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ORIGINAL ARTICLE

Ocular–visual defect and visual neglect in stroke patients – A report from Kathmandu, Nepal

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Abstract
Purpose: To find out the type of visual defects, ocular defects or visual neglect occurring in patients with stroke.
Methods: In this cross-sectional study including 40 subjects diagnosed as stroke, assessment included visual acuity with the Sheridan-Gardner chart, objective and subjective refraction, duction and version eye movement, cover test at distance and near, anterior segment examination with the slit lamp, posterior segment examination after pupil dilatation, color vision test with the Farnsworth D-15 test, diplopia charting, the Hess charting, and visual field examination on Goldmann perimetry. 33 subjects (82.5%) having stroke underwent star cancellation test for visual neglect evaluation. Chi-square test with Yate's correction was performed to evaluate associations between visual neglect and neurological findings.
Results: The mean age of the subjects was 52.1 ± 15.7 years with male/female ratio of 0.7. Neurological findings included hemiplegia/hemiparesis in 84.8%, ischemic stroke in 80%, left hemisphere involvement in 60%, and cortical area involvement in 65%. Ocular finding included extraocular muscle palsy in 17.5%, exotropia in 12.5%, and ptosis in 7.5%. Co-morbid ocular findings such as cataract, retinopathy, and age-related macular degeneration were also reported. Visual neglect was present in 54.5% subjects predominantly affecting the left side.
Conclusion: This study reports the relationship between ocular–visual disorders and stroke. There should be a formal screening for visual problems in stroke patients in hospital and rehabilitation settings.

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PALABRAS CLAVE
Accidente cerebro-vascular;
Defectos visuales;
Defectos oculares;
Desatención visual

Defecto óculo-visual y desatención visual en pacientes de accidentes cerebro-vasculares. Informe desde Katmandú, Nepal

Resumen
Objetivo: Evaluar y analizar los tipos de defectos visuales, defectos oculares y desatención visual en pacientes con accidentes cerebro-vasculares.
Métodos: En este estudio transversal de 40 pacientes diagnosticados de accidente cerebro-vascular, la evaluación incluyó agudeza visual con el test de Sheridan-Gardner, refracción objetiva y subjetiva, movimiento ocular de ducción y versión, cover test de lejos y cerca, examen del segmento anterior con la lámpara de hendidura, examen del segmento posterior tras la dilatación pupilar, prueba de visión de color con el test Farnsworth D-15, test de diplopia, test de Hess y examen del campo visual con perimetría Goldmann. Se sometió a 33 pacientes (82,5%) que habían sufrido accidentes cerebro-vasculares a la prueba de ''star cancellation test'' para evaluar el nivel de desatención visual. Se realizó la prueba de Pearson con la corrección de Yate para evaluar las asociaciones entre la desatención visual y los hallazgos neurológicos.
Resultados: La edad media de los pacientes era de $52,1 \pm 15,7$ años, con un ratio hombre-mujer de 0,7. Los hallazgos neurológicos incluyeron hemiplejia/hemiparesia en el 84,8% de los casos, accidente isquémico en el 80%, afectación del hemisferio izquierdo en el 60%, y afectación del área cortical en el 65%. Los hallazgos oculares fueron una parálisis del músculo extraocular en un 17,5%, exotropía en el 12,5%, y ptosis en el 7,5%. También se reportaron los hallazgos oculares co-mórbidos como cataratas, retinopatía y degeneración macular asociada a la edad. La desatención visual estuvo presente en el 54,5% de los pacientes, afectando de manera predominante al lado izquierdo.
Conclusión: Este estudio reporta la relación entre los desórdenes óculo-visuales y el accidente cerebro-vascular. Debería existir un seguimiento formal de los problemas visuales para los pacientes con accidentes cerebro-vasculares en los entornos hospitalarios y de rehabilitación.

Introduction

As a manifestation of sensory and motor abnormalities resulting from stroke,[1,2] impairments in the visual system such as loss of vision, visual field defect, extra ocular muscles (EOM) paralysis, diplopia, and visual perception deficits are well documented.[3–10] Visual impairment in stroke patients may not only hinder visual and physical rehabilitation, but also worsen over all functional performances.[2,11]

Visual neglect is a common behavioural syndrome in patients following stroke. It is characterized by the failure to report or respond to sensory stimuli presented to the side opposite to a brain lesion at peripersonal level.[12,13] Hemianopsia or hemianopia is visual field loss that respects the vertical midline. It occurs frequently in stroke and traumatic brain injuries due to the connections and wiring of the visual system with the brain. Perimetric testing reveals the presence of hemianopsia, since these connections are retinotopic.[14] A portion of the second major pathway that is the extended visual cortex and dorsal stream, proceeds from the occipital cortex to the parietal cortex. A lesion in this pathway presumably does not result in a visual field defect that is evident by conventional perimetric testing, but rather results in unilateral spatial neglect, because the lesion is not retinotopic.[15,16]

The concept of visual rehabilitation has not gained much attention in Nepal. Many patients with stroke in Nepal do not receive detailed eye examination and vision rehabilitation services. Either they are not referred to eye clinic or they could not understand the tests explained by eye care practitioners. The test for possibility of visual neglect has not been given much attention. This study evaluates the relationship between ocular–visual defect and stroke and the need of intervention for visual assessment.

Methods and materials

Subjects

Sixty consecutive and new cases with stroke admitted to the In-Patient Department (IPD) of Neuro-Medicine, Tribhuvan University Teaching Hospital (TUTH) were recruited in the hospital based cross-sectional study from December 2009 to May 2010. Informed verbal consent was taken from all the subjects and their care takers after a detailed description of the study. They were assessed with the Modified Glasgow Coma Scale (GCS) by a neurologist for assessment of consciousness (Appendix 1). If they had a score of less than 15, they were excluded from the study.

All of the subjects were initially assessed at bedside by an optometrist in IPD of TUTH Internal Medicine Department within one week of admission. Assessment included pupil size, pupil reaction to light and accommodation, extraocular motility, cover test, slit lamp examination of anterior segment, and direct ophthalmoscopic fundus examination. At the same time, medical records of every subject and the report of computerized tomography (CT) scan were reviewed to find out the type of stroke and cranial nerves involvement. Then the subjects were advised to visit Neuro-ophthalmology clinic for detailed eye examination at B.P. Koirala Lions Centre for Ophthalmic Studies one month after discharge. The candidates were reviewed by a team comprised of an ophthalmologist, a neurologist, and optometrists.

20 subjects were excluded from the study due to various reasons. Three subjects had died. 12 subjects had multiple handicaps. The distance from their home to hospital was too great in them as well. Five subjects were not willing to participate.

Only 40 subjects could be analyzed further in the study. This study was conducted in accordance with the Declaration of Helsinki of 2004 and was approved by the institutional ethical committee of the Institute of Medicine, Tribhuvan University.

Assessment

- Presented and best corrected visual acuity was measured with Sheridan-Gardner (SG) chart at 6 m distance under normal room illumination considering the possibility of confusion of direction and field loss which could confound the results.
- Objective and subjective refraction was performed in each subject. Myopia was considered significant for refractive error equal to or above −0.50D of spherical equivalent. Hyperopia was considered significant for refractive error equal to or greater than +1.00D of spherical equivalent.
- Duction and version extra-ocular motility were assessed in all the functional gazes with the help of a torch light. Any restriction or abnormality was noted.
- Cover test was performed at a distance of 6 m for far and at 40 cm distance for near to detect strabismus. Strabismus was defined as heterotropia more than >5 prism diopters at least for one fixation distance (near or far fixation or both).
- Careful anterior segment examination was carried out with the help of slit lamp to find out anterior segment abnormality.
- Posterior segment examination was carried out with the help of direct or indirect ophthalmoscopy and with +90 diopters aspheric lens on slit lamp 30 min after pupil dilation by instilling 0.5% tropicamide HCL.
- Color vision was assessed in each eye with the Farnsworth D-15 color vision test under normal room illumination at a distance of 33 cm. The test was performed with refractive correction as well as near addition in the required cases.
- Diplopia charting was performed in the subjects having complaint of diplopia using having subjects worn red–green goggles. Hess charting was performed in subjects having diplopia and in all cases of extra ocular muscle paresis in a dark room with red and green goggles and streak torch at 33 centimeters distance.
- Visual field examination was carried out monocularly with the Goldmann Perimeter. This test was performed with the best optical correction.

Test for visual neglect

Presence of visual neglect was assessed by using star cancellation test with near correction at the subject working distance (Fig. 1). A total of 52 large stars, 56 small stars, 13 letters and 10 short words were pseudo randomly positioned over an A4 page.[4] The task was to cross out all small stars keeping both eyes open. The maximum score was 54 comprising 27 in each half (the two small stars in the center were not scored). A cutoff of <44 was considered as the presence of visual neglect. A Laterality Index or Star Ratio was calculated from the ratio of stars cancelled on the left of the page to the total number of stars cancelled. Scores between 0 and 0.46 indicate unilateral neglect in the left hemispace. Scores between 0.54 and 1 indicate unilateral neglect in the right hemispace.

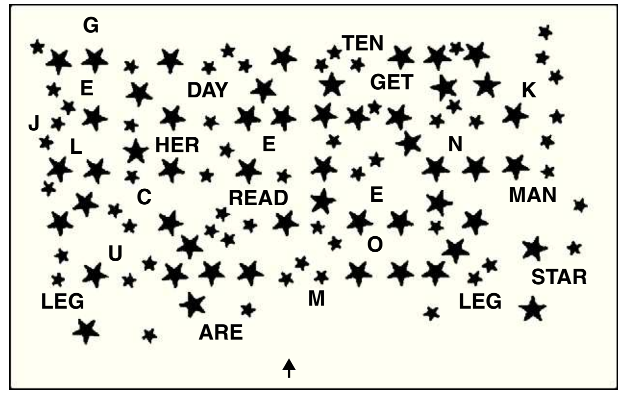

Figure 1 Star cancellation test. Image from: http://www.medicine.mcgill.ca/strokengine-assess/module_sct_indepth-en.html.

Star cancellation test has been shown to correlate with other clinical tests indicating construct validity. Cancellation tests are believed to have greater test-retest reliability than the line bisection test[17] and are often more sensitive for detecting ULN.[18,19]

Statistical analysis

All the data were evaluated using a statistical package for social science (SPSS 17.0). Chi-square test with Yate's adjustment was performed to determine associations between visual neglect and other neurological findings (hemisphere involvement, type of stroke, area of involvement, age and gender). The confidential interval was considered at 95% level. When p value was equal to or less than 0.05, the finding was considered significant.

Results

General characteristics of subjects with stroke

The general characteristics of stroke subjects are presented in Table 1. The mean age and standard deviation of the subjects were 52.1 ± 15.7 years (range: 29–76 years). The cohort was comprised of 40% male and 60% female. Neurological findings included a clinical presentation of hemiplegia or hemiparesis in 32 subjects (80%), ischemic type of stroke in 32 subjects (80%), involvement of left hemisphere of brain in 24 subjects (60%), and involvement of cortical area in 26 subjects (65%). Cortical areas included frontal, parietal, temporal, and occipital lobes; internal

Table 1 General characteristics of subjects with stroke.

Age	Mean age ± SD	52.1 ± 15.7 years (29–76 yrs)
Gender	Male	16 (40%)
	Female	24 (60%)
Hemiplegia/hemiparesis	Absent	6 (15.2%)
	Present	34 (84.8%)
Type of stroke	Hemorrhagic	8 (20%)
	Ischemic	32 (80%)
Hemisphere involved	Right	16 (40%)
	Left	24 (60%)
Area involved in CT Scan	Cortical areas	26 (65%)
	Brain stem	14 (35%)

capsule; thalamus and basal ganglion. Involvement of cranial nerves was found in 26 subjects (65%).

Ophthalmic disorder in subject with stroke

Ophthalmic disorders in the analyzed sample is given in Fig. 2. About 7.5% of subjects had isolated ptosis after stroke. One subject who had left hemispheric ischemic stroke affecting the occipital lobe had optic atrophy at the same side after stroke. Twenty-six subjects (65%) had cranial nerve involvement. Nineteen subjects (73.1%) of them had 7th cranial nerve involvement. However, diplopia and Hess charting confirmed extra-ocular muscle palsy in seven subjects (26.9%). Among them, three subjects had bilateral rectus palsy, the other three subjects had double elevator palsy, and the one had partial 3rd and 4th cranial nerve palsy. On cover test, five subjects (12.5%) developed exotropia after stroke with magnitude of 23 ± 6 prism diopters for near and 17 ± 2 prism diopters for distance excluding the cases of extraocular muscle palsy. Among the five subjects having exotropia, three subjects also had right eye hypertropia for both distance and near of magnitude of 25 prism dioptres.

Thirty three subjects (82.5%) had visual field within normal limits and sensitivity for age. Six subjects (15.0%) had constriction of peripheral field and only one subject had homonymous hemianopic visual field defect. Color vision was abnormal in only one subject with tritan defect in both eyes of almost the same pattern.

Proper spectacle correction is important for a patient entering into rehabilitation. Refractive error was present in 11 subjects (27.5%) with mean spherical equivalent of 0.5 ± 2.2 (range: −3.50D to +3.50D). Out of 40 subjects, six subjects (15%) had visual acuity less than 6/18 even after best refractive correction.

Four subjects (10%) having refractive error did not have their spectacles available. Spectacles were dirty and damaged in 3 subjects. Visual acuity could be improved to normal in five subjects after refractive correction.

Other ocular abnormalities such as cataract (10%), diabetic retinopathy (7.5%), hypertensive retinopathy (12.5%),

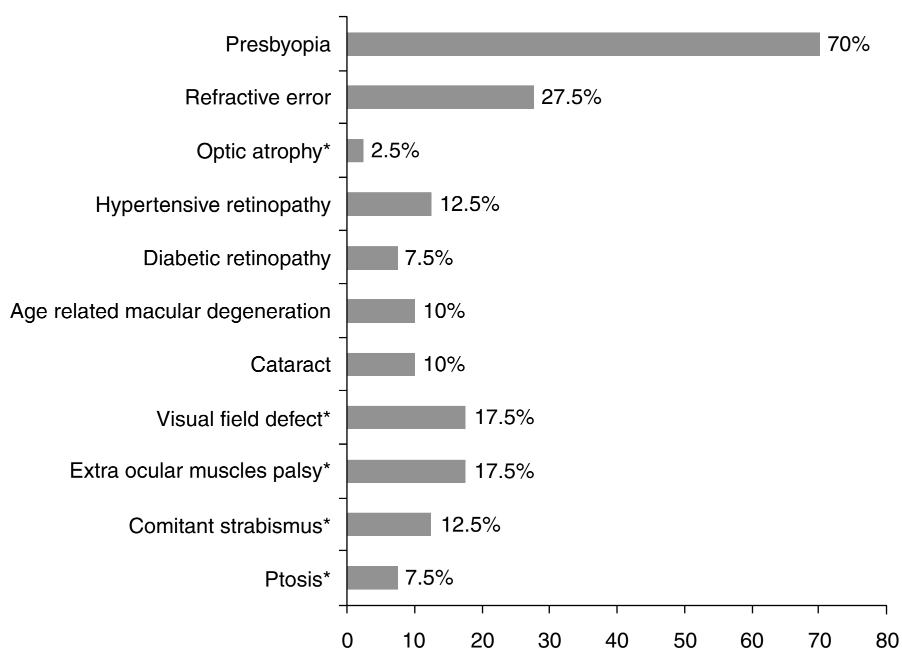

Figure 2 Ophthalmic disorders in stroke patients. (*Ocular manifestation due to stroke.)

Table 2 Visual neglect in subjects with stroke as indicated by star cancellation test.

	Visual neglect absent	Visual neglect present	P^a	OR
Right hemisphere	3 (9.1%)	9 (27.3%)	0.08 ($\chi^2 = 2.02$)	4.0
Left hemisphere	12 (36.3%)	9 (27.3%)		
Ischemic	15 (45.5%)	12 (36.3%)	0.06 ($\chi^2 = 2.29$)	–
Hemorrhagic	0	6 (18.2%)		
Cortical	11 (33.3%)	15 (45.5%)	0.4 ($\chi^2 = 0.07$)	1.8
Brain stem	4 (12.1%)	3 (9.1%)		
Male	6 (18.2%)	6 (18.2%)	0.5 ($\chi^2 = 0.00$)	0.75
Female	9 (27.3%)	12 (36.3%)		

[a] Chi-square test with Yate's correction; OR = Odd ratio.

and age related macular degeneration (10%) were also reported though they were not a manifestation of stroke.

Assessment of visual neglect

Visual neglect could be assessed in only 33 subjects (82.5%). Visual neglect could not be assessed due to poor vision in 2 cases, and poor co-operation in 5 cases. Eighteen subjects (54.5%) had visual neglect present (Table 2). Out of 12 subjects with right hemisphere involvement, 9 subjects had visual neglect. Out of 21 subjects with left hemisphere involvement, 9 subjects had visual neglect.

Discussion

Our study is mostly comparable to other studies on type of stroke (ischemic, 80%), hemisphere involved (left, 60%), and area involved (cortical, 65%) except age of onset (52.1 ± 15.7 years) and manifestation in gender (female, 60%). In other studies, stroke was reported around 48–59% in males with mean age around 69–74 years.[3,6,20] Ischemic type of stroke was reported around 79–84%.[6,7] This variation can partly be explained by difference in patient selection criteria, assessment time post stroke, choice of test for the assessment, and sensitivity of the assessment tools.

Visual impairment in older people can have a negative influence on patient overall functional status[7,21] and may exacerbate the impact of other impairment on overall disability.[3] We have found visual impairment in 15% of the cases excluding the cases of visual neglect. This reduction in visual acuity was basically attributable to the optic atrophy in one case, the diabetic retinopathy in two cases, and combined age related macular degeneration and cataract in three cases. It was found in 26% of subjects of the Lotery et al. study.[3] In the current study, people who could benefit from a proper spectacle correction did not wear spectacles or did wear them but with dirty or damaged glasses. It should be considered that the correction of the pre-existing refractive error may possibly help the rehabilitative process of overall disability.[3] If easily correctable factors remained untreated the rehabilitation and subsequent quality of life may be adversely affected.[10]

Conjugate eye deviation towards the affected hemisphere as well as eye movement disorders due to involvement of the third, fourth and sixth cranial nerves are common.[22] The percentage of extraocular muscle paresis due to stroke in our study (17.5%) has been observed to be quite similar (18%) to that from the study done by Rowe et al. study. [23]

Variety of ocular motility disorders including infranuclear cranial nerve palsies, supranuclear gaze disorders, internuclear ophthalmoplegia, nystagmus and ocular dysmetria are well documented with brainstem stroke.[4] In our study, the upper motor nucleus of the seventh nerve has been affected in most subjects. However, its effect on ocular and visual system has not been commonly observed. Small sample size and maximum drop out in our study might have accounted for this finding.

The incidence of strabismus has been reported to be of 28–52% in subjects with stroke.[8,24] But, we could report the strabismus in only 12.5%, all of them females. These subjects may complain of diplopia, problems with saccades, smooth pursuit, reduced binocular convergence, reduced stereopsis, poor hand–eye coordination and difficulty in reading. In many cases, their symptoms and impairments improve over time with no specific intervention.[24,25] In our study, only very few subjects (7.5%) have complained of difficulty in going up stairs.

Visual field loss is a well-recognized complication of stroke, with a different incidence in different studies such as 20% in acute stroke patients,[26] 29% in transient ischemic attack and 57% in minor stroke patients.[27] Homonymous hemianopia and quadrantanopia are the most common visual field defect reported in stroke.[4,5] Lesions in the post-chiasmal tract result in either homonymous quadrantanopia or homonymous hemianopia. However, the configuration of the homonymous hemianopia does not predict the location of the lesion within the postchiasmal visual pathway.[7] Though the total incidence of visual field defect noted was 17.5%, we have reported right homonymous hemianopia in only one subject having ischemic stroke. Owing to less sample size and significant number of drop out, this finding may not represent the true incidence in our context. However, the possibility of improvement in visual field defect can also be present since examination of these stroke patients were carried out after one month of discharge from IPD when the maximum recovery was expected.[28]

It is reported in the literature that severity of retinopathy[29,30] retinal microvascular abnormality,[31,32] hypertensive retinopathy,[33,34] retinal vein occlusion[35] and retinal emboli[34] are related to an increased risk and predictive of stroke. Smoking is also a risk factor for stroke and is associated with age related macular degeneration.[36] These are the coincidental co-morbid ocular manifestation rather than a manifestation of the stroke itself. In our study, co-morbid ocular manifestations such as cataract (10%), age-related macular degeneration (10%), diabetic retinopathy (7.5%), hypertensive retinopathy (12.5%), and optic atrophy (2.5%) have been observed. Fifty percent of the study subjects had a habit of smoking, 22.5% were diabetic and 60% were hypertensive.

Visual neglect may adversely affect functional recovery[37] and exerts a slowing influence on rehabilitation.[38] The incidence of visual neglect has been observed in 54.5% subjects in our study. Prevalence of visual neglect has been observed variable in different studies ranging from 8% to 82%.[38–40]

The right hemisphere stroke (9 out of 12 cases) has been observed almost to have associated significantly higher level of visual neglect than the left hemisphere stroke (9 out of 21 cases) at $p = 0.08$ (OR = 4.0). This finding was comparable with other reports. In the Vallar et al. study,[41] 35% right brain damaged subjects and 9% left brain damaged subjects had contralateral visual neglect. Similarly, Pedersen et al.[20] have reported right hemisphere lesions in 42% subjects and left hemisphere lesions in 8% subjects. Visual neglect in lesion confined to the left hemisphere usually gives rise to minor and short-lasting spatial impairments in the contralateral side, but bilateral lesions are necessary to produce persistent and severe right visual neglect.[42] This could probably explain the incidence of left visual neglect more than right visual neglect. Though star cancellation was the most sensitive measure of neglect,[19,43] a single test alone was not sufficient for precise determination of visual neglect. The star cancellation test cannot be used to differentiate between sensory neglect and motor neglect because it requires both visual search and manual exploration.[44] A battery of visual neglect tests has been advised to rule out the presence of neglect in a given subject.[19,45,46]

Ocular manifestation and visual neglect often improve with time, yet this recovery is maximum from the first month to three months.[28,47] This study was conducted in limited number of samples, subjects' drop out was high, and prolonged follow-up of the cases was not considered. Ocular pathologies were not excluded also their visual effects could not be considered as confounders to the result of the star cancellation test. No control was included in the study design. Inclusion of an evaluation of the star cancellation test in patients without stroke would allow calculation of relative prevalence to validate the comparative calculations of this study. Longitudinal study is necessary to follow the pattern of recovery so that ultimate manifestation could be judged and effective rehabilitation plans can be suggested.

The incidence of ocular–visual defects (strabismus, visual field defect, extraocular muscle paresis, and visual impairment) was found to be less than that from other peer reviewed literature reports. This finding could be expected to rise if drop out of subjects with multiple handicaps could have been enrolled. In spite of this fact, ocular and visual disorders were found to be significantly associated with stroke in the study. Patients with stroke were found to require an eye examination at different period of times. There may be a role for formal screening for visual problems in stroke patients in in-patient department and rehabilitation setting.

Appendix 1. Modified Glasgow Coma Scale

Date:
Name: Age: Sex: M/F
Diseases:

Coma Scale		Score
1. Eye open	Spontaneously = 4	
Eye closed by swelling = C	To speech = 3	
	To pain = 2	
	None = 1	
2. Best verbal response	Oriented = 5	
Dysphasia = D	Confused = 4	
E.T. tube or	Infrequent = 3	
Tracheostomy = T	Incomprehensible = 2	
	None = 1	
3. Best motor response	Obeys commands = 6	
Usually best arm:	Purposeful move = 5	
Chart poorer function	Purposeless move = 4	
(RA, LA, RL, LL)	Decorticate = 3	
	Decerebrate = 2	
	None = 1	
Total score		
a. Normal Strength = 4	Right arm (RA)	
b. Lifts and holds = 3	Right leg (RL)	
c. Lifts and falls back = 2	Left arm (LA)	
d. Moves on bed = 1	Left leg (LL)	
e. No movement = 0		

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