

REVIEW ARTICLE

Optical Coherence Tomography in Different Subtypes of Age-related Macular Degeneration: A Literature Review

Rituparna Ghoshal¹, Somnath Ghosh², Sharanjeet Sharanjeet-Kaur³, Nor Fariza Ngah⁴, Roslin Azni Binti Abd Aziz⁴

¹ Department of Optometry, CT University, Ferozepur Rd, Sidhwan Khurd, 142024 Punjab, India

² Department of Allied Health Science and Technology, Kazi Nazrul University, Domohani Railway Colony, Asansol, 713340 West Bengal, India

³ Optometry and Vision Science Program, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul Aziz, 50300 Kuala Lumpur, Wilayah Persekutuan Kuala Lumpur, Malaysia

⁴ Department of Ophthalmology, Hospital Shah Alam, Persiaran Kayangan, Seksyen 7, 40000 Shah Alam, Selangor, Malaysia

ABSTRACT

Optical coherence tomography (OCT) is considered as an important tool for the diagnosis, differentiation and monitoring of various subtypes of AMD. Understanding OCT findings in different subtypes of AMD is the key to manage AMD. Thus, present review aimed to report the different OCT features seen in different subtypes of AMD and to discuss the OCT parameters that are associated with visual functions of AMD eyes. Electronic search engines such as were employed to search articles that justified the objective of this review. While, changes such as drusens associated with alterations in outer nuclear layer and inner segment and outer segment junction of photoreceptor and external limiting membrane were observed in early to intermediate AMD, components of neovascular membrane, retinal pigment epithelium detachment, neurosensory retinal detachment along with subretinal and intraretinal fluid, subretinal tissue were reported in neovascular AMD. Similarly, variations in pattern of retinal pigment epithelium detachment, presence of polyp, presence of hyper-reflective mass like lesions, intraretinal cysts were some of the features that differentiated various sub types of neovascular AMD. While, in early to intermediate AMD, changes in retinal pigment epithelium and outer nuclear layer associated well with the visual functions, more research were needed to establish a strong correlation between visual functions and OCT parameters in different sub types of neovascular AMD. The present review concluded that OCT plays an important role in diagnosis, differentiating different subtypes of AMD. However, there is scope for future research to establish specific OCT biomarkers in various subtypes of AMD.

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Keywords: Optical coherence tomography, Age related macular degeneration, Ophthalmic imaging, OCT biomarkers, Polypoidal choroidal vasculopathy

Corresponding Author:

Dr. Rituparna Ghoshal, PhD

Email: rituparna4ab@yahoo.co.in

Tel : +919732090205

INTRODUCTION

Age related macular degeneration (AMD) was first described in 1874 as “symmetrical central choroid-retinal disease occurring in senile persons” (1). Over the years, it has emerged as one of the major causes of visual impairment in individuals over 50 years of age (2). Clinically, AMD is often characterized by drusen. Almost every individual over the age of 50 years has at least one small drusen which is less than 63µm in diameter in one or both eyes. When the diameter of the drusen is more than 63µm, it becomes clinically significant (3, 4). AMD is classified as early, intermediate and late stages. Early and intermediate AMD is characterized by pigmentary abnormalities, with intermediate and/ or large drusen

of greater than 63 µm and or 125 microns respectively. Late stage of AMD has two forms that are, geographic atrophy and neovascular AMD (5). Geographic atrophy occurs as the result of continuous loss of retinal pigment epithelium and outer retinal layers. However, this form of the disease does not involve leakage of blood or serum; and therefore, it is called dry AMD. The wet or neovascular AMD is characterized by choroidal neovascularization and serous or haemorrhagic detachment of either the retinal pigment epithelium or sensory retina from Bruch membrane. Choroidal neovascularization may lead to leakage of blood and fluid followed by a dense fibro vascular scar which may cover the entire macula. Being accountable for 90% of cases of severe visual loss in elderly population, neovascular AMD is more sight threatening than the dry AMD (1, 4-7). Over the years the neovascular AMD has been divided into different subtypes, that are, typical neovascular AMD with different forms of choroidal neovascularization (classic choroidal neovascularization

or occult choroidal neovascularization or mixed choroidal neovascularization), polypoidal choroidal vasculopathy (PCV) and retinal angiomatous proliferation (RAP) (8-11). Typical neovascular AMD is more prevalent in western countries whereas PCV is the most commonly seen subtypes of Asian neovascular AMD (12, 13). Ophthalmoscopy is the first point of diagnostic test in detection of AMD. In early AMD, the first morphological alteration is evident as presence of intermediate drusen (>63 micron) which can be identified through ophthalmoscopy. Whereas, neovascular AMD can be detected by the presence of subretinal fluid, lipid deposition, haemorrhage, retinal pigment epithelium detachment and a fibrotic scar. However, several imaging techniques including colour fundus photography, fundus autofluorescence imaging, fluorescein angiography, indocyanine green angiography and Optical Coherence Tomography (OCT) are some of the extensively adopted detailed diagnostic approaches towards morphological alteration of the retina in AMD. Ophthalmic imaging was revolutionized by introduction of OCT. OCT produces cross sectional images of different retinal layers that help in detection of the exact location and depth of AMD lesion. In modern ophthalmology practice, understanding OCT findings in different subtypes of AMD is the key to managing AMD. Thereby, the present literature review aims to discuss the different OCT features seen in different subtypes of AMD. Furthermore, the present review also discusses the OCT parameters that are correlated with visual functions of AMD eyes.

METHODS

Present literature review included articles that reported OCT parameters in different subtypes of AMD. Relevant researches were found employing the electronic search engines such as PubMed, research gate and Google scholar. The key words used included OCT, dry AMD, early AMD, intermediate AMD, late AMD, neovascular AMD, typical AMD, PCV, Exudative AMD, Geographic atrophy and visual functions (visual acuity, contrast sensitivity, reading speed). Both primary and secondary researches were included. The literature search was conducted from September 2023 to April 2024. Articles of last 15 years justifying the objective of the research were included in this review.

I. Optical coherence tomography

Tomography means reformation of cross-sectional images of a particular object from its own projection (14). Optical Coherence Tomography (OCT) is a non-invasive ophthalmic imaging technique similar to ultrasound and MRI. Here instead of sound wave, reflected light is used to produce detailed cross-sectional and 3D images of the eye. Multiple layers of retina are represented by OCT images with their depth containing amplitude of spectrum modulation. This depth is proportional to the different reflectivity of each

layer. Introduction of OCT has revolutionized retinal diagnostics. Currently it plays a major role in providing most detailed structural information of retina than any other ophthalmic diagnostic instrument. Various retinal diseases including diabetic retinopathy, central serous retinopathy, macular dystrophies, macular oedema, various macular degeneration such as age-related macular degeneration, myopic macular degeneration are studied in detailed using OCT. Figure 1A shows the different retinal layers in normal eyes.

The first OCT that was used in clinic, was a Time domain OCT. Time domain OCT employs low coherence interferometry resulting into two-dimensional imaging method that can produce cross sectional images of retina (15). Introduction of time domain OCT in 1990 made it possible to quantify the retinal thickness and different layers of retina (16). Time domain OCT produces 400 axial scans (A-scans) per second. The axial resolution in time domain OCT is 10 μm . It is used to capture images from vitreo-retinal inter-phase to retinal pigment epithelium. Spectral domain OCT is advanced form of OCT that produces three dimensional images using better resolution and faster speed. A spectral domain OCT can produce 27000 to 70000 scans per second with a axial resolution of 5-7 μm as a result of employing broadband light source. In spectral domain OCT, image range varies from posterior cortical vitreous to sclera using enhanced depth imaging (17,18). Recently, introduction of swept source OCT has enabled even more faster scanning with further improved resolution. It can take up to 1,00000 to 400000 scan per second with a axial resolution of 5 μm . Both spectral domain and swept source OCT employs Fourier domain techniques to improve the speed and resolution of the scans. While, spectral domain OCT uses a broadband near-infrared super luminescent diode as a light source and array of detectors, swept source OCT uses a swept laser and a single photodiode detector. In swept source OCT, beam of a super luminescence diode also known as SLD, scans across the examined retina to produce cross sectional B-scan images. Faster scanning and increased wave length used in swept source OCT enables a better detection of signals from deeper layers of retina (19, 16).

II. OCT and AMD morphology

Optical Coherence Tomography (OCT) is one of the extensively adopted detailed diagnostic approaches in AMD. OCT plays an important role in detection of different sub-types of neovascular AMD. Previous researches have reported that spectral domain OCT is sensitive and specific in distinguishing different sub types of AMD (20, 21).

II. A. OCT in early and intermediate AMD

On OCT, drusen can be visualized as deformed and elevated area in the hyper-reflective band of retinal pigment epithelium with relatively reduced reflecting area underneath. A large drusen is seen as more prominent

retinal pigment epithelium elevation with separation of retinal pigment epithelium from Bruch membrane (Figure 1B). The separation is seen as a hypo reflecting area. Drusen may be associated with thinning of outer nuclear layer and changes in inner segment and outer segment junction of photoreceptor and external limiting membrane (22, 23). Ferrara et al. (2017) reported that abnormalities in the photoreceptors, retinal thickness, retinal pigment epithelium and choroid in early and intermediate stages of AMD were linked to higher risk of developing late AMD including geographic atrophy and neovascular AMD (24).

II. B. OCT in geographical atrophy

In case of geographic atrophy, continuous loss of retinal pigment epithelium and the outer retinal layers occur (Figure 1C). Thus, light beam can reach into the choroid that makes the choroid appear as a high reflective structure. This is associated with thinning of retinal layers especially in the outer retina. The reduced retinal thickness and volume can be identified by the retinal maps which assist in recognizing areas and extent of the atrophy and monitor progression of the disease.

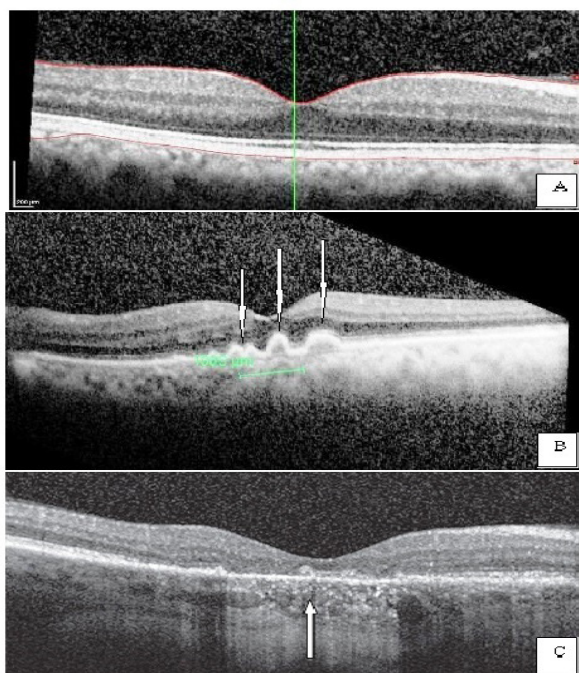


Figure 1: A: Different layers of the retina in normal eye seen with OCT. B: Drusens (white arrows) as seen with OCT in intermediate AMD. C: Loss of retinal pigment epithelium and adjacent photoreceptors (white arrow) in geographic atrophy seen with OCT. (Source: Author's PhD thesis) (21)

II. C. OCT in neovascular AMD

OCT plays an important role in identifying changes associated with choroidal neovascularization in neovascular AMD. Components of the neovascular membrane, retinal pigment epithelial detachment, detachment of the neurosensory retina, intraretinal fluid and thickening of neuro-retinal layer can be seen with OCT. Figure 2 (A-C) shows OCT images of neovascular AMD revealing some of the features described here. In the early stage, choroidal neovascularization may be visible as medium to high reflective area composed of serous or fibrovascular tissue just in front or intact with the retinal pigment epithelium whereas, when the choroidal neovascularization becomes less active over time resulting into disciform scar, it appears as a highly reflective area on OCT (25).

Thickening of the neurosensory retina is one of the commonly reported features in patients with neovascular AMD (26). Retinal pigment epithelium detachment and neurosensory retinal detachment can also be recognized with OCT image. Retinal pigment epithelium detachment can be seen as broad elevations of the retinal pigment epithelium band next to Bruch membrane whereas, neurosensory retinal detachment is characterized by a well-defined hypo-reflective space between the neurosensory retina and other highly reflective bands representing retinal pigment epithelium (27). Figure 2 B and 2 C represents the difference between retinal pigment epithelium detachment and neurosensory retinal detachment in eyes with neovascular AMD. Accumulation of subretinal fluid occurs between retinal pigment epithelium and neurosensory retina whereas intraretinal fluid accumulates in the inner retina. These are either diffused or can be localized in contour. Diffused fluid accumulation can be visible as areas with less reflectivity and increased thickness, whereas hypo-reflective spaces are seen in case of intraretinal cysts. Subretinal tissue is visible as a hyper-reflective area that can be situated in subretinal space. These hyper-reflective areas can be composed of fibrovascular tissue, fibrin, blood, fluid. In some cases where both subretinal fluids and subretinal tissue are present, subretinal tissue in OCT is demarcated as the hyper-reflective area from retinal pigment epithelium to outer border of subretinal fluid. In some literatures, subretinal tissues are referred as subretinal hyper-reflective materials (25, 26, 27, 28, 29).

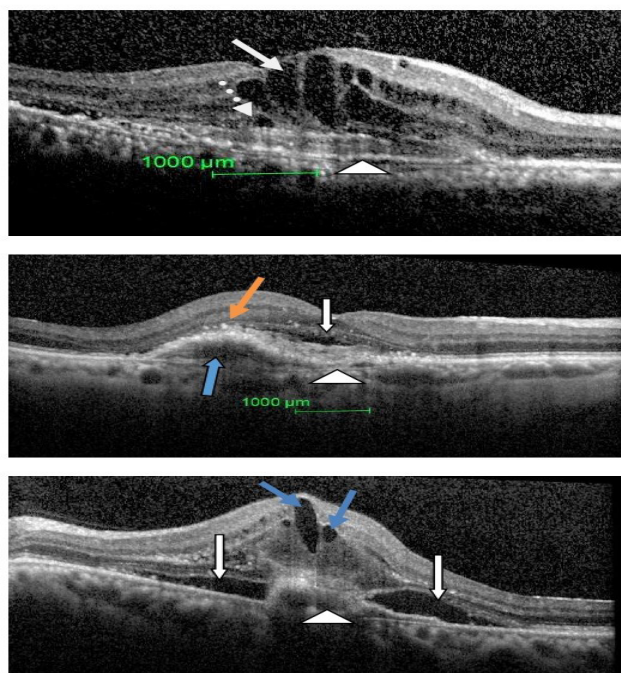


Figure 2: OCT features of typical neovascular AMD. A: Intraretinal fluid (white arrow), subretinal fluid (dotted arrow) and subretinal tissue (arrow head). **B:** Subretinal fluid (white arrow), subretinal tissue (arrow head) and retinal pigment epithelium detachment (blue arrow), hyper-reflective dots (orange arrow). **C:** Neurosensory retinal detachment with subretinal fluid accumulation (white arrow), intraretinal cystic fluid (blue arrow) and fibrovascular lesion (arrow head). (Source: 21,53)

II. D. Differentiating types of neovascular AMD with OCT

Various clinical studies have established OCT signs that can differentiate the three forms of neovascular AMD – typical neovascular AMD, PCV and RAP. (14, 30, 31). Zhang et al. (2016) described the OCT feature of PCV as sharp peak of retinal pigment epithelium detachment, double-layer sign, multiple retinal pigment epithelium detachment, and retinal pigment epithelium notch, a hypo-reflective lumen representing polyps and hyper-reflective intraretinal hard exudates (31). Among the above described 6 OCT characteristics, first two characteristics along with at least one of the other characteristics satisfied the diagnosis of PCV; in the absence of the first two characteristics, the diagnosis of PCV was confirmed when at least 3 of the other characteristics were present concurrently. Thus, these OCT features clearly discriminated PCV from typical neovascular AMD. Figure 3 A to 3 D shows some of the distinct OCT features of PCV eyes. On the other hand, some of the distinguishing features of RAP as revealed in OCT include accumulation of cyst like fluids in inner retina and presence of hyper-reflective mass like lesions usually beneath the retinal pigment epithelium pigment that can sometimes be seen in inner- retina, reduced thickness of choroid and a dome shaped PED with a low sloping, (32, 33, 34). Figure 3 E and 3 F shows OCT images of RAP revealing some of the discussed features.

It is important to note that the dome shaped retinal

pigment epithelium detachment seen in eye with PCV extends more vertically compared to horizontal diameter while dome shaped retinal pigment epithelium detachment seen in RAP has a larger horizontal diameter compared to vertical diameter that is often described by a “gentle sloping”. Similarly, retinal pigment epithelium detachment associated with PCV can reveal a sharp peak or notch while retinal pigment epithelium detachment associated with RAP is often trapezoid (34, 35). Figure 3 C shows a vertically elongated retinal pigment epithelium detachment seen in PCV eyes and Figure 3F shows a horizontally elongated (trapezoid) retinal pigment epithelium detachment seen in RAP eyes.

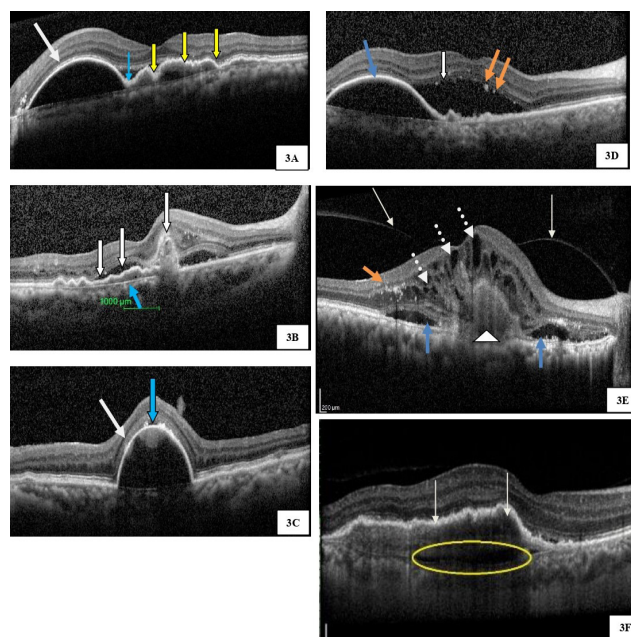


Figure 3: OCT features of PCV. A: Multiple retinal pigment epithelium detachment (yellow arrows). A large retinal pigment epithelium detachment (white arrow), Tomographic notch (blue arrow). **B:** Multiple retinal pigment epithelium detachment (white arrows), double layer sign (blue arrow). **C:** Dome shaped retinal pigment epithelium detachment (white arrow) with hypo- reflective area, termed as polyp attached to it (blue arrow). **D:** Dome shaped pigment epithelium detachment (blue arrow), neurosensory retinal detachment along with accumulation of subretinal fluid (white arrow), hyper-reflective dots (orange arrow). **E:** Hyper-reflective mass like lesion (white arrow head), subretinal fluid (blue arrows) and intraretinal cystic fluids (white dotted arrows), hyper-reflective dots (orange arrow), partial detachment of posterior hyaliod (white arrows). **F:** Trapezoid PED (white arrows) and pre choroidal cleft (yellow circle). (Source: 21, 55)

III. Association between OCT parameters and different visual functions in different subtypes of AMD

Qualitative and quantitative morphological description by OCT presents detailed insight into different stages and types of AMD. With increasing knowledge on different OCT parameters, it has become evident that central thickness of retina alone may not represent the visual damage occurred by the disease and also have failed to predict the visual outcome. Thus, identification of OCT derived anatomic markers such as thickness of subretinal fluid, subretinal tissue, integrity of inner segment and outer segment junction of photoreceptors,

external limiting membrane in neovascular AMD and thickness of different retinal layers in dry AMD have been found to correlate well with the visual functions of the affected eye (26, 38, 39,40).

Association between alteration of retinal layers morphology as observed by OCT and different visual parameters can guide to obtain some of the most related and affected OCT and visual parameters in different subtypes of AMD. This can eventually assist to establish surrogate endpoint of clinical researches including RCTs on different management options and strategies of AMD (41). Thereby, OCT-based morphologic parameters could be utilized to enhance the accuracy of clinical trials. Besides, they may potentially reduce the duration of clinical trials eventually reducing the cost. Furthermore, suitable OCT parameters in AMD may assist clinicians in the diagnosis, differentiation and continuous monitoring of this persistent retinal disease.

III. A. Association between visual and OCT parameters in early to intermediate AMD

Although in neovascular AMD eyes, the association between visual functions and OCT parameters are studied in several researches, literature on early to intermediate AMD is limited. In a retrospective study, Pappuru et al. evaluated the association between preselected OCT parameters and visual acuity in eyes with dry AMD (39). In the said study, 100 patients with dry AMD were evaluated using spectral domain OCT. LogMAR visual acuity values were compared with the areas, thicknesses, volumes and intensity of retinal pigment epithelium, photoreceptor inner segment, photoreceptor outer segment, outer nuclear layer and the total retina. In univariate analysis of OCT parameter with visual acuity, it was found that there was statistically significant correlation between visual acuity and areas, thicknesses, and volumes of outer nuclear layer ($r=-0.49$, -0.50 , -0.47 respectively), photoreceptor inner segment ($r=-0.59$, -0.63 , -0.53 respectively) and photoreceptor outer segment (-0.44 , -0.41 , -0.43 respectively). However, retinal pigment epithelium thickness did not decrease significantly. Furthermore, thicknesses of total retinal and retinal pigment epithelium intensities of photoreceptor inner segment and photoreceptor outer segment and retinal pigment epithelium were also correlated with visual acuity. Thereby, the findings of the study proved a relation between worse visual acuity and compromised integrity of outer retinal substructures in the foveal central sub field in dry age AMD. However, the correlation between best corrected distance visual acuity and selective OCT parameters were reported as moderate.

In addition to the above literature, Karampelas et al. (2013) evaluated relationship between thickness of retinal pigment epithelium-Bruch membrane complex at central ETDRS subfield and Snellen visual acuity in eyes with early and intermediate AMD. In this study, a

moderate correlation with correlation coefficient being 0.363 was observed between the study parameters. The authors of this study also compared the thickness of retinal pigment epithelium-Bruch membrane complex at central ETDRS between the study eyes and aged matched control. The study reported a significant increase in the above OCT parameter in the study eyes (42).

Thus, the said two studied evaluated relevant OCT parameters that can represent visual functions in eyes with early and intermediate AMD. However, the studies failed to achieve a good correlation between the OCT and best corrected distance visual acuity (39-42). In other words, alterations of the OCT parameters used in these studies did not justify the change in the visual acuity of the study eyes. One of the possible reasons for weak correlation between the OCT parameters and visual function found in these studies is measuring visual acuity alone to represent visual changes. Other visual components such as near vision, contrast sensitivity were not measured in the above studies.

It has been long discussed that high contrast visual acuity alone cannot completely represent visual functions especially in ocular disorders like AMD and may often overlook the visual disability (38, 43, 44, 45). Ghoshal et al. (2020) have addressed the previous lack and evaluated the association between various OCT parameters and different visual components such as distance visual acuity, near visual acuity, reading speed and contrast sensitivity (46). They found that distance visual acuity, contrast sensitivity and reading speed exhibited moderate to strong correlation ($r>(+/-).5$) with retinal pigment epithelium layers thickness, outer nuclear layers thickness and volume whereas near visual acuity exhibited moderate to strong correlation ($r>-0.5$) with outer nuclear layer volume and retinal pigment epithelium layer thickness. In this study, the highest correlation was observed between reading speed and retinal pigment epithelium layers thickness ($r=0.6$), outer nuclear layers thickness and volume ($r=0.69$, -0.7 respectively). The authors of the study concluded that all the visual functions tested in the study represented the retinal morphological changes in early stages of AMD. They also suggested outer nuclear layers thickness and volume and retinal pigment epithelium layers thickness can be considered as key biomarkers in early diagnosis AMD. This was supported by the findings of Lamin et al. (2019) who reported abnormal retinal layer volumes including outer nuclear layer, retinal pigment epithelium-Bruch membrane complex (RPE-BM) in eyes with early and intermediate AMD compared to age matched control (47).

In another study, Acton et al. (2012) found that decrease visual sensitivity evaluated with microperimeter, is significantly associated with reduced thickness of outer segment of photoreceptor layer and increased thickness and elevation of the retinal pigment epithelium in eyes

with early AMD. In this study, thickness of outer segment of photoreceptor was well correlated with MS (Pearson's $r = 0.622$, $P = 0.003$), the mean deviation ($r = 0.633$, $P = 0.003$), and the pattern standard deviation ($r = -0.617$, $P = 0.004$) whereas thickness of retinal pigment epithelium was well correlated with reduced mean sensitivity ($r = -0.448$, $P = 0.047$) and mean deviation ($r = -0.454$, $P = 0.045$) (40).

Thus, it can be stated that the thickness and volume of outer nuclear layer, thickness of retinal pigment epithelium layer and thickness of photoreceptors inner and outer segments are the OCT parameters that showed maximum correlation with the visual parameters in eyes with early to intermediate AMD.

III. B. Association between visual functions and OCT parameters in typical neovascular AMD

Several researches that evaluated relationship between OCT parameters and different visual functions in neovascular AMD are described below and in Table I. With 216 neovascular eyes, Keane et al. (2008) reported an increased total volume and thickness of subretinal tissue was correlated with decreased distance visual acuity ($r=0.269$, 0.370) whereas, an increase in the thickness of the neurosensory retina at the central fovea was correlated with reduced distance visual acuity ($r=0.245$) (20). In contrary, Moutray et al. (2008) reported no correlation between distance visual acuity, near visual acuity and contrast sensitivity and OCT parameters in a retrospective review with exudative AMD (48).

Henschel et al. (2009), Kashani et al. (2009) and Yaylali et al. (2012) reported an increase in central foveal thickness to be correlated with decreased distance visual acuity. Correlation coefficient reported in these studies were around 0.3 (49-51). In a recent study, Moraes et al. in 2021, reported that greater volumes of OCT parameters were associated with worse VA (52). However, correlation between visual acuity and those OCT parameters were weak to be considered as clinically significant with majority of the correlation coefficient ranged below 0.3.

All previously discussed researches associated OCT parameters with distance visual acuity and failed to report a considerable correlation. Keane et al. (2010) included other visual components such as contrast sensitivity and reading speed and reported comparatively stronger relationship between OCT parameters and visual functions in 120 eyes with neovascular AMD (38). The study revealed that an increased subretinal tissue volume was associated with poorer contrast sensitivity ($r=-0.49$). Furthermore, increased retinal thickness at the

foveal center also fairly correlated with reduced visual acuity in logMAR ($r=-0.45$).

Although, several studies have been conducted to measure correlation between several OCT parameters and visual components in neovascular AMD, none of the studies showed a strong correlation between the study parameters. In majority of the reports correlation coefficient ranged from 0.25 to less than 0.4. A single study by Keane et al. (2010) have reported a moderate correlation between contrast sensitivity and subretinal volume ($r=-0.49$) and between distance logMAR visual acuity and retinal thickness at the foveal center ($r=-0.45$) respectively (38). There could be several reasons behind this. Majority of the studies correlated only visual acuity with the OCT parameters. Furthermore, segregation of the different OCT parameters using different software probably needed more attention. Similarly, inter rater agreement of these OCT parameters were not reported in majority of the researches. Very recently, Ghoshal et al. (2024) reported good correlation ($r>.05$) between average retinal thickness, centre retinal thickness and centre maximum thickness and visual acuity in a pilot study using 15 eyes with typical neovascular AMD. However, author of the study recommended for further research on the same. (53) Thus, more research is required to procure suitable OCT parameters in typical neovascular AMD.

III. C. Association between visual functions and OCT parameters in PCV eyes

While several researches have been conducted on different OCT parameters that can correlate with visual functions in typical neovascular AMD, literature on PCV eyes are significantly less. A single study by Sharanjeet-Kaur et al. (2018) have established relation between OCT parameters and different visual functions in PCV eyes and reported many of the quantitative and qualitative OCT parameters showed good association with the visual functions in eyes with PCV (54). In the said research, average retinal thickness and central thickness in retinal thickness MAP showed significant association with distance visual acuity ($r=0.571$ & 0.546) and contrast sensitivity ($r= 0.576$ & 0.586). Average retinal volume and centre maximum thickness in retinal thickness map exhibited significant association with contrast sensitivity ($r=0.516$ & 0.513). The mean distance and near visual acuity and contrast sensitivity between three external limiting layer and photoreceptors inner and outer segment junction- status differed significantly ($p=.002$ & $.000$; $p=.012$ & $.029$; $p=.005$ & $.001$). However, there is a significant lack in reported data on association between visual functions and retinal pathologies in RAP. Distribution of OCT parameters and visual function by different types of AMD is tabulated in Table I.

Table I: Distribution of OCT parameters and visual function by different types of AMD

Author	Type of AMD	Type of OCT used	OCT parameters used	Visual functions used	Correlated parameters
Pappuru et al. (2011)	Dry AMD (Early and intermediate AMD, geographic atrophy)	Spectral domain OCT	Areas, thickness and volumes of internal limiting membrane, outer nuclear layer, external limiting membrane, inner segment and outer segment of photoreceptors junction, outer photoreceptor border, inner and outer retinal pigment epithelium borders and Bruch membrane	Visual acuity	i. Areas, thicknesses, and volumes of outer nuclear layer, inner segment and outer segment and visual acuity. ii. Thicknesses of total retinal and RPE intensities of inner segment and outer segment and retinal pigment epithelium and visual acuity
Acton et al. (2012)	Early AMD	Spectral domain OCT	Retinal pigment epithelium and outer segment layer thickness at location with visual field defects	Visual field sensitivities, preferred retinal locus and fixation stability	Decrease visual sensitivity and reduced thickness of outer segment and increased thickness and elevation of the retinal pigment epithelium
Karampelas et al. (2013)	Early and intermediate AMD	Spectral domain OCT	Retinal pigment epithelium and Bruch membrane complex thickness	Visual acuity	Decrease visual acuity and retinal pigment epithelium and Bruch membrane complex thickness
Ghoshal et al. (2020)	Early and intermediate AMD	Spectral domain OCT	Thickness and volume of the retina, outer retinal layer thickness and volume, outer nuclear layer thickness and volume, retinal pigment epithelium layer-Bruch's membrane complex thickness (RPET) and volume	Best- corrected distance visual acuity, near vision acuity, reading speed, and contrast sensitivity	Distance visual acuity, contrast sensitivity, and reading speed showed significantly good correlation with, retinal pigment epithelium layer-Bruch's membrane complex thickness, outer nuclear layer thickness and volume, whereas near visual acuity showed good correlation with outer nuclear layer volume and retinal pigment epithelium layer-Bruch's membrane complex thickness
Keane et al. (2008)	Neovascular AMD	Stratus OCT	Thickness and volume of neurosensory retina, subretinal fluid, subretinal tissue and pigment epithelium detachment	Best-corrected visual acuity	i. Increased total volume and thickness of subretinal tissue with decreased visual acuity ii. Increased thickness of the Neurosensory retina at the central fovea with reduced visual acuity
Moutray et al. (2008)	Neovascular AMD	Stratus OCT	Max. retinal thickness, central foveal thickness, maximum thickness of the Choroidal neovascularization	Best corrected distance visual acuity, near visual acuity and contrast sensitivity	None
Henschel et al. (2009)	Neovascular AMD	Stratus OCT	Subretinal fluid, intraretinal fluid and retinal thickness	Best-corrected visual acuity	Increase central foveal thickness and decrease visual acuity
Keane et al. (2010)	Neovascular AMD	Stratus OCT	Thickness and volume of neurosensory retina, subretinal fluid, subretinal tissue and pigment epithelium detachment	Visual acuity, contrast sensitivity, reading ability	The strongest correlation detected between decreased contrast sensitivity and increased subretinal tissue
Yaylali et al. (2012)	Neovascular AMD	Spectral domain OCT	Central foveal thickness	Visual acuity	i. Visual acuity and central foveal thickness in all patients ii. Visual acuity and greatest linear diameter, predominantly classic and minimal classic lesions
Sharanjeet-Kaur et al.(2018)	PCV	Spectral domain OCT	Integrity of external limiting membrane, inner segment and outer segment junction, retinal pigment epithelium and Bruch's membrane complex, average retinal thickness and volume, central retinal thickness, centre maximum and centre minimum thickness	Best corrected distance visual acuity, near vision acuity, reading speed, and contrast sensitivity	Best corrected distance visual acuity, near vision acuity, and contrast sensitivity, integrity of external limiting membrane, inner segment and outer segment junction, average retinal thickness and volume, central retinal thickness, centre maximum and centre minimum thickness
Moraes et al. (2021)	Neovascular AMD	Spectral domain OCT	Volumes of neurosensory retina, drusen, intraretinal fluid, subretinal fluid, subretinal hyperreflective material, retinal pigment epithelium, hyperreflective foci, fibrovascular pigment epithelium detachment, and serous PED	Visual acuity	Central subfield thickness, subretinal hyperreflective material and intraretinal fluid and visual acuity in first treated eye, subretinal hyperreflective material, ROE and intraretinal fluid and visual acuity in second treated eye

AMD: Age related macular degeneration. OCT: Optical Coherence Tomography.

CONCLUSION

Since the time of the inception of OCT, new advances are being made to improve its efficiency to detect morphological changes in retinal layers making OCT as a crucial diagnostics tool detecting retinal pathologies. While, careful observations of retinal layers using OCT can detect early changes of AMD leading better prognosis, particular OCT features can well guide treatment approaches by differentiating the subtypes of neovascular AMD. In this literature review, OCT parameters to differentiate the types of AMD are discussed. However, more researches are required to establish correlation between visual functions and suitable OCT parameters in the subtypes of AMD. In early to intermediate AMD, alterations in the outer nuclear layer and retinal pigment epithelium showed good association with different visual functions. Nevertheless, more understanding in this regard is required to establish suitable OCT parameters in neovascular AMD.

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