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A study of anatomical, seasonal and diurnal variation in the occurrence of ischemic stroke

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ABSTRACT

Introduction: Stroke is the third largest cause of mortality in India after heart attack and cancer. The stroke mortality rates are declining or stabilising in developed countries but there is concern over the emerging epidemic of stroke in India. Study of topographical distribution, seasonal and temporal variations in occurrence of ischemic stroke provides insight into factors that trigger onset of stroke which might lead to more rational treatment.

Objective: To assess and categorize anatomical distribution of ischemic strokes, seasonal and diurnal variations in occurrence of stroke.

Method: A retrospective analysis of MRI data of patients of Jabalpur Diagnostic Center, Jabalpur M.P. India who were enrolled during 1st January 2010 to 31st December 2010 was performed. The Demographic and medical history from the patients who met WHO criteria for stroke and had undergone MRI were collected and analyzed. We examined MRI data to find out early and late signs of IS and determine topography (cerebral arterial territory). Study subjects were categorized into three groups: young (<40 years), middle age (41-65 years) and elderly (>65 years). Season was categorized as: winter (December–February); summer (March–May); monsoon (June–August); and post monsoon (September-November). Time of onset of ischemic stroke was defined as the time when neurological symptoms were first noticed. It was divided into four subgroups: night (00:00–05:59 hours), morning (06:00-11:59), noon (12:00-17:59) and evening (18:00-23:59). Association between topographical distribution, season, and time of stroke onset were derived.

Result: A total of 216 subjects were included (59.3% males and 40.7% females) with median age observed at 58 years (range: 20-80 years). Middle cerebral arterial territory (MCA) was the most commonly affected (38.9%) followed by posterior cerebral artery (PCA) 13%, brainstem 13%, anterior cerebral artery (ACA) lesion in 11.1%, multiple vessel territory 9.3%, small vessel infarcts in 8.4% and cerebellum 6.5%. The rate of occurrence of stroke (33.3%) was highest in morning (0600–1159 hours) irrespective of gender or age of the patient. Summer season recorded significantly higher frequency of IS with 35.2% ($P<0.05$) followed by winter 27.8%, post monsoon 20.4% and monsoon 16.7%. The young (50.0%) and middle (55.6%) age group cases showed a peak incidence of ischemic stroke in summer, while in elderly age (43.4%)group the highest ischemic stroke incidence were reported in winter .

Conclusion: Acute ischemic stroke displays seasonal and diurnal characteristics according to gender, age group and anatomical distribution. These results may have important clinical implications in ischemic stroke prevention.

Keywords: Stroke, magnetic resonance imaging, seasons

Introduction

Stroke is the third largest cause of mortality in India after heart attack and cancer. The stroke mortality rates are declining or stabilising in developed countries but there is concern over the emerging epidemic of stroke in India. As life expectancy is projected to increase, India will likely face a significant socioeconomic burden to meet the costs of managing stroke [(1)].Reliable morbidity and mortality estimates for stroke in India are limited due to incomplete death certification, incorrect death classification, and uncertainty of aetiology in cases of sudden death or multiple co-morbidities[(2)].Several population based surveys on stroke have been conducted in various parts of India. The crude prevalence rates have shown variation according to the regions. Overall age adjusted prevalence rate for stroke is estimated to lie between 84-262/100,000 in rural and between 334-424/100,000 in urban areas [(3)].

Broadly stroke can be classified into ischemic (87%) and haemorrhagic (13%) types [(4)]. The most widely accepted classification of ischemic stroke is based on TOAST criteria which divides ischemic stroke into five categories, namely—large artery atherosclerosis, cardioembolism, small vessel occlusion (lacunar infarction), undetermined etiology and multiple possible etiologies[(5,6)] Another method of classification is modified Oxfordshire method, based on the anatomic distribution of infarcts-- total anterior circulation infarcts, partial anterior circulation infarcts, posterior circulation infarcts, watershed infarcts, centrum ovale infarcts and lacunar infarcts.[(7,8)]

Studies have been carried out to estimate the diurnal and seasonal variation of stroke and asses the various influencing factors. Our study is an attempt to asses these variation in a tropical region.

Objective

The aim of our study is to assess and categorize ischemic stroke according to anatomical distribution, seasonal and diurnal variation.

Material and Method

We conducted a retrospective analysis of MRI data of 216 patients who were enrolled at Jabalpur Diagnostic Centre, Jabalpur (MP), India for a period of one year, from 1st January 2010 up to 31st December 2010.Permission was obtained from NSCB Medical College ethical committee. We took medical and demographic history of the patients who met WHO criteria for stroke [(19)]. The MRI images obtained were assessed by the radiologist and we included only the patients with ischemic stroke and excluded those with intraparenchymal or subarachnoid haemorrhage.

The study subjects were categorized into 3 groups: young (<40 yrs), middle age (41-65yrs) and elderly (>65yrs). Season was divided as winter (December-February), summer (March-May), monsoon (June-August) and post monsoon (September-November). The time of onset of ischemic stroke was defined as the time when neurological symptoms first appeared. It was divided every 6hrly—night (00:00-05:59hrs), morning (06:00-11:59hrs), noon (12:00-17:59hrs) and evening (18;00-23:59hrs).

Statistical analysis was done using Statistical Package for Social Science (SPSS-17).For comparing multiple groups ANOVA was applied and for comparing two groups t-test was applied. The critical level of significance was considered at 0.05 level ($p<0.05$).

Results

A total of 216 subjects were included out of which 59.3% were males and 40.7% females with median age observed at 58years (range-20 to 80years).Middle cerebral arterial territory was the most commonly affected (38.9%) followed by posterior cerebral artery 13%, brainstem 13%, anterior cerebral artery lesion in 11.1%, multiple vessel territory 9.3%, small vessel infarcts in 8.4% and cerebellum 6.5%. The rate of occurrence of ischemic stroke (33.3%) was highest in morning (0600–1159 hours) irrespective of gender or age of the patient. Summer season recorded significantly higher frequency of ischemic stroke with 35.2% ($P<0.05$) followed by winter 27.8%, post monsoon 20.4% and monsoon 16.7%. The young (50.0%) and middle (55.6%) age group cases showed a peak incidence of stroke in summer, while in elderly age (43.4%) group the highest stroke incidence was reported during winter season.

Discussion

Higher occurrence of Ischemic Stroke in the morning hours as observed in our study could be attributed to large morning increase and a drop during the night for various phenomena that are related with hemodynamic and thrombogenesis, such as systolic and diastolic blood pressure [20,21], heart rate [22], plasma catecholamine [23], platelet aggregability [24], and fibrinolytic activity [25]. The diurnal variation in these parameters does not seem to be determined by an endogenous circadian rhythm, but rather through changes in physical activity over the 24-hour period. Arrhythmogenic action due to sympathetic nervous system activation during morning awakening is accompanied by hemodynamic changes via an increase in blood pressure and heart rate and by parallel phenomena related with thrombogenesis and fibrinolysis. Conversely, intrinsic plasminogen activity is at its lowest level at the time of awakening. These phenomena can explain the instigation of atrial fibrillation during awakening (via sympathetic activation), the creation of thrombi (thrombogenic mechanisms), as well as their transportation from the heart to the brain (hemodynamic changes).Some previous studies have also found higher occurrence of ischemic stroke during morning hours [26,27].

We found increased incidence of ischemic stroke in young subjects during summer which can be explained by hypothesis that since young individuals are more outdoors for work hence likely to be more exposed to heat [28,29] which causes excessive sweating and dehydration. This leads to hyperviscosity and platelet aggregation. This is in contrast to studies carried in temperate regions showing higher incidence of IS in all age groups during winter season [26].

In our study higher proportion of ischemic stroke in elderly age group was found during winter. It is known that exposure to cold causes peripheral vasoconstriction and increase in blood pressure.[30,31] Furthermore, total cholesterol and triglycerides tend to be higher in winter than in summer.[32] Perhaps most importantly, plasma fibrinogen concentration and viscosity show considerable seasonal variations, at least in elderly persons [33,34], and there is evidence that fibrinogen is a significant predictor of stroke[34] There is also increased susceptibility to infection in this age group during winter. The infection in turn causes increased levels of fibrinogen and anticardiolipin antibodies and decreased levels of protein C which results in hypercoagulable state thus laying the foundation for thrombus formation and embolic stroke.

There are many advantages of our study. Previous studies of ischemic stroke were analyzed by CT scan. Thus there was a possibility of missing out small cortical infarcts which might influence the interpretation of stroke mechanism.[9,10,11,12,13,14,15,16,17,18] With the use of newer radio diagnostic modalities like MRI, we were able to get the best estimation of stroke topography, size, stroke contour and also volumetric analysis. Our study is an endeavour to understand the factors that trigger the onset of stroke which in turn can lead to more rational treatment. MR-based perfusion and diffusion-weighted imaging methods provide a technology by which to intravitally partition zones of ischemia that are potentially salvageable and those that are not salvageable. The potential of such technology as an aid to real-time immediate therapeutic decision making and to longer-term predictions of outcome may be expected to substantially affect stroke medicine.

Given the increasing incidence of ischemic stroke during early morning, encouraging physicians to widen the use of long acting antihypertensive drugs would contribute significantly to the primary prevention of ischemic stroke. Also young individuals who are prone to develop hypercoagulable state should be advised to take precautions against dehydration during summer season. Our study showed peak incidence of ischemic stroke during summer and winter season hence screening tests like carotid doppler, an inexpensive modality and blood tests for cholesterol, triglycerides etc. can be carried out in high risk individuals during these seasons. As MCA territory was most commonly involved (38.9%) and embolism is the main culprit, most of the emboli originate in carotid artery or heart, hence carotid doppler and echocardiography can prove to be beneficial in these cases.

Due to variation in the weather conditions and temperature in various regions of India and world the association between various factors considered in our study might vary according to geographical distribution. This indicates the need for multicenter studies to asses the impact of these factors on prevalence of stroke. Further prospective studies with serial assessment of modifiable risk factors like BP, cholesterol, triglycerides can be carried out during peak season in high risk individuals to understand whether these risk factors are implicated in the pathogenesis of ischemic stroke. Studies should be done to ascertain the relationship between seasonal and diurnal patterns in occurrence of intraparenchymal bleed as well.

Conclusion

Acute ischemic stroke displays seasonal and diurnal characteristics according to gender, age group and anatomical distribution. These results may have important clinical implications in stroke prevention.

Conflict of Interest: None declared.

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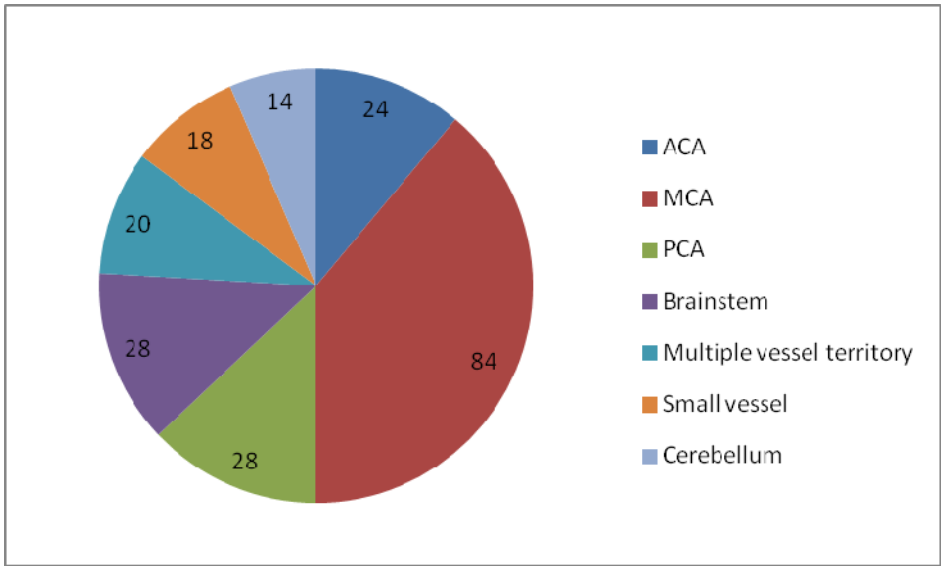

Figure 1: Frequency of infarcts according to anatomical distribution

Key: ACA (Anterior Cerebral Artery), MCA (Middle Cerebral Artery), PCA (Posterior Cerebral Artery)

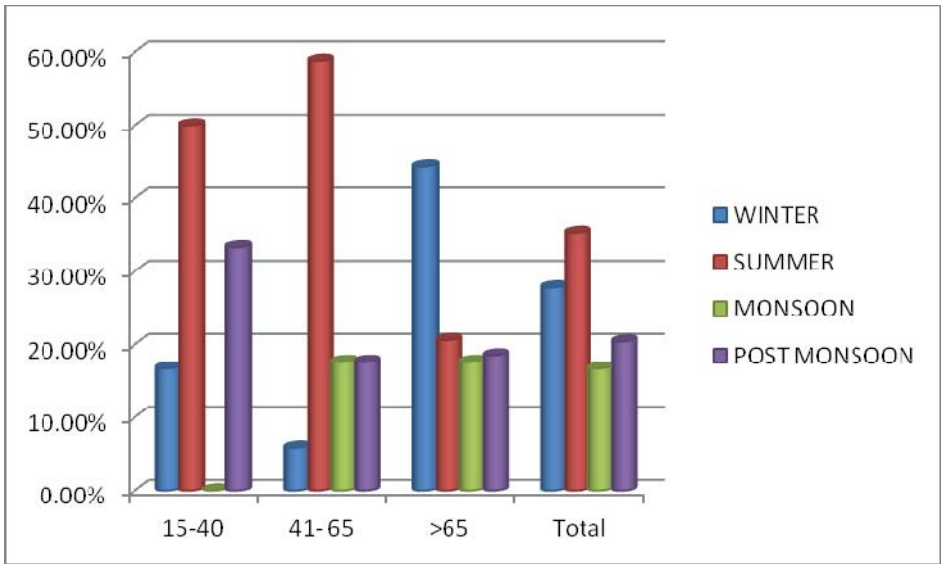

Figure 2: Seasonal variation of ischemic stroke according to age group

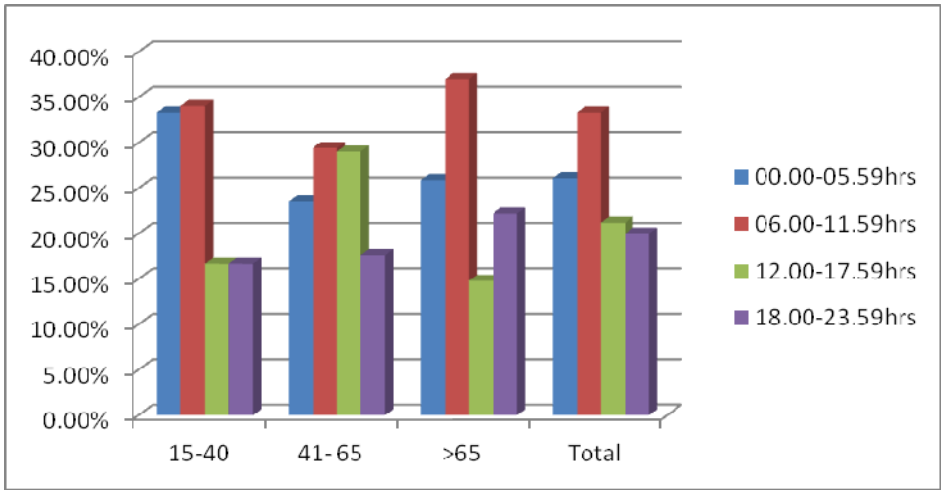

Figure 3: Diurnal variation of ischemic stroke according to the age groups