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Investigating the Association Between Serum Lipid Profiles and Age-Related Macular Degeneration: A Cross-Sectional Study

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Abstract
Age-Related Macular Degeneration (AMD) is a leading cause of vision loss among older adults. The role of serum lipid profiles in the pathogenesis of AMD has been of increasing interest. This study aimed to investigate the association between serum lipid profiles and the presence of AMD in a cross-sectional cohort. A total of 100 participants, consisting of 60 AMD patients and 40 age-matched controls, were enrolled. The study assessed serum levels of total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C) and triglycerides (TG). Logistic regression analysis was performed to evaluate the association between these lipid parameters and the risk of AMD. The AMD group exhibited significantly higher levels of TC (220.3±35.7 mg/dL) and LDL-C (140.2±25.6 mg/dL) compared to the control group (195.6± 28.9 mg/dL for TC and 120.1±20.4 mg/dL for LDL-C), with p-values < 0.01. HDL-C levels were significantly lower in the AMD group (44.8±10.2 mg/dL) than in controls (52.1±11.3 mg/dL, $p < 0.05$). No significant difference in TG levels was observed between groups ($p>0.05$). Logistic regression revealed an increased risk of AMD with higher TC and LDL-C levels, while lower HDL-C levels were associated with reduced AMD risk. The study highlights a significant association between elevated serum lipid levels and AMD, suggesting that lipid management could be pivotal in AMD prevention and treatment.

INTRODUCTION

Age-Related Macular Degeneration (AMD) is a prevalent ocular condition that primarily affects the elderly population and is a leading cause of vision impairment and blindness worldwide[1,2]. AMD is characterized by progressive damage to the macula, the central portion of the retina, leading to central vision loss. The pathogenesis of AMD is multifactorial, involving genetic, environmental and lifestyle factors[3,4]. Among these, serum lipid profiles have emerged as potential contributors to AMD development and progression.

Recent studies have suggested that abnormal lipid metabolism may play a crucial role in the pathogenesis of AMD[5]. Lipids are essential components of cellular membranes and are involved in various metabolic processes, including inflammation and oxidative stress, which are known to contribute to AMD[6]. Elevated levels of certain lipids, such as total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C), have been associated with an increased risk of AMD, while high-density lipoprotein cholesterol (HDL-C) is believed to have a protective effect[7]. However, the exact relationship between serum lipid levels and AMD remains unclear and findings across studies have been inconsistent.

This cross-sectional study aims to investigate the association between serum lipid profiles and the presence of AMD in a cohort of patients and age-matched controls. By analyzing the levels of TC, LDL-C, HDL-C and triglycerides (TG), we seek to elucidate the potential role of lipid metabolism in AMD and explore its implications for prevention and treatment strategies. Understanding the link between serum lipid profiles and AMD could offer insights into novel therapeutic approaches and risk factor management for this debilitating condition.

MATERIALS AND METHODS

Study Design: This cross-sectional study was conducted from May 2023-April 2024 at the Government Medical College, Suryapet, Telangana. The study aimed to investigate the association between serum lipid profiles and Age-Related Macular Degeneration (AMD).

Participants: A total of 100 participants were enrolled in the study, comprising 60 individuals diagnosed with AMD and 40 age-matched controls without AMD. Participants were recruited from the outpatient ophthalmology department. The inclusion criteria for the AMD group included individuals aged 55 years and above with a clinical diagnosis of AMD based on fundus examination and optical coherence tomography (OCT). The control group consisted of individuals without any signs of AMD or other significant ocular pathologies.

Data Collection: Data collection included demographic information, medical history and laboratory measurements. Blood samples were collected from all participants after an overnight fast. Serum levels of total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C) and triglycerides (TG) were measured using standard enzymatic methods.

Statistical Analysis: Data were analyzed using SPSS version 25.0. Continuous variables were expressed as mean ± standard deviation (SD). Comparisons between the AMD and control groups were performed using the independent t-test for normally distributed variables. Categorical variables were compared using the chi-square test. Logistic regression analysis was conducted to assess the association between serum lipid profiles and the risk of AMD. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. A p-value of <0.05 was considered statistically significant.

Ethical Considerations: The study protocol was approved by the Institutional Ethics Committee of Government Medical College, Suryapet. Informed consent was obtained from all participants prior to enrollment in the study, ensuring the confidentiality and anonymity of their data.

RESULTS AND DISCUSSION

Demographic Characteristics: The study cohort comprised 100 participants, with an equal distribution of males and females (50% each). The mean age of the participants was 68.5 years, with a standard deviation of 6.3 years. The AMD group had a slightly higher mean age of 69.2±6.1 years compared to the control group, which had a mean age of 67.1±6.5 years. The gender distribution was balanced in both groups, with 50% males and 50% females in each (Table 1).

Serum Lipid Profiles: Analysis of serum lipid profiles revealed significant differences between the AMD and control groups. The AMD group had significantly higher levels of total cholesterol (220.3±35.7 mg/dL) and LDL-C (140.2±25.6 mg/dL) compared to the control group (195.6±28.9 mg/dL for total cholesterol and 120.1±20.4 mg/dL for LDL-C), with p-values <0.01 for both comparisons. Conversely, HDL-C levels were significantly lower in the AMD group (44.8±10.2 mg/dL) than in the control group (52.1±11.3 mg/dL), with a p-value <0.05. No significant difference was observed in triglyceride levels between the two groups (150.7± 35.9 mg/dL in the AMD group and 145.8±30.5 mg/dL in the control group, $p>0.05$) (Table 2).

Association Between Serum Lipid Profiles and AMD Risk: Logistic regression analysis was conducted to

Table 1: Demographic Characteristics of Study Participants

Characteristic	AMD Group (n=60)	Control Group (n=40)	Total (n=100)
Mean Age (years)	69.2 ± 6.1	67.1 ± 6.5	68.5 ± 6.3
Gender			
Male	30 (50%)	20 (50%)	50 (50%)
Female	30 (50%)	20 (50%)	50 (50%)

Table 2: Serum Lipid Profiles of Study Participants

Lipid Profile	AMD Group (n=60)	Control Group (n=40)	p-value
Total Cholesterol (mg/dL)	220.3 ± 35.7	195.6±28.9	< 0.01
LDL-C (mg/dL)	140.2 ± 25.6	120.1 ± 20.4	< 0.01
HDL-C (mg/dL)	44.8 ± 10.2	52.1 ± 11.3	< 0.05
Triglycerides (mg/dL)	150.7 ± 35.9	145.8 ± 30.5	> 0.05

Table 3: Logistic Regression Analysis of Serum Lipid Profiles and AMD Risk

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Total Cholesterol (mg/dL)	2.35	1.30 - 4.26	< 0.01
LDL-C (mg/dL)	2.78	1.53 - 5.06	< 0.01
HDL-C (mg/dL)	0.62	0.39 - 0.99	< 0.05
Triglycerides (mg/dL)	1.05	0.92 - 1.20	> 0.05

assess the association between serum lipid profiles and the risk of AMD. The analysis revealed that elevated total cholesterol and LDL-C levels were significantly associated with an increased risk of AMD, with odds ratios (OR) of 2.35 (95% CI=1.30-4.26, p<0.01) and 2.78 (95% CI=1.53-5.06, p<0.01), respectively. Additionally, lower HDL-C levels were identified as a significant risk factor for AMD (OR=0.62, 95% CI=0.39-0.99, p<0.05). Triglyceride levels did not show a significant association with AMD risk (OR=1.05, 95% CI=0.92-1.20, p>0.05) (Table 3).

This study aimed to explore the association between serum lipid profiles and Age-Related Macular Degeneration (AMD) in a cohort of patients and controls. Our findings demonstrate a significant relationship between elevated serum lipid levels, particularly total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) and the presence of AMD. Conversely, lower levels of high-density lipoprotein cholesterol (HDL-C) were associated with an increased risk of AMD, while triglyceride (TG) levels did not show a significant difference between groups. The results align with previous studies suggesting that dyslipidemia may contribute to the pathogenesis of AMD. Elevated TC and LDL-C levels are known risk factors for cardiovascular diseases and their role in AMD could be attributed to similar mechanisms, including endothelial dysfunction, oxidative stress and inflammation Pennington[9]. LDL-C, in particular, can lead to the formation of lipid deposits in the retina, contributing to drusen formation, a hallmark of AMD Klein[13]. The protective role of HDL-C may be due to its anti-inflammatory and antioxidative properties, which help mitigate oxidative damage in the retinal tissues Landowski[11].

The lack of a significant association between TG levels and AMD risk in our study is consistent with some previous reports but contrasts with others that have suggested a potential link Madjedi[12]. This discrepancy may be due to differences in study populations, sample sizes, or variations in measurement methods. Further research is needed to clarify the role of triglycerides in AMD.

Our study has several strengths, including a well-defined study population and rigorous measurement of serum lipid profiles. However, it also has limitations. The cross-sectional design precludes establishing causality and the relatively small sample size may limit the generalizability of the findings. Additionally, other confounding factors, such as dietary habits, lifestyle and genetic predispositions, were not extensively controlled for and may influence the results[14].

The implications of these findings are clinically significant. They suggest that managing dyslipidemia could potentially play a role in AMD prevention and treatment. While statins and other lipid-lowering therapies are well-established in cardiovascular care, their application in ophthalmology, particularly for AMD, warrants further investigation Heesterbeek[14]. Longitudinal studies and randomized controlled trials are needed to establish the effectiveness of such interventions in AMD management Jingzhi[8].

CONCLUSION

Our study demonstrates a significant association between abnormal serum lipid profiles and Age-Related Macular Degeneration (AMD), with elevated total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) linked to increased AMD risk. Conversely, lower high-density lipoprotein cholesterol (HDL-C) levels were associated with a higher risk of AMD, while triglycerides (TG) showed no significant difference. These findings highlights the importance of lipid management in older adults for both cardiovascular health and AMD prevention.

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