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Hemianopic visual field loss in a young child tested with Pediatric Perimeter: A case report

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Dedicated to Prof Jay M Enoch

Visual field defects in children remain unrecognized due to lack of age-appropriate perimeter to assess visual fields in them. This case report highlights the case of a child who developed visual field defect following a head trauma. In this case, the use of the Pediatric Perimeter to assess the visual field aided the examiner in diagnosing the right homonymous hemianopic field loss. The conventional perimeter could not detect the defect due to low test reliability of the test for this child. The observed visual field defect correlated with the location of the brain injury and the clinical presentation of a right face turn of the child, which developed, post the head trauma. Detection of visual field defects following brain injuries are necessary for the better management and rehabilitation of the condition. The use of age-appropriate testing devices can help document visual fields in young children as well, especially when testing with conventional device is not possible. The Pediatric Perimeter is one such device for young children.

Keywords: Perimeter, Brain injury, Children, Visual field, Head trauma.

1 Introduction

Visual field is the extent of side vision present when eyes are steadily fixated straight ahead. Measuring visual field is called perimetry, and the device used for it is called perimeter. Visual field defects can impair mobility and orientation. Brain injuries and lesions in visual pathway can cause visual field defects [1]. However, these field defects largely goes undetected in infancy and early childhood [2,3]. The defect could become apparent when the child becomes mobile and active or in some cases, it is discovered only at a later age [2,4]. The reasons for the lack of early detection includes the unavailability of an appropriate perimeter for testing young children. The conventional perimeters are not suitable because of the inherent difficulty of using these devices that require stable head position, with steady eye fixation and a button press to indicate detection. Such requirements are challenging and not feasible for young children and patients with neurological disorders.

To overcome these challenges, the Pediatric Perimeter device was developed [5]. This device quantifies visual field by allowing the examiner to observe for the eye/head position towards a light stimuli presented in an otherwise dark testing room. The eye/head movement is taken as a surrogate marker for detection. In this testing, infants are placed in a comfortable supine position, older children can be tested in sitting position as well. Although the Pediatric Perimeter was built to test infants [5], it can also be used to test older patients, especially those with neurological disorders, who are unable to perform the conventional

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test. This case highlights the utility of Pediatric Perimeter in identifying a visual field loss in a child who sustained brain injury. The pattern of visual field defect observed correlated with the clinical signs.

2 Case

A 6-year-old boy accompanied by his mother presented to the children eye care center at L V Prasad Eye Institute (LVPEI) in 2018. Mother reported that the child had diminution of vision in both eyes following a fall from the second floor of their building 2 months back. The child sustained head injury and was in coma for six days. The child had one episode of vomiting post the injury and no bleeding was noted from ear, nose or throat. The computed tomography (CT) of the brain revealed multiple fractures of the left parietal skull bone and underlying subdural hemorrhage (SDH). No seizures history was noted.

Mother also reported that the child turns his head to the right to view objects since the recovery from trauma. During the ophthalmic examination, dazzle reflex (rapid response to sudden onset of light in dark room condition) was not present and both eyes pupils were sluggishly reacting to light. Anterior and posterior segments otherwise were within normal limits. Magnetic Resonance Imaging (MRI) of the brain taken 2 months after injury showed gliotic changes in the left parieto-occipital lobe (Fig 1). The child was diagnosed as a case of cerebral visual impairment secondary to traumatic brain injury by the pediatric ophthalmologist at LVPEI and was referred for visual rehabilitation.

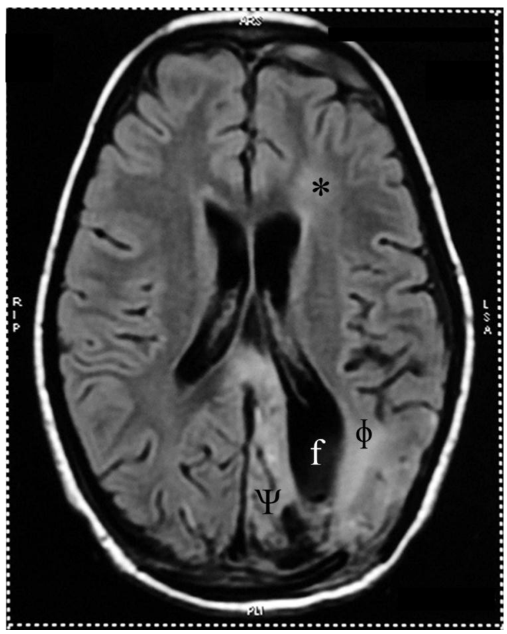
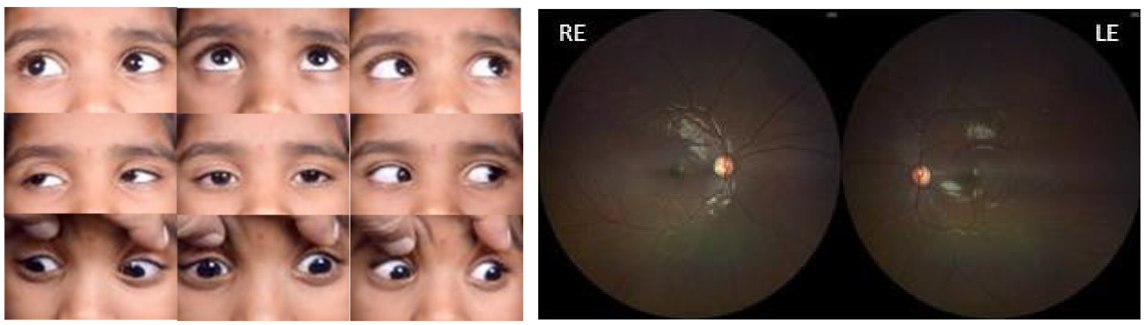


Fig 1. T2-Weighted FlAIR sequence of MRI brain shows hyperintensity in the left frontal lobe in periventricular region (*****), periventricular hyperintensity in the left parieto-occipital lobe (**ϕ**), and gliotic changes in the left occipital lobe (**Ψ**) with exvacuo-dilatation of the left lateral ventricle (**f**)

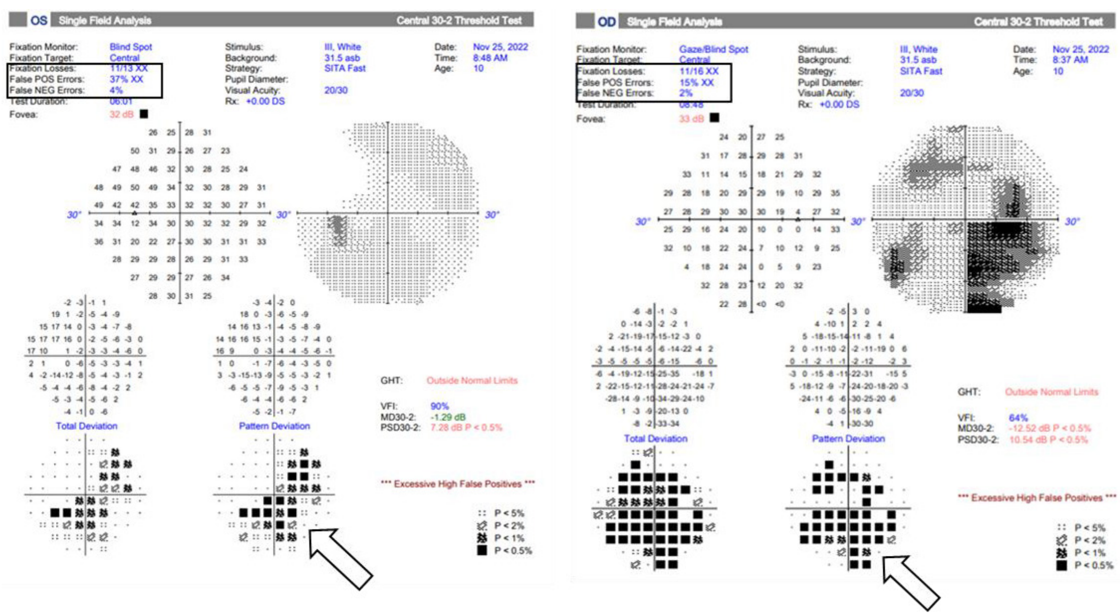
At a subsequent visit after 4 years in 2022 at the age of 10 years, the child complained of not being able to see objects that were situated below. On examination, his best corrected visual acuity was 20/30 and N6 in each eye. The color vision was within normal limits. The child had a right face turn while reading the distance and near visual acuity charts. His extraocular motility was full in all gazes (Fig 2) and the child had a comitant exotropia of 25 prism diopters for both distance and near. He was fixating with his right eye.

The anterior and posterior segments were within normal limits. Visual field was assessed with Humphrey visual field (HVF) analyzer, a conventional perimeter commonly used in many ophthalmology clinics. The central visual fields were tested using the 30-2 program of HVF, with Goldmann size III stimulus. The child was instructed to fixate at the central target and not to move his eyes and to respond with a button press if he sees any light stimulus from the side. The right eye was tested first followed by the left eye. The HVF in both eyes grossly showed visual field defect in the pattern deviation plot (Fig 3). However, since the reliability indices of the test were very low[6], with high false positive error (>33%) and with many fixation losses (>20%), no conclusive pattern of visual field defect could be made. The child was advised to undergo the visual field assessment using the Pediatric Perimeter, a perimeter built in our institute.



(A) (B)

Fig 2. (A) Clinical photographs showing full extraocular motility in all nine positions of gaze. (B) Fundus photographs of right eye (RE) and left eye (LE).



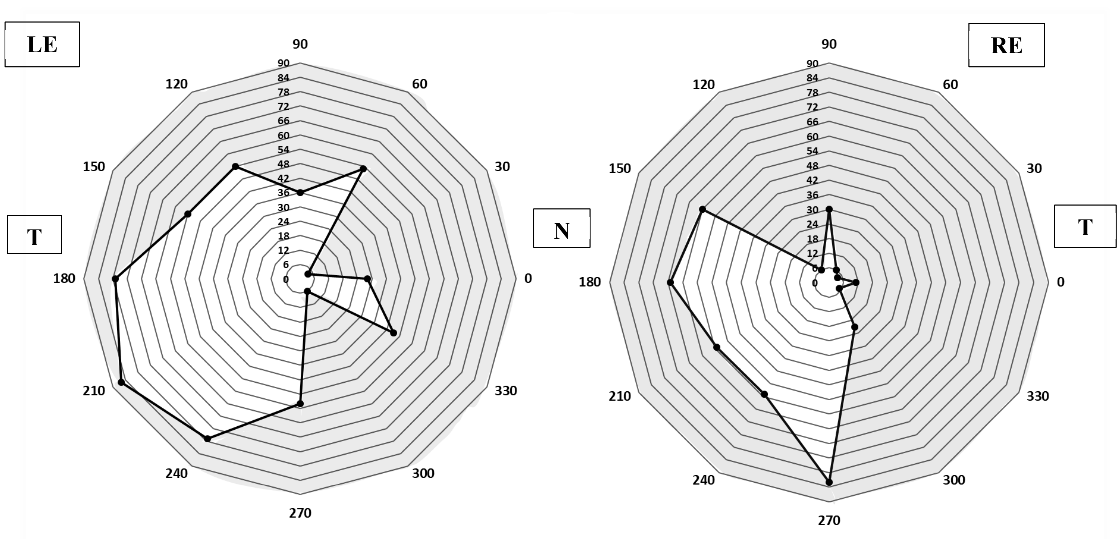
(A) (B)

Fig 3. Humphery visual field 30-2 report of the (A) left eye and (B) right eye. The rectangular box shows the reliability indices of the test, and the XX marking next to it indicates low test reliability. The arrow heads in the right and left visual field plots were marked to show the visual field defects. However, since the reliability indices are very poor, no conclusion can be made with this test report.

3 Pediatric Perimeter

The details of this device's hardware and software are described elsewhere [5]. Briefly, the Pediatric Perimeter device consists of a hemispherical dome with Light Emitting Diodes (LEDs) that are controlled through a computer using custom-built software. The infrared (IR) camera mounted at the apex of the dome allows the examiner to watch the real-time responses in dark testing conditions. The live video feed of the IR camera is displayed on the examiner's laptop. Both static and kinetic modes can be tested in this device. The visual field extent can be measured using the kinetic mode. In this mode, static LED stimuli are displayed sequentially along a meridian, giving the appearance of a stato-kinetic presentation of the target from outer periphery towards the center of the dome. The speed of presentation of the stimuli is set at 6°/s. Upon observing the infant's eye/ head movement response towards the stimulus, the examiner registers the response with a button press and presents the next stimuli to test.

The patient reported in this case was placed in supine (sleeping) position under the dome for testing his visual field extent. Each eye's visual field was tested with the right eye tested first followed by the left eye. The examiner (author MT) testing the child on this device was masked from the MRI report or the previous HVF report. Constriction in the nasal visual field of the left eye (Fig 4A) and temporal visual field of the right eye (Fig 4B) was observed after the testing. The right eye also showed a reduction in the superior visual field. Visual field defect was diagnosed as possible right homonymous hemianopia. The patient was referred back to the rehabilitation center to manage his hemianopia.



(A) (B)

Fig 4. Visual field isopter of left eye (LE) and right eye (RE) are plotted using the Pediatric Perimeter. N indicates nasal visual field and T indicates temporal visual field. Area inside the isopter is the seeing area (white region) and outside are non-seeing area (grey region).

4 Discussion

This case report highlights the utility of the Pediatric Perimeter device to detect visual field defects in children when the conventional perimetry is not possible or not reliable. Although previous studies have utilized the conventional perimetry technique (HVF) to measure visual fields in children aged 5 to 10 years of age,[7,8], there can still be challenges of low-test reliability as was seen in the case reported here. The child when tested with HVF, has pressed the response button either anxiously or in a 'triggerhappy' fashion. This resulted in a large number of false responses and resulted in the failure to detect the visual field defect. However, while testing the visual field using Pediatric Perimeter, a button response was not required, and a reflexive looking behavior towards the light stimuli was observed. Additionally, the Pediatric Perimeter requires the examiner to be engaged with the patient and can carefully curate the stimuli presented and instruct the patient constantly to avoid anticipatory looks. In HVF, in busy clinics, many patients are left to themselves to do, since the stimuli presentation is automated. Hence, in the lack of constant supervision, unreliable responses can be registered. Pediatric Perimeter test takes 5-15 minutes for each patient, depending on how well they are able to do it. Supine position, without head and chin rest is more comfortable for the child and with the dome above their head, it gives a more immersive feeling to the child and facilitates the reflexive eye movement easily, as the dome cuts off the outside clutter and distraction, making the light stimuli more salient.

The observed right homonymous hemianopia in this case correlates with the location of the brain injury (left parieto-occipital lobe) imaged by the MRI. The peripheral visual field is represented anteriorly, at the junction of the calcarine and parieto-occipital fissure [1]. The gliotic changes in the parieto-occipital lobe (as shown in Fig 1) could have led to the right homonymous hemianopia. The presence of right face turn towards the blind side, in this case, could be the compensatory mechanism developed after the field defect. Such compensatory adaptive postures has been reported in earlier studies [9,10]. The face turn towards the blind side centers the residual visual field with the compensatory doll's eye movement. These compensatory changes help to minimize bumping into objects towards the non-seeing side. The eye deviation (usually exotropia) in an individual with hemianopic field loss usually develops towards the non-seeing side in order to help enlarge the binocular visual field [11]. Anomalous retinal correspondence can also develop in such compensatory strabismus [12]. However, in the case reported here, the exotropia in the left eye was towards the seeing side (left side). This could indicate that this tropia could be a comorbidity of the brain injury and not an adaptive mechanism. Another possible explanation is that this eye deviation could have been present before the injury, but the child could have managed it with good fusional control, which perhaps was lost after the brain injury. The presence of strabismus with abnormal head posture in children warrants an investigation of their visual field with a perimeter. These signs are important to pay attention to in pediatric and pediatric ophthalmology/optometry clinics.

In conclusion, Pediatric Perimeter can be used as a tool that could help to investigate and test the visual fields in children, when conventional perimetry testing is not possible or reliable. This device can be used to understand the prevalence of unrecognized visual field defects in children with neurological disorders. In children with head trauma, it would be important to test their visual fields to arrive at correct diagnosis and therefore a better rehabilitation and management.

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Conflict of interest

Author PremNandhini Satgunam has a patent on the Pediatric Perimeter device (US Patent No.:10517475 B2, India Patent No.: 425672)

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As a young researcher, she continues her interest in understanding the development of visual functions in infants and children.

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