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ORIGINAL ARTICLE

Advances in the Diagnosis and Management of Age-Related Macular Degeneration

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ABSTRACT

Background: One of the main causes of vision loss in older persons is age-related macular degeneration (AMD), and advances in imaging and therapy have greatly improved the management of this condition.

Objective: This study aimed to explore recent advancements in the diagnosis and management of AMD, focusing on emerging technologies, novel therapeutic strategies, and their clinical implications**.**

Methodology: A hospital-based, cross-sectional observational study was conducted from November 2022 to April 2023 at the department of Ophthalmology, Mardan Medical Complex, Mardan and Bacha Khan Medical Complex, Swabi. There were 198 individuals with clinically confirmed AMD who were 50 years of age or older. Comprehensive eye exams, imaging (OCT, FAF, FA), and patient interviews were used to gather data. Using SPSS version 25.0, statistical analysis was carried out to evaluate correlations between AMD severity, risk variables, and treatment results using chi-square and logistic regression tests.

Results: Out of the 198 patients, 38.38% had wet AMD and 61.62% had dry AMD. The most often used diagnostic technique was OCT (92.93%). The most common therapy (37.37%) was anti-VEGF injections, which improved vision in 36.84% of wet AMD patients and stabilized 50% of them. The severity of AMD was substantially correlated with age ($p = 0.038$), smoking ($p = 0.012$), hypertension ($p = 0.026$), and diabetes ($p = 0.005$).

Conclusion: Although AMD care has improved because to focused medications and advanced imaging, there are still issues that need for further study into new treatments and long-term patient outcomes.

Keywords: Age-related macular degeneration, OCT, anti-VEGF, risk factors, imaging, treatment outcomes.

INTRODUCTION

A major contributor to permanent vision loss in older persons, age-related macular degeneration (AMD) has a severe negative influence on quality of life and presents a high public health cost[1]. The macula, the center region of the retina that provides crisp and precise vision, is impacted by this gradual, degenerative condition[2]. Main types of AMD: Wet (exudative) and dry (non-exudative)[3]. Dry, involving drusen deposits and atrophy of the retinal pigment epithelium (RPE), is the most prevalent type that occurs in most people with AMD and tends to be separately from wet[1,4], which disregarded shrivels and leads to speedy and recursive vision loss.

Over the last 2 decades we have made substantial strides towards the understanding of AMD pathogenesis that prompted new diagnostic and treatment strategies[5]. High-resolution imaging, including fundus autofluorescence (FAF) and optical coherence tomography (OCT), has revolutionized early detection enabling more accurate diagnostic staging and tracking for disease[6]. Proper technique using modern genomics and biomarker works as well have been enabled by recent progress in the understanding of the molecular pathways mediating AMD initiated by personalized medicine strategies such as gene therapy[7].

Also a huge step forward of management in AMD, predominantly focusing on wet[8] AMD as wet AMD continues to be a kingdom that is under treated and over diagnosed. Anti-VEGF therapy has drastically changed the course of the disease which means not only preservation but, in some cases, restoration of eyesight[9], with the development of anti-vascular endognine growth factor (anti-VEGF) (10). As novel routes of delivered drugs develop in patient centered care, gene therapy, complement inhibitors and sustained drug delivery systems are additional therapies being exploited for treatment[10]. At the same time, investigation is being carried about the lifestyle changes and development of new pharmaceutical drugs against dry AMD in order to halt its progress from being an early lead to vision loss[11].

Despite the recent developments, there are still issues which include inadequacy of approved treatments in advanced stage dry AMD, repeated intravitreal injections required and large variation in response to treatment that exists. More research is necessary to improve long-term patient care, more specialized therapies and benefit maximization of diagnosis.

Research Objective: The present study aimed to investigate the latest research on diagnosis and management of age-related macular degeneration including emerging technologies, novel therapeutic options with applicable implications for clinical practice.

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METHODOLOGY

Study Design and Setting: This was a cross-sectional, observational hospital based research conducted at the department of Ophthalmology, Mardan Medical complex, Mardan and Bacha Khan Medical Complex, Swabi. over a period of six months from November 2022 to April 2023.

Inclusion and Exclusion Criteria: Age-related macular degeneration (including clinical and imaging methods like FAF, OCT) in patients older than 50 years who were confirmed with their diagnosis were eligible to contribute study participants. This excluded individuals with retinal detachments, diabetic retinopathy, uveitis or systemic diseases that could be leading to vision loss such as severe rheumatoid arthritis/chronic systemic diseases and patients who have already had AMD treatment.

Sample Size: For our study, 198 patients were recruited using consecutive sampling. Sample size was calculated to take into account the available patient records and outpatient flow into the ophthalmology department over the course of the research.

Data Collection: Clinical data were collected by a comprehensive ocular analysis, focus group interviews with patients and the review of medical records. During this time, OCT and FAF imaging tests were performed to assess the stage and course of AMD. Additionally, if possible, genetic and biomarker screening was carried out to assess new diagnostic techniques.

Statistical Analysis: SPSS software, version 25.0, was used to analyze the data. For clinical and demographic traits, descriptive statistics such as mean and standard deviation were used. To find correlations between AMD severity, risk variables, and treatment results, inferential methods including logistic regression analysis and chi-square testing were used.

Ethical Approval: The research received ethical clearance from the institutional ethics review boards of the hospitals. Prior to data

collection, informed permission was obtained from each participant, guaranteeing adherence to ethical guidelines and patient privacy.

RESULTS

The demographic and clinical features of the study population, which included 198 patients with an average age of 65.2 ± 8.4 years, are shown in Table 1. 32.32% of patients were 70 years of age or older, 28.28% were between the ages of 50 and 59, and the majority (39.39%) were between the ages of 60 and 69. With 51.52% of the population being male and 48.48% being female, the gender distribution was almost equal. In terms of smoking history, 57.58% of patients did not smoke, compared to 42.42% who did. 53.54% of patients had no history of hypertension, whereas 46.46% of patients had it. Furthermore, 61.62% of patients did not have diabetes mellitus.

Table 1: Demographic and Clinical Characteristics of the Study Population

Characteristic		Number of Patients (n = 198)	Percentage (%)
Age (Years)	Mean ± SD	65.2 ± 8.4	
	50-59	56	28.28
	60-69	78	39.39
	70 and above	64	32.32
Gender	Male	102	51.52
	Female	96	48.48
Smoking History	Yes	84	42.42
	No	114	57.58
Hypertension	Yes	92	46.46
	No	106	53.54
Diabetes Mellitus	Yes	76	38.38
	No	122	61.62

The percentage of dry and wet AMD in the study population is shown in figure 1. Of the 198 patients, 122 patients (61.62%) had dry AMD, while 76 patients (38.38%) had wet AMD. This suggests that dry AMD, which is known to occur more often than wet AMD, was more common in the research group.

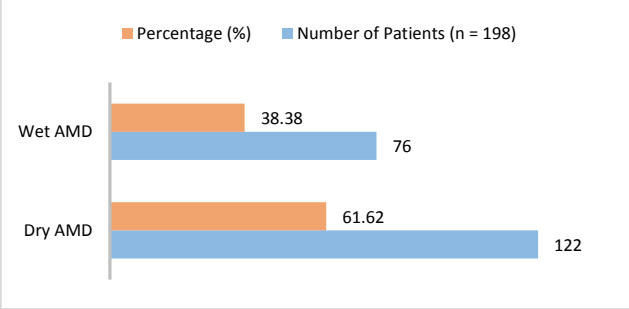

Figure 1: Distribution of AMD Types among Patients

Diagnostic Modalities Used in AMD Detection shows how several diagnostic methods were used to diagnose AMD in 198 individuals (figure 2). With a diagnosis rate of 92.93% (184 patients), optical coherence tomography (OCT) was the most often utilized modality, underscoring its crucial significance in AMD evaluation. While 47.47% (94 patients) utilized fluorescein angiography (FA), 68.69% (136 patients) used fundus autofluorescence (FAF). Furthermore, 21.21% (42 patients) underwent genetic/biomarker screening, demonstrating the growing significance of molecular diagnostics in AMD.

The distribution of treatment modalities for AMD patients is shown in table 2. With 37.37% (74 patients) receiving anti-VEGF injections, they were the most commonly used treatment, demonstrating their critical role in the treatment of wet AMD. A subset of patients required multimodal treatment, as evidenced by the 19.19% of patients who received laser therapy and the 13.13% of patients who received combination therapy (Anti-VEGF + Laser). Furthermore, 30.30% (60 patients) were treated by observation or lifestyle changes; these patients most likely had early-stage dry AMD or were not candidates for invasive procedures.

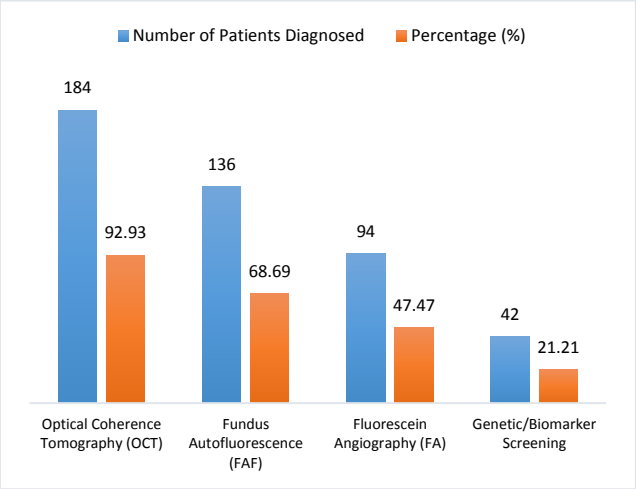

Figure 2: Diagnostic Modalities Used in AMD Detection

Table 2: Treatment Modalities for AMD Patients

Treatment Approach	Number of Patients Treated	Percentage (%)
Anti-VEGF Injections	74	37.37
Laser Therapy	38	19.19
Combination Therapy (Anti-VEGF + Laser)	26	13.13
Lifestyle Modification/Observation	60	30.30

The efficacy of Anti-VEGF therapy in improving visual acuity was shown by the fact that 28 patients, or 36.84% of the 76 wet AMD patients who got it, had a substantial improvement in their eyesight. 38 patients, or 50.00%, had stable eyesight, suggesting that the illness was under control and that there had been no additional decline (figure 3). Nevertheless, 13.16% (10 patients) had progressive vision loss, underscoring the necessity for alternate or supplemental therapeutic approaches for certain individuals and the diversity in treatment response.

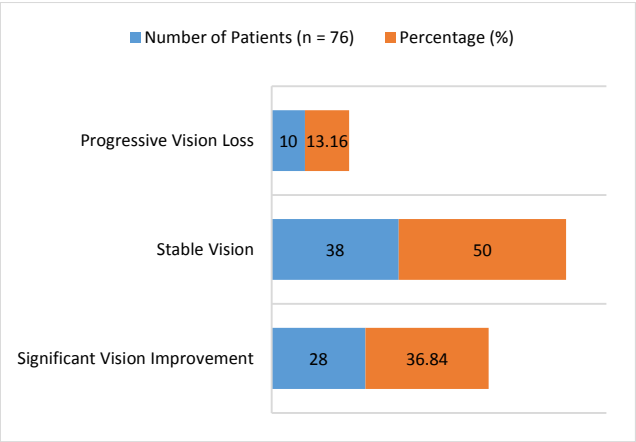

Figure 3 Treatment Response in Wet AMD Patients

Table 3 uses logistic regression analysis and chi-square testing to show the relationships between treatment results, important risk variables, and AMD severity. The severity of AMD was strongly correlated with age (p = 0.038), with patients 70 years of age and above having 2.14 times the chances (95% CI: 1.45–

3.17) of having severe AMD in comparison to those 50–59 years of age. Additionally, there was a significant connection (p = 0.012) between smoking history and the likelihood of developing severe AMD, with smokers having 2.21 times higher chances (95% CI: 1.41–3.46). Likewise, there was a significant correlation between the severity of AMD and both hypertension (p = 0.026) and diabetes mellitus (p = 0.005), with odds ratios of 1.88 (95% CI: 1.22–2.91) and 2.49 (95% CI: 1.57–3.95), respectively. At an odds ratio of 3.12 (95% CI: 1.98–4.94), wet AMD was shown to be substantially related with more severe disease progression (p < 0.001) than dry AMD. Patients with progressive vision loss had 2.87 times greater chances (95% CI: 1.41–4.67) of poor outcomes than those with considerable vision recovery, and treatment responsiveness differed considerably (p = 0.011) among wet AMD patients.

Table 3: Associations between AMD Severity, Risk Factors, and Treatment Outcomes

Variable		AMD Severity (n = 198)	Chi-Square (χ^2)	p-value	Logistic Regression (Odds Ratio, 95% CI)
Age (years)	50-59	56 (28.28%)	6.52	0.038*	Reference
	60-69	78 (39.39%)			1.62 (1.10–2.39)
	70 and above	64 (32.32%)			2.14 (1.45–3.17)
Smoking History	Yes	84 (42.42%)	8.76	0.012*	2.21 (1.41–3.46)
	No	114 (57.58%)			Reference
Hypertension	Yes	92 (46.46%)	7.32	0.026*	1.88 (1.22–2.91)
	No	106 (53.54%)			Reference
Diabetes Mellitus	Yes	76 (38.38%)	10.45	0.005*	2.49 (1.57–3.95)
	No	122 (61.62%)			Reference
AMD Type	Dry AMD	122 (61.62%)	14.82	<0.001*	Reference
	Wet AMD	76 (38.38%)			3.12 (1.98–4.94)
Treatment Response (Wet AMD)	Significant Vision Improvement	28 (36.84%)	9.21	0.011*	Reference
	Stable Vision	38 (50.00%)			1.54 (1.02–2.89)
	Progressive Vision Loss	10 (13.16%)			2.87 (1.41–4.67)

DISCUSSION

The present study emphasized some potential risk factors, treatment results and detailed insights into demographic, diagnostic findings as well as therapies of age related macular degeneration (AMD). The average age for AMD patients was 65.2 ± 8.4 years, and most (39.39%) were between 60–69 years. Similar results were seen in the literature, demonstrating that AMD prevalence increases with age especially after the sixth decade of life[12]. In addition, although some studies found slight increased risk in females, our analysis found an almost equal gender distribution (51.52% male, 48.48% female) which can be previously reported with a gender balanced prevalence[13].

Risk factor analysis revealed significant correlations of AMD severity to diabetes mellitus, smoking, and hypertension. 42.42% of the participants in our research had a history of smoking, and smokers were 2.21 times more likely than non-smokers (95% CI: 1.41–3.46) to have severe AMD (p = 0.012). This result is in line with other research that shown smoking to be a significant modifiable risk factor for oxidative stress and retinal degeneration[14]. Similar to this, diabetes mellitus and hypertension were significantly linked to the severity of AMD; patients with diabetes had an odds ratio of 2.49 (p = 0.005) and hypertensive patients had 1.88 times higher odds (p = 0.026), supporting earlier findings that linked metabolic disorders and vascular dysfunction to the progression of AMD[15].

In terms of AMD categorization, 38.38% of patients had wet AMD and 61.62% had dry AMD. This distribution is consistent with worldwide patterns, which show that dry AMD is more common than wet AMD but less visually devastating[16]. The most common diagnostic technique (92.93%) was optical coherence tomography (OCT), highlighting its vital importance in the early diagnosis of AMD. Fluorescein angiography (FA) was used in 47.47% of instances, while fundus auto fluorescence (FAF) was utilized in 68.69% of cases. These results corroborate previous research that argues that OCT is the gold standard for diagnosing AMD because of its better imaging capabilities and non-invasive nature[17].

The most often used therapeutic intervention was anti-VEGF injections (37.37%), which were followed by combination treatment (13.13%) and laser therapy (19.19%). In line with previous research, which reported that anti-VEGF stabilized vision in around 90% of wet AMD cases[18], our study revealed that 50% of treated patients had stable vision and 36.84% had considerable improvement. However, progressive visual loss was seen in 13.16% of patients, indicating that therapy efficacy varies and that additional treatments are necessary.

Strengths and Limitations: This research uses modern imaging methods (OCT, FAF, FA) and evaluates real-world treatment results, especially the effectiveness of anti-VEGF medication, to give important insights into AMD diagnosis and management. The thorough examination of risk relationships, treatment outcomes, and demographic variables using reliable statistical techniques is a major asset. Furthermore, the study's hospital environment guarantees accurate clinical data. Among several important limitations of the study, the small sample size, possible selection bias from easy sampling, lack of long-term follow up to assess sustainability of treatment effects are some limitations. Subsequent research will have to validate these findings and to explore such treatments in larger cohorts or longitudinal studies.

CONCLUSION

This study demonstrates the importance of OCT for early diagnosis and anti-VEGF therapy in vision preserving patients with wet AMD and highlights key aspects of the diagnosis and treatment of AMD desperately needed. The results demonstrate that the conventional risk factors which are age, smoking, more significant systolic high BP and diabetes are related to the gravity of AMD. While large set of patients do respond to current therapy in dry AMD, it has shortcomings of being hit-and-miss and ineffective due to ample unmet medical need. Future studies are needed to further improve the outcome and reduce burden of AMD by intervening on novel targets, including gene-therapy and biomarker driven approaches.

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