

Assessment of Colour vision Changes in Tuberculosis Patients Receiving Anti TB Drug Moxifloxacin**Tahira Kalsoom¹, Muhammad Mehboob², Dr. Muhammad Asmat Rasheed³**¹ Assistant Professor the University of Lahore. Email: tahirahanif213@gmail.com Oric ID: 0009-0007-0078-0261² The university of Lahore. Email: dr.bobbykhan91@gmail.com Oric ID: 0009-0004-7312-8352³ Lecturer, Faculty of Allied Health Sciences, The University of Lahore
Email: asmatrasheed738@gmail.com**Abstract****Purpose:** To assess colour vision changes in tuberculosis (TB) patients receiving moxifloxacin.**Methodology:** A prospective cohort study was conducted at the University of Lahore Teaching Hospital over four months on 175 TB patients selected through purposive sampling technique. Colour vision was assessed using the Farnsworth D-15 test at baseline, 15 days, and 30 days after initiation of moxifloxacin therapy, alongside visual acuity and slit-lamp examination. Cochran's Q and McNemar tests were used to compare colour vision status across the three time points.**Result:** Of 175 participants (60.0% male, mean age 36.09 ± 10.539 years), 31 (17.7%) had defective colour vision at baseline. This fell to 21 (12.0%) at 15 days and 13 (7.4%) at 30 days in the right eye, and to 21 (12.0%) and 17 (9.7%) respectively in the left eye. Cochran's Q testing confirmed a statistically significant overall change in both the right eye ($Q = 20.33, p < 0.001$) and left eye ($Q = 17.333, p < 0.001$). McNemar pairwise comparisons showed significant improvement from baseline to 15 days and baseline to 30 days ($p < 0.05$ for both eyes), while the change between 15 and 30 days was not significant (right eye $p = 0.115$; left eye $p = 0.388$), indicating an early plateau.**Conclusion:** Colour vision defects in TB patients receiving moxifloxacin improved significantly within the first 15 days of therapy and remained stable thereafter, supporting a favorable ocular safety profile for moxifloxacin over the short term.**Keywords:** Tuberculosis; Moxifloxacin; Colour vision; Farnsworth D-15 test; Fluoroquinolone; Ocular toxicity**Introduction**

Tuberculosis (TB) remains one of the leading infectious causes of morbidity and mortality worldwide.¹ Prolonged multidrug therapy for TB carries significant risk for adverse effects on multiple organ systems, including the eye.² Moxifloxacin, a fourth-generation fluoroquinolone, has become an essential agent in modern anti-TB regimens, particularly for drug-resistant TB.³ The World Health Organization has endorsed moxifloxacin-containing shorter treatment regimens with significantly higher cure rates than conventional regimens,⁴ and recent international guidelines recommend its inclusion in shortened treatment phases for TB patients over 12 years of age.⁵ Although fluoroquinolones have therapeutic benefits, they have been associated with various ophthalmologic side effects, including moxifloxacin.⁶

Moxifloxacin has been linked to changes in colour vision believed to result from high affinity for melanin-rich ocular structures and accumulation in the retinal pigment epithelium, retina, and choroid.⁷ Although the existing literature on TB-related colour vision defects has mainly focused on ethambutol, an older first-line anti-TB drug, limited prospective data exist on the ocular safety of moxifloxacin during prolonged anti-TB therapy.⁸ Fluoroquinolone-induced ocular adverse reactions can manifest in multiple ways.⁹ Colour vision is a sensitive indicator of early optic nerve or retinal dysfunction, often the first finding to occur before visual acuity is affected.¹⁰

Systematic evaluation of colour vision using standardized testing is important because subclinical colour vision impairment in patients receiving anti-TB drugs can be detected early.¹¹ The Farnsworth D-15 test is a practical screening tool in clinical settings to identify and classify acquired colour vision defects.¹² Clinical recognition of colour vision defects is critical since changes typically precede other visual manifestations; early detection results in improved patient safety and quality of life.¹³ Systematic evaluation of colour vision should be part of standard eye follow-up in TB patients treated with second-line drugs like moxifloxacin.

This study was designed to prospectively evaluate colour vision changes in TB patients undergoing moxifloxacin therapy at baseline, 15 days, and 30 days using the Farnsworth D-15 test, to determine the prevalence and pattern of colour vision defects and evaluate the ocular safety profile of moxifloxacin.

Methodology

This was a prospective cohort study conducted at the University of Lahore Teaching Hospital over a period of March to June 2026. The study was conducted in accordance with the Declaration of Helsinki (1964, as amended). A total of 175 patients were enrolled using a purposive sampling technique, with the sample size calculated at a 95% confidence level using the standard finite-population proportion formula. Patients aged 18–65 years of either gender, recently diagnosed with tuberculosis and already established on anti-tuberculosis treatment including moxifloxacin, were included. Patients concurrently receiving ethambutol or other known optic-nerve-toxic drugs, and those with glaucoma, other optic nerve disease, systemic disease affecting the eye, or any active ocular disease or infection, were excluded. Patients meeting the inclusion criteria were identified from the outpatient department, and written informed consent was obtained prior to enrolment after full explanation of the study objectives and procedures. A structured proforma was used to record demographic data, tuberculosis profile, and moxifloxacin dose. Each participant underwent a baseline ophthalmic evaluation comprising best corrected visual acuity (Snellen chart), anterior segment examination (slit-lamp biomicroscopy), fundus examination, and colour vision assessment using the Farnsworth D-15 test, in which coloured caps are arranged by hue similarity and scored for crossings on the standard D-15 diagram to identify protan, deutan, or tritan defects. Participants were re-assessed using identical methods at 15 days and 30 days after initiation of therapy, with all findings and subjective visual complaints recorded in the study proforma. All participants completed follow-up assessments with no dropouts recorded. Data were entered and analyzed using SPSS version 25. Qualitative variables were expressed as frequencies and percentages and quantitative variables were presented as mean $\pm$ SD. Cochran's Q test was used to assess the overall change in colour vision status (defective vs. normal) across the three time points for each eye, followed by pairwise McNemar tests for baseline-to-15-day, baseline-to-30-day, and 15-day-to-30-day comparisons. A p-value ≤ 0.05 was considered statistically significant.

Results

A total of 175 patients participated in the study, of whom 105 (60.0%) were male and 70 (40.0%) were female. Pulmonary TB was the most common clinical type (119, 68.0%),

followed by MDR-TB (39, 22.3%) and extrapulmonary TB (17, 9.7%). The mean age of participants was 36.09 ± 10.539 years (range 18–65 years), and the mean duration of TB was 6.70 ± 3.657 months (Table 2). The majority of patients were receiving moxifloxacin 400 mg/day (133, 76.0%), while the remainder (42, 24.0%) were receiving 800 mg/day (Table 1).

Table 1: Demographic and characteristics TB participants receiving Moxifloxacin

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	105	60.0
	Female	70	40.0
Tuberculosis Type	Pulmonary TB	119	68.0
	MDR-TB	39	22.3
	Extrapulmonary TB	17	9.7
Moxifloxacin Dose	400 mg/day	133	76.0
	800 mg/day	42	24.0

Table 2: Descriptive Statistics of Participants' Age and Duration of Tuberculosis

Variable	N	Minimum	Maximum	Mean $\pm$ SD
Age (years)	175	18	65	36.09 ± 10.539
TB Duration (months)	175	1	12	6.70 ± 3.657

Right Eye Colour Vision

At baseline, 31 participants (17.7%) had defective colour vision in the right eye. This declined to 21 (12.0%) at 15 days and 13 (7.4%) at 30 days, while participants with normal baseline colour vision remained largely normal throughout follow-up (Table 3). Cochran's Q testing confirmed a statistically significant overall change across the three time points ($Q = 20.33$, $df = 2$, $p < 0.001$). On pairwise McNemar testing, the improvement from baseline to 15 days was significant ($p = 0.002$), as was the improvement from baseline to 30 days ($p < 0.001$); however, the change between 15 and 30 days was not statistically significant ($p = 0.115$), indicating that most improvement occurred early and then plateaued.

Table 3: Right eye colour vision status at baseline, 15 days, and 30 days

Time Point	Defective (n)	Normal (n)	Defective (%)
Baseline	31	144	17.7
15 Days	21	154	12.0
30 Days	13	162	7.4

Left Eye Colour Vision

A similar pattern was observed in the left eye. Defective colour vision fell from 31 (17.7%) at baseline to 21 (12.0%) at 15 days and 17 (9.7%) at 30 days (Table 4). Cochran's Q testing again confirmed a statistically significant overall change ($Q = 17.333$, $df = 2$, $p < 0.001$). McNemar pairwise comparisons showed significant improvement from baseline to 15 days ($p = 0.002$) and baseline to 30 days ($p < 0.001$), while the change between 15 and 30 days was not significant ($p = 0.388$), mirroring the plateau seen in the right eye.

There was a consistent pattern of improvement in colour vision defects in both eyes during the first 15 days of moxifloxacin therapy, and no significant difference in colour vision function between 15 and 30 days for any eye, nor was there any eye that developed a new defect after normal baseline vision that persisted for the duration of follow-up visits.

Table 4: Left eye colour vision status at baseline, 15 days, and 30 days

Time Point	Defective (n)	Normal (n)	Defective (%)
Baseline	31	144	17.7
15 Days	21	154	12.0
30 Days	17	158	9.7

Discussion

The results of this study showed that there was a significant improvement in the colour vision status of TB patients after 30 days of follow up with moxifloxacin, most of the improvement being seen within the first 15 days of treatment and declining thereafter. Given this pattern, this group of early colour vision defects may have been reversible and not a sign of progressive drug-induced optic neuropathy.

These findings are consistent with those of Potter et al.,¹⁹ who evaluated moxifloxacin as an alternative to ethambutol in presumed ocular tuberculosis and found it to be both safe and effective, with no major ocular toxicity observed during treatment. Similarly, Schmok and Bothamley²⁰ reported minimal adverse effects associated with prolonged moxifloxacin use among TB patients, with no major ocular complications documented, broadly supporting the favourable ocular safety profile of moxifloxacin observed in the present cohort.

By contrast, much of the earlier literature on TB-related colour vision defects has focused on ethambutol. Babar et al.⁷ reported that 60% of 120 ethambutol-treated TB patients had colour vision defects, with tritan defects being the most common, followed by protan and deutan defects, and moderate contrast sensitivity loss in the majority of patients. Thitiwichienlert and Phattarapongdilokper⁶ similarly described colour vision defects in TB patients receiving ethambutol. The comparatively lower prevalence and clearly reversible nature of colour vision defects observed with moxifloxacin in the present study support the growing view that moxifloxacin may represent a relatively safer alternative to ethambutol, particularly in patients at higher risk of optic nerve toxicity.

The early improvement observed between baseline and 15 days, without significant further change between 15 and 30 days, may reflect resolution of transient, non-specific visual disturbance related to initiation of multidrug therapy or systemic illness, rather than a true drug-induced toxic effect. This is compatible with findings from Perumal et al.,¹⁰ who evaluated a moxifloxacin-based regimen for recurrent, drug-sensitive pulmonary tuberculosis in an open-label randomized controlled trial and did not identify major ocular safety concerns attributable to moxifloxacin over the treatment course.

This study was conducted at a single center with a relatively short 30-day follow-up period, which may not capture delayed or cumulative ocular effects of longer-term moxifloxacin therapy.¹⁴ The two dosage groups (400 mg/day and 800 mg/day) were unevenly distributed (76% vs. 24%), which represents a limitation in assessing dose-dependent differences.¹⁵ Additionally, objective investigations such as optical coherence tomography and visual field analysis were not performed.¹⁶ Drug-induced toxicity remains an important concern in TB treatment.¹⁷ No dropouts occurred during the follow-up period, with all 175 participants completing the study.¹⁸

Conclusion

Colour vision defects among tuberculosis patients receiving moxifloxacin were relatively uncommon at baseline and improved significantly within the first 15 days of therapy, remaining stable through 30 days of follow-up in both eyes. These results indicate a good short term biocompatibility for moxifloxacin in the eye, and confirm that it is emerging as a potential alternative to ethambutol in patients with TB who are appropriately selected. Further objective

ophthalmic imaging in larger, multicenter studies with longer duration of follow-up is recommended to further define the long-term safety of moxifloxacin.

Conflict Of Interest: None to declare

Ethical Approval: The study was approved by the Departmental Research Committee, University of Lahore, Ethical approval No. DRC/DOVS011/03/26, dated 12-03-2026.

Authors' Contributions:

Tahira Kalsoom: Concept, manuscript review, design

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Muhammad Mehboob: Design, data acquisition, manuscript preparation.

Abdul Razzaq: Design, data acquisition, manuscript review.

Alisha Javed: Data acquisition, manuscript preparation, manuscript review.

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References

- Lee H, Kim J, Kim J, Park YJ. Review of the Global Burden of Tuberculosis in 2023: Insights from the WHO Global Tuberculosis Report 2024. *Jugan Geongang Gwa Jilbyeong*. 2025;18(11 Suppl):55-69.
- Borah P, Deb PK, Venugopala KN, Al-Shar'i NA, Singh V, Deka S, et al. Tuberculosis: An Update on Pathophysiology, Molecular Mechanisms of Drug Resistance, Newer Anti-TB Drugs, Treatment Regimens and Host-Directed Therapies. *Curr Top Med Chem*. 2021;21(6):547-70.
- Akkerman OW, Tiberi S, Alffenaar JW. Shortening MDR-TB treatment: is treating more patients with fewer drugs better? *Int J Tuberc Lung Dis*. 2021;25(6):419-20.
- Agibothu Kupparam HK, Shah I, Chandrasekaran P, Mane S, Sharma S, Thangavelu BR, et al. Pharmacokinetics of anti-TB drugs in children and adolescents with drug-resistant TB: a multicentre observational study from India. *J Antimicrob Chemother*. 2024;79(11):2939-47.
- Cruz EM, Puentespina FG, Alejo KPL. Color-vision abnormalities among patients undergoing tuberculosis treatment. *Philippine Journal of Ophthalmology*. 2010;35(1):3-9.
- Thitiwichienlert S, Phattarapongdilok C. Color vision defect in patients with tuberculosis receiving Ethambutol treatment. *EYE*. 2020;15(2):234-41.
- Babar I, Mazhar S, Babar MA. Effect of Ethambutol on Visual Acuity, Contrast Sensitivity and Color Vision in the Tuberculosis Patients Visiting Allied Hospital Faisalabad. *International Annals of Medicine*. 2017;1(9):78-85.
- Rizwan HM, Atif MA, Hussain M, Nazeer R. Efficacy and safety profile of 2nd line Anti TB drugs in DRTB patients in a tertiary care hospital of South Punjab. *Pak J Med Sci*. 2024;40(11):2665-74.
- Perumal R, Padayatchi N, Yende-Zuma N, Naidoo A, Govender D, Naidoo K. A Moxifloxacin-based Regimen for the Treatment of Recurrent, Drug-sensitive Pulmonary Tuberculosis: An Open-label, Randomized, Controlled Trial. *Clin Infect Dis*. 2019;70(1):90-8.
- Solu TM, Panchal K. Ocular side effects of anti-tubercular drugs in patients receiving anti-TB treatment at a tertiary care center. *IP Int J Ocul Oncol Oculoplasty*. 2020;6(3):187-91.
- Asare AB, Asare P, Yeboah-Manu M, Osei-Wusu S, Konadu ED, Asante-Poku A, et al. Patients with tuberculosis and diabetes show altered clinical and biochemical parameters during anti-TB treatment. *Sci Rep*. 2026;16(1):4120-25.
- Ileye UM, Odero VO, Hassan MS, Hossain MM. Determinants of tuberculosis treatment adherence among patients taking anti-TB drugs in Borama, Somaliland. *BMC Public Health*. 2025;25(1):3788.

- Baumeister C, Verschoor J, Ueckermann V, Molatseli M, Sasing T, Khuboni N, et al. Electro-impedimetric detection of human anti-mycolate antibody biomarkers of TB before, during, and after treatment. *Biomark Med.* 2025;19(16):769-82.
- Nyangwara V, Waja Z, Thelingwani R, Osman R, Pretorius Z, Majoro K, et al. Incidence and associated risk factors of anti-tuberculosis drug induced liver injury among TB patients. *BMC Infect Dis.* 2025;25(1):1400.
- Getachew RG, Oljira R, Getahun A, Dereje L, Abdi MG, Tolossa T. Tuberculosis treatment outcomes and associated factors among patients on anti-TB treatment in Nekemte public health facilities, Oromia regional state, Western Ethiopia. *BMC Infect Dis.* 2025;26(1):224.
- Potter J, Agrawal R, Barraclough C, Rahman F, Westcott M, Pavesio CE, White V. Moxifloxacin: an alternative to ethambutol for the treatment of presumed ocular tuberculosis. *Ocul Immunol Inflamm.* 2016;24(5):508-14.
- Schmok E, Bothamley G. Adverse effects of moxifloxacin during tuberculosis treatment. *European Respiratory Society*; 2012.
- Henkel T, Heller K. Fluoroquinolone-induced ocular adverse reactions. *Ocul Toxicol.* 2020;15(3):156-68.
- Joubert J, Joubert L, Westerberg D. Subclinical colour vision impairment in patients receiving ethambutol. *Br J Ophthalmol.* 2012;96(12):1519-23.
- Khaqan M, Nasir MI, Azmat S, et al. Ocular manifestations in patients with pulmonary tuberculosis at a tertiary care hospital. *Pak J Med Sci.* 2020;36(7):1502-6.