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Original Research Article

Correlation between Visual Acuity and OCT Biomarkers in Patients with Neovascular AMD

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ABSTRACT

Background: Neovascular age-related macular degeneration (nAMD) is a leading cause of irreversible vision loss among older adults. Optical coherence tomography (OCT) enables detailed assessment of retinal morphology and provides valuable biomarkers that may correlate with visual function. Identifying structural predictors of visual acuity is essential for prognosis and treatment planning.

Methods: A hospital-based observational cross-sectional analytical study was conducted on 62 eyes diagnosed with neovascular AMD. Demographic and clinical data were recorded, and all patients underwent comprehensive ophthalmic examination, including best-corrected visual acuity (BCVA) assessment and spectral-domain OCT imaging. OCT biomarkers evaluated included central retinal thickness (CRT), intraretinal fluid (IRF), subretinal fluid (SRF), pigment epithelial detachment (PED), hyperreflective foci (HRF), subretinal hyperreflective material (SHRM), ellipsoid zone (EZ) disruption, and external limiting membrane (ELM) disruption. Correlation and multivariable regression analyses were performed using SPSS, with $p < 0.05$ considered statistically significant.

Results: The mean age of the participants was 68.5 ± 8.2 years, and 58.1% were males. The mean BCVA was 0.82 ± 0.32 logMAR. IRF (64.5%), SRF (58.1%), and EZ disruption (54.8%) were the most common OCT biomarkers. Poorer BCVA showed significant positive correlations with CRT ($r = 0.41$), IRF ($r = 0.48$), PED ($r = 0.32$), HRF ($r = 0.37$), SHRM ($r = 0.44$), EZ disruption ($r = 0.56$), and ELM disruption ($r = 0.52$) (all $p < 0.05$). Multiple regression analysis identified EZ disruption ($\beta = 0.36$) as the strongest independent predictor of poor visual acuity, followed by IRF, SHRM, CRT, and age.

Conclusion: OCT biomarkers demonstrated significant associations with visual acuity in patients with neovascular AMD. Among these, ellipsoid zone disruption, external limiting membrane disruption, and intraretinal fluid were the strongest predictors of visual impairment. Comprehensive OCT biomarker evaluation may improve prognostic assessment and support individualized management of neovascular AMD.

Keywords: Neovascular Age-Related Macular Degeneration, Optical Coherence Tomography, Best-Corrected Visual Acuity, OCT Biomarkers, Ellipsoid Zone Disruption.

INTRODUCTION

Neovascular age-related macular degeneration (nAMD), also known as wet age-related macular degeneration, is a leading cause of irreversible central vision loss among individuals aged 50 years and older worldwide. It is characterized by the growth of abnormal choroidal neovascular membranes beneath or within the retina, resulting in leakage of fluid, lipids, and blood into the macular region. These pathological changes lead to progressive disruption of retinal architecture, photoreceptor damage, fibrosis, and permanent loss of visual function if left untreated. With increasing life expectancy and an aging global population, the burden of AMD

continues to rise, making it a major public health concern because of its profound impact on quality of life, independence, and socioeconomic costs.[1]

Early diagnosis and timely treatment have become increasingly important with the advent of intravitreal anti-vascular endothelial growth factor (anti-VEGF) therapy, which has significantly improved visual outcomes in patients with nAMD by inhibiting pathological angiogenesis and reducing retinal exudation.[2]

Although best-corrected visual acuity (BCVA) remains the gold standard functional outcome measure for evaluating disease severity and treatment response, visual acuity alone does not fully reflect the structural changes occurring within the retina. Patients with similar visual acuity may exhibit markedly different retinal morphologies and prognoses, emphasizing the need for objective imaging biomarkers that accurately represent disease activity and predict visual outcomes.[3,4]

Optical coherence tomography (OCT) has revolutionized the diagnosis and management of retinal diseases by providing rapid, non-invasive, high-resolution cross-sectional imaging of the retina, allowing detailed visualization of retinal layers and pathological alterations associated with neovascular AMD.[5]

OCT enables clinicians to identify and quantify several structural biomarkers, including central retinal thickness (CRT), intraretinal fluid (IRF), subretinal fluid (SRF), pigment epithelial detachment (PED), hyperreflective foci (HRF), disruption of the ellipsoid zone (EZ), external limiting membrane (ELM) integrity, subretinal hyperreflective material (SHRM), and retinal pigment epithelium abnormalities. These biomarkers provide valuable information regarding disease activity, treatment response, and long-term prognosis.[5,6] Numerous studies have demonstrated that certain OCT biomarkers correlate more strongly with visual function than retinal thickness alone.[6]

Persistent intraretinal fluid has consistently been associated with poorer visual acuity because it reflects irreversible retinal damage and photoreceptor dysfunction, whereas limited amounts of subretinal fluid may not adversely affect vision and, in some cases, have been associated with favorable anatomical outcomes.[7]

Similarly, disruption of the ellipsoid zone and external limiting membrane has emerged as a significant predictor of reduced visual acuity because these structures represent photoreceptor integrity, which is essential for visual function.[8] Hyperreflective foci are considered markers of inflammation, retinal pigment epithelium migration, or lipid deposition and have also been associated with worse visual prognosis. Subretinal hyperreflective material and large pigment epithelial detachments are frequently observed in active neovascular lesions and may predict chronicity, fibrosis, and incomplete visual recovery despite treatment.[9,10]

With the widespread use of anti-VEGF therapy, OCT biomarkers have gained increasing importance not only in establishing the diagnosis but also in guiding individualized retreatment strategies such as treat-and-extend and pro re nata regimens. Serial OCT examinations enable clinicians to monitor disease activity objectively, detect recurrence earlier than clinical examination alone, and optimize treatment intervals while minimizing unnecessary injections. Nevertheless, considerable variability exists in the relationship between retinal morphology and visual acuity, and the predictive value of individual OCT biomarkers remains incompletely understood.

Establishing the correlation between visual acuity and specific OCT biomarkers is therefore essential for improving prognostic accuracy, identifying patients at greater risk of poor visual outcomes, and facilitating personalized management strategies. In this context, the present study aims to evaluate the correlation between visual acuity and OCT biomarkers in patients with neovascular AMD, thereby contributing to a better understanding of the structural-functional relationship and enhancing evidence-based clinical decision-making in the management of this sight-threatening retinal disease.

MATERIALS & METHODS

Study Design

This study was conducted as a hospital-based observational cross-sectional analytical study to evaluate the correlation between visual acuity and optical coherence tomography (OCT) biomarkers in patients diagnosed with neovascular age-related macular degeneration (nAMD). The cross-sectional design enabled simultaneous assessment of functional visual outcomes and structural retinal changes observed on OCT at the time of presentation. The study aimed to determine the relationship between best-corrected visual acuity (BCVA) and individual OCT biomarkers without

introducing any therapeutic intervention or altering routine clinical management. All clinical assessments and imaging investigations were performed according to standard institutional ophthalmic protocols.

Study Setting

The study was carried out in the Department of Ophthalmology at a tertiary care teaching hospital equipped with specialized retina services and advanced ophthalmic imaging facilities, including spectral-domain Optical Coherence Tomography (SD-OCT). The institution serves as a referral center for retinal diseases and receives a large number of patients with neovascular age-related macular degeneration from both urban and rural populations. All ophthalmic examinations, OCT imaging, and data collection were performed within the retina clinic under the supervision of experienced vitreoretinal specialists.

Study Duration

The study was conducted over a period of 18 months, commencing after obtaining approval from the Institutional Ethics Committee and continuing until the required sample size was achieved. During this period, all eligible patients attending the retina outpatient department were screened consecutively for inclusion in the study.

Participants Inclusion Criteria

- Patients aged 50 years and above.
- Patients diagnosed with neovascular (wet) age-related macular degeneration based on comprehensive ophthalmic examination and OCT findings.
- Patients who underwent best-corrected visual acuity (BCVA) assessment and OCT imaging during the study period.
- Patients willing to participate and who provided written informed consent.

Exclusion Criteria

- Patients with dry (non-neovascular) age-related macular degeneration.
- Eyes with other retinal diseases affecting visual acuity, such as diabetic retinopathy, retinal vein occlusion, central serous chorioretinopathy, or inherited retinal disorders.
- Eyes with significant media opacity (dense cataract, vitreous hemorrhage, or corneal opacity) preventing adequate retinal examination or OCT imaging.
- Patients with previous vitreoretinal surgery.
- Patients with advanced glaucoma or optic neuropathy affecting visual function.
- Poor-quality OCT images due to fixation instability or image acquisition artifacts.
- Patients unwilling to participate or with incomplete clinical records.

Study Sampling

A consecutive sampling technique was employed throughout the study period. Every patient fulfilling the eligibility criteria and attending the retina clinic during the study period was included until the predetermined sample size was achieved. This sampling method minimized selection bias and ensured that the study population represented routine clinical practice.

Study Sample Size

The sample size was calculated using the formula for estimating a correlation coefficient based on the retrospective cross-sectional study by Keane PA et al., who evaluated the relationship between OCT biomarkers and visual acuity in patients with neovascular age-related macular degeneration. The study demonstrated a significant correlation between subretinal tissue volume and visual acuity ($r = 0.37$). Using this anticipated correlation coefficient, a confidence level of 95% and statistical power of 80%, the minimum required sample size was calculated as 56 eyes. After allowing for approximately 10% incomplete data or suboptimal OCT image quality, the final sample size was increased to 62 eyes.

Study Parameters

The primary outcome measure was best-corrected visual acuity (BCVA), measured using a standardized Snellen visual acuity chart and converted to logarithm of the minimum angle of resolution (logMAR) values for statistical analysis. OCT biomarkers evaluated included central retinal thickness (CRT), intraretinal fluid (IRF), subretinal fluid (SRF), pigment epithelial detachment (PED), hyperreflective foci (HRF), subretinal hyperreflective material (SHRM), ellipsoid zone (EZ) integrity, external limiting membrane (ELM) integrity, retinal pigment epithelium (RPE) abnormalities, and other relevant morphological retinal changes identified on spectral-domain OCT. Demographic variables including age, sex, laterality of the affected eye, duration of symptoms, systemic

comorbidities such as diabetes mellitus and hypertension, and previous anti-VEGF treatment history were also recorded.

Study Procedure

Following Institutional Ethics Committee approval, eligible patients attending the retina outpatient clinic were identified and screened according to the predefined inclusion and exclusion criteria. Written informed consent was obtained before enrolment. A detailed clinical history was recorded, including demographic characteristics, ocular symptoms, duration of visual impairment, systemic illnesses, smoking history, and previous ocular treatments. All participants underwent comprehensive ophthalmic evaluation consisting of measurement of best-corrected visual acuity using the Snellen chart, slit-lamp biomicroscopy of the anterior segment, intraocular pressure measurement using applanation tonometry, and dilated fundus examination with indirect ophthalmoscopy and slit-lamp biomicroscopy using a 90D lens. Spectral-domain OCT imaging of the macula was subsequently performed using the same OCT device following standardized acquisition protocols. OCT scans were carefully reviewed by experienced retinal specialists to identify and document the presence or absence of each predefined biomarker. Only high-quality scans with adequate signal strength were included for analysis.

Study Data Collection

Clinical information was collected using a structured case record proforma specifically designed for the study. Demographic data, ocular examination findings, best-corrected visual acuity, OCT measurements, retinal morphological characteristics, and relevant clinical history were recorded systematically. OCT images were archived electronically, and retinal biomarkers were evaluated independently by trained ophthalmologists to ensure consistency in interpretation. All collected data were verified for completeness before being entered into a secure computerized database for analysis.

Data Analysis

The collected data were entered into Microsoft Excel and analyzed using IBM Statistical Package for the Social Sciences (SPSS) version 26.0 (or the latest available version). Continuous variables were expressed as mean ± standard deviation or median with interquartile range depending on data distribution, whereas categorical variables were summarized as frequencies and percentages. Normality of continuous variables was assessed using the Shapiro-Wilk test. Correlation between best-corrected visual acuity and continuous OCT biomarkers was analyzed using Pearson's correlation coefficient for normally distributed variables or Spearman's rank correlation coefficient for non-normally distributed variables. Differences in visual acuity according to categorical OCT biomarkers were evaluated using the independent Student's t-test or Mann-Whitney U test, as appropriate. Multiple linear regression analysis was performed to determine independent OCT predictors of visual acuity after adjusting for potential confounding variables. A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

The study was conducted only after obtaining approval from the Institutional Ethics Committee (IEC) of the participating institution. The study adhered to the ethical principles outlined in the Declaration of Helsinki and Good Clinical Practice guidelines. Written informed consent was obtained from every participant before enrolment after explaining the objectives, procedures, potential benefits, and minimal risks associated with the study. Confidentiality of participant information was strictly maintained by assigning unique identification numbers and securely storing all clinical data. Participation was entirely voluntary, and patients were informed of their right to withdraw from the study at any stage without affecting their ongoing treatment or standard ophthalmic care. No additional invasive investigations beyond routine clinical evaluation were performed exclusively for research purposes.

RESULTS

A total of 62 eyes with neovascular age-related macular degeneration were evaluated. The mean patient age was 68.5 ± 8.2 years, with a predominance of males (58.1%). Intraretinal fluid (64.5%), subretinal fluid (58.1%), and ellipsoid zone disruption (54.8%) were the most frequently observed OCT biomarkers. The mean best-corrected visual acuity was 0.82 ± 0.32 logMAR, indicating moderate visual impairment. Correlation analysis demonstrated significant

associations between poorer visual acuity and increased central retinal thickness, intraretinal fluid, pigment epithelial detachment, hyperreflective foci, subretinal hyperreflective material, ellipsoid zone disruption, and external limiting membrane disruption. Multiple regression analysis identified ellipsoid zone disruption as the strongest independent predictor of reduced visual acuity, followed by intraretinal fluid, subretinal hyperreflective material, increased central retinal thickness, and advancing age. These findings suggest that structural OCT biomarkers, particularly those reflecting photoreceptor damage, correlate closely with visual function and may serve as valuable prognostic indicators in patients with neovascular age-related macular degeneration.

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
50–59	12	19.4
60–69	24	38.7
70–79	18	29.0
≥80	8	12.9
Mean Age (years)	68.5 ± 8.2	
Gender		
Male	36	58.1
Female	26	41.9
Eye Involved		
Right	34	54.8
Left	28	45.2
Smoking History		
Yes	22	35.5
No	40	64.5

Table 1. Demographic Characteristics of the Study Population (n = 62)

Among the 62 patients included in the study, the majority (38.7%) belonged to the 60–69-year age group, followed by 29.0% in the 70–79-year age group. The mean age was 68.5 ± 8.2 years, indicating that neovascular AMD predominantly affected older adults. Males constituted 58.1% of the study population, while females accounted for 41.9%. The right eye was slightly more frequently involved (54.8%) than the left eye (45.2%). Approximately one-third of patients (35.5%) had a history of smoking.

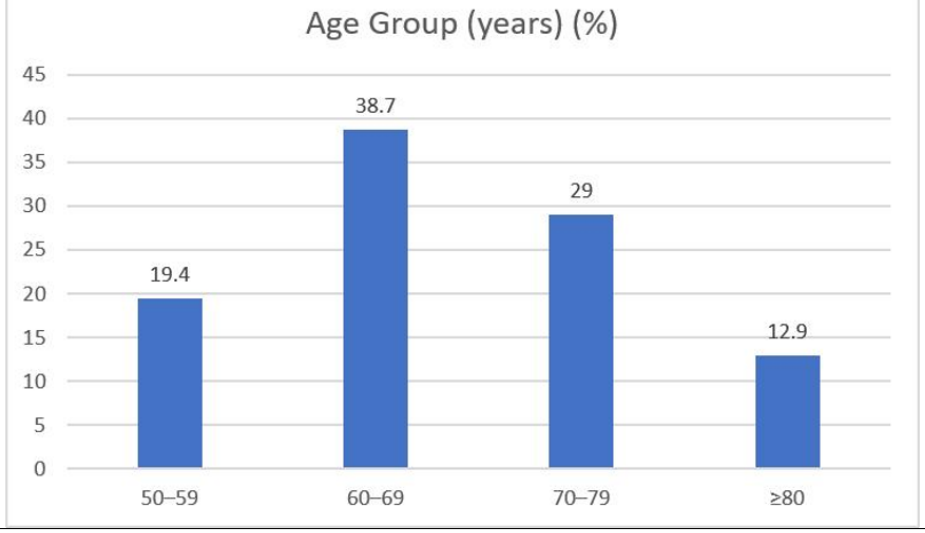

Figure 1

Variable	Frequency (n)	Percentage (%)
Hypertension	39	62.9
Diabetes Mellitus	24	38.7
Previous Anti-VEGF Treatment	18	29.0
Treatment-naïve	44	71.0
Duration of Symptoms <3 months	28	45.2
Duration 3–6 months	21	33.9
Duration >6 months	13	21.0

Table 2. Clinical Characteristics of Patients (n = 62)

Hypertension was the most common systemic comorbidity, affecting 62.9% of patients, while diabetes mellitus was present in 38.7%. Nearly three-fourths (71.0%) of the patients were treatment-naïve at presentation. Most patients presented within three months of symptom onset (45.2%), whereas only 21.0% had symptoms for more than six months before diagnosis.

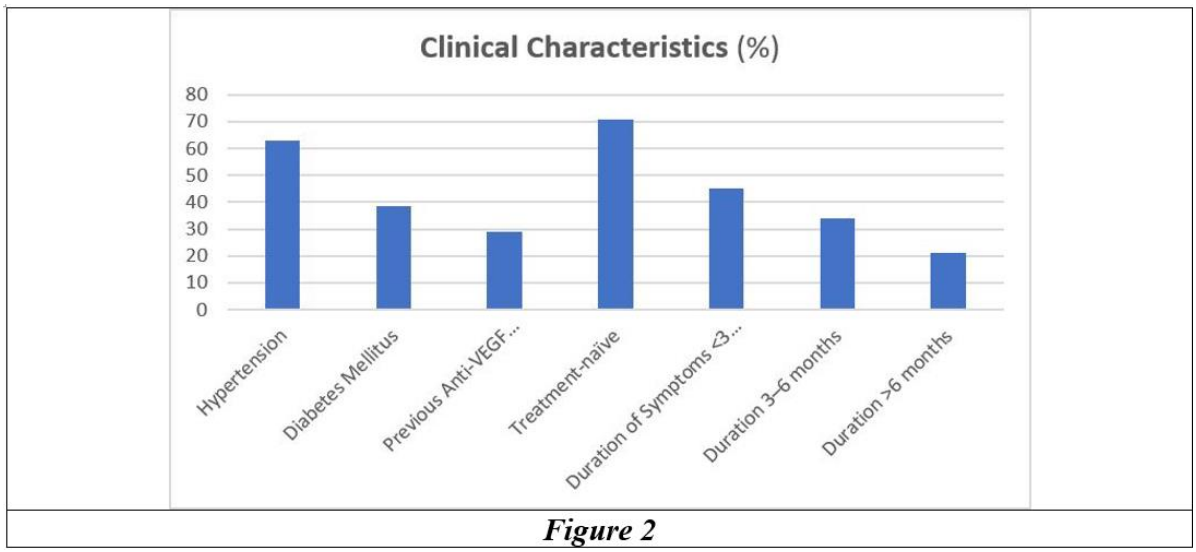

Figure 2

OCT Biomarker	Present n (%)	Absent n (%)
Intraretinal Fluid (IRF)	40 (64.5)	22 (35.5)
Subretinal Fluid (SRF)	36 (58.1)	26 (41.9)
Pigment Epithelial Detachment (PED)	31 (50.0)	31 (50.0)
Hyperreflective Foci (HRF)	27 (43.5)	35 (56.5)
Subretinal Hyperreflective Material (SHRM)	25 (40.3)	37 (59.7)
Ellipsoid Zone Disruption	34 (54.8)	28 (45.2)
External Limiting Membrane Disruption	30 (48.4)	32 (51.6)

Table 3. Distribution of OCT Biomarkers (n = 62)

Intraretinal fluid was the most frequently observed OCT biomarker (64.5%), followed by subretinal fluid (58.1%). Ellipsoid zone disruption was identified in 54.8% of patients, suggesting significant photoreceptor damage. Pigment epithelial detachment was present in exactly half of the patients. Hyperreflective foci and subretinal hyperreflective material were identified in approximately 40–45% of cases.

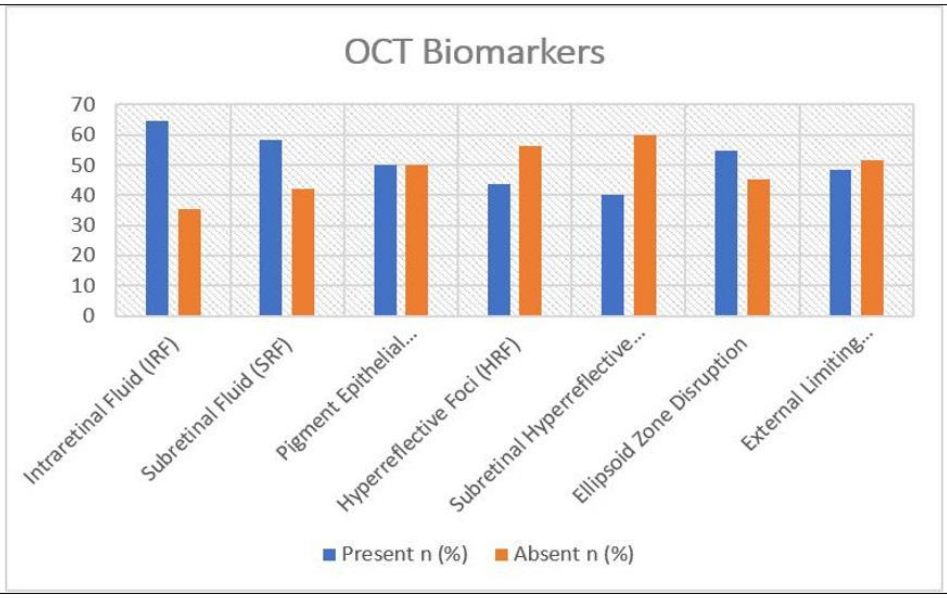

Figure 3

Visual Acuity (logMAR)	Frequency	Percentage
≤0.30	8	12.9
0.31–0.60	16	25.8
0.61–1.00	25	40.3
>1.00	13	21.0
Mean BCVA (logMAR)	0.82 ± 0.32	

Table 4. Distribution of Best Corrected Visual Acuity (BCVA)

The majority of patients (40.3%) demonstrated a BCVA between 0.61 and 1.00 logMAR, indicating moderate visual impairment. Only 12.9% of patients had relatively good vision (≤0.30 logMAR), whereas 21.0% exhibited severe visual impairment (>1.00 logMAR). The mean BCVA was 0.82 ± 0.32 logMAR.

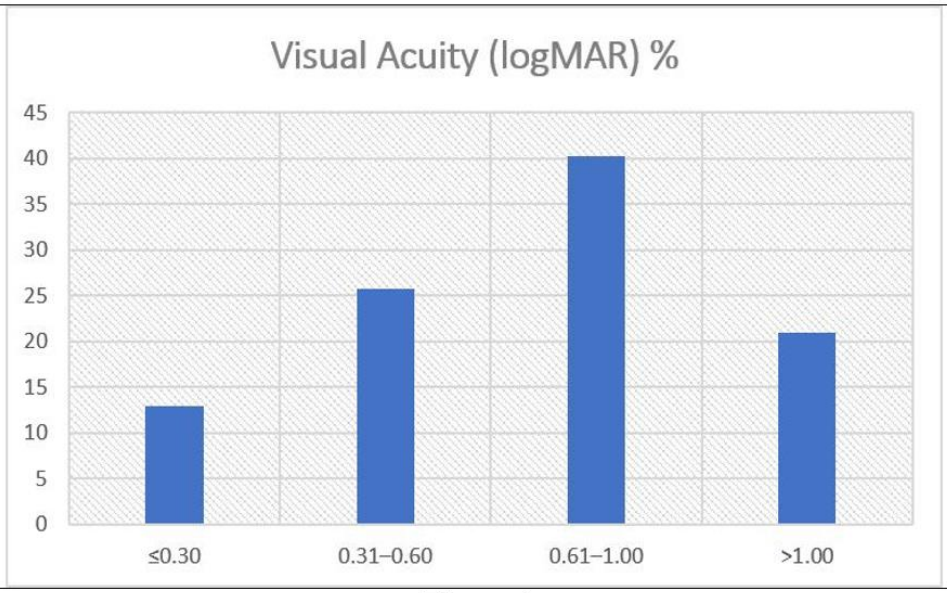

Figure 4

Variable	Correlation (r)	p value
Central Retinal Thickness	0.41	<0.001*
Intraretinal Fluid	0.48	<0.001*
Subretinal Fluid	0.19	0.138
PED Height	0.32	0.011*
Hyperreflective Foci	0.37	0.003*
SHRM	0.44	<0.001*
Ellipsoid Zone Disruption	0.56	<0.001*
ELM Disruption	0.52	<0.001*

Table 5. Correlation Between BCVA and OCT Biomarkers

Best-corrected visual acuity demonstrated significant positive correlations with central retinal thickness, intraretinal fluid, pigment epithelial detachment height, hyperreflective foci, subretinal hyperreflective material, ellipsoid zone disruption, and external limiting membrane disruption ($p<0.05$). The strongest correlations were observed for ellipsoid zone disruption ($r=0.56$) and ELM disruption ($r=0.52$), indicating that photoreceptor integrity was the strongest structural predictor of visual impairment. Subretinal fluid did not show a statistically significant correlation with visual acuity.

Variable	β coefficient	Standard Error	p value
Age	0.18	0.07	0.041*
Central Retinal Thickness	0.23	0.08	0.018*
Intraretinal Fluid	0.29	0.09	0.004*
SHRM	0.25	0.10	0.016*
Ellipsoid Zone Disruption	0.36	0.08	<0.001*
PED	0.11	0.09	0.214

Table 6. Multiple Linear Regression Analysis for Predictors of Poor BCVA

Model $R^2 = 0.61$

Multiple linear regression analysis demonstrated that ellipsoid zone disruption emerged as the strongest independent predictor of poor visual acuity ($\beta=0.36$, $p<0.001$), followed by intraretinal fluid, subretinal hyperreflective material, increased central retinal thickness, and increasing age. Pigment epithelial detachment was not independently associated with visual acuity after adjusting for other OCT biomarkers. The regression model explained 61% of the variability in BCVA.

Biomarker	Present (Mean BCVA logMAR)	Absent (Mean BCVA logMAR)	p value
IRF	0.98 ± 0.29	0.54 ± 0.21	<0.001*
SRF	0.86 ± 0.31	0.76 ± 0.30	0.173
PED	0.91 ± 0.34	0.74 ± 0.28	0.028*
SHRM	1.01 ± 0.33	0.69 ± 0.24	<0.001*
EZ Disruption	1.05 ± 0.27	0.56 ± 0.18	<0.001*
ELM Disruption	0.99 ± 0.29	0.65 ± 0.22	<0.001*

Table 7. Comparison of BCVA According to OCT Biomarker Status

Patients with intraretinal fluid, subretinal hyperreflective material, ellipsoid zone disruption, and external limiting membrane disruption had significantly poorer visual acuity compared with patients without these biomarkers ($p<0.001$). Although patients with subretinal fluid showed slightly poorer vision, the difference was not statistically significant. The greatest reduction in visual acuity was observed in eyes demonstrating ellipsoid zone disruption.

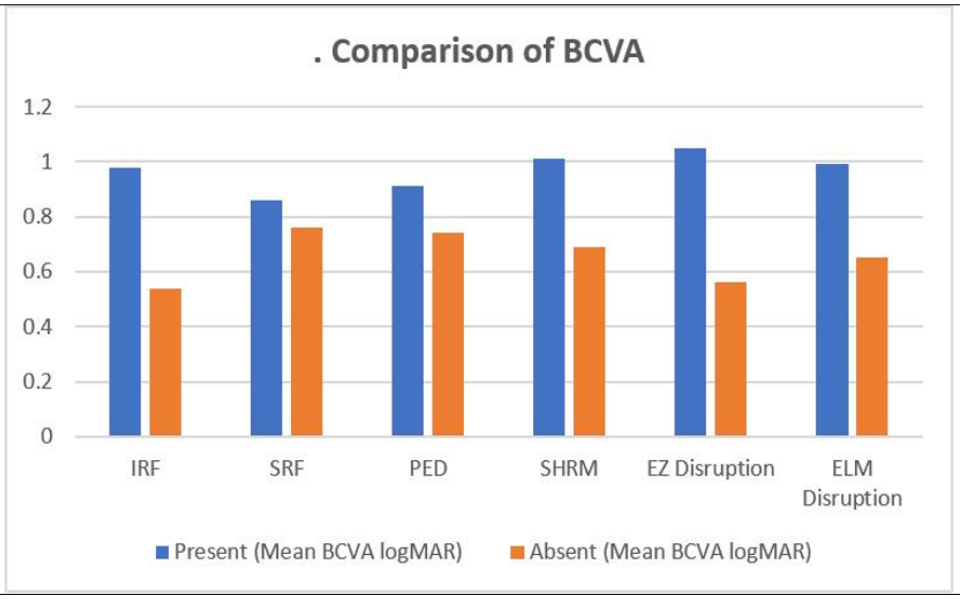

Figure 5

Predictor	Strength of Association	Statistical Significance
Ellipsoid Zone Disruption	Very Strong	<0.001*
External Limiting Membrane Disruption	Strong	<0.001*
Intraretinal Fluid	Strong	0.004*
SHRM	Moderate	0.016*
Central Retinal Thickness	Moderate	0.018*
Age	Mild	0.041*
PED	Weak	0.214
SRF	Not Significant	0.138

Table 8. Summary of Significant Predictors of Poor Visual Acuity

Table 8 summarizes the significant predictors of poor best-corrected visual acuity (BCVA) in patients with neovascular age-related macular degeneration. Ellipsoid zone (EZ) disruption was the strongest predictor ($p < 0.001$), followed by external limiting membrane (ELM) disruption ($p < 0.001$) and intraretinal fluid (IRF) ($p = 0.004$). Subretinal hyperreflective material (SHRM) and increased central retinal thickness (CRT) showed moderate but significant associations with poor visual acuity ($p < 0.05$). Age had a mild yet significant influence ($p = 0.041$), whereas pigment epithelial detachment (PED) and subretinal fluid (SRF) were not significant predictors ($p > 0.05$). Overall, biomarkers indicating photoreceptor damage and intraretinal structural changes were the strongest determinants of visual impairment in this study.

DISCUSSION

The present observational study evaluated the correlation between best-corrected visual acuity (BCVA) and optical coherence tomography (OCT) biomarkers in patients with neovascular age-related macular degeneration (nAMD). A total of 62 eyes were included in the analysis. The mean age of the participants was 68.5 ± 8.2 years, with the majority of patients belonging to the 60–69 years age group (38.7%), followed by the 70–79 years group (29.0%). Male patients constituted 58.1%, while females accounted for 41.9%. Hypertension was the most common systemic comorbidity (62.9%), followed by diabetes mellitus (38.7%), and most patients (71.0%) were treatment-naïve. The mean BCVA was 0.82 ± 0.32 logMAR, indicating moderate visual impairment at presentation. The most frequent OCT biomarkers observed were intraretinal fluid (IRF) (64.5%), subretinal fluid (SRF) (58.1%), ellipsoid zone (EZ) disruption (54.8%), pigment epithelial detachment (PED) (50.0%), external limiting membrane (ELM) disruption (48.4%), hyperreflective foci (HRF) (43.5%), and subretinal hyperreflective material (SHRM) (40.3%). Correlation analysis

demonstrated significant positive associations between poorer BCVA and central retinal thickness ($r = 0.41$, $p < 0.001$), IRF ($r = 0.48$, $p < 0.001$), PED ($r = 0.32$, $p = 0.011$), HRF ($r = 0.37$, $p = 0.003$),
SHRM ($r = 0.44$, $p < 0.001$), EZ disruption ($r = 0.56$, $p < 0.001$), and ELM disruption ($r = 0.52$, $p < 0.001$), whereas SRF was not significantly associated with visual acuity ($r = 0.19$, $p = 0.138$). Multiple regression analysis further identified EZ disruption ($\beta = 0.36$) as the strongest independent predictor of poor visual acuity, followed by IRF ($\beta = 0.29$), SHRM ($\beta = 0.25$), central retinal thickness ($\beta = 0.23$), and increasing age ($\beta = 0.18$), with the model explaining 61% of the variability in BCVA.

The demographic profile of the present study is comparable to that reported by Keane et al. who evaluated 216 eyes with newly diagnosed neovascular AMD and demonstrated that the disease predominantly affected older individuals undergoing OCT evaluation at diagnosis.[11] Similarly, Lai et al. retrospectively evaluated 126 eyes with neovascular AMD treated with anti-VEGF therapy and emphasized the importance of baseline OCT findings in determining subsequent visual outcomes.[12] More recently, Riazi-Esfahani et al. studied 89 treatment-naïve eyes and reported sustained improvement in BCVA after aflibercept therapy while highlighting the prognostic importance of baseline OCT biomarkers.

Among the OCT biomarkers evaluated in the present study, intraretinal fluid emerged as one of the strongest determinants of poor visual acuity, being present in 64.5% of eyes and demonstrating a significant positive correlation with BCVA deterioration ($r = 0.48$, $p < 0.001$). Patients with IRF had significantly worse mean BCVA (0.98 ± 0.29 logMAR) than those without IRF (0.54 ± 0.21 logMAR). These findings are consistent with Lai et al., who demonstrated that persistence of intraretinal cysts was associated with poorer visual improvement after one year and that eyes with persistent IRCs showed less favorable treatment response.[12] Likewise, the systematic review by Nanji et al. concluded that the presence of baseline IRF and IRF involving the foveal center predicted worse visual acuity at 12 months after anti-VEGF therapy.[13] Similarly, Riazi-Esfahani et al. observed that patients with baseline IRF experienced significantly smaller visual gains than those without IRF following aflibercept treatment (1.6 ± 18.2 vs 11.1 ± 10 ETDRS letters; $P = 0.002$).[14] Furthermore, Olivieri et al. identified baseline IRF as an independent predictor of subsequent macular atrophy during long-term follow-up.

In contrast, subretinal fluid was not significantly associated with visual acuity in the present study ($r = 0.19$, $p = 0.138$). This observation closely resembles the findings of Keane et al., who reported no statistically significant association between visual acuity and total subretinal fluid volume.[11] Likewise, although Lai et al. demonstrated that SRF responded favorably to anti-VEGF therapy, they primarily identified persistent intraretinal cysts and PED rather than SRF as factors associated with poorer visual improvement.[12]

The present study also demonstrated that subretinal hyperreflective material (SHRM) and central retinal thickness were significantly associated with poorer visual acuity. SHRM showed a moderate positive correlation ($r = 0.44$, $p < 0.001$), and patients with SHRM exhibited significantly poorer BCVA (1.01 ± 0.33 logMAR) than those without SHRM (0.69± 0.24 logMAR). These findings are in agreement with Keane et al., who reported that increased subretinal tissue volume correlated with decreased visual acuity ($r = 0.370$; $P < 0.0001$), whereas increased neurosensory retinal thickness at the fovea showed a weaker correlation ($r = 0.245$; $P = 0.0004$).[11] Similarly, Ristau et al. demonstrated that increased subretinal hyperreflective material correlated with poorer baseline visual acuity ($R = 0.4$; $p < 0.001$) and that degeneration of the photoreceptor layer was closely associated with reduced visual function.[15]

The strongest findings of the present study were related to ellipsoid zone and external limiting membrane disruption, which demonstrated the highest correlation coefficients with visual acuity ($r = 0.56$ and $r = 0.52$, respectively). Regression analysis further identified ellipsoid zone disruption as the strongest independent predictor of poor vision ($\beta = 0.36$, $p < 0.001$). These observations are comparable to the systematic review by Nanji et al., which reported that the presence of an intact external limiting membrane predicted better visual acuity (+14 ETDRS letters) and that an intact ellipsoid zone was associated with improved visual outcomes (+6.8 ETDRS letters) after anti-VEGF therapy.[13] These findings collectively emphasize the importance of photoreceptor

integrity in determining visual prognosis.

Overall, the findings of the present study support the concept that structural OCT biomarkers are closely associated with functional visual outcomes in neovascular AMD. Among the evaluated biomarkers, ellipsoid zone disruption, external limiting membrane disruption, intraretinal fluid, subretinal hyperreflective material, and increased central retinal thickness demonstrated the strongest relationship with visual impairment, whereas subretinal fluid alone was not significantly associated with BCVA. These observations are consistent with the available observational evidence reported by Keane et al.[11] Lai et al.[12] Nanji et al.[13] Riazi-Esfahani et al.[14] Ristau et al.[15] Rezende et al.[16] and Olivieri et al.[17] reinforcing the clinical value of comprehensive OCT biomarker assessment for prognostication and individualized management of patients with neovascular age-related macular degeneration.

CONCLUSION

The present study demonstrated a significant correlation between best-corrected visual acuity (BCVA) and several OCT biomarkers in patients with neovascular age-related macular degeneration. Among the evaluated biomarkers, ellipsoid zone disruption, external limiting membrane disruption, intraretinal fluid, subretinal hyperreflective material, and increased central retinal thickness showed significant associations with poorer visual acuity, while subretinal fluid alone did not demonstrate a significant correlation. Multiple regression analysis identified ellipsoid zone disruption as the strongest independent predictor of visual impairment. These findings highlight the importance of comprehensive OCT assessment in evaluating retinal structural changes and predicting functional visual outcomes in neovascular AMD. The integration of OCT biomarkers with routine clinical assessment may facilitate early identification of high-risk patients, improve prognostic accuracy, and support individualized treatment planning. Larger prospective longitudinal studies are warranted to further validate these biomarkers and optimize personalized management strategies for patients with neovascular age-related macular degeneration.

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