AN ANALYSIS OF LATERALITY IN ACUTE ARTERIAL STROKE AND ITS ASSOCIATIONS

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ABSTRACT

BACKGROUND

Stroke is defined as a sudden loss of brain function caused by a decreased cerebral blood flow. The objective of this study was to find out the association between laterality of stroke and age group, gender, type of stroke and anatomical site.

MATERIALS AND METHODS

A retrospective descriptive study was designed to collect the reports of consecutive cranial computerised tomography (CT) scan taken over a period of seven months commencing from September 2016. The details of patients' age, gender, stroke type, anatomical site and laterality of acute arterial stroke were entered in Excel spread sheet and analysed statistically using Chi square test with Yates' correction.

RESULTS

Among 2,020 cranial CT scans, only 182 satisfied the eligibility criteria of stroke and thus the prevalence of acute arterial stroke was 9% among the study population. The ratio between non-haemorrhagic and haemorrhagic stroke was 5.7:1. Of the 155 non-haemorrhagic strokes, 77 (49.6%) belonged to middle cerebral, 38 (24.5%) to posterior cerebral and two (1.2%) to anterior cerebral artery territory. The anatomical location of haemorrhage was significantly more in striatum (44.4%) among the study group and it was followed by lobar (22.2%), thalamus (18.5%), cerebellum (7.4%), pons (3.7%) and interventricular sites (3.7%). Bilateral lesions were noticed among 14.8% of non-haemorrhagic infarcts but none in haemorrhagic infarcts.

CONCLUSION

Overall right-sided lesions were noticed significantly more among males of all age groups among the non-haemorrhagic stroke cases, whereas there was no preferential laterality in haemorrhagic group.

KEYWORDS

Acute Arterial Stroke, Laterality, Age, Gender, Type of Stroke, Association.

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BACKGROUND

Acute stroke is one of the leading causes of morbidity and mortality all over the globe. Understanding the aetiological aspects, risk factors, early recognition and appropriate interventions have helped to bring down the morbidity and mortality related to stroke in developed countries.[1] The efforts taken in the west to control non-communicable diseases, made the Government of India to take initiatives for early diagnosis, management, infrastructural, public awareness and capacity building at different levels of healthcare for all noncommunicable diseases under the National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS).[2]

Despite the efforts, stroke continues to be a problem more in rural areas, low income groups and among young individuals in many developing nations.

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The age-related peculiarities and the variety of manifestations make the diagnosis of stroke extremely difficult and often delayed.[2] However, history and clinical examinations help to decide on investigations so as to find out risk factors and the spectrum of differential diagnosis of acute neurological accidents.[3] Various aspects of stroke such as epidemiology, clinical features, scoring for assessment, imaging, therapy, outcome, community-based rehabilitation, home-based care, etc., were studied extensively.

The presentation of acute stroke and its outcome depend on both ischaemic infarct volume and location.[4] The human brain is organised into large-scale and lateralised functional networks, and the anatomical location of the lesion and the laterality (especially side of lesion), have substantial influence on motor, sensory, visual, wakefulness, language, neglect, and other functional components which have not been well delineated.[2,5,6] Moreover very few studies were carried out on the laterality of stroke and its association with one or other aspects. Hence, it was decided to find out the association between laterality of stroke and age group, gender, type of stroke and anatomical site.

MATERIALS AND METHODS

A retrospective descriptive study was designed to collect the details of consecutive cases of acute stroke of arterial origin brought to the hospital over a period of seven months

commencing from September 2016. Those who had evidences of meningitis, postvaccinial complications, recurrent stroke and secondary haemorrhages such as trauma, rupture of aneurysm, coagulopathy, arteriovenous malformations; and postpartum venous infarcts were not considered for the study. All the selected cases underwent cranial computerised tomography (CT) scan using GE dual slice CT scan machine.

The CT findings were reviewed by two radiologists independently. If any controversy arose, it was discussed with other authors and a consensus was arrived for making a final decision on the type of lesion and anatomical site. Patients' age and gender were collected from the requisition form and confirmed with the hospital records. For analytical purposes, the cases were classified as young, middle and elderly if they belonged to the age group 15 to 44, 45 to 64, and 65 and above respectively. All the data were entered in Microsoft excel spread sheet and analysed statistically using SPSS version 21. Chi square test with Yates' correction were used for comparison of variables.

RESULTS

Over a period of seven consecutive months, 2,020 patients underwent cranial CT scan in the Department of Radiology. Among them, 182 cases satisfied the eligibility criteria of the study. Thus, the prevalence of acute stroke of arterial aetiology among the cranial CT studied was 9% and none had features of sub-arachnoid haemorrhage. All the stroke cases arrived in the hospital invariably 6 to 24 hours after the onset of the illness. Among the 182 cases, there were 155 (85.2%) non-haemorrhagic and 27 (14.8%) haemorrhagic strokes which included four other cases who had haemorrhagic transformation of ischaemic stroke. The ratio between non-haemorrhagic and haemorrhagic stroke was 5.7:1 (Table 1) during the study period.

Overall the age range and median years for those who had non-haemorrhagic stroke and haemorrhagic stroke were 23 to 95 and 58 years; and 26 to 75 and 50 years respectively. This indicated that the occurrence of haemorrhagic stroke was much earlier and was significant [$p<0.01$]. This could probably be attributed to uncontrolled elevated blood pressure among such cases. Distribution of all the 182 cases when analysed together with regard to age group, it was almost equal among the middle (42.2%) and elderly (43.4%), whereas it was far less among the young (14.8%). In general, the occurrence of stroke was significantly more among males irrespective of the age group.

Of the 155 cases of non-haemorrhagic stroke, 77 (49.6%) belonged to middle cerebral artery (MCA) territory, 38 (24.5%) to posterior cerebral artery (PCA) territory and two (1.3%) to anterior cerebral artery (ACA) territory. Thus, the lesion in the MCA territory were significantly more than other groups (Table 2) and involvement of MCA was seen significantly more among males ($p<0.001$) and in elderly. Also, right-sided lesions were significantly more in those cases who had non-haemorrhagic stroke at MCA territory. On the contrary, when PCA and ACA lesions were analysed, the distribution was significantly more among middle age group ($p<0.01$) with male preponderance but without any preferential laterality. The other groups included under the non-haemorrhagic stroke were watershed lesions (n=25; 16.2%) and lacunar infarction (n=13; 8.4%) (Table 2).

Excluding 23 cases who had bilateral manifestations in non-haemorrhagic group, other 159 were analysed for the occurrence of laterality in relation to age group and gender. Overall the non-haemorrhagic stroke was noticed significantly more on the right side and among males irrespective of the age group. In fact, it was also found out that males were susceptible more as age advances irrespective of the type of lesion i.e., non-haemorrhagic and haemorrhagic stroke. Embarking conclusions on laterality could not be arrived among the haemorrhagic stroke as the total number under different age groups and gender was small. However, it was noticed that the patients belonging to the middle age group suffered more than other age groups and all had hypertension. When the laterality of the lesions was further analysed, bilateral lesions were noticed in the non-haemorrhagic group but not in the haemorrhagic group.

As the distributions of haemorrhagic cases were small in relation to age and gender, further statistical analysis was not attempted. However, the distribution of cases in relation to the anatomical location showed that it was more in striatum (44.4%). It was followed by lobar, thalamus, cerebellum, pons and intraventricular and it was 22.2, 18.5, 7.4, 3.7 and 3.7% respectively. Haemorrhagic lesions were seen more among males and in striatum, whereas females had lesions more in thalamus (Table 3). There was no gender difference and laterality with reference to haemorrhagic stroke in other anatomical sites. Overall there was no statistical difference noticed when laterality was analysed in relation to gender.

Age Group in Years	Non-haemorrhagic Stroke						Haemorrhagic Stroke						Sub-Total		Total
	Gender		Total	Laterality			Gender		Total	Laterality			Gender		
	M	F		R	L	B/L	M	F		R	L	B/L	M	F	
15-44	18	6	**24**	12	7	5	3	-	**3**	2	1	-	21	6	**27 (14.8)**
45-64	33	27	**60**	28	22	10	9	7	**16**	8	8	-	42	34	**76 (42.2)**
65 & above	47	24	**71**	34	29	8	3	5	**8**	4	4	-	50	29	**79 (43.3)**
Total	**98**	**57**	**155 (85.2)**	**74**	**58**	**23**	**15**	**12**	**27 (14.8)**	**14**	**13**	**-**	**113**	**69**	**182**

Table 1. Distribution of Acute Stroke in Relation to Age Group, Gender, Laterality and Type of Lesions

[M – Male; F – Female; R –Right; L – Left; B/L – Bilateral] Figure in parenthesis indicates percentage.

Age Group in Years	Arterial Territory									Watershed			Lacunar			Sub-Total
	MCA			PCA			ACA									
	M	F	Total	M	F	Total	M	F	Total	M	F	Total	M	F	Total	
15-44	13	3	**16**	3	2	**5**	-	-	**-**	1	1	**2**	1	-	**1**	**24**
45-64	10	12	**22**	9	11	**20**	1	-	**1**	11	2	**13**	2	2	**4**	**60**
65 & above	26	13	**39**	8	5	**13**	-	1	**1**	9	1	**10**	4	4	**8**	**71**
Total	**49**	**28**	**77 (49.6)**	**20**	**18**	**38 (24.5)**	**1**	**1**	**2 (1.3)**	**21**	**4**	**25 (16.1)**	**7**	**6**	**13 (8.4)**	**155**

Table 2. Pattern of Non-haemorrhagic Stroke in Relation to Age Group and Gender

[M – Male; F – Female; MCA – Middle cerebral artery; PCA – Posterior cerebral artery; and ACA – Anterior cerebral artery]. Figure in parenthesis indicates percentage.

Anatomical Site (Location)	Gender		Total	Laterality	
	Male	Female		Right	Left
Lobar	4	2	**6**	2	4
Striatum	9	3	**12**	7	5
Thalamus	2	3	**5**	3	2
Cerebellum	-	2	**2**	1	1
Pons	-	1	**1**	-	1
Intraventricular	-	1	**1**	1	-
Total (%)	**15 (55.5)**	**12(44.4)**	**27**	**14 51.8)**	**13 $8.1)**

Table 3. Distribution of Haemorrhagic Stroke in Relation to Anatomical Site, Gender and Laterality

DISCUSSION

Acute stroke affects large number of people and continues to cause premature death more so among those living in rural areas and less affordable population. Thus, it contributes to huge economic and social burden. Early detection of risk factors and community empowerment reduced the incidence of stroke and improved their outcome too in developed nations.

In general, patients who developed acute stroke are brought to the hospital and subjected to medical imaging studies. Computer tomography (CT) and magnetic resonance (MR) imaging mostly help to find out the type of stroke, identify the anatomical site, assess the effects on the brain, and also assist for endovascular therapies or guide to other modalities of treatment. Compared to MR imaging, CT has distinct advantages in terms of availability and cost for rural population who come invariably 6 to 12 hours after the onset of stroke.

In the present study, non-haemorrhagic stroke was seen in 85.2% and haemorrhagic stroke in 14.8% of cases with significant ($p<0.01$) male predominance. In a British study, ischaemic stroke was noticed in 85% of cases and haemorrhagic stroke in 15%.[7] In their series, the lesions were noticed more among elderly and in males. Dalal[8] noted ischaemic stroke in 77% and haemorrhagic stroke in 22% in Mumbai, India. Pooled data of Indian studies[9] revealed the range of ischaemic stroke and haemorrhagic stroke was 60 to 80% and 20 to 30% respectively. In the series of McCluskey et al,[10] large vessel involvement was noticed in 41% and small vessel (lacunar) in 18%; in contrast, it was 75.3 and 8.4% respectively in our study.

Another review of Indian reports on stroke analysed the published materials over a period of 50 years, and found that life time risk of getting stroke after 55 years was 1 in 5 for women and 1 in 6 for men. They also noticed that the ratio between ischaemic and haemorrhagic stroke was 5:1.[11,12]

Average age of occurrence of stroke in developing counties is usually 15 years younger than those in developed countries.[2] In India by and large, the earliest age at which stroke occurred was found to be 40 years or less, in contrast it was 66 and 67 years among the stroke cases noticed in Mumbai[8] and Trivandrum[12] respectively. In the present study, the median age observed among those who had non-haemorrhagic and haemorrhagic stroke was 58 and 50 years respectively, and present observations tallied with the median age noticed in a study conducted at Bangalore.[13]

Stroke cases were noticed more among men in the present study. Male preponderance was noticed among the Mumbai Stroke Registry,[8] whereas women dominated in Trivandrum Stroke Registry.[12] Interestingly, Trivandrum registry had documented rural cases more than urban. Probable causes for less number of women noticed in the present study as well as many others could be attributed to the health seeking behaviour and attitude of the rural population towards elderly women by way of keeping them at home and adopting alternative treatment at home.

It is often believed that stroke occurs on the left side than right side, but it is not well known whether the stroke occurs more frequently on one side or simply recognised by treating doctors. On analysis of laterality in relation to arterial territory, in the present study, right side involvement was predominant and significant ($p<0.01$) in middle cerebral artery (MCA) territory whereas no difference was noticed with regard to laterality in PCA and ACA territory irrespective of age and gender. Laterality was not noticed among the cases who had either watershed or lacunar infarction in the present study. Similarly, during the study period, preferential laterality could not be made out among those who had infratentorial lesions as the numbers were small. After analysing 11,328 cases, Foerch et al[14] demonstrated left hemispheric events in 56% and right in 44%. They also noticed that patients with right-sided lesions had difficulty to recognise the symptoms with consequent delay in the arrival

to hospital. In general, left-sided lesions appear clinically more whereas laterality preference was not made out on CT or MR imaging.[14,15,16]

Interestingly, higher risk of death at 90 days was noticed among those who had cerebral haemorrhage on right side after adjusting with confounding variables, but no difference was noticed with major disability among survivors.[16,17] Some studies did not reveal any difference in the laterality with regard to the occurrence of stroke and 10-year survival.[10,17]

The distribution of intracerebral haemorrhage (ICH) in the present study was compared with another study from India and USA. The details are shown in table 4. In our study, and another study from Gujarat,[18] the haemorrhagic lesions were seen more in striatum (Table 4), whereas it was more in lobar in a study from USA.[19] Population based study which compared lobar to non-lobar intracranial haemorrhage (ICH) revealed that hypertension is the strong risk factor for anatomic site for non-lobar but not for lobar.[19] Interestingly, it was noticed that the strong risk factor for lobar was noticed to be elevated apolipoprotein E genotype. Hence, it is clear that the site of lesion and nature of lesions in primary ICH are influenced by various other factors or combination of factors such as genetic predisposition, hypertension and cerebral amyloid angiopathy (CAA).

Location	Haemorrhagic Stroke in Percentage		
	Present Study (2016) (n=27)	Indian Study[18] (2016) (n=109)	USA (2011)[19] (n=330)
Lobar	22.3	21	35
Striatum	44.4	49	27
Cerebellum	7.4	07	10
Thalamus	18.5	14	19
Brain stem	03.7	09	4
Intraventricular	03.7	-	1
Multiple	-	-	4

Table 4. Comparative Analysis of Haemorrhagic Lesions in Relation to Location

(n = number of cases studied).

The management decisions in acute stroke setting rely on the differentiation of haemorrhagic from ischaemic stroke. Imaging is required to make this differentiation because there are no clinical features that reliably predict haemorrhagic stroke. CT has traditionally been the preferred imaging for identification of ICH. CT scanning is faster, less expensive and more widely available; it can be safely performed in patients with contraindications to MR.[19]

MR has potential advantage over CT in evaluation of ischaemic stroke, both for delineating the extent of infarction with diffusion weighed imaging (DWI) and detecting the presence of haemorrhagic complications with Gradient Echo sequences.[20] In most studies, the intracranial haemorrhage is the second most common cause of stroke accounting for 10 to 15% of all strokes. The intracranial haemorrhage due to hypertensive vasculopathy, cerebral amyloid angiopathy or unknown causes are referred as primary intracranial haemorrhage to distinguish from other defined causes such as vascular malformation, tumour, trauma and infarction.[19]

The limitation of the study is that the data were confined to a single centre. The strengths of the study are rural domicile of the cases, independent interpretation of CT findings and arriving at consensus, and screening all consecutive stroke cases. Future studies shall focus more on the laterality preference for haemorrhagic stroke and the outcome with regard to laterality.

CONCLUSION

Primary arterial pathology contributing to acute stroke is 182 (9%) of the 2020 cranial CT recorded cases over a period of seven months in a rural teaching hospital. Among the type of stroke in 182, 85.2% belonged to non-haemorrhagic stroke and 14.8% to haemorrhagic stroke. The non-haemorrhagic stroke was more on the right side and among middle and elderly males in a significant manner. Bilateral lesions were noticed among 14.8% of non-haemorrhagic stroke but not in haemorrhagic stroke. Overall, the chances of occurring acute cerebrovascular accident increases as age advances irrespective of the gender. Among the non-haemorrhagic stroke, involvement of MCA, PCA and ACA was 49.6, 24.5 and 1.3% respectively. Watershed lesions and lacunar infarcts were noticed among 16.1 and 8.4% respectively. During the study period, haemorrhagic stroke contributed to 14.8% and more in striatum without any preferential laterality.

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