A Study on Prevalence of Malarial Retinopathy among Malaria Cases and to Determine Its Presence as a Marker of Severe Malaria: Observations from Eastern India

Rupak Chatterjee[1], Tania Ray Bhadra[2], Nandini Chatterjee[3], Shatavisa Mukherjee[4], Prantiki Halder[5], Kumkum Sarkar[6], Indradeb Chatterjee[7], Bibhuti Saha[8], Partha Sarathi Karmakar[9], Netai Pramanik[10], Shambo Samrat Samajdar[11*]

Received: 02 March 2025; *Accepted:* 14 February 2026

Abstract

Background: Malarial retinopathy refers to a constellation of changes seen in severe or complicated malaria cases. These include: retinal whitening, vessel changes–whitening, tramlining, retinal hemorrhages, and papilledema. There are very few Indian studies on this entity. Since retina can be easily visualized by direct ophthalmoscopy, this study was done to determine prevalence of malarial retinopathy among malaria cases and to determine relationship between malarial retinopathy and severity of the disease.

Materials and methods: The study was done at Indoor and Outdoor Departments of Tropical Medicine, School of Tropical Medicine (STM), Kolkata, with the support of the Department of Ophthalmology, Regional Institute of Ophthalmology (RIO), Medical College, Kolkata. Adult malaria cases, both complicated/severe and uncomplicated, were included. Patients unable or unwilling to cooperate with eye examination, contraindications to tropicamide eye drops (angle closure glaucoma or known allergy to product), severe corneal scarring or cataracts hindering view by ophthalmoscopy, diabetes mellitus, hypertension, intracranial space occupying lesions, epilepsy, alcohol use, chronic renal failure, age > 60 years and any other known ocular/systemic disease that can cause retinopathy changes were excluded. Severe malaria was diagnosed as per the WHO criteria. Cases with acute febrile illness of other causes were taken in control arm, and normal population subjects were taken as controls. All patients were assessed clinically, followed by appropriate laboratory investigations and then direct ophthalmoscopic examination was done. Ocular findings were be collaborated with severity of illness.

Results: A total of 71 malaria cases were included in our study. Among them, 12 cases were of severe malaria, and rest of the cases were uncomplicated. Of the 12 severe malaria cases, 8 were *Plasmodium vivax*, 3 were *Plasmodium falciparum*, and 1 was mixed. Uncomplicated malaria cases were mostly *P. vivax* (35 out of 59). Features suggestive of malarial retinopathy were noted in 9 out of 12 cases of severe malaria (75%) and 2 out of 59 cases of uncomplicated malaria (3.4%). We noted two cases of retinal changes—one case of retinal whitening in falciparum malaria and one case of vivax malaria with retinal hemorrhage in the uncomplicated group. Both of the cases subsequently needed admission for recurrent vomiting, reduced urine output, and severe weakness 40 dengue cases were included in control arm of AFI cases—20 DHF cases and 20 cases of DF with warning signs. Among them, retinal hemorrhage was noted in one case of DHF (2.5%). Out of 40 sepsis cases, retinal hemorrhage was seen in one case (2.5%). No retinal changes were noted among 40 other AFI cases which included scrub typhus, enteric fever, chikungunya, and acute viral hepatitis. Also, no abnormality was detected on ophthalmoscopy in 40 healthy individuals. The presence of retinopathy was suggestive of severe malaria ($p < 0.05$). We found the sensitivity and specificity of malarial retinopathy as a marker of severe malaria to be 75% and 96.6% with a positive predictive value of 81.8%.

Conclusion: Malarial retinopathy may serve as an important clinical biomarker for predicting severe malaria. All clinicians should be appropriately trained in performing direct ophthalmoscopy to detect the retinopathy changes.

Journal of The Association of Physicians of India (2026): 10.59556/japi.74.1438

Introduction

Malaria is a mosquito-borne parasitic infection caused by protozoa of genus *Plasmodium*.[1] It is an important vector-borne disease in tropical and subtropical countries of Asia, Africa, and America.[2] Mainly four species of *Plasmodium*, namely *vivax*, *falciparum*, *ovale*, and *malariae* cause malaria.[3] Plasmodium knowlesi is a recent addition to the list. *Plasmodium falciparum* malaria, especially in children of Africa with Cerebral or severe complicated malaria is reported to cause a cluster of retinal signs[4] collectively known as malarial retinopathy. The severity of malarial retinopathy correlated with mortality and severity of the infection in such cases.[4] Components of malarial retinopathy include: Retinal whitening, vessel changes–whitening, tramlining, retinal hemorrhages and papilledema.[5] Retinopathy is seen in complicated malaria cases only.[6] Among the ocular retinopathy changes, retinal whitening and vessel discoloration are unique to malaria only and not seen in other ocular or systemic conditions.[4,6] Papilledema and retinal hemorrhages can be seen with an ordinary direct ophthalmoscope but distinctive retinal whitening and vessel abnormalities can be seen with indirect ophthalmoscopy as the peripheral retina can be visualised.[7] The pathophysiology behind the retinopathy changes have been postulated to be due to sequestration of infected erythrocytes in the retinal microvasculature.[8] As both the retina and brain have same embryological origin–namely, neuroectoderm, so, the vasculature is similar in both. Breakdown of the blood-tissue barrier, endothelial dysfunction also contributes to the development of the changes.[8]

[1]Senior Resident, Department of Medicine, Bijoygarh State General Hospital; [2]Assistant Professor, Department of Ophthalmology, Regional Institute of Ophthalmology, Medical College; [3]Professor, Department of Medicine, Institute of Postgraduate Medical Education and Research, and SSKM Hospital; [4,7]Research Officer, Department of Clinical and Experimental Pharmacology; [5,6]Assistant Professor, Department of Tropical Medicine, School of Tropical Medicine; [8]Professor, Department of Infectious Diseases and Advanced Microbiology, School of Tropical Medicine; [9]Professor, Department of Medicine, College of Medicine and Sagore Dutta Hospital; [10]Professor, Department of Tropical Medicine, School of Tropical Medicine, Kolkata; [11]Clinical Pharmacologist, JMN Medical College and Hospital, Nadia, West Bengal, India; *Corresponding Author

How to cite this article: Chatterjee R, Bhadra TR, Chatterjee N, *et al.* A Study on Prevalence of Malarial Retinopathy among Malaria Cases and to Determine Its Presence as a Marker of Severe Malaria: Observations from Eastern India. J Assoc Physicians India 2026;74(3):62–67.

In children, severe malaria presents as cerebral malaria, severe anemia, and metabolic acidosis or respiratory distress syndrome. Almost two-thirds of such severe malaria cases had evidence of malarial retinopathy. The large prospective study on Malawian children with cerebral malaria showed that the severity of retinal signs, including number of hemorrhagic spots was related to the outcome and length of coma in the cases.[4] In a study involving Kenyan children, retinal hemorrhage was associated with deeper coma and severe anemia.[9] In children of Mali with malaria, retinopathy was also related to severity of the infection.[10]

Compared to children, severe malaria in adults presents as multisystem involvement, including renal failure, hepatic dysfunction.[5] In studies done on Thai and Indian adults with severe malaria, retinal hemorrhages were detected less frequently than in children.[11–13] In adults, retinal edema and exudate have been reported, instead of the classical retinal whitening seen in children. Macular whitening of retina has been reported in two Malawian adults with cerebral malaria in a study.[14]

Malarial retinopathy changes have been reported to resolve some time after resolution of coma in Cerebral malaria and there no residual persisting retinal abnormalities after that.[15] In a detailed observational study of malarial retinopathy conducted on Bangladeshi adults with *P. falciparum* malaria admitted in hospital, out of 234 study subjects, 85% with cerebral, 67% noncerebral severe and 47% uncomplicated malaria had retinal changes. Moderate to severe retinopathy was found in 6% of those with fatal and 62% of cerebral malaria. They reported resolution of signs to take a median of 2 weeks. The severity of retinopathy correlated with severity of malaria. According to their study, although indirect ophthalmoscopy was more sensitive to detect retinal changes, it provided minimal additional prognostic information when compared to direct ophthalmoscopy.[16]

Malarial retinopathy in adults with severe malaria, although not as common as in children, Medicine and Infectious Disease Specialists should always keep it in mind so as not to miss it. Considering the burden of malaria in our country and scarcity of literature on this topic, this study was undertaken

Aim and Objective

- To determine prevalence of malarial retinopathy among malaria cases.
- To determine relationship between malarial retinopathy and severity of the disease.

Materials and Methods

Study Setting

Indoor and outdoor, Department of Tropical Medicine, School of Tropical Medicine (STM), Kolkata and Department of Ophthalmology, Regional Institute of Ophthalmology (RIO), Medical College, Kolkata, West Bengal, India.

Study Period

12 months.

Definition of Study Population

Malaria parasite found in blood smear, thick and thin.

Sampling Method and Size

The consecutive sampling method was used. A 70 sample size is needed. Considering prevalence rate of malaria, 5.02%.[17]

Inclusion Criteria

Patients >18 years of age of both sexes.

Exclusion Criteria

- Patients are unable or unwilling to cooperate with eye examination.
- Contraindications to tropicamide eye drops (angle closure glaucoma or known allergy to product).
- Severe corneal scarring or cataracts are hindering vision by ophthalmoscopy.
- Diabetes mellitus.
- Hypertension.
- Intracranial space-occupying lesions.
- Epilepsy.
- Alcohol use.
- Chronic renal failure.
- Age > 60 years.
- Any other known ocular/systemic disease that can cause retinopathy changes.

Study Design

Observational study.

Study Tool

- Predesigned proforma for data collection.
- Informed consent document.
- Parameters to be assessed:
    - History taking, clinical examination.
    - CBC, LFT, urea, creatinine, electrolytes—Na^+, K^+.
    - Direct ophthalmoscopy in all cases.
    - Other investigations as per necessity.

Study Technique

- Malaria cases, both complicated/severe and uncomplicated, were taken.
- Severe malaria was diagnosed as per the WHO criteria.[18]
- There were two control groups for comparison. Cases with acute febrile illness of other causes were taken in the control arm group, and normal population subjects were taken as another control group.
- All patients were assessed clinically, followed by appropriate laboratory investigations; direct ophthalmoscopic examination was then performed. Ocular findings were be collaborated with the severity of illness.
- Observations were made by two independent observers, one of them being an ophthalmologist.
- Ophthalmoscopy was done on the day of admission, and in those patients where changes were noted, repeat examination was done at time of discharge and follow-up after 1 month.
- Two drops of tropicamide (0.5 or 1%) eye drops were used to dilate pupil for purpose of examination.
- A subset of patients underwent color fundus/retinal photography when stable enough to be transported to RIO for documentation of the pictures of retinopathy.
- Data was collected and compiled in an MS Excel sheet.

Data Analysis

Descriptive data were represented as mean, standard deviation, range, frequency, or percentages, as applicable. Different levels were expressed at a 95% confidence interval. The normality of the data was assessed using the Shapiro–Wilk test. The continuous variables were compared using the Student's *t*-test. The categorical variables were compared using the chi-squared statistic and Fisher's exact test. Analysis for the various measures was performed using various standard statistical software packages such as Microsoft Excel and GraphPad Prism.

Ethical Issues

- Informed consent was obtained from patient or patient's relatives in all cases
- Management of the patients under the study was not intervened in by any means.
- The proposal was submitted to the Clinical Research Ethics Committee (CRE-STM), School of Tropical Medicine, for approval.
- Patient identity was not disclosed by any means.
- Ethics Committee Approval number: CREC/STM 2022 AS-19 dated December 5, 2022.

Results

A total of 71 malaria cases were included in our study. Among them, 12 cases were of severe malaria and rest cases were uncomplicated. Of the 12 severe malaria cases, 8 were *P. vivax*, 3 were *P. falciparum*, and 1 was mixed. Uncomplicated malaria cases were mostly *P. vivax* (35 out of 59). Tables 1 and 2 show the clinicolaboratory profile of the cases and the clinical profiles of severe malaria cases, respectively.

Severe anemia, hypotension, and hemoglobinuria were noted in one case of falciparum malaria. Two cases of falciparum with renal failure (creatinine >3 mg/dL) with jaundice were seen. Renal failure (creatinine > 3 mg/dL) was seen in a mixed malaria cases as severe malaria.

Features suggestive of malarial retinopathy were noted in 9 out of 12 cases of severe malaria (75%) and 2 out of 59 cases of uncomplicated malaria (3.4%) (Table 3 and Figs 1 to 4)

We noted two cases of retinal changes—one case of retinal whitening in falciparum malaria and one case of vivax malaria with retinal hemorrhage in the uncomplicated group. Both of the cases subsequently needed admission for recurrent vomiting, reduced urine output, and severe weakness.

Forty dengue cases were included in the control arm of AFI cases: 20 DHF cases and 20 cases of DF with warning signs. Among them, retinal hemorrhage was noted in one case of DHF (2.5%).

Out of 40 sepsis cases, retinal hemorrhage was seen in one case (2.5%).

No retinal changes were noted among 40 other AFI cases who needed hospitalization and were admitted indoors, considering disease severity. The cases included 10 cases of scrub typhus, 10 cases of enteric fever, 4 cases of chikungunya, 5 cases of acute viral hepatitis, 4 cases of leptospirosis, and 7 undifferentiated febrile illnesses.

Also, no abnormality was detected on ophthalmoscopy in 40 healthy individuals (Fig. 1). So, the presence of retinopathy was suggestive of severe malaria ($p < 0.05$).

Table 1: Clinicolaboratory profile of study cases

Characteristics	*Uncomplicated malaria (n = 59)*			*Severe/Complicated malaria (n = 12)*			*p-value*
	P. vivax (n = 35)	*P. falciparum (n = 18)*	*Mixed (n = 6)*	*P. vivax (n = 8)*	*P. falciparum (n = 3)*	*Mixed (n = 1)*	
Age (in years)	40.4 ± 13.02	36.7 ± 15.05	36 ± 9.08	32 ± 5.58	39.3 ± 17.56	22	
Sex (M/F)	22/13	12/6	4/2	5/3	2/1	0/1	
Clinical features							
Fever	35	18	6	8	3	1	0.893
Chills	35	18	6	8	3	1	0.893
Headache	11	12	5	6	3	1	0.521
Vomiting	3	4	1	4	2	1	0.688
Diarrhea	2	2	–	1	1	1	> 0.05
Abdominal pain	2	2	–	3	1	1	> 0.05
Decreased urine output	–	–	–	3	2	–	< 0.05
Altered sensorium	–	–	–	2	–	–	< 0.05
Icterus	–	–	–	–	2	–	< 0.05
Hepatomegaly	6	5	2	6	3	1	> 0.05
Laboratory parameters							
Hb	12.32 ± 1.098	12.15 ± 1.28	12.18 ± 0.62	10.39 ± 1.42	8.33 ± 3.23	9.9	0.700
TLC	7150.86 ± 1141.74	7400 ± 800	7633 ± 1284.78	7703.75 ± 1630.10	10166.67 ± 2797.02	6700	0.313
Platelet	1.42 ± 0.17	1.45 ± 0.09	1.54 ± 0.71	1.2 ± 0.2	0.86 ± 0.185	1.51	0.132
Total bilirubin	1.77 ± 0.298	1.89 ± 0.5	1.64 ± 0.39	2.325 ± 0.39	3.1 ± 0.2	3.4	0.351
SGOT	44.4 ± 3.73	44.39 ± 1.54	44.83 ± 6.65	47.75 ± 4.46	53.67 ± 5.03	78	0.148
SGPT	46.28 ± 3.97	46.17 ± 1.76	47 ± 6.98	50 ± 4.14	59.67 ± 2.08	84	0.122
Urea	29.06 ± 5.46	31.17 ± 5.79	33 ± 7.24	43.12 ± 3.14	41.33 ± 3.05	54	0.371
Creatinine	1.21 ± 0.18	1.21 ± 0.17	1.1 ± 0.11	1.77 ± 0.10	1.63 ± 0.15	2.1	0.746

Table 2: Profile of Severe malaria cases ($n = 12$)

Criteria	*No. of cases*
Impaired consciousness (GCS < 11)	2
Prostration (severe generalized weakness with inability to sit, stand, or walk without assistance)	4
Renal failure (serum creatinine > 3 mg/dL)	3
Jaundice (serum bilirubin > 3 mg/dL)	3
Severe anemia (Hb < 5 gm/dL)	1
ARDS	1
Hypoglycemia (plasma glucose < 40 mg/dL)	2
Metabolic acidosis (plasma bicarbonate < 15 mmol/L)	1
Circulatory collapse/shock (BP < 80 mm Hg)	2
Hemoglobinuria	1

Table 3: Malarial retinopathy noted in severe malaria cases

Retinal changes	*Falciparum (n = 3)*	*Vivax (n = 8)*	*Mixed (n = 1)*
Whitening	–	1	1
Hemorrhage	3	2	–
Papilledema	–	2	–

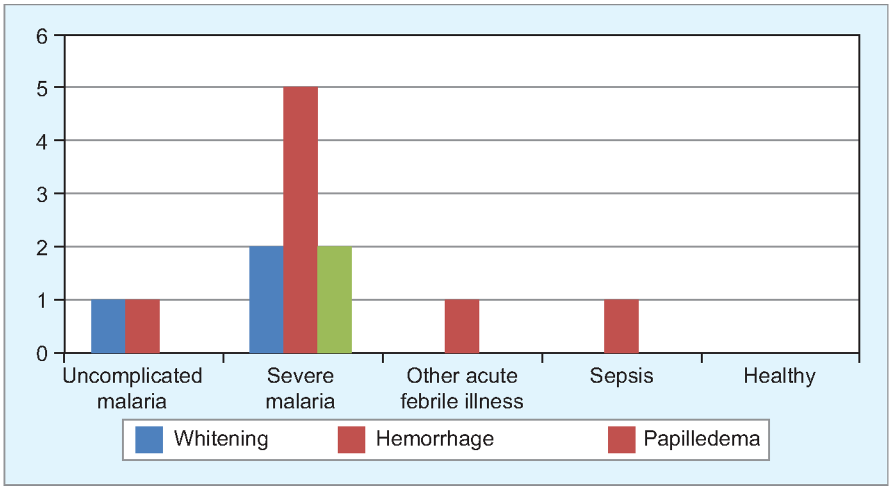

Fig. 1: Retinal changes noted in the study population

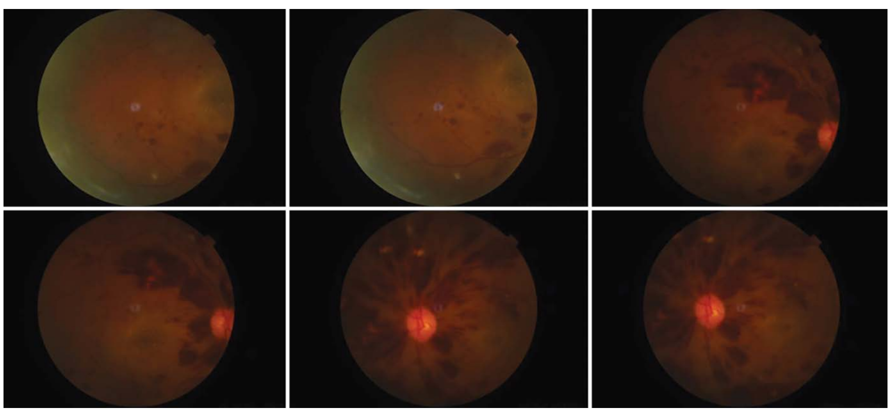

Fig. 2: Serial fundus photo showing multiple intraretinal flame-shaped hemorrhage and a few cotton wool spots centered around the optic disc with dull foveal reflex

Fig. 3: Blurred disc margin, retinal whitening, with flame-shaped hemorrhage along the inferotemporal vein

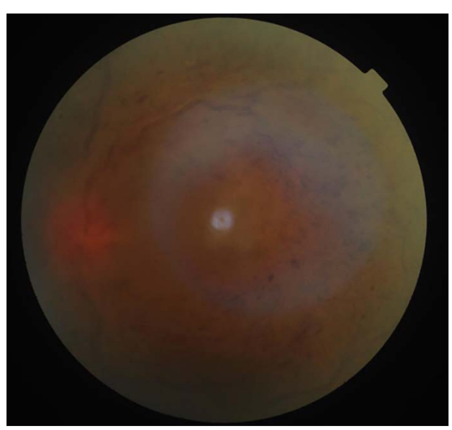

Fig. 4: Fundus photo showing blurred disc margin, mild tortuosity of veins, multiple intraretinal (flame-shaped and dot) hemorrhage in all quadrants with dull foveal reflex

All the retinopathy changes were present at the time of discharge of the patients but resolved at follow-up visit after 1 month.

All the malaria cases were treated according to the National Guidelines. There was one mortality in our study of the *P. vivax* case who developed ARDS, shock, refractory metabolic acidosis, and then renal failure and subsequent multiorgan dysfunction.

Of the eight cases of severe malaria with retinopathy, five cases had headache persisting for up to 1 month. In three cases of them, headache was so excruciating that neuroimaging was needed to exclude other pathologies. Thus, the presence of retinopathy also had a relation with post-malaria headache ($p < 0.05$).

Discussion

Malaria continues to remain an important cause of fever, especially in tropical and subtropical countries.[19]

Despite being a preventable and treatable disease with highly effective drugs such as artemisinin-based combination therapies and injectable artesunate, malaria still leads to mortality and morbidity in developing countries like India. Globally, there were an estimated 241 million cases of malaria in 2020 with 6,27,000 deaths. India accounts for around 4% of global malaria cases, with more than half of the population at risk of malaria.[20]

Although *P. falciparum* has long been associated to be cause of severe malaria, there is emerging evidence that *P. vivax,* which was once considered a benign species, can also cause severe malaria.[21]

In our study, we also found vivax malaria alone to account for 60.6% of the total cases (43/71).

In our study, fever with chills was the most common presenting symptom in all the cases, followed by headache.

A study in North India also reported fever to be the commonest symptom (present in 100% of cases), followed by chills (73.4%), headache (48%), vomiting (46%), abdominal pain (29%), and decreased urine output (20%). Regarding the laboratory parameters, they observed hemoglobin to be significantly lower in falciparum malaria in comparison to vivax or mixed infection and total leukocyte count to be significantly lower in mixed malaria cases. Other hematological and biochemical parameters were similar among the groups of vivax, falciparum, and mixed malaria. However, AKI, altered sensorium, anemia, thrombocytopenia, and transaminitis were significantly higher in the severe malaria cases compared to the uncomplicated group.[22]

This was consistent with our study also. Decreased urine output, altered sensorium, and icterus were noted only in severe malaria group. In regard to laboratory parameters, hemoglobin and platelet count were lower in severe malaria than in uncomplicated cases, while liver enzymes, bilirubin, urea, and creatinine were higher in the severe malaria group, although the difference was nonsignificant.

Retina being an integral part of the CNS, examination of the retina by easily accessible noninvasive fundoscopy can serve as a surrogate in visualizing inflammatory and obstructive changes in microvasculature occurring in the brain in severe malaria. As both retina and brain tissue have a similar network of vessels and have high metabolic demand, they are vulnerable to sequestration and hypo/nonperfusion. Retinal whitening, hemorrhages, vessel discoloration, and papilledema are components of malarial retinopathy. Hemorrhages are hypothesized to occur as a result of damage or destruction of pericytes, resulting in blood–brain barrier damage leading to rupture of vasculature and subsequent hemorrhage. Adherence of sequestered infected RBCs to endothelium of retinal vessels results in obstruction to blood flow, leading to hypo- and nonperfusion, explaining retinal whitening. Papilledema signifies raised intracranial pressure.[23,24]

A study in Bangladesh included 210 adult subjects, incorporating 75 cerebral malaria cases, 64 severe malaria cases without coma, 31 uncomplicated falciparum malaria cases, 20 vivax malaria cases, and 20 healthy controls. None of the vivax malaria cases and healthy controls had any retinal changes. However, in falciparum malaria cases, indirect ophthalmoscopy detected malarial retinopathy (retinal hemorrhage being the predominant lesion) to be present in 86% of fatal cases, 41% cerebral malaria cases, 25% noncerebral but severe cases. Only 1 out of 31 uncomplicated falciparum cases had a retinal change. On examination by direct ophthalmoscope, only one case of retinopathy was missed, and a lesser number of retinal hemorrhages were detected in comparison to indirect technique. They reported severity of retinopathy to have a significant correlation with severity of malaria. They concluded that malarial retinopathy is an independent predictor of mortality and severity.[25]

Another study from Chittagong, Bangladesh, reported malarial retinopathy to be present in 63% cases of severe malaria, 78% cases with fatal course, 70% with cerebral malaria, 43% noncerebral severe malaria, and 60% uncomplicated malaria cases. 1 out of 5 patients with sepsis had retinopathy changes. Hemorrhage was the most common abnormality, followed by whitening.[26]

An Indian study on 104 adult cases of vivax malaria reported 38% of the severe cases to have retinal changes. On the other hand, only 6% of nonsevere cases had retinopathy. Arteriovenous changes were the commonest change noted, followed by retinal hemorrhage.[27]

In our study, malarial retinopathy was noted in 9 out of 12 cases of severe malaria (75%) and 2 out of 59 cases of uncomplicated malaria (3.4%). Retinal hemorrhage was the most common abnormality in severe malaria. We noted two cases of retinal changes: one case of retinal whitening in falciparum malaria and one case of vivax malaria with retinal hemorrhage in the uncomplicated group. Out of 40 dengue cases included in the control arm, retinal hemorrhage was noted in one case of DHF (2.5%). Out of 40 sepsis cases, retinal hemorrhage was seen in 1 case (2.5%). No retinal changes were noted among 40 other AFI cases, which included scrub typhus, enteric fever, chikungunya, and acute viral hepatitis. Also, no abnormality was detected on ophthalmoscopy in 40 healthy individuals (Fig. 1). Thus, the presence of retinopathy was suggestive of severe malaria ($p < 0.05$).

Another Indian study also reported a significant correlation between retinal changes in malaria patients with mortality and neurological sequelae.[28]

In our study, one mortality was noted in a *P. vivax* case who developed ARDS, shock, refractory metabolic acidosis, and then renal failure and subsequent multiorgan dysfunction. That case had maximum hemorrhagic spots seen on retinal examination. Of the eight cases of severe malaria with retinopathy, five cases had headache persisting for up to 1 month. In three cases, headache was so excruciating that neuroimaging was needed to exclude other pathologies. Thus, the presence of retinopathy also had a relation with post-malaria headache.

So, malarial retinopathy may serve as a bedside clinical biomarker of severe malaria and may be included in the criteria for severe malaria. Early detection of malarial retinopathy may help in the stratification of cases based on severity so that more aggressive treatment may help reduce mortality.

Study Limitations

The small sample size was a major limitation of our study. Moreover, a few cases of malarial retinopathy might have been missed as indirect ophthalmoscopy could not be done in all cases, considering the issue of transport of severe malaria patients. Also, grading of retinopathy was not possible due to the same reason.

Future studies should try to overcome these limitations.

Conclusion

Malarial retinopathy may serve as an important clinical biomarker for predicting severe malaria. We found the sensitivity and specificity of malarial retinopathy as a marker of severe malaria to be 75% and 96.6%, with a positive predictive value of 81.8%. All clinicians should be appropriately trained in performing direct ophthalmoscopy to detect the retinopathy changes.

Source of Support

Nil

Conflicts of Interest

None

Author Declaration

I hereby declare that this study is my original work and has not been presented anywhere in any form, either as part or as a whole study before. I also declare that this article has not been sent anywhere, under consideration for publication, or published.

Authors Contribution

The study was conceptualized by RC and NC. Data collection done by RC, TRB, and IC. Data analyzed by RC and SM. KS and PH provided ophthalmoscope instrument. Others supervised the project.

Orcid

Nandini Chatterjee https://orcid.org/0000-0002-7729-812X

Shatavisa Mukherjee https://orcid.org/0000-0001-9524-1525

Shambo Samrat Samajdar https://orcid.org/0000-0002-9199-0905

References

1. Koram KA, Molyneux ME. When is "malaria" malaria? The different burdens of malaria infection, malaria disease, and malaria-like illnesses. Am J Trop Med Hyg 2007;77(Suppl 6):1–5.
2. Snow RW, Guerra CA, Noor AM, et al. The global distribution of clinical episodes of *Plasmodium falciparum* malaria. Nature 2005;434(7030):214–217.

3. Marx A, Pewsner D, Egger M, et al. Meta-analysis: accuracy of rapid tests for malaria in travelers returning from endemic areas. Ann Intern Med 2005;142:836–846.
4. Beare NA, Southern C, Chalira C, et al. Prognostic significance and course of retinopathy in children with severe malaria. Arch Ophthalmol 2004;122:1141–1147.
5. Beare NAV, Taylor TE, Harding SP, et al. Malarial retinopathy: a newly established diagnostic sign in severe malaria. Am J Trop Med Hyg 2006;75:790–797.
6. Lewallen S, Harding SP, Ajewole J, et al. A review of the spectrum of clinical ocular fundus findings in P. falciparum malaria in African children with a proposed classification and grading system. Trans R Soc Trop Med Hyg 1999;93:619–622.
7. Lewallen S, Brozman RN, Beare NA, et al. Using malarial retinopathy to improve the classification of children with cerebral malaria. Trans R Soc Trop Med Hyg 2008;102:1089–1094.
8. Maude RJ, Dondorp AM, Sayeed AA, et al. The eye in cerebral malaria: what can it teach us? Trans R Soc Trop Med Hyg 2009;103:661–664.
9. Hero M, Harding SP, Riva CE, et al. Photographic and angiographic characterization of the retina of Kenyan children with severe malaria. Arch Ophthalmol 1997;115:997–1003.
10. Schemann JF, Doumbo O, Malvy D, et al. Ocular lesions associated with malaria in children in Mali. Am J Trop Med Hyg 2002;67:61–63.
11. Looareesuwan S, Warrell DA, White NJ, et al. Retinal haemorrhage, a common sign of prognostic significance in cerebral malaria. Am J Trop Med Hyg 1983;32:911–915.
12. Kochar DK, Shubhakaran,Kumawat BL, et al. Ophthalmoscopic abnormalities in adults with falciparum malaria. QJM 1998;91:845–852.
13. Kochar DK, Shubhakaran, Kumawat BL, et al. Prognostic significance of eye changes in cerebral malaria. J Assoc Physicians India 2000;48:473–477.
14. Beare NA, Lewis DK, Kublin JG, et al. Retinal changes in adults with cerebral malaria. Ann Trop Med Parasitol 2003;97:313–315.
15. Beare NAV, Southern C, Kayira K, et al. Visual outcomes in children in Malawi following retinopathy of severe malaria. Br J Ophthalmol 2004;88(3):321–324.
16. Maude RJ, Sayeed AA, Beare NA, et al. Retinopathy and microcirculation in adult severe malaria. Malar J 2010;9(Suppl 2):17.
17. Khatoon S, Khan MMA. Socio-economic status and burden of malaria in Kolkata Municipal Corporation (KMC) area, West Bengal. J Commun Dis 2020;52(1):72–77.
18. .World Health Organization. Severe malaria. Trop Med Int Health 2014;19(Suppl 1):7–131.
19. Chatterjee R, Chatterjee N, Mukherjee S, et al. A study on travel-associated febrile illness among patients attending a tertiary care hospital in eastern India. Beng Physic J 2024;11(1):3–7.
20. World Health Organization. World Malaria Report 2021. Geneva: World Health Organization; 2021.
21. Matlani M, Kojom LP, Mishra N, et al. Severe vivax malaria trends in the last two years: a study from a tertiary care centre, Delhi, India. Ann Clin Microbiol Antimicrob 2020;19(1):49.
22. Karoli R, Shakya S, Gupta N, et al. Clinical profile of malaria at a tertiary care teaching hospital in North India. Trop Parasitol 2021;11:25–30.
23. Brodeur KRN, Herculano A, Oliveira K. Clinical aspects of malarial retinopathy: a critical review. Pathog Glob Health 2023;117(5):450–461.
24. Beare NAV. Cerebral malaria: using the retina to study the brain. Eye (Lond) 2023;37(12):2379–2384.
25. Abu Sayeed A, Maude RJ, Hasan MU, et al. Malarial retinopathy in Bangladeshi adults. Am J Trop Med Hyg 2011;84(1):141–147.
26. Maude RJ, Beare NA, Abu Sayeed A, et al. The spectrum of retinopathy in adults with *Plasmodium falciparum* malaria. Trans R Soc Trop Med Hyg 2009;103(7):665–671.
27. Kochar A, Kalra P, Sb V, et al. Retinopathy of vivax malaria in adults and its relation with severity parameters. Pathog Glob Health 2016;110(4–5):185–193.
28. Chaudhari KS, Uttarwar SP, Tambe NN, et al. Role of serum lactate and malarial retinopathy in prognosis and outcome of falciparum and vivax cerebral malaria: a prospective cohort study in adult Assamese tribes. J Glob Infect Dis 2016;8(2):61–67.