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Evaluation of Diabetic Maculopathy Using Amsler's Grid, Colour Vision and Fluorescein Angiography

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HIGHLIGHTS

1. Amsler's Grid detects central vision distortions.
2. Colour vision tests identify retinal changes.
3. Fluorescein angiography highlights retinal blood flow.
4. Combined methods improve diabetic maculopathy diagnosis.
5. Early detection enhances treatment outcomes significantly.

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ABSTRACT

Introduction: Diabetic maculopathy, a complication of diabetes, is a leading cause of acquired blindness in diabetic patients. It is characterized by retinal thickening and fluid accumulation in the macula, leading to vision impairment. Early detection of macular changes is essential in preventing irreversible vision loss. Various diagnostic tools, including Amsler's grid, color vision testing, and fluorescein angiography (FFA), are used for detection. **Objective:** This study aims to evaluate the efficacy of non-invasive diagnostic tools, such as Amsler's grid and colour vision tests, in detecting diabetic maculopathy, and compare their diagnostic performance to FFA. **Methods:** This prospective study was conducted from October 2002 to September 2003 at M.S. Ramaiah Medical Teaching Hospital. It included 60 diabetic patients over the age of 40 attending routine diabetic eye check-ups. The study excluded patients with color vision deficiencies, corneal opacity, macular diseases, or post-laser-treated eyes. The evaluation included Amsler's grid, color vision tests, and FFA for detecting maculopathy. **Results:** The study revealed that 96.7% of the eyes exhibited abnormal color vision, with diffuse maculopathy being the predominant form, occurring in 97.3% of cases. Amsler's grid effectively identified macular abnormalities in 90.9% of focal maculopathy cases and 97.3% of diffuse maculopathy cases. These findings were further validated by FFA, which showed leakage in 58 eyes, representing 96.7% of the cases. **Conclusion:** Non-invasive tools such as Amsler's grid and color vision tests proved effective in detecting early macular changes in diabetic patients. While FFA remains the gold standard, these simple diagnostic tools provide a practical alternative for early detection in settings with limited resources, allowing for timely intervention.

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INTRODUCTION

Diabetes mellitus, one of the most common metabolic disorders, is rapidly increasing worldwide, posing significant public health challenges. As a chronic condition marked by high blood sugar levels, diabetes can cause various complications, with the eyes being particularly vulnerable [1]. Among these, diabetic retinopathy and diabetic maculopathy stand out as major causes of visual impairment. Diabetic macular edema (DME), a key feature of diabetic maculopathy, is the leading cause of acquired blindness in diabetic patients. Its prevalence is closely tied to the duration of diabetes, and it appears earlier in adult-onset diabetics, especially those on insulin therapy [2]. The risk of developing diabetic maculopathy is compounded by factors such as poor glycemic control and hypertension. Despite advancements in treatment, the irreversible nature of this condition makes early detection essential to preserve vision [3].

In India, the prevalence of diabetes is growing, contributing to a significant rise in diabetic eye diseases. Currently, cataract is the leading cause of curable blindness in the country, with successful treatment being a major focus of the National Blindness Eradication Programme [4]. However, with cataract-related blindness being increasingly managed, diabetic maculopathy is poised to become one of the leading causes of vision loss, particularly among the aging population. As diabetes becomes more prevalent, so does the risk of ocular complications like diabetic retinopathy and maculopathy [5]. This growing burden underscores the importance of effective screening and management programs for diabetic eye diseases. Over the years, public awareness of diabetes-related eye complications has risen significantly in India, largely due to the efforts of both government and non-governmental organizations [6]. Educational initiatives have highlighted the importance of regular eye examinations for diabetic patients, allowing more individuals to seek timely medical intervention. Diagnostic and treatment options that were previously available only in major cities are now accessible to patients in rural and semi-urban areas, improving care for diabetic eye complications across the country [7].

Diabetic maculopathy involves damage to the central retina, or macula, which is essential for clear, central vision. The macula is responsible for the sharp vision required for activities like reading, driving, and recognizing faces [8]. Diabetic maculopathy occurs primarily due to the accumulattion of fluid in the macula, leading to retinal thickening and the formation of hard exudattes. This condition can also manifest through macular ischemia, where a compromised blood supply causes tissue damage. Both forms of diabetic maculopathy can result in significant, often irreversible, vision loss if not identified and treated in the early stages [9]. In India, where the number of diabetic patients continues to rise, the burden of diabetic maculopathy is expected to increase in parallel. With cataract surgeries becoming more widespread and effective, diabetic maculopathy is likely to emerge as a major cause of vision loss in older adults [10].

Various diagnostic tools are critical in the early detection and evaluation of diabetic maculopathy, with Amsler's Grid, colour vision testing, and fluorescein angiography being the most commonly used methods. Amsler's Grid, a simple yet effective tool, allows patients to assess their macular function by identifying any distortions or missing areas in the grid, which may indicate the presence of macular pathology [11]. Though it is not a definitive diagnostic tool, it is a valuable screening method for early detection of macular abnormalities. Colour vision testing is another useful tool in evaluating diabetic maculopathy [12]. The macula contains a high concentration of cone cells responsible for colour perception, and any damage to the macula due to diabetic maculopathy can impair a patient's ability to distinguish between colours, particularly red and green hues. Colour vision tests help assess the functional health of the macula and can detect early signs of macular damage before vision loss becomes more apparent [13].

Fluorescein angiography, however, remains the gold standard in diagnosing diabetic retinopathy and maculopathy. This technique involves injecting a fluorescein dye into the bloodstream, followed by the capture of detailed images of the retina [14]. These images reveal key information about the condition of the retinal blood vessels, allowing ophthalmologists to detect areas of leakage, ischemia, or other abnormalities [15]. Fluorescein angiography provides a clear understanding of the extent of retinal damage and helps guide treatment decisions, such as determining whether laser therapy or intravitreal injections are necessary. This diagnostic tool is invaluable in assessing the severity of diabetic maculopathy and planning the appropriate course of action to prevent further vision loss [16].

Early detection and management of diabetic maculopathy are crucial in preventing permanent vision impairment. With the increasing incidence of diabetes worldwide, and particularly in India, the burden of diabetic eye diseases is expected to grow [17]. This highlights the urgent need for regular screen-

-ing programs and access to advanced diagnostic techniques like fluorescein angiography. By identifying macular changes at an early stage, before significant vision loss occurs, these diagnostic methods can play a pivotal role in reducing the impact of diabetic maculopathy on patients' lives [18]. Diabetic maculopathy is becoming a significant cause of visual impairment, especially in countries like India where diabetes is on the rise. As cataract-related blindness becomes more manageable, diabetic maculopathy is emerging as a leading cause of vision loss in older adults [19]. Diagnostic tools like Amsler's Grid, colour vision tests, and fluorescein angiography are essential for the early detection of this condition, helping to identify macular damage before it leads to irreversible blindness. By improving awareness and access to treatment, the burden of diabetic maculopathy can be reduced, ensuring that patients receive timely interventions to preserve their vision [20].

The aim of this study is to evaluate the early detection of macular changes in diabetic patients and assess the role of non-invasive diagnostic tools like colour vision testing and Amsler's grid in diagnoosing diabetic maculopathy. The study seeks to determine whether these methods can serve as simple, effective alternatives to fluorescein angiography (FFA) and fundus examination for detecting diabetic maculopathy. By comparing the efficacy of colour vision testing and Amsler's grid with traditional diagnostic methods, the study aims to explore whether these tools can be reliably used for early diagnosis and monitoring of retinal dysfunction in diabetic patients.

MATERIALS AND METHODS

This prospective study was conducted from October 2002 to September 2003 at the M.S. Ramaiah Medical Teaching Hospital. It included 60 diabetic patients aged over 40 years, attending routine diabetic eye checks or referred from departments of medicine, endocrinology, and nephrology. Exclusion criteria included patients with color vision deficiency, glaucoma, corneal or lenticular opacity greater than grade-II according to the LOCS III classification, macular diseases like ARMD, SCARS, SRNVM, trauma, and those with post-laser treated eyes for diabetic retinopathy. This study aimed to identify early macular changes using non-invasive diagnostic tools while ensuring a diverse and relevant sample group.

RESULTS

Table 1: Age and Sex Distribution of the Study Population

Age in years	Sex		Total
	Female (%)	Male (%)	
<=50	2 (18.2)	2 (10.5)	4 (13.3)
51-55	2 (18.2)	2 (10.5)	4 (13.3)
56-60	3 (27.3)	2 (10.5)	5 (16.7)
61-65	1 (9.1)	6 (31.6)	7 (23.3)
>65	3 (27.3)	7 (36.8)	10 (33.3)
Total	11 (100.0)	19(100.0)	30

The table presents the distribution of 30 individuals by age and sex. It reveals that both sexes are almost equally represented in the ≤50 and 51-55 age groups, each contributing to 13.3% of the total. The 56-60 age group has a higher female proportion (27.3%) compared to males (10.5%), making up 16.7% overall. In contrast, males predominate in the 61-65 and >65 age groups, contributing significantly more than females, with these groups together comprising over half (56.6%) of the study population.

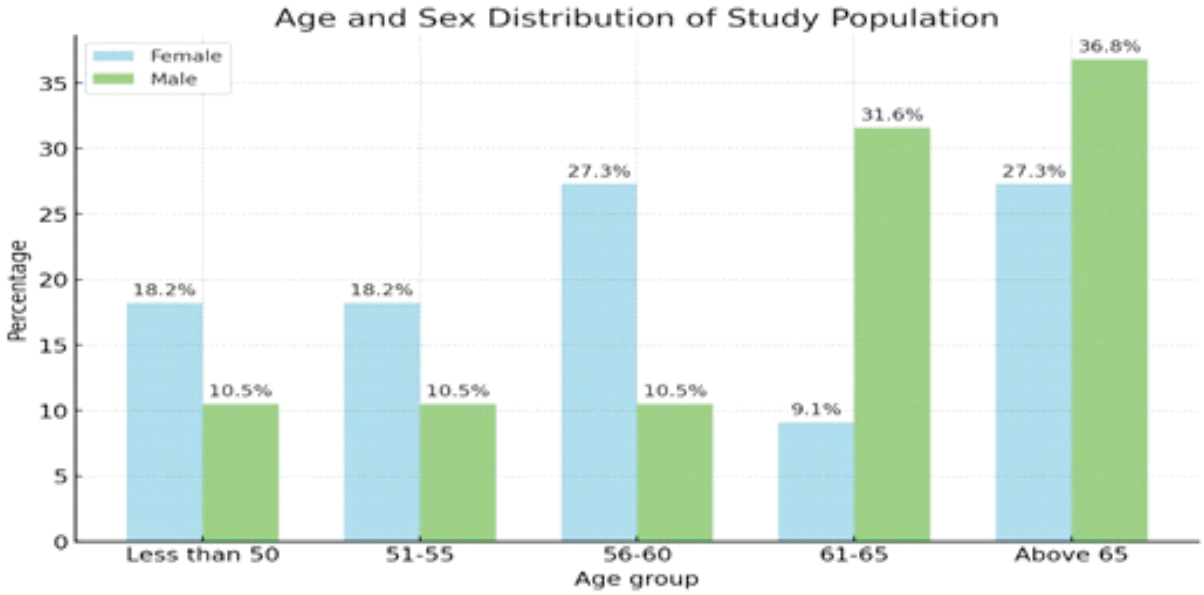

Figure 1: Age and Sex Distribution of the Study Population

Table 2: Sex Distribution of the Study Population

Sex	No. of Patients	Percentage
Female	11	36.7
Male	19	63.3

Majority of the study population were males 19(63.3%). The ratio of female to male is 1:1.7. This could be due to small sample size and also due to the fact that female attendance to OPD to seek medical attention is less.

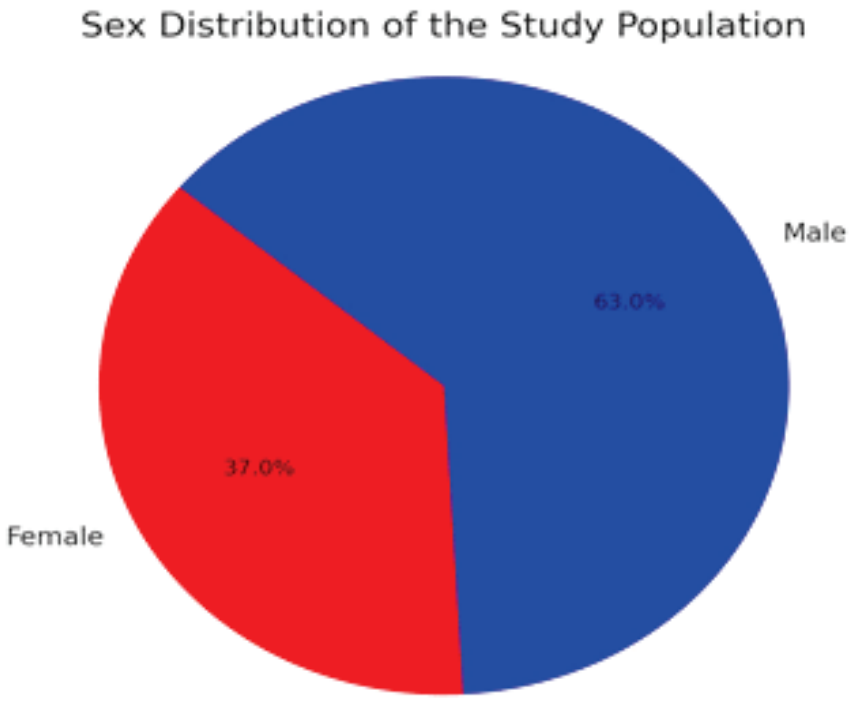

Figure 2: Sex Distribution of the Study Population

Table 3: Distribution of Diabetic Retinopathy Among Study Population

Type of Retinopathy	Left Eye No. of Patients	Left Eye %	Right Eye No. of Patients	Right Eye %	No. of Eyes	%
Early NPDR	2	6.7	5	16.7	7	11.7
Moderate NPDR	7	23.3	8	26.7	15	25.0
Severe NPDR	4	13.3	1	3.3	5	8.3
Early PDR	11	36.7	11	36.7	22	36.7
Severe PDR	6	20.0	5	16.7	11	18.3
Total	**30**	**100.0**	**30**	**100**	**60**	**100**

Patients were grouped based on the type of diabetic retinopathy they exhibited, as detailed in Table 4. Out of the 60 eyes evaluated, 22 (36.7%) displayed early proliferative diabetic retinopathy, while 11 (18.3%) showed severe proliferative diabetic retinopathy. Additionally, 7 (11.7%) of the eyes had early non proliferative diabetic retinopathy, 15 (25.0%) had moderate non proliferative diabetic retinopathy, and 5 (8.3%) suffered from severe non proliferative diabetic retinopathy.

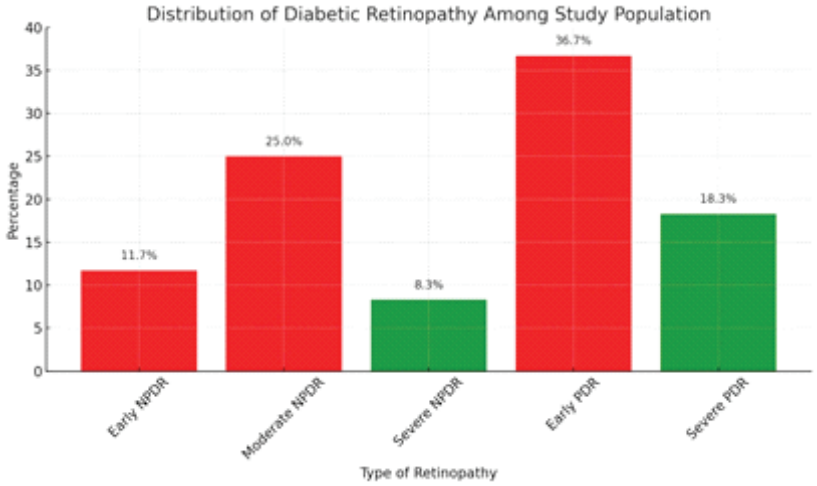

Figure 3: Distribution of Diabetic Retinopathy Among Study Population

Table 4: Diabetic Maculopathy and Colour Vision Among Study Population

Type of Diabetic Maculopathy	Total Eyes (Normal)	Total Eyes (Abnormal)	Total
Focal	1 (9.1%)	19 (90.9%)	20 (100.0%)
Diffuse	1 (2.7%)	36 (97.3%)	37 (100.0%)
Ischaemic	0	3 (100.0%)	3 (100.0%)
Total	2 (3.3%)	58 (96.7%)	60 (100.0%)

The table shows that colour vision tests identified abnormalities in 58 (96.7%) of the eyes examined. Specifically, 36 (97.3%) of these abnormal cases were associated with diffuse maculopathy, 19 (90.9%) with focal maculopathy, and all 3 cases of ischaemic maculopathy exhibited abnormalities. Additionally, no cystoid changes were detected in this study.

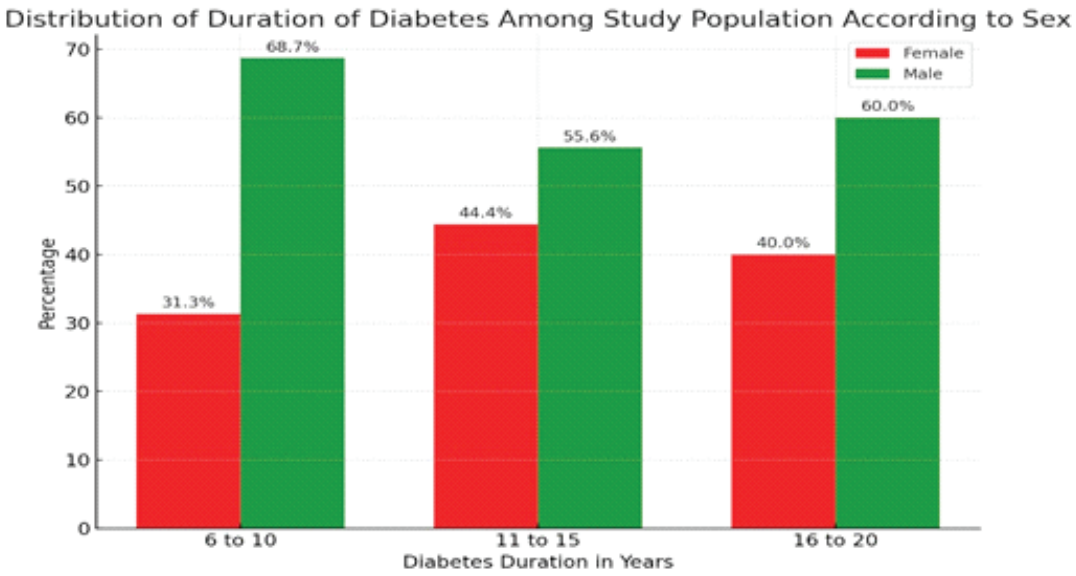

Figure 4: Distribution of Duration of Diabetes Among Study Population According to Sex

Table 5: Distribution of Duration of Diabetes Among Study Population According to Sex

Duration of Diabetes in years	Female (%)	Male (%)	Total (%)
6-10	5 (31.3)	11 (68.7)	16 (100.0)
11-15	4 (44.4)	5 (55.6)	9 (100.0)
16-20	2 (40.0)	3 (60.0)	5 (100.0)
Total	11 (36.7)	19 (63.3)	30 (100.0)

In this table, the duration of diabetes among participants varied significantly. of the study group, 53.3% had diabetes for 6-10 years, 30.0% for 11-15 years, and 16.7% for 16-20 years. The data indicates that diabetic maculopathy is more prevalent in individuals with a diabetes history exceeding 6-10 years.

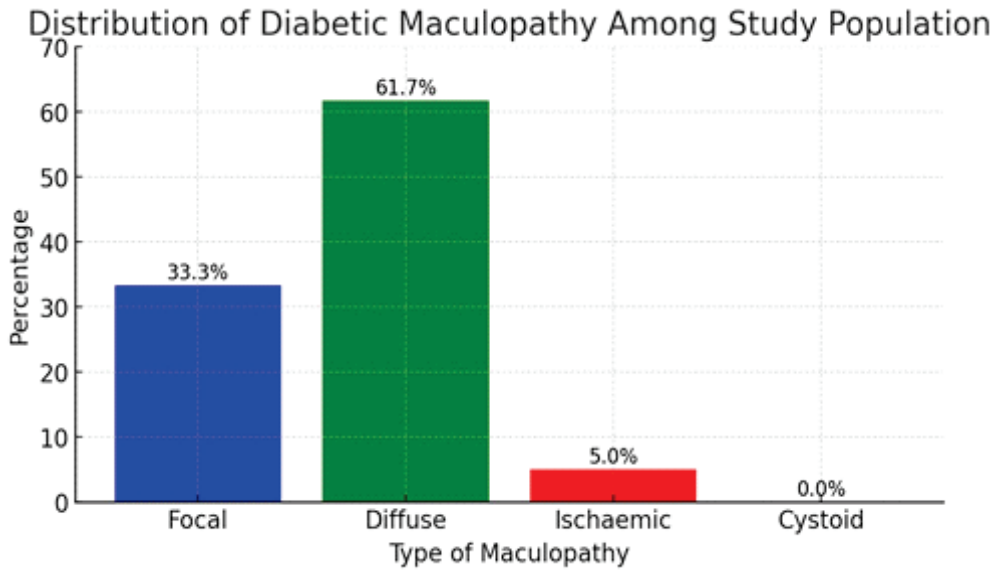

Figure 5: Distribution of Diabetic Maculopathy Among Study Population

Table 6: Distribution of Diabetic Maculopathy Among Study Population

Type of Maculopathy	Left Eye (No. of Patients)	Left Eye (%)	Right Eye (No. of Patients)	Right Eye (%)	Total No. of Eyes	Total (%)
Focal	11	36.7	9	30.0	20	33.3
Diffuse	17	56.7	20	66.7	37	61.7
Ischaemic	2	6.7	1	3.3	3	5.0
Cystoid	0	0.0	0	0.0	0	0.0
Total	**30**	**100**	**30**	**100**	**60**	**100**

In this study of 60 eyes, Diffuse Maculopathy was the most prevalent, affecting 61.7% of the subjects. Focal Maculopathy followed at 33.3%, and Ischaemic varieties were least common at 5.0%. There were no instances of Cystoid changes observed.

Table 7: Type of Diabetic Maculopathy and Amsler's Grid Among Study Population

Diabetic Maculopathy	Total Eyes		Total
	Normal	Abnormal	
Focal	6 (30.0%)	14 (70.0%)	20 (100.0%)
Diffuse	11 (29.8%)	26 (70.2%)	37 (100.0%)
Ischaemic	1 (33.3%)	2 (66.7%)	3 (100.0%)
Total	**18 (30.0%)**	**42 (70.0%)**	**60 (100.0%)**

Amsler's Grid detected abnormalities in 42 eyes (70.0%), with 26 eyes (70.2%) from diffuse maculopathy cases, 14 eyes (70.0%) from focal maculopathy cases, and 2 eyes (66.7%) from ischemic maculopathy cases, while no cystoid changes were observed in the study.

Table 8: Detection of Diabetic Maculopathy Cases Using Colour Vision and Amsler's Grid Test Diagnosed by Fluorescein Angiography

Examination	Examination No. of Eyes	Abnormal	Fluorescein Angiography
Colour Vision	60	58	96.7%
Amsler's Grid	60	42	70.0%

The Colour Vision test showed abnormalities in 58 eyes (96.7%), all diagnosed with Diabetic Maculopathy via Fluorescein Angiography. Similarly, the Amsler's Grid test was abnormal in 42 eyes (70.0%) with Diabetic Maculopathy, also confirmed by Fluorescein Angiography.

DISCUSSION

Diabetes mellitus is a growing global health challenge, particularly in India, where it contributes significantly to diabetic eye diseases like diabetic maculopathy, a leading cause of visual impairment. As cataract-related blindness declines, diabetic maculopathy, especially diabetic macular edema (DME), is becoming a major cause of vision loss, particularly in older adults. Early detection through tools like Amsler's Grid, color vision tests, and fluorescein angiography is crucial to prevent irreve--rsible damage. Improved awareness, screening, and treatment accessibility are essential in managing diabetic eye complications and reducing the impact of diabetic maculopathy on patients' vision [21].

Our findings, showing a male majority (63.3%) and a female-to-male ratio of 1:1.7, align with the significant observations of Wolfe KA et al. (1991) and Agrawal AA et al. (2021). Wolfe's study also observed a male predominance in the sample, attributing it to health-seeking behaviors and demographic patterns, which mirrors our findings. Agrawal's study further emphasized the male dominance in their population, suggesting cultural and social factors influencing female participation in healthcare. Both authors highlight the significance of gender disparities in healthcare settings, corroborating our study's demographic results and the potential impact of smal-

-ler sample sizes [22, 23].

Our findings, showing a male majority (63.3%) and a female-to-male ratio of 1:1.7, align with the observations of Wolfe KA et al. (1991) and Agrawal AA et al. (2021). Wolfe's study noted a predominance of males, potentially linked to healthcare-seeking behaviors and cultural factors influencing female attendance at medical consultations, which mirrors our findings. Similarly, Agrawal's study reported a higher male ratio, attributing this to socio-economic factors and traditional roles affecting women's healthcare access. Both authors emphasize the significance of gender disparities in medical studies, corroborating our results and supporting the influence of demographic and healthcare-seeking patterns [22,23].

Our findings, showing that 36.7% of eyes exhibited early proliferative diabetic retinopathy and 18.3% showed severe proliferative diabetic retinopathy, align with the studies of Wolfe KA et al. (1991) and Agrawal AA et al. (2021). Wolfe's study found notable cases of proliferative retinopathy and background retinopathy, highlighting the prevalence of advanced stages of the disease. Agrawal's study also noted a significant distribution of moderate and severe diabetic retinopathy, though with fewer cases of proliferative retinopathy. Both studies underscore the varied stages of diabetic retinopathy, corroborating our findings of retinopathy progression within the patient population [22,23].

Our findings, showing that 96.7% of eyes had color vision abnormalities, with 97.3% associated with diffuse maculopathy and all ischemic maculopathy cases exhibiting abnormalities, align with the observations of Wolfe KA et al. (1991) and Agrawal AA et al. (2021). Wolfe's study noted significant visual impairments in patients with diabetic maculopathy, particularly in cases with diffuse and ischemic types, which mirrors our results. Similarly, Agrawal's study highlighted the prevalence of color vision abnormalities in eyes affected by various stages of maculopathy, emphasizing the link between these abnormalities and disease severity. Both studies reinforce the strong correlation between maculopathy and color vision deficits [22,23].

Our study shows a significant correlation between the duration of diabetes and the prevalence of diabetic maculopathy, with 53.3% of participants having diabetes for 6-10 years, 30.0% for 11-15 years, and 16.7% for 16-20 years. This aligns with the findings of Barros Garcia JM et al. (2017) and Agrawal AA et al. (2021), who also observed a higher prevalence of diabetic maculopathy in patients with a longer history of diabetes, particularly beyond 6-10 Both studies emphasize that prolonged diabetes increases the risk of maculopathy, supporting our conclusion that the duration of diabetes plays a crucial role in its development [23,24].

Our study of 60 eyes found Diffuse Maculopathy in 61.7% of cases, Focal Maculopathy in 33.3%, and Ischaemic Maculopathy in 5.0%, with no instances of Cystoid changes. These findings align with Agrawal AA et al. (2021) and Barros Garcia JM et al. (2017), who also reported a higher prevalence of Diffuse Maculopathy compared to other forms. Both studies highlight the predominance of Diffuse Maculopathy in diabetic patients, supporting our results [23,24].

Our findings, showing 70% abnormalities detected by Amsler's Grid across various maculopathies, align with Wolfe KA et al. (1991), who reported similar detection rates for diffuse and focal maculopathy, emphasizing the grid's utility in early macular pathology identification. Similarly, de Barros Garcia JM et al. (2017) found comparable results in detecting retinal abnormalities, particularly in diffuse and focal maculopathy cases. Both studies, like ours, underscore the Amsler Grid's effectiveness in identifying subtle visual distortions without detecting cystoid changes [22,24].

CONCLUSION

Diabetic maculopathy is characterized by thickening of the macula due to breakdown of the inner blood-retinal barrier, leading to fluid leakage into the retina. It is a primary cause of vision loss in diabetic patients. While photocoagulation can reduce vision impairment risks, early detection of macular edema is crucial for preventing functional loss. Fluorescein angiography, used for detection, has risks such as allergic reactions and is not always available, necessitating the development of non-invasive diagnostic methods for retinal dysfunction evaluation. The study found a prevalence rate of 66.6% in patients over 61, with a male predominance (63.3%).

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