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Original Article

Clinical Profile, Etiology, and Outcome of Pediatric Patients with Stroke: A Tertiary Care Hospital-based Study

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Abstract

Introduction: Stroke constitutes a significant health problem in pediatric population. The reported incidence of childhood stroke has risen to 2–6 per 100,000 children per year in the past 10 years. The estimates from North America report an incidence of 2.5–2.7 cases per 100,000 children per year, while in France, the incidence is reported to be 13 cases per 100,000 children per year. There is no population-based published data about the incidence or prevalence of pediatric stroke in India.

Objective: The objective is to study the clinical profile, etiology, and outcome of pediatric patients with stroke admitted to our hospital.

Material and Methods: This was a prospective observational, single-center study designed to study the clinical profile, etiology, and outcome of pediatric stroke patients in Kashmir conducted in the Postgraduate Department of Pediatrics, GMC Srinagar. All children aged 6 months to 18 years of age were included in the study. Children aged <6 months or >18 years and children with a history of head injury were excluded from the study. All included children were evaluated clinically and necessary investigations were done after taking proper informed consent. The present study was conducted over 1 year. On examination, general physical examination and neurological examination were done. The presence of edema, jaundice, cyanosis, lymphadenopathy, petechial hemorrhage, purpura, bruit, cardiac findings, and hepatosplenomegaly was noted. Admission vital parameters (heart rate, blood pressure, and respiratory rate), consciousness as assessed by the Glasgow Coma Scale (GCS), and focal neurological deficit (monoplegia, hemiplegia, quadriplegia, aphasia, visual field defect, cranial nerve palsy, and sensory abnormalities) were noted. Neuroimaging (either CT or MRI) of the brain was performed for each patient. The location and arterial territory of infarction were noted.

Results: It was a prospective hospital-based observational study conducted over a period of 1 year. A total of 38 patients were enrolled in the study. There were 21 males and 17 females in our study. The mean age of presentation in our study was 6.43 years. Majority of patients in our study were in the age group of 6 months–4 years (50%). Seizures (focal + generalized) were the most common presenting feature in our study. Consciousness was impaired in most patients in our study. The most common infectious cause of stroke was meningoencephalitis followed by neurotuberculosis. Hemiparesis was the most common neurological deficit. MCA was the most common territory involved on arterial ischemic stroke. The most common type of stroke was found to be arterial ischemic stroke.

Conclusion: The current study has provided valuable information into the pediatric strokes clinical profile, etiology, and outcome. This study further strengthens the observation that AIS is the most common type of stroke in children at all ages, followed by CSVT and hemorrhagic variety. The study further confirms that MCA is the most common territory involved. Thereby, the presentation of stroke more or less is same in different parts of the world. However, there is a difference in etiology which may be due to underlying genetic and environmental factors. Survivors have high morbidity and moderate-to-severe neurologic deficits are common.

Key words: Stroke, Etiology, Moyamoya, Embolism, Neurotuberculosis, Hemiparesis

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INTRODUCTION

Stroke constitutes a significant health problem in pediatric population. The reported incidence of childhood stroke has risen to 2–6 per 100,000 children per year in the past 10 years.[1] The estimates from North America report an incidence of 2.5–2.7 cases per 100,000 children per

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year,[2,3] while in France, the incidence is reported to be 13 cases/100,000 children per year.[4] There is no population-based published data about the incidence or prevalence of pediatric stroke in India. The identification of etiology and risk factors of childhood stroke is important as many of these are age and population specific.

Stroke is a known complication of acute infections of central nervous system. In such situations, either direct inflammation of blood vessels or hematological disturbances causing hypercoagulable state cause ischemic injury.[13] The common CNS infections associated with stroke can be categorized into viral, bacterial, parasitic, and fungal in origin.[14] Cardiac diseases whether congenital or acquired constitute a significant risk factor for stroke.[15-17] Hypernatremic dehydration and systemic hypotension are also known to cause childhood strokes.[18] A variety of congenital cerebrovascular anomalies such as Sturge–Weber Syndrome, intracranial aneurysm, and arteriovenous malformations are also potential risk factors.[19-21]

Childhood stroke is a disorder bearing poor prognosis as evidenced by the fact that up to 50% patients develop chronic sequelae.[22] One European study[23] used convenience sampling to study pediatric hemorrhagic stroke of any etiology and described recurrences in 9 of 56 (16%) during a mean of 10.3 years of follow-up. However, this studies did not present recurrence rates or predictors of recurrence. For a family whose child has experienced a hemorrhagic stroke, recurrence risk often becomes the dominant question, but medical providers lack data needed to provide such counseling outside the setting of the specific etiologies mentioned above.

There is some evidence from adult studies that Asians are at higher risk of primary intracerebral hemorrhage and ischemic stroke.[24] However, there is a paucity of data on childhood stroke in Asian patients.

Objectives

The objective is to study the clinical profile, etiology, and outcome of pediatric patients with stroke admitted to our hospital.

MATERIAL AND METHODS

The study was conducted at the Post Graduate Department of Pediatrics in GB Pant Hospital, an associated hospital of Government Medical College, Srinagar. This study was a hospital-based prospective observational study conducted from April 1, 2016, to March 31, 2017. The study was approved by ethical committee of Government Medical College, Srinagar. This was a prospective observational, single-center study designed to study the clinical profile, etiology, and outcome of pediatric stroke patients in Kashmir.

Inclusion Criteria

All children aged 6 months–18 years of age fulfilling the criteria of stroke were included in the study.

Exclusion Criteria

Age of child <6 months or >18 years and all children with history of head injury were excluded from the study.

Source of Data

All children between age group of 6 months–18 years attending the Post Graduate Department of Pediatrics in GB Pant Hospital, who were admitted and satisfying the inclusion criteria were evaluated clinically and necessary investigations were done after taking proper informed consent. The present study was conducted over 1 year.

Definitions and Diagnostic Criteria Used in the Study

- Stroke was defined as a sudden-onset, focal, neurologic deficit resulting from focal, ischemic, or hemorrhagic damage to the brain parenchyma secondary to a cerebrovascular disorder.[30]
- Ischemic stroke was defined on the basis of the sudden onset of a neurologic deficit, localized to the brain, that lasted more than 24 h, with accompanying computerized axial tomography (CT) or magnetic resonance imaging (MRI) findings or results showing changes consistent with brain infarction.[3]
- Intracerebral hemorrhage was defined on the basis of clinical history and examination findings consistent with intracerebral hemorrhage (sudden onset of headache, changes in the level of responsiveness, or focal neurologic deficit), accompanied by a focal collection of blood within the brain parenchyma on CT scans or MRI scans.[30]
- Sinovenous thrombosis was defined on the basis of clinical history and examination findings consistent with sinovenous thrombosis (seizure, lethargy, or focal neurologic deficit), with evidence of thrombosis in cerebral veins or sinus on CT scans or MRI scans.[29]

All patients satisfying the above criteria for stroke were taken as cases and information collected on a proforma after taking informed consent.

Patients admitted with stroke were evaluated beginning with a proper history and clinical examination with special emphasis on neurological examination followed by investigations.

The patients' demographic data (age, gender, area of residence, and religion) were recorded. The history of presenting complaints such as fever, headache, vomiting, seizure, joint pain, skin rash, dyspnea, diarrhea, palpitation, anemia, and bleeding diathesis was noted.

Other information collected from these patients included family history of stroke, drug history (including use of recreational drugs), presence of infection, head injury, or any associated systemic or neurologic diseases.

On examination, general physical examination and neurological examination were done. The presence of edema, jaundice, cyanosis, lymphadenopathy, petechial hemorrhage, purpura, bruit, cardiac findings, and hepatosplenomegaly was noted. Admission vital parameters (heart rate, blood pressure, and respiratory rate), consciousness as assessed by Glasgow Coma Scale (GCS), and focal neurological deficit (monoplegia, hemiplegia, quadriplegia, aphasia, visual field defect, cranial nerve palsy, and sensory abnormalities) were noted.

Neuroimaging (either CT or MRI) of the brain was performed for each patient.

The location and arterial territory of infarction were noted.

All imaging studies were reviewed by the consultant radiologist at our hospital. Patients who did not satisfy the clinical and radiologic diagnostic criteria for stroke were excluded from the study. The cases of stroke were classified as arterial ischemic stroke, hemorrhagic stroke, and cerebral sinus venous thrombosis, according to the diagnostic criteria described previously.

Statistical Analysis

Data were entered in a Microsoft Excel spreadsheet. Continuous variables were summarized as mean and categorical variables were summarized as frequency and percentage. Data were analyzed by MedCalc version 17.

RESULTS

It was a prospective hospital-based observational study conducted over a period of 1 year. A total of 38 patients were enrolled in the study. Arterial ischemic stroke was seen in 32 (84.2%) patients (17 males and 15 females) and cerebral sinovenous thrombosis was seen in 3 (7.8%) patients (2 males and 1 female). Hemorrhagic stroke was seen in 3 (7.8%) patients (2 males and 1 female). Majority of our patients, i.e., 19 (50%) were 6 months to 4 years of age, followed by 10 (26.3%) patients ageing 10–14 years. In our study, male children were more than female children, with male constituting 21 (55.3%) and female children constituting 17 (44.7%). Seizure was the major presenting symptom in 26 (68.4%) patients. Fever was presenting symptom in 7 (18.4%) patients, while as hemiparesis was presenting symptom in 4 (10.5%), facial palsy and headache were presenting symptom seen in 3 (7.9%) patients each, and 2 (5.3%) patients came with vomiting as presenting symptom. On admission, out of a total of 38 patients, consciousness was impaired in 27 (71.1%) patients while as 11 (28.9%) patients were conscious. Infectious etiology was found in 12 (31.6%) cases including neurotuberculosis in 6 (15.8%), encephalitis in 3 (7.9%), and meningitis in 3 (7.9%). Cardiac etiology was found in 4 (10.5%) of cases including atrial septal defect in 2 (5.3%), dilated cardiomyopathy in 1 (2.6%), and tetralogy of fallot in 1 (2.6%). Hematolgic etiology was found in 2 (5.3%) including Wiskott–Aldrich syndrome in 1 (2.6%) and fanconis anemia in 1 (2.6%). Prothrombotic conditions as etiology were found in 3 (7.9%) including Protein C deficiency in 2 (5.3%) and protein S deficiency in 1 (2.6%). Vascular etiology in the form of moyamoya disease was found in 2 (5.3%) whereas no cause could be determined in 15 (39.5%) of cases. On discharge, there were 28 (73.7%) patients with hemiparesis as the neurological deficit followed by 4 (10.5%) patients with facial palsy, and quadriparesis was seen in 2 (5.3%) patients. Slurring of speech, dystonia, and monoparesis were seen in 1 (2.6%) patient each. Neurological deficit was present in 32 (84.2%) of the patients, 3 (7.9%) patients expired while as 3 (7.9%) patients had no neurological deficit. MCA territory was involved in 75% of the cases with arterial ischemic stroke including left MCA in 34.2% of cases and right MCA in 28.9% of cases. Furthermore, left MCA + ACA was involved in 5.3% of cases. Left MCA + PCA + ACA, left PCA, right ACA, right MCA + PCA, right MCA + ACA, and bilateral ACA were involved in 2.6% patients.

DISCUSSION

Arterial ischemic stroke was seen in 32 (84.2%) patients (17 males and 15 females) and cerebral sinovenous thrombosis in 3 (7.8%) patients (2 males and 1 female). Hemorrhagic stroke was seen in 3 (7.8%) patients (2 males and 1 female).

These results are comparable with the study conducted by Kalita *et al*. (2013) 42 from a tertiary care medical center in North India in which 78.5% patients had arterial ischemic stroke (AIS), 12.7% intracerebral hemorrhage (ICH), and 8.9% had cerebral venous sinus thrombosis (CVST).

As in the literature reports, ischemic stroke was more common than hemorrhagic stroke. Isolated reports have reported that hemorrhagic and ischemic strokes are equally common.[3] These suggest that the stroke subtypes vary between populations, probably also depending on the distribution of risk factors.

Majority of our patients, i.e., 19 (50%) were 6 months to 4 years of age, followed by 10 (26.3%) patients ageing 10–14 years. 6 (15.8%) patients were 5–9 years while as only 3 (7.9%) patients were 15 years or above. Mean age of presentation in our study was 6.43 years. The results were comparable with the findings of study conducted by Chung *et al*. in Hong Kong in 2004 in which the mean age at presentation was 5.6 years.

In our study, male children were more than female children with male constituting 21 (55.3%) and female children constituting 17 (44.7%). The results were comparable with the findings of study conducted by Lee *et al*. (2012) in Korea in which 53.2% (33) of subjects were boys and 46.7% (29) of subjects were girls. Multiple studies have suggested that pediatric stroke may be more common in boys than in girls. A population-based Californian study relying on administrative data found that boys had a higher incidence of childhood (non-neonatal) stroke than girls for both ischemic and hemorrhagic stroke subtypes with a relative risk of 1.25 (95% CI, 1.11–1.40) for ischemic stroke.

Data from studies of childhood arterial ischemic stroke and cerebral sinovenous thrombosis from Europe, Israel, Argentina, and Turkey also showed a male predominance, although it was not always statistically significant.

Seizure was the major presenting symptom in 26 (68.4%) patients. Fever was presenting symptom in 7 (18.4%) patients, while as hemiparesis was presenting symptom in 4 (10.5%), facial palsy and headache were presenting symptom seen in 3 (7.9%) patients each, 2 patients came with vomiting as presenting symptom, 1 (2.6%) had dysphagia, 1 (2.6%) had hemisensory loss, 1 (2.6%) had aphasia, and 1 had (2.6%) slurring of speech.

These results were comparable with the study conducted by Bibi *et al*. (2011) in Pakistan in which seizures were they most common presenting feature in 28 (60.86%), and fever was the second most common presenting feature in 56.52%, while 26.08% had cranial nerve involvement as the third most common presenting feature.

Chung *et al*. conducted a similar study in Hong Kong in 2004 in which seizures (52%) were the most common presenting features which were comparable to our study.

Out of a total of 38 patients, consciousness on admission was impaired in 27 (71.1%) patients while as 11 (28.9%) patients were conscious. These results are in conformity with the findings of Patra *et al*. (2015)[44] in which altered consciousness was found in 85.7% of the patients. However, consciousness was impaired in only 43.2% of the patients in a study conducted by Parakh *et al*. (2014).[43]

Approximately 50–80% of children with stroke have at least one identifiable risk factor/etiology. In our study, a known etiology for stroke was found in 60.05% (23) of cases (infectious etiology was found in 12 cases, cardiac etiology was found in 4 cases, hematologic etiology was found in 2 cases, prothrombotic conditions were found in 3 cases, and vascular etiology was found in 2 cases). This was comparable to the results of study conducted by Parakh *et al*. (2014)[43] in which co-morbid conditions were seen in 58% patients. This was also comparable to the study conducted by Masri *et al*.[45] in Jordan in 2015 in which a known etiology for stroke was found in 58.3% patient.

In our study, infectious etiology was found in 12 (31.6%) cases including neurotuberculosis in 6 (15.8%), encephalitis in 3 (7.9%), and meningitis was found in 3 (7.9%) of patients. This was comparable to the results of study conducted by Parakh *et al*. (2014)[43] in which infection was the most common etiology seen in patients with stroke accounting for 30% of cases (including neurotuberculosis in 22% and viral encephalitis in 8%). Similar results were found in another study conducted by Bibi *et al*. (2011)[39] in which infections were the most common cause. A study by Siddiqui *et al*. from Abbottabad reported intracranial infection as the most common etiology of stroke in their study, like ours. In developing countries, infection is one of the most common causes of childhood stroke.[13-15]

In contrast to our study, studies by Lee *et al*.[41] showed vasculopathy (35.5%) as the most common cause, and intracranial infection was placed 4th in frequency in their study. Another Asian study by Lee *et al*.[36] also showed vascular etiology (33%) as most common and intracranial infection was found to be next most common.

Inflammatory mechanisms that accompany infections can stimulate coagulation by several pathways. These include expression of thromboplastin by monocytes and macrophages increased serum level of tumor necrosis factor which can affect pro-coagulant function of endothelium, inhibition of protein C and protein S anticoagulation systems, and increased levels of clotting factors such as fibrinogen. Thus, there can be a significant chance of overlap between infective and vascular etiologies, as the mechanism of stroke in intracranial infection is often some form of vascular catastrophe.

Cardiac etiology was found in 4 (10.5%) of cases including atrial septal defect in 2 (5.3%), dilated cardiomyopathy in 1 (2.6%), and Tetralogy of Fallot in 1 (2.6%). This was comparable to the results of study conducted by Parakh *et al*. (2014)[43] in which cardiac etiology was found in 6% of cases (dilated cardiomyopathy in 2% and acyanotic congenital heart diseases in 4%).

Long-standing cyanotic lesions cause polycythemia and anemia, which both increase the risk of thromboembolism and cerebral infarction. Embolic clots can arise in children with cardiomyopathies, rheumatic heart disease, prosthetic valves, or valvular vegetation from endocarditis. A patent foramen ovale (PFO) can occur in as many as 35% of people between ages 1 and 29 years and may serve as a portal for venous embolic events to pass from the right to left side of the heart.

In our study, prothrombotic conditions as etiology were found in 3 (7.9%) including protein C deficiency in 2 (5.3%), and protein S deficiency in 1 (2.6%). Hematolgic etiology was found in 2 (5.3%) including Wiskott–Aldrich syndrome in 1 (2.6%) and fanconis anemia in 1 (2.6%). These results are comparable with the findings of Patra *et al*. (2015)[44] in which hematologic and prothrombotic conditions were found in 11.8% of cases).

In contrast to our study, prothrombotic disorders have been identified in 30–76% in various studies conducted in the west. This may be due to higher contribution of infections to etiology in Asian studies.

In our study, vascular etiology in the form of moyamoya disease was found in 2 (5.3%). This was comparable to the results of study conducted by Parakh *et al*. (2014)[43] in which moyamoya was found in 4% of patients.

Etiology of stroke in children is diverse in different studies because of variation in inclusion and exclusion criteria and various genetic and environmental differences.

On discharge, there were 28 (73.7%) patients with hemiparesis as the neurological deficit followed by 4 (10.5%) patients with facial palsy, and quadriparesis was seen in 2 (5.3%) patients. Slurring of speech, dystonia, and monoparesis were seen in 1 (2.6%) patient each, respectively. These results are comparable with the findings of Patra *et al*. (2015)[44] in which hemiparesis (70.6%) was the most common neurological deficit. Furthermore, similar results were obtained in study conducted by Parakh *et al*. (2014)[43] in which hemiparesis was the most common (66%) neurological deficit followed by facial palsy (26%).

In our study, on discharge, neurological deficit was the outcome in 32 (84.2%) of the patients, 3 (7.9%) patients expired while as 3 (7.9%) patients had no neurological deficit. The results in our study are comparable with the study conducted by Parakh *et al*. (2014)[43] in which on discharge, 66% patients had neurological deficit (mild, moderate, and severe) and 8% patients expired.

In our study, MCA territory was involved in 75% of the cases with arterial ischemic stroke. MCA + PCA territory was involved in 7.9% of the patients while as MCA + ACA territory was involved in 5.3% of the patients. Similar results were found by Parakh *et al*. (2014)[43] in their study in which middle cerebral artery (MCA) was the most common territory involved at all ages; however, it was only in 45.6% cases of AIS.

CONCLUSION

The current study has provided valuable information into the pediatric stroke clinical profile, etiology, and outcome. In the developing world scenario, meningoencephalitis and neurotuberculosis are an important comorbidity seen with pediatric stroke. This study further strengthens the observation that AIS is the most common type of stroke in children at all ages, followed by CSVT and hemorrhagic variety. The study further confirms that MCA is the most common territory involved. Thereby presentation of stroke more or less is same in different parts of the world. However, there is difference in etiology which may be due to underlying genetic and environmental factors. Survivors have high morbidity and moderate-to-severe neurologic deficits are common.

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