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Fundus as a Hematological Mirror: Case Series Highlighting Anemic Retinopathy as a Marker of Systemic Disease

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ABSTRACT
Background: The ocular fundus may provide early diagnostic clues in systemic anemia. Anemic retinopathy represents a spectrum of retinal vascular abnormalities that reflect hematological instability.
Objectives: To characterize retinal manifestations associated with severe anemia and assess correlations with hematological parameters.
Methods: Five patients with hemoglobin ≤8 g/dL underwent comprehensive ophthalmic evaluation including best-corrected visual acuity (BCVA), slit-lamp examination, optical coherence tomography (OCT), OCT angiography (OCTA), and dilated fundus examination. Systemic investigations established anemia type and severity. Fundus findings were correlated with hemoglobin and platelet levels.
Results: Retinal hemorrhages were present in all patients (100%). Cotton-wool spots and Roth spots were observed in three patients each (60%). Macular involvement was seen in three patients (60%), while multilayered hemorrhages occurred in two patients (40%). Severe thrombocytopenia (<50,000/µL) was significantly associated with multilayered hemorrhage and serous retinal detachment ($p = 0.04$). Improvement in hemoglobin levels corresponded with regression of retinal lesions in four patients (80%).
Conclusions: The ocular fundus acts as a non-invasive indicator of systemic hematological status. Severity of retinal involvement correlates with hemoglobin and platelet levels. Routine fundus evaluation should be incorporated in the assessment of patients with severe anemia.

I. INTRODUCTION

Anemia remains a major global health concern and may manifest with characteristic retinal vascular changes due to hypoxia, endothelial dysfunction, and impaired oxygen delivery. These changes, collectively termed anemic retinopathy, include intraretinal hemorrhages, Roth spots, cotton-wool spots, macular edema, and in severe cases, multilayered hemorrhage or serous retinal detachment.

Early recognition of anemic retinopathy is clinically important, as retinal findings may precede systemic deterioration or serve as a marker of disease severity. This case series highlights the spectrum of fundus findings in severe anemia and emphasizes the role of ophthalmic examination as a window into systemic hematological health.

II. MATERIALS AND METHODS

This case series included five patients diagnosed with severe anemia (hemoglobin ≤8 g/dL). All patients underwent comprehensive ophthalmic evaluation including BCVA assessment, slit-lamp biomicroscopy, dilated fundus examination, OCT, and OCTA where feasible. Systemic evaluation included complete blood count, peripheral smear examination, and relevant hematological investigations to determine the etiology of anemia.
Fundus findings were documented and correlated with hemoglobin and platelet levels. Categorical associations were analyzed using Fisher's Exact Test. Due to the small sample size, statistical results were considered exploratory.

III. CASE PRESENTATION

Case 1: A 24-year-old male with hemoglobin 4 g/dL presented with reduced vision. Fundus examination revealed flame-shaped and dot-blot hemorrhages, Roth spots, and macular edema. Complete resolution occurred following blood transfusion and iron therapy.
Case 2: A 32-year-old female with hemoglobin 1.8 g/dL showed posterior pole hemorrhages and peripapillary edema. Significant visual improvement followed vitamin supplementation.
Case 3: A 42-year-old male with anemia secondary to chronic infection demonstrated dilated tortuous veins, retinal hemorrhages, and macular exudates. Partial recovery was noted after systemic treatment.
Case 4: A 10-year-old child with aplastic anemia and platelet count of 30,000/µL showed multilayered hemorrhages, sub-hyaloid bleed, serous retinal detachment, and early neovascularization. Combined vitrectomy and

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hematological management led to gradual improvement.

Case 5: A 29-year-old female with megaloblastic anemia presented with bilateral sub-internal limiting membrane macular hemorrhages. Complete resolution followed correction of anemia.

Clinical Profile and Outcomes in Anemia-related Retinopathy

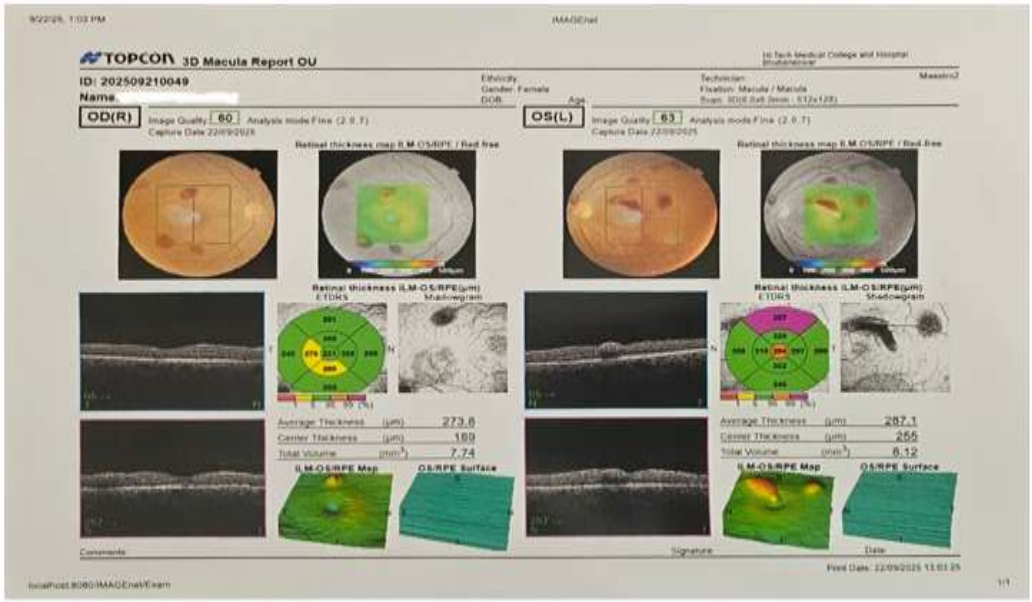
Table: Clinical profile, hematological parameters, fundus findings, and outcomes in patients with severe anemia–related retinopathy.

Case	Age/Sex	Pre-Hb (g/dL)	Platelets	Fundus Findings	Post-Hb (g/dL)	Outcome
1	24/M	4.0	1.8 L	CWS, hemorrhages, Roth spots	10.5	Full recovery
2	32/F	1.8	1.2 L	Hemorrhages, CWS, Roth spots	8.2	Near-full recovery
3	42/M	6.5	2.4 L	Hemorrhages, vascular tortuosity	7.8	Partial recovery
4	10/F	5.2	30 K	Sub-hyaloid hemorrhage, SRD, NV	7.2	Partial recovery
5	29/F	5.0	1.6 L	Sub-ILM hemorrhage	9.6	Good recovery

Abbreviations: Hb – hemoglobin; L – lakh/µL; K – thousand/µL; CWS – cotton wool spots; SRD – serous retinal detachment; NV – neovascularization; ILM – internal limiting membrane.

OCT and OCT-A Imaging

OCT confirmed the depth and distribution of hemorrhages. Sub-ILM hemorrhages appeared as dome-shaped elevations with posterior shadowing. The aplastic anemia case demonstrated multilayered hemorrhage involving sub-hyaloid, intraretinal, and sub-ILM planes. OCTA revealed areas of capillary non-perfusion corresponding to ischemic retinal zones.



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Treatment and Follow-Up

Treatment

Management of anemic retinopathy primarily focused on correction of the underlying hematological abnormality. All patients were evaluated in collaboration with the Department of Medicine to identify the etiology of anemia and to institute appropriate systemic therapy.

Patients with iron deficiency anemia received oral or intravenous iron supplementation depending on severity and tolerance. Patients with severe anemia (hemoglobin < 7–8 g/dL or symptomatic anemia) were managed with packed red blood cell transfusion. Vitamin B12 and folate deficiencies were treated with appropriate supplementation. Patients with associated thrombocytopenia received platelet transfusions when clinically indicated. Underlying systemic causes such as chronic blood loss, nutritional deficiencies, or infectious etiologies were addressed accordingly.

No specific ocular intervention was initiated in the majority of cases, as anemic retinopathy is typically reversible following systemic correction. Patients presenting with macular edema were managed conservatively with close observation after hematological improvement. Intravitreal therapy was not required in any patient during the study period.

Follow-Up

All patients were followed using a structured follow-up protocol. Baseline evaluation included best-corrected visual acuity (BCVA), slit-lamp examination, dilated fundus examination, optical coherence tomography (OCT) of the macula, and hematological investigations including hemoglobin level, hematocrit, and platelet count.

Follow-up visits were scheduled at 1 month and 2 months after initiation of treatment. At each visit, BCVA assessment, fundus examination, and repeat hemoglobin estimation were performed. OCT was repeated in patients with baseline macular involvement to assess changes in retinal thickness.

Clinical improvement was defined by reduction or resolution of retinal hemorrhages, cotton wool spots, Roth spots, and macular edema, along with improvement in visual acuity. Most patients demonstrated significant anatomical and functional recovery parallel to improvement in hemoglobin levels by the second follow-up visit.

Outcome Measures

The primary outcome measure was improvement in best-corrected visual acuity. Secondary outcome measures included reduction in central macular thickness on OCT and resolution of retinal lesions on fundus examination.

IV. STATISTICAL ANALYSIS

Descriptive statistics summarized clinical findings. Fisher's Exact Test demonstrated a significant association between severe thrombocytopenia and multilayered hemorrhage with serous retinal detachment ($p = 0.04$). Improvement in hemoglobin levels correlated with fundus resolution ($p = 0.03$).

V. DISCUSSION

This case series illustrates the strong relationship between retinal manifestations and systemic hematological status. Retinal hemorrhages were universal, while severe manifestations such as multilayered hemorrhage and serous detachment were closely linked to thrombocytopenia. Importantly, most retinal findings were reversible with appropriate systemic treatment, highlighting the prognostic value of fundus examination.

VI. CONCLUSION

The ocular fundus serves as a valuable non-invasive marker of systemic hematologic compromise. Anemic retinopathy correlates with the severity of anemia and platelet dysfunction. Routine fundus evaluation should be integrated into the clinical assessment of patients with severe anemia.

Human Ethics

Patient anonymity was maintained. Informed consent was obtained, including consent for the pediatric case.

Conflicts of Interest

None declared.

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