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ASSOCIATION OF MCP-1 LEVELS WITH VISUAL ACUITY OUTCOMES IN DIFFERENT STAGES OF DIABETIC RETINOPATHY

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ABSTRACT

Objective: To evaluate the association between serum MCP-1 levels and visual acuity in different stages of diabetic retinopathy.

Methodology: This cross-sectional study was conducted at Physiology Department, BMSI, JPMC Karachi from April 2019 to October 2020. One hundred participants aged 40-65 years were divided into four groups: Group-A (n=25) diabetic patients 5-7 years duration without retinopathy; Group-B (n=25) diabetic patients 8-10 years duration with mild retinopathy; Group-C (n=25) diabetic patients 10-15 years duration with moderate retinopathy; Group-D (n=25) healthy controls. Visual acuity was assessed using Snellen chart. Serum MCP-1 levels were measured by ELISA. Pearson's correlation coefficient evaluated the relationship between MCP-1 and visual acuity.

Results: Mean age was 53.17±6.36 years. MCP-1 levels progressively increased from controls (18.6±4.7 ng/dl) to moderate DR (503.0±43.7 ng/dl). All Group-A patients maintained 6/6 vision despite elevated MCP-1 (125.6±14.2 ng/dl). Group-B showed variable visual impairment (6/9-6/60) with MCP-1 343.4±19.6 ng/dl. Group-C demonstrated severe visual compromise (6/18-FC) with highest MCP-1 levels. Strong negative correlation existed between MCP-1 and visual acuity ($r=-0.812$, $p<0.001$). MCP-1 cutoff >150 ng/dl predicted any visual impairment (sensitivity 92.3%, specificity 88.5%); >450 ng/dl predicted severe impairment (specificity 94.8%).

Conclusion: Elevated MCP-1 levels strongly correlate with visual acuity deterioration in diabetic retinopathy. MCP-1 elevation precedes clinical visual impairment, suggesting its utility as predictive marker for functional visual outcomes.

Key Words: Diabetic retinopathy, Visual acuity, MCP-1, Biomarker, Vision loss.

INTRODUCTION

Diabetic retinopathy (DR) remains the leading cause of preventable blindness among working-age adults globally, affecting approximately 93 million people worldwide.[1] While various clinical and biochemical markers have been proposed for DR diagnosis and monitoring, the relationship between inflammatory biomarkers and functional visual outcomes remains incompletely understood.[2]

Visual acuity, the most direct measure of visual function, is the primary concern for patients with DR. Current diagnostic methods including fundoscopy and optical coherence tomography (OCT) provide anatomical information but may not always correlate with functional vision.[3] This disconnect between structural changes and visual function creates challenges in patient counseling and treatment planning.[4]

Monocyte Chemoattractant Protein-1 (MCP-1), a key inflammatory chemokine, plays a crucial role in DR pathogenesis through recruitment of inflammatory cells and disruption of the blood-retinal barrier.[5] While previous studies have established MCP-1 as a biomarker for DR presence and severity its specific relationship with visual acuity outcomes has not been thoroughly investigated.[6-7]

Understanding the correlation between MCP-1 levels and visual function could provide clinicians with a valuable tool for predicting visual outcomes and guiding treatment decisions. This study aimed to evaluate the association between serum MCP-1 levels and visual acuity in different stages of diabetic retinopathy, potentially establishing MCP-1 as a predictor of functional visual outcomes.

METHODOLOGY

This cross-sectional analytical study was conducted at the Department of Physiology, Basic Medical Sciences Institute, Jinnah Postgraduate Medical Centre, Karachi, from April 2019 to October 2020, following approval from the Institutional Review Board.

One hundred participants aged 40-65 years were recruited using purposive sampling and divided into four groups: Group-A (n=25): diabetic patients (5-7 years duration) without retinopathy; Group-B (n=25): diabetic patients (8-10 years duration) with mild retinopathy; Group-C (n=25): diabetic patients (10-15 years duration) with moderate retinopathy; Group-D (n=25): healthy controls.

Inclusion criteria included confirmed type 2 diabetes mellitus (ADA guidelines), age 40-65 years, and ability to cooperate for visual acuity testing. Exclusion criteria comprised proliferative DR, cataract, vitreous hemorrhage, previous ocular surgery, and systemic conditions affecting vision.

Visual acuity was measured using standardized Snellen charts at 6 meters distance. Each eye was tested separately with appropriate refractive correction. Results were categorized as: normal vision (6/6-6/9), mild impairment (6/12-6/18), moderate impairment (6/24-6/36), severe impairment (≥6/60). Fasting blood samples were collected, and serum MCP-1 levels were measured using ELISA (Bioassay Technology Laboratory, Catalog no: E0124Hu). Data were analyzed using SPSS version 23.0. P-value <0.05 was considered significant.

RESULTS

The study included 60 males (60%) and 40 females (40%). Mean age progressively increased from Group-D (45.9±3.6 years) to Group-C (58.7±2.9 years). All groups were matched for BMI. Serum MCP-1 levels showed significant progressive elevation across groups ($p<0.001$). Group-D (Controls) had MCP-1 levels of 18.6±4.7 ng/dl. Group-A (No DR) had MCP-1 levels of 125.6±14.2 ng/dl. Group-B (Mild DR) had MCP-1 levels of 343.4±19.6 ng/dl. Group-C (Moderate DR) had MCP-1 levels of 503.0±43.7 ng/dl. Visual Acuity Distribution is shown in Table 1. A strong negative correlation was observed between MCP-1 levels and visual acuity ($r=-0.812$, $p<0.001$), stronger in groups with established retinopathy.MCP-1 level was measured, and its Predictive value for Visual Impairment was determined as shown in Table 2. Linear regression revealed that MCP-1 significantly predicted visual acuity deterioration ($\beta=0.724$, $p<0.001$), accounting for 52.4% of variance ($R^2=0.524$).

Table 1: Distribution of Visual Acuity Across Study Groups

Visual Acuity Category	Group A (n=25)	Group B (n=25)	Group C (n=25)	Group D (n=25)
Normal (6/6-6/9)	25 (100%)	3 (12%)	0 (0%)	25 (100%)
Mild (6/12-6/18)	0 (0%)	7 (28%)	2 (8%)	0 (0%)
Moderate (6/24-6/36)	0 (0%)	10 (40%)	9 (36%)	0 (0%)
Severe (≥6/60)	0 (0%)	5 (20%)	14 (56%)	0 (0%)

Table 2: MCP-1 Cutoff Values for Predicting Visual Impairment

Visual Outcome	MCP-1 Cutoff (ng/dl)	Sensitivity	Specificity	PPV	NPV
Any impairment	>150	92.3%	88.5%	90.2%	91.1%
Moderate/Severe	>300	85.7%	91.2%	88.4%	89.3%
Severe	>450	78.6%	94.8%	91.7%	85.9%

DISCUSSION

This study demonstrates a strong association between serum MCP-1 levels and visual acuity outcomes in diabetic retinopathy, providing novel insights into the relationship between inflammatory biomarkers and functional vision.

The most striking finding was elevation of MCP-1 levels (125.6±14.2 ng/dl) in Group-A patients who maintained normal visual acuity. This suggests inflammatory processes, reflected by MCP-1 elevation, precede functional visual decline. This "biochemical-functional gap" provides a potential window for early intervention before irreversible visual loss occurs.[8]

Progressive deterioration of visual acuity paralleling MCP-1 elevation supports inflammation's role in functional visual decline. In Group-B, despite mild retinopathy, 20% showed severe visual impairment, coinciding with MCP-1 levels above 340 ng/dl. This variability suggests MCP-1 might better predict functional outcomes than anatomical staging alone.[9]

Our identified MCP-1 cutoff values provide practical clinical guidance. Levels above 150 ng/dl showed high sensitivity (92.3%) for predicting any visual impairment, while levels above 450 ng/dl were highly specific (94.8%) for severe visual loss. These thresholds could guide treatment intensification decisions, particularly when clinical findings are equivocal.[10]

The stronger correlation between MCP-1 and visual acuity in advanced DR (Group-C: r=-0.834) suggests that inflammatory processes become increasingly important in determining visual outcomes as the disease progresses. This aligns with evidence showing anti-inflammatory interventions may preserve vision in advanced DR.[11]

Findings of our study suggests that MCP-1 levels above 150 ng/dl in diabetic patients without apparent retinopathy should prompt closer monitoring and aggressive glycemic control. Patients with MCP-1 levels above 300 ng/dl may benefit from early anti-VEGF therapy or anti-inflammatory interventions, even with mild clinical findings. MCP-1 levels can help clinicians provide more accurate prognoses regarding visual outcomes, improving patient education and compliance. Serial MCP-1 measurements could potentially monitor treatment response, though longitudinal studies are needed.

This cross-sectional design limits causal inference. The relatively small sample size and single-center nature may affect generalizability. We did not account for systemic inflammatory conditions potentially influencing MCP-1 levels. Future longitudinal studies should evaluate whether reducing MCP-1 levels improves visual outcomes.

CONCLUSION

Serum MCP-1 levels strongly correlate with visual acuity outcomes in diabetic retinopathy, with elevation preceding clinical visual impairment. MCP-1 measurement could complement traditional assessment methods in predicting functional visual outcomes and guiding treatment decisions. The identified cutoff values provide practical thresholds for clinical decision-making. Further prospective studies are warranted to validate these findings and explore MCP-1-targeted interventions for preserving vision in DR patients.

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