1.2)	0	0.383
Mineralizing microangiopathy	0	1 (1.2)	0	1 (1.2)	1 (1.2)	0.637
CVST	0	1 (1.2)	1 (1.2)	0	0	0.251
Cryptogenic	1 (1.2)	1 (1.2)	3 (3.7)	6 (8.2)	7(9.6)	0.286

in one patient, three (3.7%) cases were detected to have TORCH infection.

Cerebrospinal Fluid (CSF) analysis was performed in 59 (72%) cases where infective etiology was suspected or in whom altered sensorium was not explained by other investigations and neuroimaging features. CSF showed pleocytosis in 12.2% with lymphocytic predominance, increased protein in 54.9% and decreased glucose in 8.5% of cases. ADA was high in 36.6% cases.

Outcome: All children with a PedNIHSS score above fifteen (9 cases) expired (MRS of 6). Out of the 73 cases who survived, 9 (13.2%) had excellent recovery with MRS-1, 26 (38.2%) had MRS-2, 2 had MRS-4 and 3 cases were lost to follow-up at 3 months.

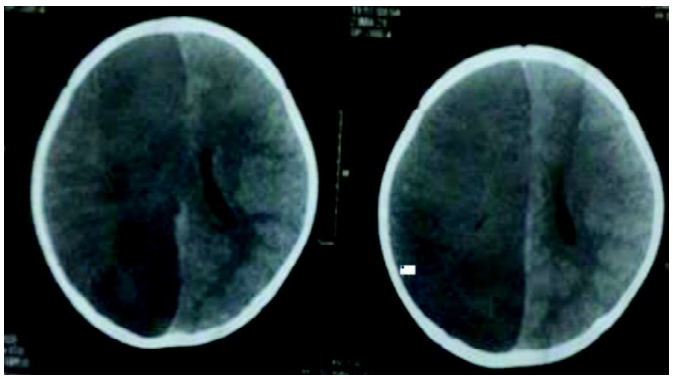

Figure 3 Axial section of CT-brain plain, showing hypodensity over right ICA territory. (A case of post-varicella infection large vessel arteriopathy)

DISCUSSION

In present study stroke was found mostly in 6-10 years age group. 61% were males with a male:female ratio of 1.6:1. This was in accordance with The International Paediatric Stroke Study group (IPSS),[10] Turkey study[11] and a Western Rajasthan study.[12] The National Institute of Neurological Disorders and Stroke report was somewhat different, where forty percent of stroke cases were under 1 year of age.[13] This could be due to the inclusion of neonates in the study who comprised about one-fourth of their study population.

stenosis or spasm initially, followed by progressive occlusion. Therefore, increased incidence of childhood stroke could be observed in rural population, as infective causes are the leading causes of stroke in children.

Birth weight of < 2.5kg was found in 25.1% cases in our study, which is in accordance with the study conducted by, R Rajeswari et al; who had 25.8% of low birth weight (LBW) babies in their study.[14] According to National Family Health Survey-4 (NFHS) 2015-16, prevalence of LBW in India is

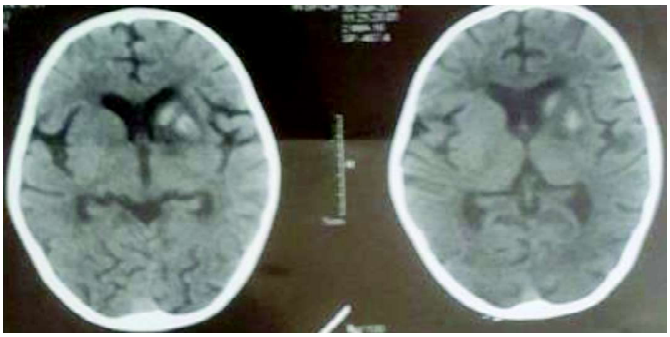

Figure 4 Axial section CT-Brain plain showing haemorrhage in left caudate nucleus with surrounding edema

18%.[15] Assessing the trend of low birth weight will be an important key to identify the predominant risk factor and intervene at the earliest.

The presenting symptoms in our study were diverse. Seventy-

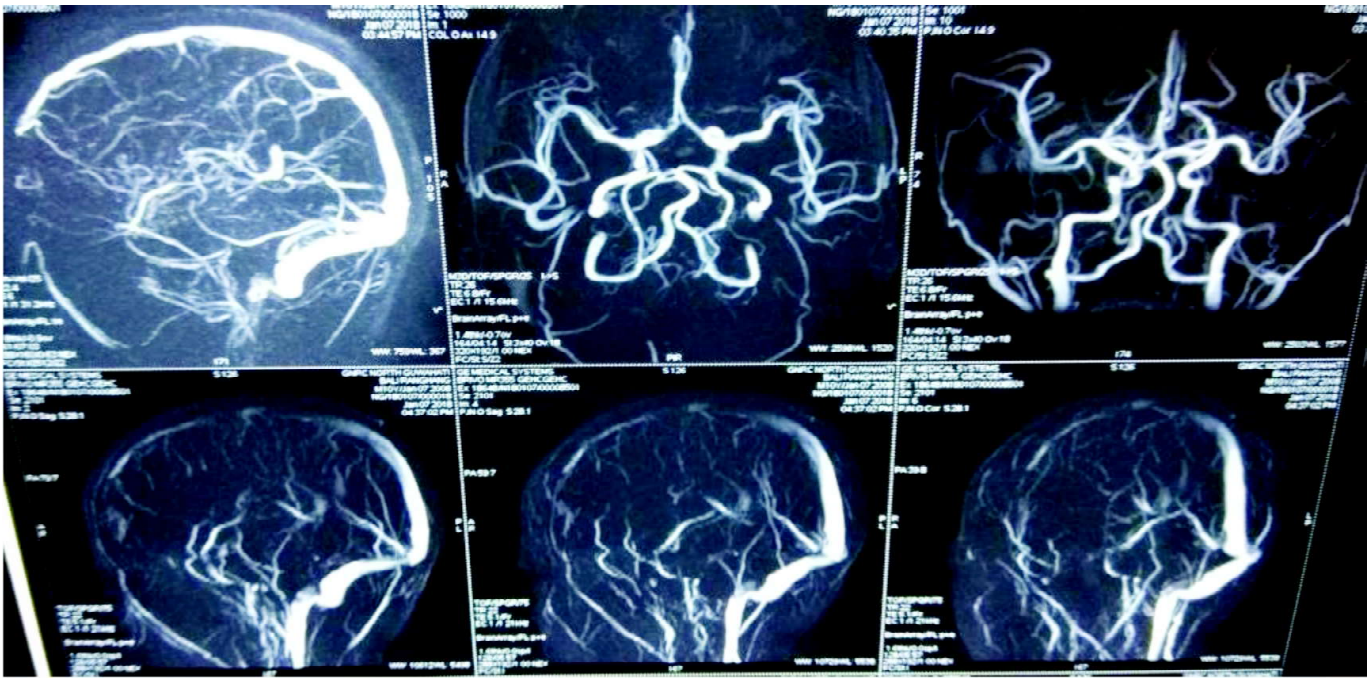

Figure 5 MR Venography reveals lack of flow within the cavernous sinuses, petrosal sinuses and ophthalmic veins bilaterally. There is lack of flow in the right sigmoid sinus

So far, there is only a limited literature discussing the rural predominance in the occurrence of stroke in children. Tuberculous meningitis (TBM) is common in people living in rural areas which can cause progressive vasculopathy with

1 (86.6%) patients had ischemic stroke suggesting it was higher in our study. Both the cases of CVST **(Fig.5)** in our study were of infective aetiology and they improved on follow-up. A study by Saima Bibi *et al*[16] correlated with our findings,

however the findings of the International Paediatric Stroke Study were contradictory from our studies.

Anterior circulation territory involvement was most common with Left middle cerebral artery distribution (MCA) comprising of 26 (36.7%) cases in our study. Sarah Buerki *et al* had anterior circulation territory stroke in 60% children.[17]

Initial PedNIHSS score between 15-20 was noted in 9(22.5%) and all 9 cases expired. High PedNIHSS score on admission was an independent predictor of unfavorable outcome. Sandra Bigi *et al* also showed High PedNIHSS/ NIHSS score on admission was an independent predictor of unfavourable outcome among children.[18]

Three (4.2%) cases with mineralizing microangiopathy, suspected on the basis of cases presenting with focal deficit following minor trauma due to lacunar stroke involving lenticulostriate vessels, coronal CT-scan brain showing evidence of calcification of these vessels. Of these, two cases were found to have high titres for CMV IgG. Other studies like N. Aydinli *et al*.[19], Siddiqui TS *et al*.[20] and Lingappa L et al.[21] found similar results.

In our study, 11% cases expired which was higher than an African study[22], J Kalita *et al*,[23] and other studies.[24-26] CNS infections were the most common cause of stroke in our study and many cases had a higher initial PedNIHSS score which could be the possible explanation for increased mortality reported in our study.

CONCLUSION

The present study has provided valuable insight into clinico-radiological profile of paediatric stroke patients. Extensive evaluation of any child with stroke is highly recommended for discovering probable risk factor and appropriate treatment. Priority should be given to identify the territory involved in the cerebral arterial circulation and identification of potentially modifiable risk factors. Most of the patients improve with conservative management and there is a high survival rate in childhood stroke if timely and appropriately managed.

This study highlights that the occurrence of stroke in children is not a rare entity as believed previously and that many more studies are needed in this area for its better management. There is a need for a large multinational studies of the risk factors for stroke in children. In view of the high recurrence rate in cryptogenic stroke, thorough diagnostic investigation at presentation and follow-up is justified, to prevent the occurrence of subsequent strokes with appropriate management.

Conflict of interest: Nil.

Ethical clearance: Taken.

Contribution of Authors: We declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by the authors.

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