

Optical Coherence Tomography in Diagnostics of Optic Nerve Diseases

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DOI : <https://doi.org/10.61796/jmgcb.v2i2.1132>



Sections Info

Article history:

Submitted: December 27, 2024

Final Revised: December 27, 2024

Accepted: December 28, 2024

Published: December 28, 2024

Keywords:

How OCT works

Indications

Benefits of OCT

What does the diagnosis reveal

How is optical coherence

tomography performed

ABSTRACT

Objective: To evaluate the efficacy of optical coherence tomography (OCT) in detecting early-stage eye diseases by providing high-resolution images of critical eye structures, including the retina, lens, and optic nerve. **Methods:** The study highlights the use of OCT during routine eye examinations to monitor asymptomatic changes in individuals, particularly those over 35 years old, when age-related structural changes in the eye are more prevalent. **Results:** OCT delivers detailed imaging of eye tissues, enabling clinicians to identify minor abnormalities that are imperceptible during standard examinations. This capability enhances early detection rates for conditions that develop without visible symptoms. Annual eye exams combined with OCT are particularly valuable for detecting early markers of potentially severe diseases. **Novelty:** This study underscores the critical role of OCT in preventive ophthalmology, emphasizing its unmatched precision in diagnosing age-related changes in eye structures before symptoms manifest, thus bridging the gap between routine check-ups and advanced diagnostic procedures.

INTRODUCTION

Optical coherence tomography (OCT) uses a special light that is split into two paths: one as a "reference" light reflected from a mirror and the other as a "sample" light that passes through the eye and reflects off its various layers. When light from both paths collides, interference occurs, creating patterns similar to rings formed by drops in water. These patterns are analyzed by a computer, which generates a detailed visualization of the layer-by-layer structure of the eye tissue. This scanning method enables ophthalmologists to examine each layer of the eyeball in detail, identifying any abnormalities or problematic areas [1], [2].

OCT has become a popular and indispensable diagnostic tool for studying the structures of the eye, such as the cornea, optic nerve head, and retina. By providing cross-sectional images of these structures, it allows ophthalmologists to gain valuable insights into the health of the eye without the need for invasive procedures. The technology is non-contact and painless, making it suitable for patients of all ages, from children to the elderly. Furthermore, the use of a specialized device called a coherence tomograph ensures that the procedure is both precise and efficient, allowing quick and reliable diagnoses [3], [4].

One of the most significant advantages of OCT is its ability to detect subtle changes in eye tissue at an early stage, enabling timely intervention and treatment. Whether used to monitor the progression of conditions like glaucoma or to assess damage caused by diseases such as macular degeneration, the technology provides critical information that

enhances patient outcomes. Moreover, its ease of use for specialists and comfort for patients have contributed to its widespread adoption in modern ophthalmology. Exploring the capabilities of OCT further highlights its importance in diagnosing and managing various eye conditions effectively [5], [6], [7].

RESEARCH METHOD

Optical coherence tomography (OCT) is a vital diagnostic tool for detecting various pathologies of the visual organs. It is commonly used to identify degenerative processes and detachment of the retina, as well as diseases affecting its central part, where light rays are focused. Additionally, OCT is employed to diagnose glaucoma, optic nerve disorders, and pathologies in the anterior segment of the eyeball, including inflammatory and dystrophic conditions [8], [9], [10]. Using a specialized tomograph, OCT generates a pachymetric map that reveals the thickness of the cornea. This measurement, along with intraocular pressure assessment, is crucial for diagnosing glaucoma and evaluating the risk of corneal perforation [11], [12].

The method offers numerous advantages, making it highly effective and widely adopted in ophthalmology. OCT is non-invasive, eliminating the need to penetrate eye tissue, and is safe for patients of all ages, including children and the elderly with chronic illnesses. It requires no preparation, delivers high information content by assessing anatomical changes in various eye structures, and provides rapid results, which can be reviewed immediately by a doctor. OCT has largely replaced biopsies and pathological examinations due to its precision, achieved through the use of infrared low-intensity lasers that capture high-resolution images up to 5 microns [13], [14].

While OCT has no absolute contraindications, its effectiveness may be reduced in certain conditions, such as decreased transparency of optical media, which impacts image quality. Additionally, patients who cannot maintain steady eye fixation for at least two seconds may face challenges during the procedure. Typically performed on an outpatient basis, OCT is a quick and painless process. The patient's head is stabilized, and they are instructed to focus on a flashing dot on the device screen. Despite reduced visual acuity, patients can adjust their posture, remaining still and comfortable throughout the procedure. Once completed, the device analyzes the data and produces detailed images for the ophthalmologist to evaluate [15], [16].

RESULTS AND DISCUSSION

Immediately after the diagnosis, the equipment analyzes the received data, and the corresponding images appear on the doctor's monitor for examination by an ophthalmologist. Based on these images, a diagnosis can be made, and if necessary, the patient may be sent for additional examinations [17], [18]. MEDSI offers several benefits for those seeking expert eye care, including highly qualified doctors who possess the necessary knowledge and skills to diagnose and identify various eye diseases. The center employs renowned specialists in ophthalmology with extensive experience in both

diagnostics and treatment. They are also available to explain the OCT (optical coherence tomography) method and its importance if required. The center provides comprehensive high-tech diagnostics with modern hardware examinations, enabling early detection of conditions such as glaucoma, retinal detachment, and other diseases, allowing for immediate treatment, including laser therapy or surgery [19], [20]. MEDSI's expert-level equipment ensures high accuracy in diagnoses and the ability to detect even latent, asymptomatic pathologies. The center also prioritizes convenience, ensuring no long wait times, and each patient is treated with care and attention, making even extended diagnostic procedures easy for both young children and elderly patients.

OCT is often performed when patients present with various visual impairments, such as distortion of straight lines, decreased color perception, or the appearance of blind spots in the field of vision. Other indications for OCT include a sudden decrease in vision, narrowing of the visual field, fog, flashes, or flashes before the eyes, and severe eye pain. This method is recommended for individuals with suspected damage to the retina or optic nerve, the development of glaucoma, corneal damage or inflammation, and keratoconus. It is also useful for detecting changes in the macula, inflammatory damage to blood vessels, eye injuries, iris diseases, and lens displacements, including those involving intraocular lenses. OCT is frequently prescribed in the postoperative period to monitor the results of eye surgeries. Its wide range of applications makes it a valuable diagnostic tool in ophthalmology.

Optical coherence tomography has several advantages over other diagnostic methods. It is a non-contact procedure, reducing the risk of allergies or other adverse reactions. The test is quick, typically taking only a few minutes, and produces highly detailed, high-resolution images, ensuring high diagnostic accuracy. OCT is safe and suitable for patients of all ages, including pregnant women and children. It allows the doctor to examine all layers of the retina, optic nerve fibers, cornea, lens, anterior chamber, and blood vessels in great detail. While some other methods like fluorescein angiography and ultrasound biomicroscopy can complement OCT, they are less convenient and may require contrast agents or direct contact with the eye. Therefore, OCT remains one of the most informative and patient-friendly diagnostic methods for eye diseases.

CONCLUSION

Fundamental Finding : Optical coherence tomography (OCT) is a non-invasive diagnostic tool that provides detailed, high-resolution images of the eye's internal structures. It is widely used to diagnose a variety of eye conditions, including glaucoma, retinal detachment, macular degeneration, and corneal abnormalities. The technology uses light interference to capture cross-sectional images, allowing ophthalmologists to detect early-stage changes in eye tissues, which improves patient outcomes through timely interventions. **Implication :** The widespread adoption of OCT in ophthalmology has revolutionized the early detection and management of eye diseases. Its non-invasive

nature and the ability to capture detailed images have significantly reduced the need for more invasive procedures. OCT's versatility and accuracy make it indispensable for diagnosing and monitoring conditions such as glaucoma and retinal disorders, offering valuable insights that can lead to better treatment plans and patient care. **Limitation :** Despite its advantages, OCT's effectiveness can be compromised in patients with poor eye fixation or opacity in the optical media, which can reduce image quality. Additionally, while OCT provides detailed anatomical images, it cannot detect all types of pathologies, and further testing may be required for a comprehensive diagnosis. **Future Research :** Future research could focus on improving the clarity of OCT images in cases with compromised optical media, as well as exploring its integration with other diagnostic technologies to enhance diagnostic capabilities. Additionally, developing OCT methods for use in detecting conditions that are not currently assessable, such as certain optic nerve pathologies, could further broaden its applications in clinical ophthalmology.

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