# Assessment of visual field defects in cerebrovascular disease (CVD)

**Soumya Ramani[1], Divya Vishwanatha Kini[2,*], Mahendra Javali[3]**

[1]Assistant Professor, [2]Student, [3]Associate Professor, [1,2]Dept. of Ophthalmology, [3]Dept. of Neurology, Ramaiah Medical College, M.S.R Nagar, Bangalore, Karnataka, India

***Corresponding Author:**
Email: dillakini@gmail.com

## Abstract

To expedite the rehabilitation process of CVD patients, it becomes imperative to identify and assess the extent of the Visual Field defect and the type of CVD. Through this study we aim to assess the visual field loss in patients following Cerebrovascular disease (CVD) and correlate the site and vessel involved with the Visual Field Loss. The study is a cross sectional study carried out over 3 months. All patients with anterior or posterior circulation stroke irrespective of the cause at 2 weeks following the episode of stroke formed a part of this study. They underwent a thorough ophthalmological assessment and Visual Field Assessment. Also, the corresponding radiological data was analysed for the site and the vessels involved in the CVD and correlated with the visual field defect obtained. A total of 25 patients were assessed with 88% being male and 12% female. Common co-morbidities were ischemic heart disease (IHD), diabetes mellitus (DM) and hypertension (HTN). Here, 100% of the patients with IHD had visual field loss as a symptom (P=0.032). All the patients who had gait abnormalities and giddiness as complaints were found to present primarily with visual field defect (P=0.032). When the Posterior Cerebral Artery (PCA) was involved visual field defect was seen in 100% of the patients (Left PCA, P=0.032) and in 60% of patients with Right PCA involvement (P=0.133). Hundred percent of patients with Right occipital lobe involvement had a visual field defect (P=0.032). PCA involvement with the Left Lower temporal field loss and also MCA involvement with Right nasal fields were found to correlate significantly (P= 0.015, 0.022, 0.023 respectively). Hence, incorporating Ophthalmological assessment in all patients of stroke helps in rehabilitation of the patients better and at the earliest.

**Keywords:** Cerebrovascular disease, Nasal, Rehabilitation, Site of lesion, Temporal, Vascular territory, Visual field defect.

## Introduction

Cerebrovascular Disease (CVD) also known as stroke has been found to occur at an increasing rate in recent years. In India, it was found to have an estimated adjusted prevalence rate ranging from 84-262/100,000 in rural and 334-424/ 100,000 in urban areas. The incidence rate ranges from 119-145/100,000 based on the recent population based studies.[1] Increasing changes in the lifestyle and habits of individuals today has led to early onset of numerous chronic preventable diseases in the world today, CVD being one of the frequent complications of these diseases.

Of the many manifestations, compromised vision in the form of visual field defects commonly being homonymous hemianopia or quadrantanopia are the most important ones.[2] Also it is seen that most cases of homonymous hemianopia is attributed to stroke and the most important cause of this stroke being posterior cerebral artery infarcts.[3] These defects impair the daily functioning ability and quality of life of the individual to a large extent.[4] It has an impact on the successful completion of the rehabilitation process and also increases their dependence on others as well as their isolation from the society.[5]

CVD being a major burden in the Indian scenario, and it being a preventable health issue, the government has launched the National programme for prevention and control of cancer, diabetes, cardiovascular diseases and Stroke (NPCDCS) to prevent its occurrence and limit its further complications. Also, a stroke programme for India has been proposed in order to create an efficient 'Stroke Team' consisting of an amalgam of clinicians to effectively tackle the situation.[6]

Through this study we aim to assess the extent to which CVD affects the visual fields and thus help prevent delay of the rehabilitation process in stroke patients. Hence, it becomes imperative to identify and assess the extent of the visual field defect and the stroke type and also correlate these defects with the intracranial site of the haemorrhage or infarction.

## Materials and Methods

This study is a cross sectional study carried out over a duration of 3 months. In the study carried out, 25 patients were recruited for the study to achieve the objective. Criteria for inclusion were all patients with anterior or posterior circulation stroke, within 2 weeks, irrespective of the cause while patients excluded were those with esotropia or exotropia in primary gaze, recently detected / pre-existing glaucoma, best corrected visual acuity of less than 6/36 and nystagmus. Also, any other retinal cause of visual field defect, high hyperopes and high myopes, patient unable to sit and patients with aphasia, disorientation and behavioural changes.

An informed consent was taken by all the patients attending the stroke clinic of the Neurology Department who were further referred to the ophthalmology OPD for evaluation who then underwent a thorough ophthalmological assessment for best corrected visual acuity using a Snellen's Visual chart, anterior segment

examination using a slit lamp biomicroscope, dilated eye fundus examination using a slit lamp biomicroscope with a 90D lens, ocular motility assessment and visual Field Assessment using the Humphrey's visual field analyser.

Cases were considered based on the inclusion and exclusion criteria mentioned earlier. Also, the corresponding radiological data i.e. whether a hemorrhagic stroke or an infarct, the site of the lesion and the artery territory affected was analysed and correlated with the visual field defect obtained on examination.

All these patients of acute CVD underwent a CT/MRI as a part of the initial management protocol of the department of Neurology and General Medicine. CT scan was performed using the Siemens somatom (128 slice) / Toshiba (single slice) and MRI using the Siemens Magnatom 1.5T. The report thus obtained was taken and all the radiological data as mentioned above were noted for further correlation.

The data regarding the fields was graded based on the "number of nullities" in each quadrant. The grading was divided as follows:

0 to 6 – Grade 1

7 to 10 – Grade 2

>10 – Grade 3.

Other quantitative data such as the fixation losses, false positives and false negatives were also noted. The Statistical Package for the Social Sciences version 18.0 (SPSS Inc., Chicago, IL, USA) was used for data analysis. Chi-Square test/Fisher's exact tests were employed to test the association between various categorical variables and a P value less than 0.05 was considered statistically significant.

## Results

Of all the 25 patients we have included, the mean age of the patients was 55.12 ± 9.9 years. Male patients were 88% and 12% patients were female. Of the total 25 cases, 64% were found to have severe visual field defects (Grade 3).

As shown in Figure 1, history of speech impairment post-stroke was given by 44% of the patients while 72% of the patients complained of weakness and none of the patients had any episode of loss of consciousness. The history of giddiness was elicited in 8% of the patients, chest pain in 4% and gait disturbances in 8% of the patients.

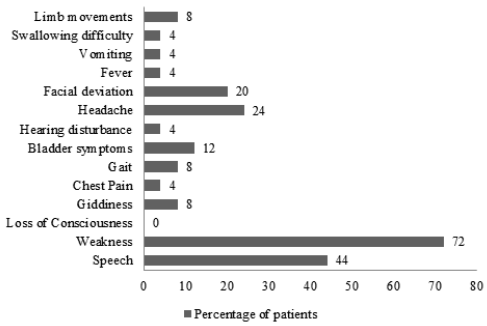


**Fig. 1:**

Common co-morbidities associated in most of the cases were as shown in Fig. 2. History of Ischemic heart disease (IHD) was given in 8% of the patients, while 60 % of the patients had a history of hypertension. 36 % of the patients were known diabetics. This has been diagrammatically represented in Fig. 2.

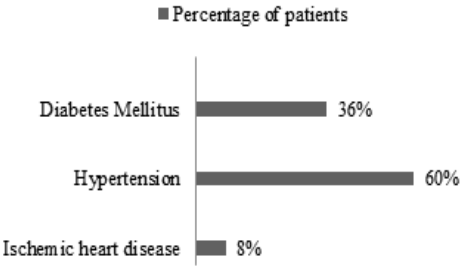


**Fig. 2:**

On assessing the effect of IHD on the symptom of visual field defect (figure 3), 100 % of the patients with a IHD had a symptom of visual field defect, while 35.2% of the patients with no IHD had a symptom of visual field defect (P=0.032). Patients with no hypertension and patients with hypertension showed that 20% and 40% had a visual field defect respectively (P=0.294). Of the patients with no DM, 31.25 % had a symptom of a visual field defect, while 33.33% of the patients with DM had a symptom of visual field defect (P=0.915).

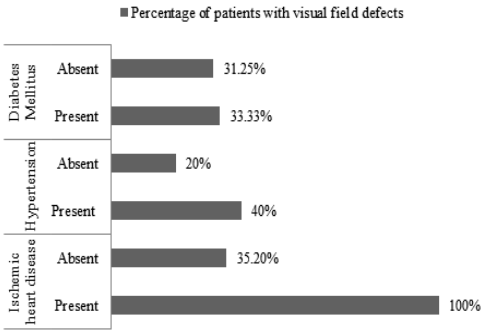


**Fig. 3:**

When the neurological symptoms were compared with presence or absence of visual defect as a symptom, it was seen that 5 (45.45%) patients among the patients with a speech defect had a visual defect as well, while 3 (27.27%) with no speech defect and a visual field defect. But this was not found to be statistically significant (P=0.205). All the patients who complained of giddiness also complained of a visual field defect (P=0.032). 35.2% of the patients who had no giddiness had history of a visual field defect. All patients who complained of gait abnormalities also complained of a visual field defect (P=0.032). In 35.2% of the patients with no gait abnormalities complains of a visual field defect was obtained as well. These symptoms are very important as many a times a visual field defect can present in a similar manner and are falsely attributed as gait abnormalities and giddiness due to vertigo and light-headedness hence failing to recognise the underlying field defects. In 50 % of the patients with headache and 46.15 % of the patients without headache complains of visual field defects were seen too (P=0.936).

On enquiring about the ocular history, none of the patients in the study had diplopia, ocular movement issues or difficulty in lid closure. But eight of the patients (32%) had symptoms of a defective visual field and four (16%) of the patients gave history of beneficial post stroke physiotherapy as well.

Visual acuity as examined using a snellen's chart was another parameter that was noted. Eighty percent of the patients had a visual acuity of better than 6/18 and twenty percent had a visual acuity of between 6/18 to 6/36 in the right as well as the left side.

**Table 1:**

| | |
|---|---|
| Right Haemorrhage | 4% |
| Right Infarct | 48% |
| Left Haemorrhage | 0% |
| Left Infarct | 56% |
| Venous thrombosis | 8% |

On looking into the number of cases involved with type of CVD as well as the laterality of lesion, we see that the percentage of infarcts are more than that of haemorrhages and also that left sided infarcts are more when compared to haemorrhages on the right side (Table 1). Of all the vessels involved, the Middle Cerebral Artery was affected the most with 32% right sided artery involvement and 40% involvement of left sided Middle cerebral arteries.

Visual defect as a symptom was complained by 32% of the patients. A further assessment was made by correlating between the artery involved and the percentage of patients who complained of visual defects (defect) or not (no defect). This yielded the following information as in Table 2:

**Table 2:**

| Artery | Defect % | No defect % |
|---|---|---|
| R ICA | 66.6 | 33.4 |
| R ACA | 0 | 0 |
| R MCA | 25 | 75 |
| R PCA | 60 | 40 |
| L ICA | 50 | 50 |
| L ACA | 0 | 100 |
| L MCA | 30 | 70 |
| L PCA (P=0.032) | 100 | 0 |

Here we see that only when the PCA is involved, the patients' complaint of a visual defect is statistically significant wherein all the patients with a PCA infarct complained of symptoms of a field defect. So in this we conclude that PCA infarcts are most probable when the patient has a symptom of a visual field defect.

Similarly in Table 3, the comparison was made regarding whether the patient complained of visual defects (defect) or not (no defect) based on the site of the lesion

**Table 3:**

| Site | Defect % | No defect % |
|---|---|---|
| R Frontal | 0 | 100 |
| R Temporal | 66.6 | 33.3 |
| R Parietal | 0 | 100 |
| R Occipital Lobe **(P=0.032)** | 100 | 0 |
| R Thalamus | 50 | 50 |
| R Corona Radiata | 0 | 100 |
| R Medulla | 50 | 50 |
| R Internal Capsule | 0 | 0 |
| L Frontal | 0 | 100 |
| L Temporal | 0 | 100 |
| L Parietal | 33.33 | 66.6 |
| L Occipital Lobe | 100 | 0 |
| L Thalamus | 33.3 | 66.6 |
| L Corona Radiata | 0 | 100 |
| L Medulla | 0 | 0 |
| L Internal Capsule | 0 | 0 |

Statistically significant data was seen in 25% of the patients with Right Occipital lobe lesions with P=0.032. All such patients complained of field defects. Left sided occipital lobe lesions were also seen in a similar manner but results were not found to be statistically significant (P=0.137).

All four quadrants of the right and left fields were found to be affected to varied extents depending on the severity of damage. A comparison between the severity of loss of field between Grade 3 with whether the patient complained of any visual field defects (DEFECT) or not (NO DEFECT) as in Table 4 though data was found to be statistically not significant.

**Table 4:**

| Quadrant | Defect % | No defect % |
|---|---|---|
| RUN | 28.6 | 71.4 |
| RLN | 18.2 | 81.8 |
| RUT | 14.2 | 85.7 |
| RLT | 25 | 75 |
| LUN | 27.2 | 72.7 |
| LLN | 20 | 80 |
| LUT | 33.3 | 66.6 |
| LLT | 27.2 | 72.7 |

In the series of patients, 5 were admitted after a second stroke against 20 who had the first episode of stroke, but none of these five patients with more than one episode of stroke complained of a visual field defect on admission (P=0.08). All the patients underwent perimetric examination, the severity of visual field defect in all the quadrants were taken into account and the involvement was compared among patients with one episode of stroke against those with more than one episode of stroke as shown in Table 5.

**Table 5:**

| Quadrant | 1st Episode of stroke | >1 Episode of stroke |
|---|---|---|
| RUN | | |
| 1 | 30% | 40% |
| 2 (Grade 2+3) | 70% | 60% |
| RLN | | |
| 1 | 20% | 40% |
| 2 | 80% | 60% |
| RUT | | |
| 1 | 55% | 60% |
| 2 | 45% | 40% |
| RLT | | |
| 1 | 65% | 60% |
| 2 | 35% | 40% |
| LUN | | |
| 1 | 25% | 80% |
| 2 | 75% | 20% |
| LLN | | |
| 1 | 35% | 80% |
| 2 | 65% | 20% |
| LUT | | |
| 1 | 25% | 80% |
| 2 | 75% | 20% |
| LLT | | |
| 1 | 45% | 80% |
| 2 | 55% | 20% |

*LUN-Left Upper Nasal, LLN-Left Lower Nasal, LUT-Left Upper Temporal, LLT-Left Lower Temporal, RUN-Right Upper Nasal, RLN-Right Lower Nasal, RUT-Right Upper Temporal, RLT-Right Lower Temporal; GRADING : 1 - 0 to 6 nullities, 3 - ≥10

All the vessels were further compared with the severity of visual field defects as graded on perimetric examination in all the cases. As in table 6, comparison of grade 2 & 3 (i.e. Affected) against grade 1 (i.e. Not Affected) visual loss in the right and left side with respect to the involvement of various vessels (as obtained on radiological imaging) was performed. Here, significant results were obtained with respect to PCA involvement and Left Lower Temporal field loss (P=0.015) and MCA involvement with both Right nasal fields (P=0.028 and 0.023) with statistically significant results as depicted below.

**Table 6:**

| LUN | Affected % | Not Affected % |
|---|---|---|
| ICA | 66.70 | 33.3 |
| MCA | 75 | 25 |
| ACA | 0 | 0 |
| PCA | 80 | 20 |
| Vertebral | 100 | 0 |
| Transverse Sinus | 100 | 0 |
| Sigmoid Sinus | 100 | 0 |
| Jugular | 100 | 0 |

| LUT | Affected % | Not Affected % |
|---|---|---|
| ICA | 66.7 | 33.3 |
| MCA | 87.5 | 12.5 |
| ACA | 0 | 0 |
| PCA | 100 | 0 |
| Vertebral | 100 | 0 |
| Transverse Sinus | 100 | 0 |
| Sigmoid Sinus | 100 | 0 |
| Jugular | 100 | 0 |

| LLN | Affected % | Not Affected % |
|---|---|---|
| ICA | 66.7 | 33.3 |
| MCA | 62.5 | 37.5 |
| ACA | 0 | 0 |
| PCA | 60 | 40 |
| Vertebral | 100 | 0 |
| Transverse Sinus | 100 | 0 |

| LLT | Affected % | Not Affected % |
|---|---|---|
| ICA | 66.7 | 33.3 |
| MCA | 50 | 50 |
| ACA | 0 | 0 |
| PCA (P=0.015) | 100 | 0 |
| Vertebral | 100 | 0 |
| Transverse Sinus | 100 | 0 |

| | | |
|---|---|---|
| Sigmoid Sinus | 100 | 0 |
| Jugular | 100 | 0 |

| | | |
|---|---|---|
| Sigmoid Sinus | 100 | 0 |
| Jugular | 100 | 0 |

| **RUN** | Affected % | Not Affected % |
|---|---|---|
| ICA | 50 | 50 |
| MCA (P=0.028) | 40 | 60 |
| ACA | 68 | 32 |
| PCA | 50 | 50 |
| Vertebral | 0 | 100 |
| Transverse Sinus | 0 | 0 |
| Sigmoid Sinus | 0 | 0 |
| Jugular | 0 | 0 |

| **RLN** | Affected % | Not Affected % |
|---|---|---|
| ICA | 100 | 0 |
| MCA (P=0.023) | 50 | 50 |
| ACA | 0 | 100 |
| PCA | 100 | 0 |
| Vertebral | 100 | 0 |
| Transverse Sinus | 0 | 0 |
| Sigmoid Sinus | 0 | 0 |
| Jugular | 0 | 0 |

| **RUT** | Affected % | Not Affected % |
|---|---|---|
| ICA | 0 | 100 |
| MCA | 30 | 70 |
| ACA | 0 | 100 |
| PCA | 0 | 100 |
| Vertebral | 0 | 100 |
| Transverse Sinus | 0 | 0 |
| Sigmoid Sinus | 0 | 0 |
| Jugular | 0 | 0 |

| **RLT** | Affected % | Not Affected % |
|---|---|---|
| ICA | 0 | 100 |
| MCA | 20 | 80 |
| ACA | 0 | 100 |
| PCA | 50 | 50 |
| Vertebral | 0 | 100 |
| Transverse Sinus | 0 | 0 |
| Sigmoid Sinus | 0 | 0 |
| Jugular | 100 | 0 |

*R-Right, L-Left, ICA-Internal Carotid Artery, MCA-Middle Carotid Artery, ACA-Anterior Cerebral Artery, PCA-Posterior Cerebral Artery

## Discussion

Our study involved 25 patients of stroke selected based on the inclusion and exclusion criteria as mentioned earlier and were subjected to perimetric visual field assessment. A cumulative of all these cases were analysed and results obtained as shown above.

The current scenario is such that Ischemic heart disease, hypertension and diabetes mellitus are co-morbidities seen in a high percentage of the general. Its association with stroke was shown by Oxbury J M et al. in their study where around 50% of the cases had associated non-cerebral cardiovascular diseases.[7] Such an incidence was also noticed in the present study as shown in the results with history of Ischemic heart disease (IHD) in 8% of the patients, while 60 % of the patients with history of hypertension and 36 % of the patients with diabetes mellitus. Also the effect of IHD on the symptom of visual field defect was such that 100 % of the patients with IHD had a symptom of visual field defect, while 35.2% of the patients with no IHD had a symptom of visual field defect (P=0.032).

Gait abnormalities and dizziness are frequent complaints of a patient post-stroke and are manifestations similar to that as seen in a patient with visual field loss. Hence probing into history of visual complaints and also a thorough clinical examination plays a very important role in diagnosing at the earliest. Not many literatures with respect to these parameters are available. In the present study, all the patients with gait abnormalities and giddiness had visual field complaints which was found to be statistically significant as well (P=0.032).

CVD is a very common occurrence these days.[1] Owing to the change in lifestyle, dietary habits and associated co-morbidities it is seen that many a times patients suffer from multiple episodes of a cerebrovascular disease. In a similar study by Townend et al. [8] 14 of their total 61 cases (23%) were cases of previous episodes of stroke while the remaining were first stroke patients. This implies that even though a first episode of stroke, visual field assessment becomes imperative. This parameter was assessed in this study as well and it was seen that of the total 25 cases, 5 were known cases of previous episodes of stroke (20%) while the remaining 20 cases were subjects with first episode of a stroke.

Visual defect is a serious defect that is seldom investigated for, a very important cause of morbidity in the patient and hinders the effective rehabilitation of the patient. Early work-up management can be carried out if the patient primarily complaints of visual field defects than those who were detected to be having the defect on clinical examination. But a large number, as seen in the present study, did not present in this manner. Studies have shown that 84% of their patients

complained of visual field defect as a symptom while only about 32% (8 patients) did so in this study.[4] Hence we see that to a large extent, the delay in detection of such gross defects can be done at an earlier stage in order to treat as well as rehabilitate them better.

Rowe FJ et al. found that stroke presented mostly in the form of Visual field loss or ocular motility abnormalities. 49.5% of the patients had visual field impairment with 29.4% of these having complete homonymous hemianopia.[2] On the other hand, none of the patients in our study were found to have any ocular motility abnormality and had primarily visual field defects only i.e. 64% with severe Grade 3 defects with no other ophthalmological abnormalities. They have also shown in their study that visual field loss is seen in 3.5% of their patients and was attributed to the concomitant presence of other ocular pathologies.[4] But presence of such ocular diseases that would significantly affect the visual fields were not found in any of our patients. Despite no ocular abnormality, visual defect was found to be still prevalent.

Zhang X et al. in their study have shown that of all the cases of homonymous hemianopia, most of the cases were caused due to ischemia when compared to the number of cases due to haemorrhage.[3] Similar results in this study were obtained with a predominant number of infarcts when compared to hemorrhagic lesions.

Most arteries are involved to various extent of severity during a stroke hence presenting differently with different grades of visual field loss. Haerer A F conducted a study where it was found that the Middle cerebral artery involvement were found to be the maximum in the form of infarcts.[9] In the current study we have noted that the maximum number of cases, i.e.32%, were due to involvement of the middle cerebral artery as well. Also, according to the artery involved, corresponding sites of the lesion also will vary. These sites of lesions can be further classified as cortical and non-cortical areas. The study by A L M Pambakian and C Kennard has shown that visual field loss was found to be maximum when the lesion was localised to the occipital lobes (40%) followed by parietal lobe (30%), temporal lobe (25%) and lastly optic tract and lateral geniculate nucleus (5%).[9] Similar results were obtained in studies by Zhang et al wherein it was proven that the occipital area was affected in the largest percentage of cases i,e 54%.[10] Also, the most commonly affected area of the brain for stroke was the occipital regions as seen in the results obtained in another study as well.[4] In this current study, visual defect (grade 3) was found to be the maximum in the occipital area, right more than left side, which was 25% (P=0.032) and 12.5% (P=0.137) of the cases respectively. Only 2 of the total 25 cases (8%) were cases with medullary lesions and all the other cases were those with cortical lesions.

Visual field loss is dependent on the artery involved. In the study by Rowe F et al, it was seen that 51.4% of all patients to the study had visual field loss with 38% having right sided, 53.5% having left sided and 8.5% having bilateral visual field loss. As seen by the results obtained by them, visual field defects were found to occur significantly more frequently on the left side than the right side[4] and here in our study as well, the left quadrants were most affected (68%) highest being the left upper temporal quadrant (50%) (though this data was not found to be statistically significant), 60% were right sided lesions and lastly 68% with bilateral field loss. Similar left sided preponderance was observed in another study.[7] But contradicting results were obtained in the study by Townend et al. where Right sided lesions (70%) were more than left sided field loss.[8]

Visual field impairment is seldom complained of and is usually detected only after thorough clinical examination. This also depends on how severe the field loss is, greater the severity thereby compelling the patient to bring it to the physician's notice; rest go undetected. Hence it is necessary that this be incorporated in the regular protocol in the management of any case of stroke. Sixty four percent of this study group was found to have severe Grade 3 visual field defects as was also seen in the study wherein almost half of their patients had visual field impairment (49.5%).[2] This shows the importance of visual field assessment in a case of cerebrovascular disease which has to be performed at the earliest.

## Conclusion

Visual field defects are a significant cause of morbidity in patients with stroke. Stroke rehabilitation involves the combined effort of a neurologist, physiotherapist and, when ocular problems are encountered, an ophthalmologist. Assessment of visual field defects may be incorporated into the regular management of patients with stroke, in order that the defect can be assessed, mode of physiotherapy may be tailor-made to the patient, and field expanders may be provided to the patient, when deemed necessary. In this manner, post stroke rehabilitation can be expedited.

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