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Original Research Article

Comparison Between Age-Related Macular Degeneration And Polypoidal Choroidal Vasculopathy Using Optical Coherence Tomography

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Abstract: *Age-Related Macular Degeneration (ARMD) and Polypoidal Choroidal Vasculopathy (PCV) are retinal conditions leading to central vision loss, especially in older individuals. Differentiating between these two conditions is critical for proper management, and Optical Coherence Tomography (OCT), particularly with OCT Angiography (OCTA) and Enhanced Depth Imaging (EDI) OCT, plays a key role in their diagnosis. Despite the availability of these advanced imaging techniques, PCV often remains undiagnosed, especially in resource-limited regions.* ***Objective:*** *This study compared the qualitative and quantitative features of ARMD and PCV using OCT and OCTA to enhance our understanding of their differences and promote accurate diagnosis, especially in settings where OCTA is underutilized.* ***Methods:*** *A retrospective study was conducted at Lahore Eye Care Center and Nishtar Hospital, Multan, from February to August 2024. Forty-three patients diagnosed with ARMD and PCV were included. The inclusion criteria required the presence of characteristic OCT findings, while patients with conditions such as diabetic retinopathy or retinal detachment were excluded. OCT measurements of central subfoveal and parafoveal thickness were used to quantify macular changes. Qualitative analysis focused on drusen, retinal pigment epithelium (RPE) elevation, and choroidal neovascularization (CNV) for ARMD and macular thickening and RPE irregularities for PCV.* ***Results:*** *The study revealed that patients with PCV exhibited significantly higher central subfoveal and parafoveal thicknesses than those with ARMD. Central subfoveal thickness in PCV was greater than 290 microns, while in ARMD, it was less than 250 microns. Parafoveal thickness was also thicker in PCV, with values exceeding 290 microns, compared to ARMD, which was below 270 microns. Qualitative features, including irregular RPE and ring-like lesions, were more prominent in PCV.* ***Conclusion:*** *This study demonstrates that OCT and OCTA are invaluable tools in differentiating ARMD from PCV, with distinct differences in qualitative and quantitative features. The findings underscore the need for greater awareness and access to OCTA, particularly in developing countries where PCV remains underdiagnosed. Early and accurate diagnosis through OCT and OCTA can significantly improve management outcomes for patients with these conditions.*

Keywords: Age-Related Macular Degeneration, Polypoidal Choroidal Vasculopathy, Optical Coherence Tomography, Choroidal Neovascularization, Macular Edema

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Introduction

Age-Related Macular Degeneration (ARMD) and Polypoidal Choroidal Vasculopathy (PCV) are two distinct retinal conditions that significantly affect the central vision of individuals, particularly in the elderly population. ARMD is a leading cause of vision loss among individuals aged 50 years and older, characterized by the gradual degeneration of the macula, leading to impaired central vision (1, 2). The pathophysiology of ARMD involves the accumulation of drusen beneath the retinal pigment epithelium (RPE) and the subsequent degeneration of the macula. There are two main forms of ARMD: dry and wet. The wet form is characterized by the growth of choroidal neovascularization (CNV) beneath the retina, often leading to rapid vision loss (3, 4).

PCV is a variant of ARMD that has gained attention due to its distinct pathophysiological features, although it remains a topic of ongoing research. It is characterized by polypoidal lesions in the choroidal vasculature, which can lead to macular edema, subretinal hemorrhage, and visual impairment. Unlike ARMD, PCV is often associated with a thickened macula, ring-like lesions, and a greater prevalence of retinal pigment epithelium irregularities (5, 6). The diagnosis of PCV is challenging, particularly in developing countries where advanced imaging techniques such as Optical Coherence Tomography Angiography (OCTA) are less frequently utilized(7,8).

Optical Coherence Tomography (OCT) has revolutionized the diagnosis and management of retinal diseases, providing high-resolution, non-invasive retina imaging. OCT has been instrumental in distinguishing between ARMD and PCV based on their distinct structural features. Enhanced Depth Imaging (EDI) OCT and OCTA have further improved the diagnostic capabilities, allowing for better visualization of the choroidal vasculature and the identification of polypoidal lesions (3). (9). Despite the availability of advanced imaging techniques, many cases of PCV remain undiagnosed due to a lack of resources and the limited use of OCTA in routine clinical practice, particularly in developing regions (6, 7).

The primary aim of this study was to compare the qualitative and quantitative features of ARMD and PCV using OCT, focusing on identifying specific markers that could aid in the differential diagnosis of these two conditions. This study also sought to raise awareness about the prevalence of PCV and the importance of using advanced imaging modalities like OCTA for accurate diagnosis and appropriate management. Given the high prevalence of these conditions and their potential impact on visual health, it is essential to improve early detection and treatment strategies, particularly in underserved regions (4). (10).

Methodology

This retrospective study was conducted at Lahore Eye Care Center, Multan, in collaboration with Nishtar Hospital, Multan, from 1 February 2024 to 1 August 2024. The study aimed to compare the qualitative and quantitative features of Age-Related Macular Degeneration (ARMD) and Polypoidal Choroidal Vasculopathy (PCV) using Optical Coherence

Tomography (OCT). Patients were selected based on specific features indicative of ARMD and PCV, as identified by OCT imaging.

Inclusion criteria consisted of patients diagnosed with ARMD or PCV, exhibiting characteristic findings on OCT, such as the presence of drusen, retinal pigment epithelium (RPE) elevation, and choroidal neovascularization (CNV) in ARMD, and macular thickness greater than 290 microns, irregular RPE, and ring-like lesions in PCV. Patients aged between 30 and 80 years were included. Exclusion criteria included those with comorbid conditions such as diabetic retinopathy, retinal detachment, uveitis, or high myopia, as well as those who had previously undergone laser treatment or received anti-VEGF therapy.

Data was collected using a non-invasive intervention, with OCT imaging as the primary diagnostic tool. The NIDEK RS-3000 OCT (Retinascan Advance) was used to obtain macular maps of the patients. Quantitative data, including central subfoveal and parafoveal thickness, were recorded and analyzed using Microsoft Excel and SPSS version 22. The data were processed to identify the differences between ARMD and PCV in qualitative and quantitative features.

The study adhered to ethical guidelines, with informed consent from all participants before data collection. The qualitative analysis identified distinct features on OCT, including drusen and RPE elevation for ARMD and macular thickness and irregular RPE for PCV. Quantitative analysis involved comparing the two groups' central subfoveal thickness and parafoveal thickness, with statistical analysis conducted to assess significant differences.

Results

This retrospective study included 43 patients diagnosed with Age-Related Macular Degeneration (ARMD) and Polypoidal Choroidal Vascularopathy (PCV), with significant findings identified through Optical Coherence Tomography (OCT). The study population ranged in age from 30 to 80.

The sample consisted of 55.8% male and 44.2% female patients. Most cases involved the right eye (OD), accounting for 67.4%, while 32.6% involved the left eye (OS). The p-value for gender and laterality differences was statistically significant ($p < 0.05$).

The demographic characteristics of the patients in terms of gender and laterality are presented in Table 1.

The qualitative features utilized to diagnose ARMD and PCV were compared and are shown in Table 2.

The qualitative analysis highlighted significant differences between ARMD and PCV. ARMD was characterized by drusen, retinal pigment epithelium (RPE) elevation, and choroidal neovascularization (CNV). In contrast, PCV cases displayed a notably thicker macula (greater than 290 microns) and lacked RPE elevation or CNV, key differentiators in diagnosis.

Tables 3 and 4 present the quantitative measurements, focusing on central subfoveal thickness and parafoveal thickness.

The central subfoveal thickness in patients with ARMD was consistently below 250 microns, while in patients diagnosed with PCV, it was significantly higher (greater than 290 microns). This key quantitative difference serves as an important marker for distinguishing between the two conditions.

Similarly, the mean parafoveal thickness was greater in patients with PCV (greater than 290 microns) thanin those with ARMD (less than 270 microns). This difference further supports the role of OCT in the differential diagnosis of ARMD and PCV.

Table 1: Demographic Characteristics of the Patients

Characteristic	Frequency (n)	Percentage (%)
Gender		
Male	24	55.8%
Female	19	44.2%
Laterality		
Right Eye (OD)	29	67.4%
Left Eye (OS)	14	32.6%

Table 2: Qualitative Features of ARMD vs. PCV

Diagnostic Feature	ARMD (n=24)	PCV (n=19)
Drusen	Present	Absent
RPE Elevation	Present	Absent
CNV (Choroidal Neovascularization)	Present	Absent
Macular Thickness	<250 microns	>290 microns

Table 3: Central Subfoveal Thickness Comparison between ARMD and PCV

Condition	Central Subfoveal Thickness (microns)
ARMD	<250
PCV	>290

Table 4: Parafoveal Thickness Comparison between ARMD and PCV

Condition	Mean Parafoveal Thickness (microns)
ARMD	<270
PCV	>290

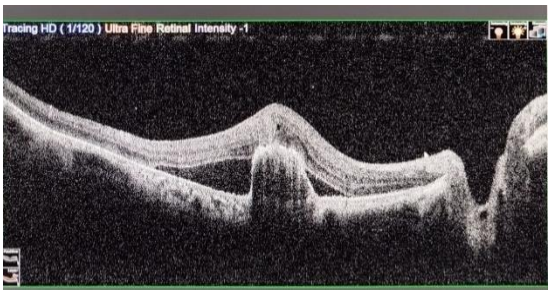

Figure 1: OCT Scan of a Patient with ARMD
The OCT scan shows structural changes typical of ARMD, with visible drusen accumulation and RPE elevation. These features are characteristic of dry ARMD, where degenerative changes in the macula occur without the presence of choroidal neovascularization. The central subfoveal thickness is below the threshold for PCV, confirming the diagnosis.

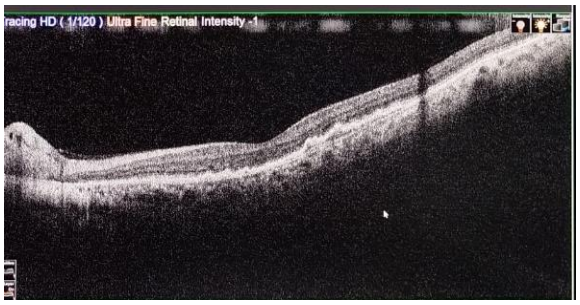

Figure 2: OCT Scan of a Patient with PCV
The OCT scan reveals a much thicker macula, consistent with PCV, where there is an increase in central subfoveal thickness (>290 microns) due to polypoidal lesions. These lesions, along with irregular RPE and macular edema, are key diagnostic features of PCV. This thickening of the macula is a critical differentiator when compared to ARMD.

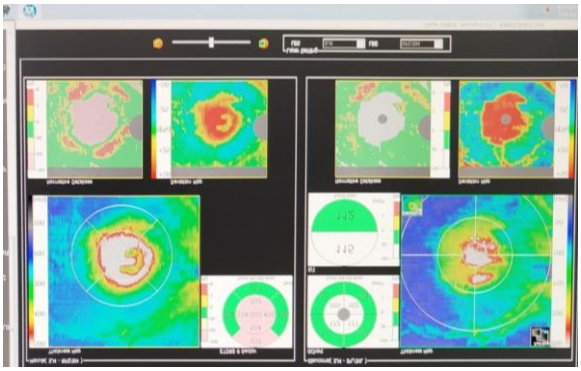

Figure 3: Retinal Thickness Map of a Patient with ARMD
The thickness map shows the distribution of retinal thickness in the macula. For this ARMD patient, the map demonstrates lower central subfoveal thickness and a lack of significant macular edema, which is characteristic of dry ARMD. The normative data points in the central macula further confirm the absence of severe swelling or thickening seen in PCV.

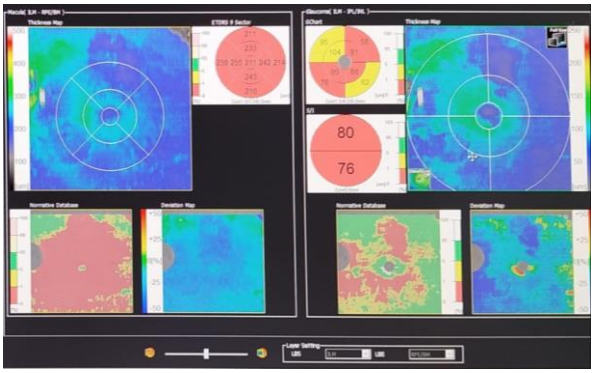

Figure 4: Retinal Thickness Map of a Patient with PCV
The map presents clear deviations from the normative database, indicating thickening of the macula due to the presence of polypoidal lesions in PCV. These findings contrast with ARMD, where the macula typically remains thinner, and thickening is less pronounced. The deviation map shows areas of increased macular thickness in the central foveal region, which is a hallmark of PCV.

Discussion

This study demonstrated distinct differences in both qualitative and quantitative features between Age-Related Macular Degeneration (ARMD) and Polypoidal Choroidal Vasculopathy (PCV) as observed through Optical Coherence Tomography (OCT). The findings suggest that OCT, especially with advanced techniques such as Enhanced Depth Imaging (EDI) and OCT Angiography (OCTA), can play a critical role in differentiating between these conditions, facilitating accurate diagnoses and more effective management strategies.

The significant differences observed in central subfoveal thickness between patients with ARMD and those with PCV are consistent with previous studies. Patients with PCV exhibited a significantly greater central subfoveal thickness (>290 microns), compared to those with ARMD (<250 microns), aligning with the work of Guymer et al. (2020) and Teo et al. (2023), who also noted that increased macular thickness is a hallmark of PCV(11)(12). This difference is likely due to the presence of polypoidal lesions in the choroid, which leads to thickening of the macula in PCV, whereas ARMD is primarily characterized by drusen formation and RPE degeneration (13, 14).

Additionally, the parafoveal thickness was greater in PCV compared to ARMD, corroborating findings reported by Kim et al. (2020), who observed that PCV is often associated with thickening of the parafoveal region (15). These measurements, along with the qualitative findings of irregular RPE and ring-like lesions in PCV, further support the utility of OCT as a diagnostic tool for distinguishing these two conditions. The importance of OCTA in this context cannot be overstated, as it provides detailed visualization of choroidal vasculature and is essential for identifying polypoidal lesions, a key feature of PCV that is often missed on traditional imaging modalities(12)(16).

While the current study confirms previous reports on the diagnostic utility of OCT and OCTA, it also emphasizes the importance of considering PCV in the differential diagnosis when there is an increase in macular thickness, especially in regions where access to advanced imaging techniques is limited. This study highlights the critical need for greater awareness and access to these imaging technologies in developing countries, where PCV remains underdiagnosed due to the lack of OCTA. As Lee et al. (2023) indicated, the underutilization of OCTA in clinical practice is a major barrier to accurate diagnosis and effective management of PCV (17).

The findings also stress the significance of early detection of PCV, as the condition can lead to irreversible vision loss if not managed appropriately. The high prevalence of PCV and its overlap with ARMD in terms of clinical presentation suggest that clinicians should be vigilant in using OCTA to ensure accurate diagnoses, particularly in patients with macular thickening and RPE abnormalities (18). Additionally, the results of this study support the growing body of evidence that multimodal imaging, including OCTA, should be routinely incorporated into clinical practice for better patient outcomes (19).

The results of this study underscore the importance of utilizing advanced OCT modalities, such as OCTA and EDI OCT, for the accurate differentiation of ARMD and PCV. This study contributes to the understanding of the role of OCT in retinal diseases and highlights the need for increased access to these diagnostic tools, particularly in underserved regions. Further studies with larger sample sizes and long-term follow-up are warranted to explore the full potential of OCTA in managing these conditions and improving visual outcomes.

Conclusion

The study highlights significant qualitative and quantitative differences between ARMD and PCV, emphasizing the crucial role of OCT and OCTA in accurate diagnosis. OCT revealed clear distinctions in central subfoveal and parafoveal thickness between the two conditions, with PCV showing thicker macular regions. Given the high prevalence of PCV and its potential to go undiagnosed in areas with limited access to advanced imaging, the study advocates for increased use of OCTA to ensure early and accurate diagnosis, ultimately improving patient outcomes.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-MMNCS-EYEi-09-24)

Consent for publication
Approved

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The authors declared the absence of a conflict of interest.

Author Contribution

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Conception of Study, Development of Research Methodology Design,
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Study Design, manuscript review, critical input.

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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