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ORIGINAL PAPER

Ocular manifestations in patients with cerebrovascular accidents in India: a cross-sectional observational study

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Abstract

Purpose To assess ophthalmic manifestations in patients with stroke and emphasize the importance of a formal screening for visual problems in stroke patients in hospital and rehabilitation settings.

Methods This was a cross-sectional study of 50 newly diagnosed patients with stroke with Glasgow Coma Scale (GCS) > 8 examined within 3 days of onset. A detailed ophthalmic examination was performed for each patient including visual acuity, fields, ocular motility, slit lamp and fundus examination, line bisection tests and cranial nerve assessment. Radiological investigations were reviewed and anatomically correlated.

Results A total of 50 patients (41 male and nine female) were included in the study. Mean age of the stroke cohort was 51.36 years. Twenty-nine patients (58%) had a subcortical stroke, while 42% (n = 21) patients had a cortical stroke. Nineteen patients (38%) demonstrated visual field defects. Twenty-one patients (42%) had a gaze palsy. Vertical gaze palsy (n = 8) was more common in cortical stroke, while internuclear ophthalmoplegia (n = 2), horizontal gaze palsies (n = 4) and Parinaud's syndrome (n = 1) were seen more commonly in those with subcortical stroke. Twenty-four percent (n = 12) patients had nystagmus. Twelve percent (n = 6) patients had diplopia. Thirty-eight percent (n = 19) patients had convergence insufficiency. Sixteen patients (32%) complained of visual impairment. Retinal abnormalities were seen in 58% (n = 29) of patients.

Conclusions Ophthalmic manifestations were seen in 90% of stroke survivors. Their presence in majority of the patients in our cohort suggests that earliest routine ophthalmic examination should be mandatory in all patients with acute stroke.

Keywords Stroke · Hemianopia · Visual neglect · Screening · Rehabilitation

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Introduction

Cerebrovascular accidents (CVA) are one of the most common causes of mortality and a significant cause of adult disability [1]. In India, approximately 1.8 million people suffer from new onset CVA annually [2]. There are majorly three types of CVAs: ischemic, hemorrhagic and transient, of which ischemic are the most

common. They can lead to focal neurological deficits to permanent damage or even death.

There is high likelihood of ocular involvement with CVAs as a large portion of the central nervous system is dedicated to vision, which can involve the afferent pathways (vision) or efferent pathway (eye movements). Neuro-ophthalmic manifestations such as gaze palsies, gaze preferences, strabismus, visual field defects, cortical blindness, nystagmus, ptosis and diplopia have been reported in the past [3–5]. Documentation of ophthalmic features can help in identifying the underlying etiology (especially, when a patient is in altered sensorium), localizing the site of the neurologic lesion and monitoring treatment.

The location and severity of a stroke determine the specific ophthalmic manifestations, some of which may improve over their natural course, while others might require treatment. Because many ophthalmic problems improve with intervention, there may be a role for formal ophthalmic screening for stroke patients so that their rehabilitation potential is maximized. Retinal screening as a means of identifying the type of stroke has already been piloted in patients attending a fast-track transient ischemic attack (TIA) clinic and found to be useful [6]. The role of the neurophysician, occupational therapist, speech therapist and physiotherapist in the management of stroke patients is well recognized. Similarly, an ophthalmologist can assist in the management of clinically obvious visual pathology, as well as pick up subtle signs such as abnormal saccades and stereopsis more efficiently.

There is extensive literature on the association of systemic manifestations such as hemiplegia and hemianesthesia with the anatomic localization of the stroke. However, similar studies are lacking with respect to ophthalmic manifestations. The present article aims at reviewing and understanding the associations between location of CVA and ophthalmic manifestations.

Materials and methods

The Institutional Ethics Committee for research on human subjects of the parent institution (The Lokmanya Tilak Municipal Medical College & General Hospital Staff and Research Society) approved the study. Patients were given an information sheet regarding the purpose of the study and recruited after informed consent. The study was performed as per the tenets of the declaration of Helsinki. It was a cross-sectional, observational study carried out over a period of 18 months and included newly diagnosed cases of CVA in adults > 18 years, with Glasgow Coma Scale (GCS) more than 8, admitted to the Medicine/Neuromedicine units of our tertiary care hospital. Patients with history of previous stroke and those not willing to provide consent were excluded.

A standardized investigation sheet was used for the eye assessment consisting of identification of known pre-existent ocular pathology, symptoms and signs, investigation of vision, visual field, ocular motility and perceptual aspects.

The presenting and best-corrected visual acuity (BCVA) with Snellen's chart at 6 m distance under normal room illumination was checked in all patients who were sufficiently ambulatory to come to the ophthalmology outpatient clinic. A bedside-vision assessment was carried out in all other patients using gross techniques such as counting fingers at 6 m and closer.

Assessment of ocular alignment and motility was done by cover, uncover and alternate cover test; evaluation of voluntary saccades, smooth pursuit and vergence eye movements was done. Posterior segment examination with the help of indirect ophthalmoscopy at bedside and with + 90 diopters aspheric lens on slit lamp at the outpatient clinic was done 30 min after pupil dilation with 0.5% tropicamide. Diplopia charting was performed after wearing red–green goggles, in a dark room as described previously [7]. Visual fields were assessed by confrontation method if the patient was seen in the ward. When seen in clinic, quantitative measures of visual field were undertaken by Humphrey Field Analyzer (HFA) employing the SITA FAST strategy and 30-2 visual field. Visual hemineglect was assessed by means of one or more combinations of assessments including line bisection (the patient had to mark the midpoint of a horizontal line presented on a sheet of paper) and copying task (the examiner asked the patient to copy one or more line drawings) methods [8]. All these tests including visual fields and diplopia charting were performed only in physically and mentally coherent/compliant patients.

Patients with significant comorbidities such as cataract and glaucoma were treated accordingly. Any refractive error was treated with glasses. Patients with

binocular diplopia were advised mono-ocular patching, and patients with visual neglect or squint were advised appropriate prism glasses and guided thoroughly regarding how to carry out the daily activities.

Neuroimaging reports available at the bedside (MRI/CT/MR angiography plates) were reviewed, and anatomical correlation between type of ophthalmic manifestation and area of brain affected was attempted. Cortical stroke was recorded when stroke involved the frontal, parietal, temporal and occipital lobes, and subcortical stroke was recorded when the stroke involved the basal ganglia, thalamus, internal capsule, corona radiata, cerebellum and brainstem. The type of stroke (ischemic vs. hemorrhagic) and systemic work-up of all stroke patients for comorbidities such as diabetes, hypertension, ischemic heart disease, dyslipidemia done during in-patient admission were also recorded. Additionally, systemic associations such as cranial nerve palsy, hemiplegia and dysarthria were recorded in consultation with a neurophysician at the bedside.

Statistical analysis

Continuous variables were expressed as mean with standard deviation, and categorical variables were described as proportions. Group differences between clinical manifestations of cortical and subcortical stroke were analyzed using the Student's t test or Wilcoxon rank-sum test for continuous variables and the Chi-square or Fisher's exact test for categorical variables. All data were entered in Excel sheets and analyzed using SPSS software. A p value of < 0.05 was considered statistically significant.

Results

Fifty patients with CVA were admitted during the study period from June 2015 to December 2016. Out of these, 41 were men and nine were women. Their mean age was 51.36 ± 7.6 years with 34% ($n = 17$) being below 40 years of age. Ischemic stroke accounted for 74% ($n = 37$) of CVA, while 26% ($n = 13$) patients had a hemorrhagic stroke. Fifty-one percent of the patients had an involvement of the right hemisphere. Ophthalmic assessment was performed within the first 3 days of admission. Ophthalmic manifestations were found in 90% ($n = 45$) of them.

Subcortical stroke was seen in 29 patients (58%) in our study, while cortical stroke was seen in the remaining 42% ($n = 21$) patients. Table 1 shows the ophthalmic manifestations in those with cortical versus subcortical stroke.

Visual impairment

Out of 50 patients, 16 (32%) complained of visual impairment, out of which five patients had blurring of vision, ten patients had visual disturbance and one patient had visual agnosia.

Out of ten patients with visual disturbance, four patients (8% of the total study population) complained of diminution of vision at the time of stroke/due to occipital stroke. Other six patients suffered from visual disturbances due to co-existing or pre-existing ocular pathology (one patient complained of visual disturbance due to diplopia (left superior oblique paresis), one due to pre-existing disk pallor with sensory exotropia, one secondary to upbeat nystagmus, one had nutritional optic neuropathy due to chronic tobacco abuse, one had central retinal artery occlusion (CRAO), and one patient had a mature cataract).

Neuro-ophthalmic manifestations

Assessment of visual field loss was done by confrontation method in all patients, while HFA 30-2 could be additionally done in only 25% of the patients. Nineteen patients (38%) demonstrated visual field defects, out of which 12 (63%) had cortical stroke and remainder had subcortical stroke. Homonymous hemianopia ($n = 7$) was the commonest field defect in our study and seen exclusively in those with cortical stroke ($p < 0.001$). Patients with subcortical CVA demonstrated generalized visual field constriction and altitudinal field defects most commonly.

Twenty-one patients (42%) had a gaze palsy, out of which ten had subcortical stroke and 11 had cortical stroke. Vertical gaze palsy ($n = 8$) was much more common in cortical stroke (six out of eight patients). All these eight patients had an ischemic stroke. Internuclear ophthalmoplegia (INO), horizontal gaze palsies and Parinaud's syndrome were seen more commonly in those with subcortical stroke. There was no significant difference between specific types of gaze abnormalities caused by infarctions or

Table 1 Comparison of neuro-ophthalmic manifestations between cortical and subcortical CVAs

Category	Cortical (n = 21)	Subcortical (n = 29)	p value
Age (years, SD)	48.5 + 5.6	51.9 + 6.7	0.33
Visual field defects			
Homonymous hemianopia	7 (33%)	0	< 0.001
Heteronymous hemianopia	0	1 (4%)	0.72
Quadrantanopia	2 (10%)	1 (4%)	0.12
Constricted visual fields	1 (5%)	2 (7%)	0.56
Altitudinal defects	2 (10%)	3 (10%)	0.83
Gaze palsies			
Horizontal gaze palsy	2 (10%)	2 (7%)	0.53
Vertical gaze palsy	6 (29%)	2 (7%)	0.04
Skew deviation	0	0	–
Supranuclear gaze palsy	0	0	–
INO	0	2 (7%)	0.09
Parinaud's syndrome	0	1 (4%)	0.31
Saccadic palsy	3 (14%)	3 (10%)	0.77
Strabismus			
Paralytic strabismus	2 (10%)	4 (14%)	0.43
Concomitant strabismus	0	0	–
Nystagmus	4 (19%)	8 (28%)	0.22
Hemineglect	3 (14%)	2 (7%)	0.16
Visual association cortex			
Visual agnosia	1 (5%)	0	0.52
Prosopagnosia	2 (10%)	0	0.31

hemorrhagic strokes. Saccadic and smooth pursuit eye movement palsy/paresis was seen in 28% of patients with gaze dysfunction. Nystagmus was much more common in subcortical stroke. Gaze-evoked nystagmus was seen in seven, end gaze in one, jerky in one, upbeat nystagmus in one and Bruns nystagmus in two patients. Central nystagmus, if present, was of small amplitude and only present outside of primary position, so patients did not complain of any visual disturbance. Hemineglect was seen more with cortical stroke, and all the affected patients had a left hemineglect with right hemispheric stroke. Stroke involving visual association areas (which are cortical) showed prosopagnosia in two patients and visual agnosia in one.

Six patients (12%) had diplopia, out of which three patients had vertical diplopia, two patients had horizontal diplopia (associated with INO) and one patient had diplopia due to partial third nerve palsy. All patients with diplopia had an associated subcortical stroke, with 80% of it being a posterior fossa stroke. Nineteen patients (38%) were found to be having deficient convergence, out of which 72% (n = 14) cases were associated with subcortical strokes and 71% (n = 13) patients had an ischemic stroke.

Figure 1 shows common visual and systemic manifestations between different anatomical varieties of stroke. Where majority of the cortical strokes were of the ischemic variety, only two-thirds in the

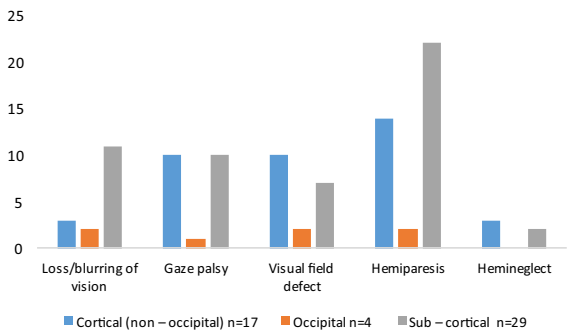

Fig. 1 Comparison of visual and systemic manifestations between different anatomical varieties of strokes

subcortical stroke were ischemic in nature, remaining were hemorrhagic strokes. Fifty-two percent patients with ischemic stroke had coronary artery disease diagnosed after admission, and 12% patients of those with ischemic subtype were previously diagnosed cases of ischemic heart disease. More than half of the patients (58%, $n = 29$) had retinal abnormalities, out of which 69% ($n = 20$) had a subcortical stroke and 31% had a cortical stroke. Hypertensive retinopathy was the commonest retinal finding seen in 68% ($n = 19$) patients. Out of ten patients having diabetes, four patients showed moderate-to-severe non-proliferative diabetic retinopathy changes.

Discussion

We evaluated 50 patients with acute stroke within 3 days of onset and found that as many as 90% of them showed ophthalmic manifestations. The occurrence of homonymous hemianopia strongly suggested cortical involvement.

Many retrospective case reviews have reported ocular manifestations in 62–71% of stroke patients [3]. We had a relatively young study population with almost a third of patients below 40 years of age. Most of them did not have cardiovascular risk factors but had a history of tobacco addiction. The mean age of stroke onset in the South Asian region has been reported to be lower (59 years in Pakistan and 63 years in India) [9–11] than in Western countries (68 years in the USA and 71 years in Italy) [1]. This trend is disturbing because most of our patients are in the most productive phase of their lives and may be confronted with a permanently reduced quality of life and resultant financial difficulties on survival.

Visual field loss was seen in 38% of our patients, which is comparable with the previous studies (20–57%) [3, 12–14]. None of the patients showed signs of pre-existing glaucoma such as disk changes or raised IOP, which ruled out the possibility of pre-existent field defects. Confrontation method for visual field testing, although crude, has been found to be reliable on admission [15] and was done within 3 days from the onset of stroke in all patients. However, Townend et al. [16] have reported that hemianopia is likely to be underestimated by confrontation and automated perimetry is more sensitive. However, we could do perimetry in about 25% of patients only. We found that homonymous hemianopia and quadrantanopia were seen exclusively in patients suffering from cortical stroke due to involvement of areas supplied by the middle and posterior cerebral artery. Field defects were more commonly seen in ischemic strokes, which support the findings of Fiona et al., where visual field defects in patients having lacunar infarcts of the anterior, middle and posterior cerebral arteries are well documented [17]. Interestingly, 60% of our patients did not actively complain of any visual field loss and seemed hardly affected by this deficit in their daily lives. Previous reports have also identified that a number of patients may be unaware of their visual field loss but continue to do daily activities such as driving and crossing roads, and possibly could impact road safety for themselves and others [7]. In such asymptomatic cases, additional observations such as noticing increased collisions to the affected side and turning of the head to view objects on the affected side might be helpful.

Unexpectedly, we also observed some patients with brainstem and thalamic infarcts with heteronymous hemianopia or quadrantanopia. These areas are not traditionally associated with the visual pathway. In these cases, after excluding previous stroke-related visual field loss, we assume that the visual pathway was affected by either of the two mechanisms: (1) an extension of the stroke that was not documented in the imaging report and (2) vascular compromise of one or more of the vessels supplying the visual pathway and surrounding areas [17].

Visual hemineglect was noted in 10% of our patients. Neglect is considered to be a poor prognostic indicator for functional recovery after stroke as literally and functionally one half of the visual field is not acknowledged at all [18]. Prevalence of visual neglect has been extremely variable in different studies, ranging from 8% [19] to 82% [4]. The right-hemisphere stroke (5/5 cases) was observed to be associated with significantly higher level of visual neglect than the left in our study. This finding was comparable with the study by Vallar et al. [20], where 35% right-brain-damaged subjects and 9% left-brain-damaged subjects had contralateral visual neglect. Similarly, Pedersen et al. [21] reported right-hemisphere lesions in 42% subjects and left-hemisphere lesions in 8% subjects. Visual neglect in lesions confined to the left hemisphere is not very severe as it usually gives rise to only minor and short-lasting

spatial impairments on the contralateral side. Bilateral lesions are necessary to produce persistent and severe right visual neglect [22]. This could probably explain the increased reported incidence of left visual neglect. Hemispatial neglect has been traditionally associated with lesions of the inferior parietal lobe (IPL) or temporoparietal junction (TPJ) [23]. However, two out of five patients in our study had a hemineglect associated with a subcortical stroke in areas such as corona radiata and gangliocapsular region. Hillis et al. [24] and Newhart et al. [25] also had similar findings which showed that affection of subcortical lesions that do not encroach directly on the cortex can also lead to neglect. Brain areas responsible for visuospatial attention maybe were indirectly damaged due to hypoperfusion and resultant hypoxia and decreased nutrient supply which made them structurally intact on neuroimaging, but had an underlying functional defect.

Of the entire study population, 62% ($n = 31$) patients had some kind of ocular motility abnormalities and of these 68% were due to or associated with gaze dysfunction. Karatas et al. [26] reported that gaze abnormalities account for approximately 10% of all patients with disorders of eye movements. Rowe et al. [5] did a large study on profile of gaze dysfunction following CVA and found that 23% of all recruited patients had gaze abnormalities. The ability to make full ocular rotations combined with neural integration to maintain eye position is required for normal gaze holding. Thus, gaze holding can be impeded by cortical stroke involving eye movement pathways, or brainstem/cerebellum strokes involving structures that mediate gaze such as the interstitial nucleus of Cajal and medial vestibular nuclei. Complete gaze palsy is generally seen in conditions such as Parkinson's disease, but has also been reported following stroke [27]. A range of stroke lesions were documented in this study giving rise to saccadic and smooth pursuit deficits, which is very much possible considering the extensive spatial pathways present for their control.

Asymmetric or sustained gaze-evoked nystagmus is pathological in nature and in many cases is indicative of an ipsilateral stroke. This finding should thus prompt further evaluation such as neuroimaging. All patients with nystagmus had ischemia as the underlying pathology, emphasizing further the role of extent of infarction and involvement of cortical pathways in normal gaze holding. Since visual field defects and gaze palsies were the commonest manifestations, an ophthalmologist is better suited to identifying these compared to neurophysicians. Additionally, identifying diplopia, nystagmus, etc. at an early stage could lead to prescription of prism glasses and other rehabilitative measures that alleviate these disturbing symptoms and help in early rehabilitation of patients.

Reduced visual acuity and altered visual quality such as reduced color vision and contrast sensitivity usually occur due to retinal manifestations associated with the stroke [28, 29].

The prevalence of retinal abnormalities was as high as 40% in stroke patients in a study by Baker et al. [30] and 59% in the Singapore study [31] which is comparable to our data (58%). Our results are also similar to a study by Hand et al. who found that the retinopathy prevalence was particularly high in patients with acute stroke with subcortical lesions (44.2%) [32]. A dilated retinal evaluation should be mandatory in all patients as it could identify retinopathy and sometimes provide clues to the underlying systemic condition which could be responsible for the stroke.

In conclusion, we found a high incidence of ophthalmic manifestations in patients with acute stroke. The ophthalmic manifestations are different in cortical and subcortical strokes. We recommend careful visual screening of all acute stroke survivors to accurately diagnose the presence of visual field loss and any other visual impairment so that prompt treatment can be initiated to maximize visual function and give best outcomes to these patients.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Animal rights statement This article does not contain any studies with animals performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants included in the study.

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