

# Identification and Management of Children with Cortical Visual Impairment

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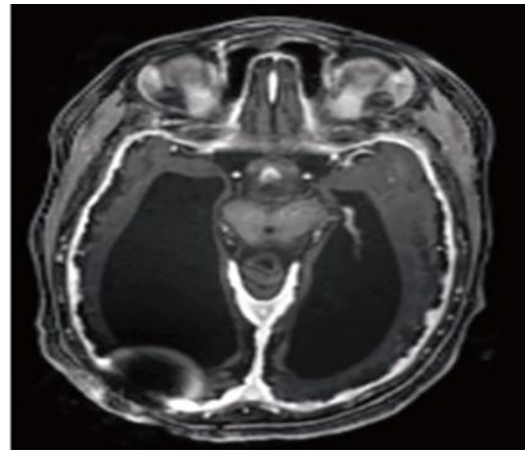
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**Abstract:** Cortical Visual Impairment presents distinctive challenges in children's visual development, stemming from impairments in visual processing due to brain-related damage or dysfunction. This abstract provides a succinct overview of the strategies involved in identifying and managing cortical visual impairment in children. Identifying cortical visual impairment necessitates a thorough assessment extending beyond conventional ophthalmic evaluations. An accurate diagnosis requires a multidisciplinary approach, incorporating insights from neurologists, developmental specialists, and educators. The identification process encompasses observing unconventional visual behaviors, evaluating functional vision, and utilizing neuroimaging tools to pinpoint underlying brain abnormalities. Subsequent to identification, effective management strategies become paramount in fostering the visual development and overall well-being of children with cortical visual impairment. Educational interventions are central, emphasizing the creation of visually accommodating environments and the utilization of adaptive technologies. Tailored individualized education plans are imperative, addressing each child's unique needs and emphasizing improvements in visual attention, promotion of visual-motor integration, and the cultivation of communication skills. Moreover, successful management relies on collaboration among healthcare professionals, educators, and parents. Regular follow-up assessments and adjustments to intervention strategies are imperative, acknowledging the dynamic nature of cortical visual impairment and its evolving impact on visual function. The early identification and comprehensive management of cortical visual impairment in children are critical for optimizing their visual potential and overall developmental outcomes. A cooperative, interdisciplinary approach ensures a broad understanding of the child's needs, facilitating implementation of targeted interventions and supporting their journey toward both visual and developmental success.

**Keywords:** Cortical Visual Impairment, Visual Development, Multidisciplinary Approach, Educational Interventions, Interdisciplinary Collaboration.

## INTRODUCTION



Brain MRI of a 5-year-old with cortical visual impairment reveals extensive cerebral volume loss, hydrocephalus with a ventriculo-peritoneal shunt, hypoxic-ischemic encephalopathy, and seizure activity.

Cortical Visual Impairment is a neurological condition where visual processing is impaired due to brain damage, despite healthy eye structures. It represents the leading cause of visual impairment in children in developed countries, often associated with other neurological issues such as cerebral palsy, epilepsy, and developmental delays. Cortical visual impairment can result from various causes, including perinatal hypoxia, brain malformations, and traumatic brain injuries. Recognizing and managing cortical visual impairment is crucial for the affected child's development and quality of life. Early intervention, tailored educational strategies, and environmental modifications can significantly enhance visual functioning and overall developmental outcomes. This

guide outlines the essential steps for identifying and managing cortical visual impairment, emphasizing the importance of a multidisciplinary approach involving healthcare providers, educators, and families to ensure comprehensive support for children with cortical visual impairment.

#### Objective:

The objective of this paper is to provide a comprehensive overview of Cortical Visual Impairment in children, encompassing its definition, characteristics, diagnostic approaches, and management strategies. This paper aims to consolidate current knowledge and research findings to enhance understanding and awareness among clinicians, educators, and caregivers. By exploring the diverse visual manifestations and behavioral patterns associated with CVI, this paper seeks to facilitate accurate diagnosis and effective intervention. Additionally, it aims to highlight the importance of a multidisciplinary approach in managing CVI, including early intervention, visual rehabilitation, and educational support tailored to the unique needs of each child. Ultimately, this paper aspires to contribute to improved outcomes and quality of life for children with CVI by promoting informed, evidence-based practices and identifying future research directions to address gaps in current knowledge and treatment methodologies.

#### Definition:

- 1- Cortical Visual Impairment is vision loss due to brain damage, not eye problems, affecting how the brain processes visual information. It affects how visual information is processed by the brain, leading to difficulties with vision despite normal eye function.
- 2- Cortical Visual Impairment has visual dysfunction from brain damage, not related to eye disorders or issues with the anterior visual pathways.<sup>11</sup>
- 3- "Bilateral visual acuity or visual field loss in the presence of a normal eye examination or vision loss that is greater than expected based on the degree of ocular pathology."<sup>12</sup>

#### Etiology

Cortical Visual Impairment is caused by damage or malformation in the brain's visual pathways. Common

etiological factors include hypoxic-ischemic encephalopathy, traumatic brain injury, and periventricular leukomalacia, infections such as meningitis and encephalitis, and developmental brain anomalies like cortical dysplasia. Premature birth, stroke, metabolic disorders, and genetic conditions can also contribute to CVI. The damage disrupts the processing of visual information, leading to a range of visual impairments despite healthy eyes. Understanding these causes is crucial for diagnosis, early intervention, and tailoring individualized management strategies for affected children.

#### Characteristics of Cortical Visual Impairment

- Cortical Visual Impairment exhibits a wide spectrum of visual manifestations.
- Visual acuity varies from no light perception to age-appropriate levels, but most children have significantly lessened visual acuity.
- Characteristics include visual field loss, reduced contrast sensitivity, generally normal color vision, impaired global motion processing, or sometimes, preserved ability to perceive motion.
- Visual behaviors associated with cortical visual impairment include difficulty with visual search, highly variable visual function, eccentric gaze preference, and sensitivity to light.
- Children with good visual acuity, peerless visual processing abnormalities may manifest, such as difficulties with recognition, spatial orientation, depth perception, and simultaneous perception.
- Abnormal oculomotor behaviors like increased saccadic latency, reduced vestibulo-ocular reflexes, and fixation instability are also observed.
- Recognition challenges involve identifying objects, faces, or symbols due to impaired integration of visual information.
- Orientation difficulties may lead to disorientation or spatial relationship problems. Depth perception deficits affect judging distances and navigating safely.

#### Diagnosis of Cortical Visual Impairment

##### Signs and Symptoms

- Visual Responses: Delayed or Inconsistent Responses: Children with cortical visual impairment may have delayed reactions to visual stimuli or respond inconsistently, sometimes not

appearing to see objects right in front of them (Roman-Lantzy, 2007).

- **Light Gazing: Prolonged Fixation on Lights:** A common behavior is an unusual fascination with lights or bright objects, leading to prolonged gazing at such sources (Good et al., 2001).
- **Color Preference: Bright Color Attraction:** Many children with cortical visual impairment show a marked preference for looking at brightly colored objects, particularly red and yellow, which are easier for them to see (Roman-Lantzy, 2007).
- **Movement: Attraction to Movement:** Moving objects often capture the attention of children with cortical visual impairment more effectively than stationary ones. This preference can help in engaging their visual attention (Good et al., 2001).
- **Visual Field Preferences: Use of Peripheral Vision:** Children with cortical visual impairment frequently use their peripheral vision rather than central vision. They may look away from objects to see them better, indicating a preference for peripheral visual fields (Hoyt, 2003).
- **Additional Indicators: Difficulty with Complex Visual Scenes:** Children may struggle to process complex visual environments, finding it easier to see in simplified, clutter-free settings.
- **Impaired Visual-Motor Integration:** Challenges in coordinating vision with motor tasks, such as reaching for objects, are common.

#### Clinical evaluation:

Clinical evaluation of Cortical Visual Impairment involves the expertise of pediatric ophthalmologists and neurologists to accurately diagnose and manage the condition. Pediatric ophthalmologists play a crucial role in assessing visual function and identifying ocular abnormalities that may contribute to visual impairment. They conduct comprehensive eye examinations, including visual acuity testing, assessment of refractive error, ocular motility evaluation, and examination of the anterior and posterior segments of the eye. While many children with CVI may have structurally normal eyes, identifying any co-existing ocular conditions is essential for appropriate management.

Neurologists contribute to the diagnosis of CVI by evaluating the neurological basis of visual impairment. They assess neurological history, developmental

milestones, and conduct neurological examinations to identify signs of brain dysfunction. Neuroimaging techniques, such as magnetic resonance imaging (MRI), may be used to visualize structural abnormalities in the brain's visual pathways.

Collaboration between pediatric ophthalmologists and neurologists is crucial for diagnosing CVI comprehensively. Ophthalmologists provide insights into visual function, while neurologists investigate the underlying neurological causes. Together, they ensure a multidisciplinary approach to the assessment and management of CVI.

#### Assessment tools:

Assessment of visual function and brain imaging techniques are essential components in diagnosing Cortical Visual Impairment in children. Several tools and methods are used for this purpose:

##### 1. Visual Function Assessment Tools:

- **Visual Acuity Testing:** Snellen charts, Teller Acuity Cards, or preferential looking techniques assess visual acuity.
- **Contrast Sensitivity Testing:** Tests such as the Pelli-Robson chart assess the ability to detect low-contrast stimuli.
- **Visual Field Assessment:** Perimetry evaluates visual field defects.
- **Color Vision Testing:** Ishihara plates and the Farnsworth-Munsell 100 Hue Test are used to evaluate color discrimination abilities.

##### 2. Functional Vision Assessment:

- **Observational Assessment:** Evaluation of visual behaviors and responses to visual stimuli in various environments.

##### 3. Brain Imaging Techniques:

- **MRI (Magnetic Resonance Imaging):** Structural MRI can detect brain abnormalities such as cortical malformations, periventricular leukomalacia, or cerebral atrophy.
- **Functional MRI (fMRI):** Functional MRI studies brain activity and connectivity during visual tasks.
- **Diffusion Tensor Imaging (DTI):** DTI assesses white matter integrity and connectivity in the brain's visual pathways.
- **Electroencephalography (EEG):** EEG measures brain electrical activity, helpful in assessing cortical function related to vision.

#### 4. Neurological Examination:

- Neurodevelopmental Assessment: Evaluation of developmental milestones and neurological signs.
- Electrophysiological Tests: Visual Evoked Potentials (VEP) provide objective measures of visual pathway function.

Combining these assessment tools allows clinicians to comprehensively evaluate visual function and identify underlying neurological abnormalities contributing to CVI in children.

#### Differential diagnosis:

Differential diagnosis of Cortical Visual Impairment involves distinguishing it from other visual and neurological conditions that may present with similar symptoms:

##### 1. Ocular Conditions:

- Refractive Errors: Unlike CVI, refractive errors such as myopia or astigmatism can often be corrected with glasses.
- Strabismus and Amblyopia: While strabismus and amblyopia can coexist with CVI, they primarily affect ocular alignment and visual acuity, respectively.
- Retinal Disorders: Retinal conditions like retinopathy of prematurity (ROP) primarily affect the retina, while CVI results from brain damage.

##### 2. Other Neurological Conditions:

- Optic Nerve Disorders: Optic nerve hypoplasia or atrophy primarily affect optic nerve function, whereas CVI results from cortical brain damage.
- Neurodevelopmental Disorders: Conditions like autism spectrum disorder may involve sensory processing difficulties but do not solely affect vision as in CVI.
- Neurodegenerative Disorders: Conditions like Alzheimer's disease primarily affect cognitive function, whereas CVI primarily affects visual processing.

##### 3. Cerebral Visual Impairment Specific Features:

- Variable Visual Performance: CVI often exhibits inconsistent visual behavior, which may worsen with fatigue or illness.
- Characteristics of Visual Field Defects: CVI-related visual field defects are often more complex and variable compared to those seen in ocular diseases.

- Global Developmental Delay or Neurological Signs: Children with CVI often exhibit signs of developmental delay or neurological dysfunction beyond visual impairment.

By carefully evaluating visual function, neurological signs, and brain imaging findings, clinicians can differentiate CVI from other conditions, enabling appropriate management and intervention strategies tailored to the child's needs.

#### Management Strategies

##### 1- Early diagnosis and intervention

Early diagnosis and intervention are crucial for children with Cortical Visual Impairment as they significantly impact the child's development and quality of life.

- Optimizing Developmental Outcomes: Early identification of CVI allows for timely intervention to support the child's visual and overall development. Visual experiences during critical periods of brain development play a vital role in establishing neural connections necessary for visual processing. Early intervention can help stimulate these neural pathways, potentially improving visual function and developmental outcomes.
- Maximizing Learning Potential: Visual impairment due to CVI can affect a child's capacity to learn and interact with their environment. Early intervention strategies, such as vision therapy, sensory integration, and adaptive techniques, can help optimize the child's learning potential. By addressing visual challenges early, children with CVI can better access educational materials and participate in learning activities tailored to their needs.
- Facilitating Adaptation: Early intervention provides opportunities for children with CVI to learn adaptive strategies and develop compensatory skills to overcome visual challenges. These strategies may include using tactile or auditory cues, modifying environments for better visual access, and implementing assistive technology. Early intervention helps children adapt to their visual impairment and enhances their ability to function independently.
- Supporting Families: Early diagnosis and intervention also provide crucial support to

families, helping them understand their child's condition and access appropriate resources and services. It allows families to receive guidance on how to best support their child's visual and overall development from an early age.

Early diagnosis and intervention are essential for maximizing the potential of children with CVI, promoting optimal visual function, development, and participation in daily activities and society.

## 2- Visual rehabilitation

Visual rehabilitation for children with Cortical Visual Impairment involves various strategies and therapies aimed at improving visual function and enhancing independence:

- **Vision Therapy:** Structured programs focus on visual stimulation, such as light tracking exercises, contrast sensitivity training, and visual scanning tasks, aimed at improving visual attention, acuity, and perception.
- **Occupational Therapy (OT):** OT addresses functional visual skills necessary for daily living, including visual motor integration, visual perceptual skills, and activities of daily living (ADLs). Therapists may use specialized techniques and adaptive equipment to promote independence in tasks like dressing, feeding, and self-care.
- **Use of Assistive Technology:** Devices such as magnifiers, CCTVs (closed-circuit television), electronic magnification systems, and screen readers can enhance visual access to printed materials and digital content. Augmentative communication devices can facilitate communication for non-verbal children with CVI.
- **Environmental Modifications:** Optimizing environmental lighting, reducing visual clutter, using high-contrast materials, and providing clear visual cues help improve visual access and reduce visual fatigue.

By integrating these strategies into a comprehensive rehabilitation program, children with CVI can develop and utilize their visual skills more effectively, enhancing their overall independence and quality of life.

## 3- Educational Support:

Educational support for children with Cortical Visual Impairment is essential for addressing their unique learning needs. Individualized Education Plans (IEPs) and specialized teaching strategies play a crucial role in maximizing the child's educational outcomes:

- a. **Individualized Education Plans (IEPs):**
  - IEPs are tailored education plans developed collaboratively by educators, parents, and specialists.
  - They outline the child's current abilities, educational goals, accommodations, and services needed to support learning.
  - For children with CVI, IEPs focus on addressing visual impairment-related needs, such as modifying teaching materials, adapting classroom environments, and providing specialized instruction.
- b. **Specialized Teaching Strategies:**
  - **Visual Modification:** Materials are modified to optimize visual access, such as using high-contrast materials, large print, and tactile cues.
  - **Multisensory Approaches:** Incorporating auditory, tactile, and kinesthetic cues alongside visual information helps reinforce learning.
  - **Structured Learning Environment:** Providing consistent routines, clear organization, and predictable environments helps reduce visual clutter and supports attention and learning.
  - **Functional Vision Assessment:** Conducting ongoing assessments to monitor visual progress and adjust teaching strategies accordingly.
  - **Augmentative and Alternative Communication:** Implementing these systems for children with communication difficulties related to CVI.
- a. **Teacher Training and Collaboration:**
  - Educators receive training on understanding CVI, implementing appropriate teaching strategies, and supporting visual development.
  - Collaboration between educators, therapists, and families ensures a coordinated approach to addressing the child's educational needs.
- b. **Transition Planning:**
  - Planning for transitions between educational settings ensures continuity of support and services as the child progresses through different grade levels or transitions to post-secondary education or vocational training.

By incorporating these strategies and ensuring ongoing collaboration between educators, therapists, and families, children with CVI can access quality education tailored to their unique strengths and challenges, fostering their academic and social development.

#### Research and Future Directions

Recent research on Cortical Visual Impairment has focused on various aspects, including:

1. **Neuroplasticity:** Studies explore the brain's ability to reorganize and adapt in response to visual rehabilitation interventions, offering insights into optimizing visual outcomes.
2. **Assessment Tools:** Development of novel assessment tools and techniques to better characterize visual function and monitor progress in children with CVI.
3. **Intervention Strategies:** Research examines the efficacy of different intervention approaches, such as vision therapy, sensory integration, and technology-based interventions, in improving visual skills and functional outcomes.
4. **Genetic Studies:** Investigations into the genetic basis of CVI to better understand its etiology and identify potential therapeutic targets.

These studies contribute to advancing our understanding of CVI and improving intervention strategies for affected children.

Future research on Cortical Visual Impairment should focus on:

1. **Advanced Imaging Techniques:** Developing more sensitive neuroimaging methods to better understand the structural and functional brain abnormalities underlying CVI.
2. **Genetic Studies:** Further investigating the genetic basis of CVI to identify specific gene mutations and pathways contributing to the condition.
3. **Early Intervention:** Studying the long-term outcomes of early intervention strategies and identifying optimal timing and intensity of interventions.
4. **Therapeutic Interventions:** Exploring novel therapeutic approaches, including neurostimulation techniques and pharmacological interventions, to enhance visual function and neuroplasticity in children with CVI.

Addressing these gaps will lead to improved diagnosis, intervention, and outcomes for children with CVI.

#### CONCLUSION

The paper provides a comprehensive overview of Cortical Visual Impairment in children, highlighting its diverse visual manifestations and associated challenges. Visual acuity in CVI varies widely, with most children exhibiting significantly reduced visual acuity. Common features include field of vision defects, diminished contrast perception, and preserved color differentiation. Children with CVI may also experience difficulties in higher-order visual processing, including recognition, orientation, and depth perception. Abnormal oculomotor behaviors are often observed, alongside inconsistent visual behaviors influenced by factors like fatigue and illness. Diagnosis involves collaboration between pediatric ophthalmologists and neurologists, utilizing assessment tools and brain imaging techniques. Early intervention is crucial for optimizing developmental outcomes, and various strategies such as vision therapy, occupational therapy, and assistive technology aim to improve visual function. Future research directions include advanced imaging techniques, genetic studies, and exploring novel therapeutic interventions to address gaps in our understanding and treatment of CVI.

A multidisciplinary approach is paramount in managing Cortical Visual Impairment, ensuring comprehensive assessment and tailored interventions. Collaboration between pediatric ophthalmologists, neurologists, educators, therapists, and families allows for holistic evaluation and personalized support. This approach facilitates early diagnosis, optimal intervention planning, and coordinated care that addresses the complex visual, developmental, and educational needs of children with CVI, ultimately improving their outcomes and quality of life.

In conclusion, continued research and enhanced support systems are essential for children with Cortical Visual Impairment and their families. By investing in research to deepen our understanding of CVI and develop innovative interventions, we can improve diagnostic accuracy and therapeutic outcomes. Moreover, improving support systems, including access to specialized services and education, is crucial for empowering families and ensuring the best

possible outcomes for children with CVI. Let us work together to advocate for and advance the well-being of children affected by CVI.

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