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RESEARCH ARTICLE

Opening Eyes to Overlooked Red Eyes: Incidence of Corneal Foreign Bodies in Patients Presenting with Red Eye at a Tertiary Care Centre in Kanchipuram

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Abstract: ***Background***: Red eye is a frequent ocular complaint with diverse etiologies, including infection, allergy, and trauma. Among trauma-related causes, corneal foreign bodies (CFBs) are often overlooked despite their potential to cause keratitis, scarring, and vision loss if not promptly diagnosed. Understanding their burden within the spectrum of red eye presentations is essential for accurate diagnosis and preventive strategies. ***Objective***: To estimate the incidence of CFBs among patients presenting with red eye at a tertiary care hospital in Kanchipuram, and to describe demographic trends, occupational risk, foreign body characteristics, and diagnostic challenges. ***Methods***: This hospital-based cross-sectional study evaluated 211 consecutive patients with red eye. All underwent slit-lamp examination to detect CFBs. Data collected included age, gender, occupation, laterality, type and location of foreign body, and history of misdiagnosis. Descriptive statistics were applied, and findings compared with published literature. Results: Among 211 red eye patients, 90 (42.7%) had corneal foreign bodies. Most affected were working-age adults (31–40 years, 42.2%) and males (86.7%; male:female ratio 6.5:1). Right eye involvement predominated (56.7%). Metallic fragments were most common (53.3%), followed by stone/sand (21.1%), plant debris (15.5%), and miscellaneous particles (10%). Industrial workers, especially welders and grinders, represented the majority (54.4%). Paracentral lesions were most frequent (62.2%). Misdiagnosis occurred in 17.1% of cases, mainly in peripheral lesions. ***Conclusion***: CFBs contribute significantly to red eye presentations in this population, reflecting occupational risks and diagnostic challenges. Comprehensive slit-lamp evaluation, better awareness among primary care providers, and stricter enforcement of workplace eye protection can mitigate associated morbidity.

Keywords: Red eye, corneal foreign body, occupational exposure, metallic fragments, misdiagnosis

INTRODUCTION

Red eye is one of the most common presentations in ophthalmology, encompassing a wide spectrum of underlying causes that range from benign conditions such as allergic conjunctivitis to potentially sight-threatening infections and ocular trauma. Despite its apparent simplicity, the differential diagnosis of red eye can be challenging, as the clinical features often overlap and subtle signs may be overlooked, particularly in busy clinical settings. While infections and inflammatory conditions are frequently considered, traumatic causes—including corneal foreign bodies (CFBs)—remain underrecognized, especially in occupationally exposed populations.

Corneal foreign bodies are among the most prevalent forms of ocular trauma worldwide, with significant implications for vision if not promptly diagnosed and managed. These injuries are particularly common in young adults engaged in industrial, construction, or agricultural work, where exposure to metallic fragments, stone particles, or plant material is frequent. Failure to identify and remove CFBs in a timely manner can lead to complications such as microbial keratitis, corneal scarring, recurrent erosions, and, in severe cases, permanent vision impairment. The burden of such injuries is compounded by delayed presentation, inadequate use of protective eyewear, and misdiagnosis at primary care levels.

Previous studies in South Asia have highlighted the occupational dimension of corneal injuries. Agrawal et al. reported that metallic fragments were the predominant cause of CFBs among industrial workers in North India, with a peak incidence in young adults.[1] Similarly, Bahoo et al. found a strong correlation between professional exposure and the occurrence of ocular surface foreign bodies in a Pakistani cohort.[2] Sharma et al. demonstrated that inadequate adherence to protective eyewear protocols significantly

increased the risk of CFBs in Nepal, emphasizing the role of occupational safety measures in reducing ocular trauma.[3] Despite these insights, most existing studies focus on ocular trauma in general rather than specifically on red eye presentations, which remain a frequent first point of contact in primary or secondary care.

Understanding the incidence and profile of CFBs in patients presenting with red eye is critical for several reasons. First, early recognition allows timely intervention, preventing complications that can impair vision. Second, it enables healthcare providers to identify high-risk populations and implement targeted preventive measures, such as occupational safety training and protective equipment enforcement. Third, identifying patterns of misdiagnosis and delayed recognition can inform education and training for primary care providers, who often encounter these patients first. In low-resource or high-volume settings, failure to recognize subtle corneal injuries may result in repeated visits, inappropriate treatment, or progression to more severe ocular pathology.

In India, where industrial and agricultural occupations form a substantial part of the workforce, corneal trauma is a major public health concern. The combination of high occupational exposure, limited awareness of eye safety, and inadequate access to specialist care contributes to a substantial burden of preventable ocular morbidity. Regional data on the incidence of CFBs specifically among red eye presentations remain limited, leaving a gap in understanding the true scope of this problem and hindering effective planning for preventive strategies. Given these considerations, the present study aims to address this knowledge gap by systematically evaluating the incidence of corneal foreign bodies in patients presenting with red eye at a tertiary care hospital in Kanchipuram, Tamil Nadu. In addition to quantifying incidence, the study seeks to characterize demographic patterns, occupational risk factors, types and locations of foreign bodies, laterality of involvement, and the frequency of prior misdiagnosis. By providing a comprehensive profile of CFBs in this context, the study intends to inform clinical practice, occupational health policy, and public health interventions aimed at reducing preventable vision loss associated with ocular trauma.

Objectives

Our study aims to determine the incidence of corneal foreign bodies among patients presenting with red eye, characterize their demographic and occupational profile, classify foreign bodies by type and corneal location, evaluate laterality and patterns of involvement, assess the frequency and causes of misdiagnosis, and identify risk factors to inform strategies for early detection, prevention, and improved diagnostic accuracy.

Materials and Methodology

Design of Study and Setting

This study was a cross-sectional observational investigation conducted in the Ophthalmology Department of Saveetha Medical College and Hospital, Kanchipuram, Tamil Nadu. The hospital serves a mixed population comprising both urban and semi-rural communities. A significant proportion of the patient population is engaged in industrial, construction, and agricultural occupations, making it an appropriate setting to study ocular trauma and corneal foreign bodies (CFBs) among patients presenting with red eye.

The study was designed to systematically determine the prevalence of CFBs, characterize their demographic and occupational distribution, and assess clinical patterns and diagnostic challenges associated with these injuries. Ethical approval for the study was obtained from the Institutional Ethics Committee, and the study was conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent after the objectives, procedures, and potential risks of the study were explained.

Study Population

A total of 211 consecutive patients presenting with red eye to the outpatient department during the study period, from September 2023 to September 2025, were included. We included ocular redness of any duration, with or without associated symptoms such as pain, foreign body sensation, tearing, photophobia, or blurred vision.

Exclusion criteria were carefully defined to avoid confounding factors:

1. Recent ocular surgery within the past three months,
2. Pre-existing chronic ocular surface disease, including severe dry eye, bullous keratopathy, or recurrent epithelial defects,
3. Inability to undergo slit-lamp examination due to non-cooperation or other limitations.

By applying these criteria, the study focused on acute red eye presentations, ensuring accurate assessment of corneal foreign body prevalence and patterns.

Data Collection

Data were collected using a structured case sheet designed to capture detailed demographic, occupational, and clinical information. This included:

i. Age and gender of the patient,
ii. Occupation and type of work,
iii. History of ocular trauma,
iv. Presenting symptoms,
v. Prior treatments or misdiagnoses,
vi. Use of protective eyewear.

All patients underwent a comprehensive slit-lamp examination to evaluate the presence of corneal

foreign bodies. For patients in whom a CFB was identified, the following variables were meticulously recorded:

- Laterality: right or left eye,
- Type of foreign body: metallic (iron or other alloys), stone/sand, plant material, glass/plastic, or miscellaneous,
- Location on the cornea: central (involving the visual axis), paracentral (within 3 mm of the central zone), or peripheral,
- History of misdiagnosis: whether the patient had previously been treated at another healthcare facility, including for conditions such as conjunctivitis or keratitis.

This comprehensive data collection allowed the study to identify both occupational and demographic risk factors, as well as clinical characteristics of the foreign bodies, which could influence visual outcomes and diagnostic accuracy.

Ethical Considerations

The study obtained formal approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrolment. Participation was voluntary, and patients were informed that they could withdraw at any time without affecting their care. Confidentiality was maintained by assigning unique identifiers to all participants, and access to the data was restricted to the research team. All procedures posed minimal risk, as slit-lamp examination is a routine, non-invasive diagnostic procedure in ophthalmology.

Statistical Analysis

Collected data were entered into Microsoft Excel and checked for completeness and accuracy before analysis. Statistical analysis was performed using SPSS version 25.0. Descriptive statistics were reported as percentages or means with standard deviations where applicable. Comparisons with existing published literature were used to contextualize findings.

This methodological approach allowed a systematic assessment of the prevalence, occupational and demographic associations, clinical characteristics, and diagnostic challenges related to corneal foreign bodies in patients presenting with red eye. The detailed subcategorization of foreign body type, location, and prior misdiagnosis also provides insight into targeted preventive strategies and diagnostic vigilance.

Results

During the study period, a total of 211 patients presented to the ophthalmology department with red eye and were consecutively evaluated. Among these, 90 patients were found to have corneal foreign bodies, yielding an incidence of 42.7%. This finding indicates that nearly half of the red eye cases in this tertiary care setting were trauma-related rather than being primarily infective or inflammatory in nature. Such a high proportion underscores the importance of considering ocular trauma as a significant etiology in red eye presentations, particularly in populations with substantial occupational exposure.[1,2]

Demographic Distribution

The age distribution of patients with corneal foreign bodies revealed a clear peak in the 31–40 year age group, accounting for 42.2% of cases, followed by the 21–30 year age group (20%). Patients younger than 20 years and older than 50 years were comparatively less affected. This trend aligns with prior studies highlighting the vulnerability of young, working-age adults to ocular trauma, especially in industrial and manual labour occupations.[1,3,4]

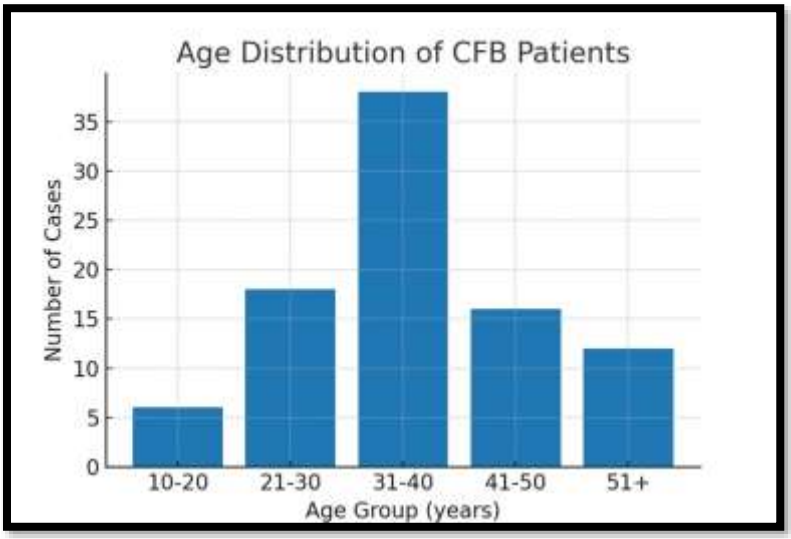

Figure 1: Age distribution

Analysis of gender revealed a pronounced male predominance, with 78 male patients (86.7%) and 12 female patients (13.3%), resulting in a male-to-female ratio of approximately 6.5:1. This finding reflects occupational patterns in the region, where males are more commonly engaged in high-risk industrial, construction, and agricultural work.[1,4]

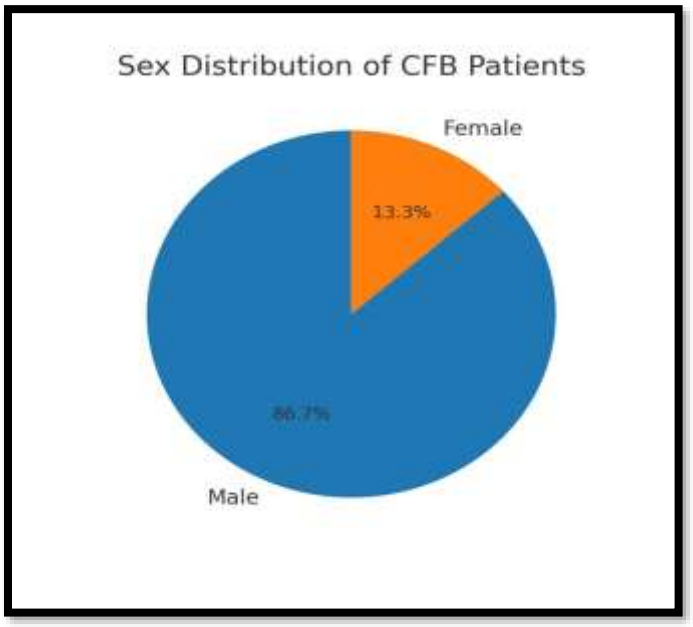

Figure 2: Gender distribution

Laterality of Involvement

Evaluation of eye involvement indicated that the right eye was affected in 51 patients (56.7%), while the left eye was affected in 39 patients (43.3%). This right-eye predominance may be associated with right-hand dominance and the typical orientation of industrial and manual tasks. [2,4]

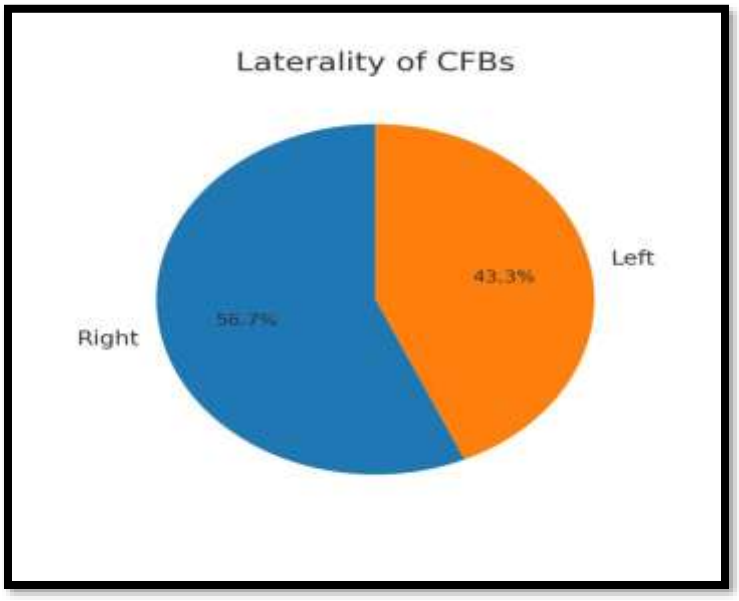

Figure 3: Eye Laterality

Type and Location of Corneal Foreign Bodies

Metallic fragments were the most common type of CFB, present in 48 patients (53.3%), with iron being the dominant component. Stone and sand were observed in 19 patients (21.1%), plant debris in 14 patients (15.5%), and glass, plastic, or other miscellaneous materials in 9 patients (10%). These findings are consistent with prior studies reporting metallic particles as the leading cause of occupational ocular trauma.[1,2,3]

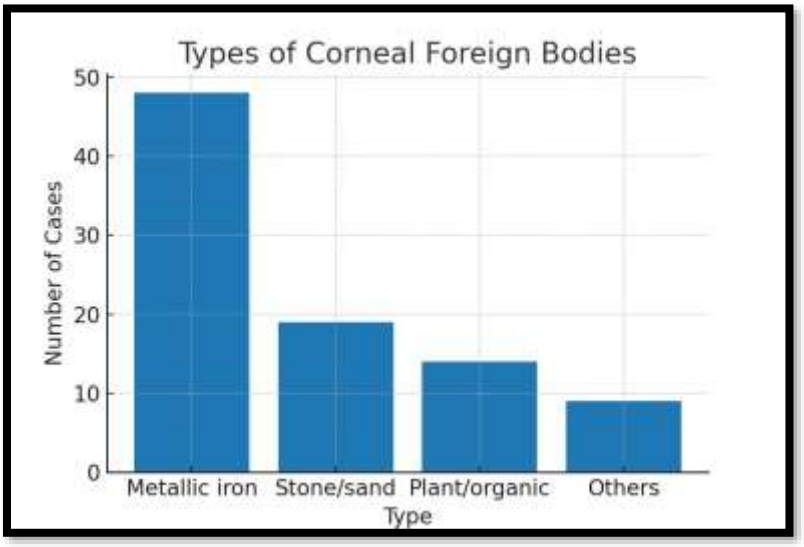

Figure 4: Types of CFBs

Regarding corneal location, paracentral lesions were most frequently observed, affecting 56 patients (62.2%). Central corneal involvement was noted in 21 patients (23.3%), and peripheral lesions in 13 patients (14.4%). Paracentral and central lesions are clinically significant due to their proximity to the visual axis, with a higher risk of visual impairment if not promptly addressed.[3,5,8]

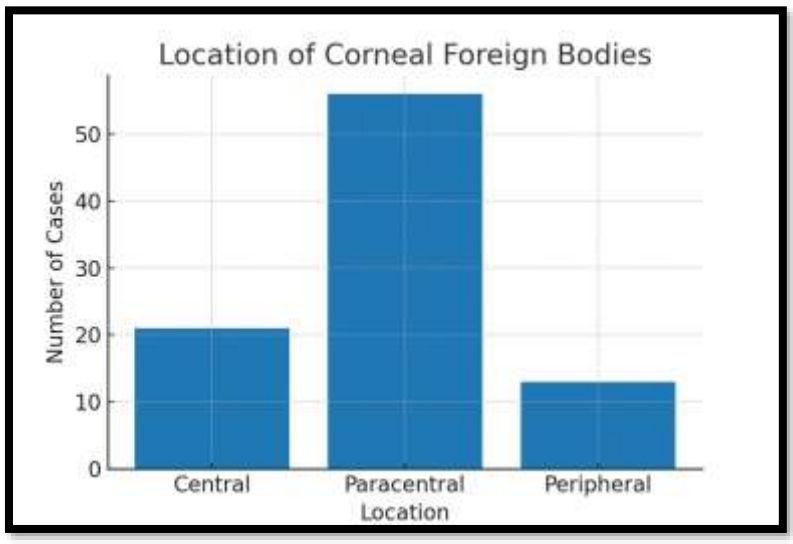

Figure 5: Location of CFBs

Occupational Distribution

Occupational analysis revealed that industrial workers were the largest affected group, comprising 49 patients (54.4%), particularly welders and grinders. Construction workers accounted for 18 patients (20%), agricultural labourers for 12 patients (13.3%), and students or other professions represented 11 patients (12.2%). These patterns align with previous studies demonstrating a strong correlation between high-risk occupations and the occurrence of CFBs.[1,2,4,6,7]

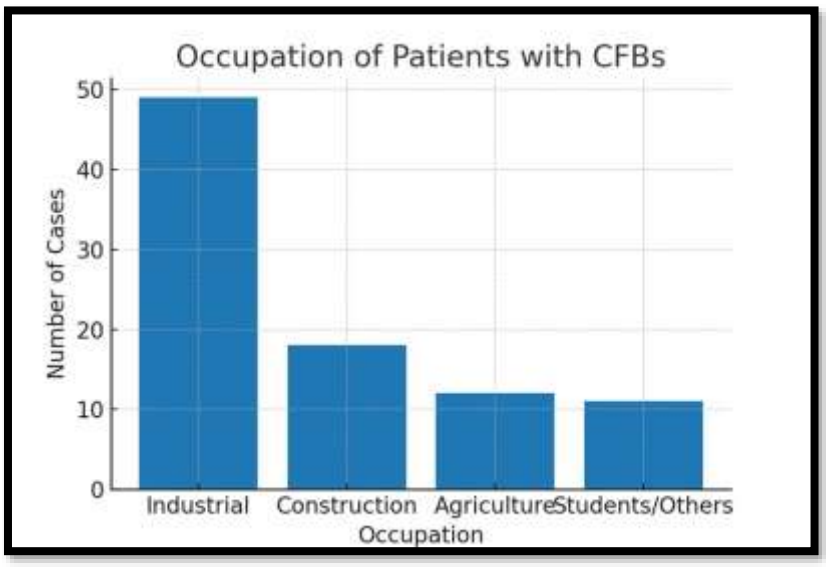

Figure 6: Occupational Distribution

History of Misdiagnosis and Delayed Recognition

Fifteen patients (17.1%) reported prior misdiagnosis at other healthcare facilities, most commonly being treated for conjunctivitis or non-specific keratitis. Misdiagnosis was more frequent when lesions were located in the peripheral cornea, where subtle signs may be overlooked.[5,9,10] This emphasizes the importance of careful slit-lamp examination and clinical vigilance in both primary care and tertiary settings.

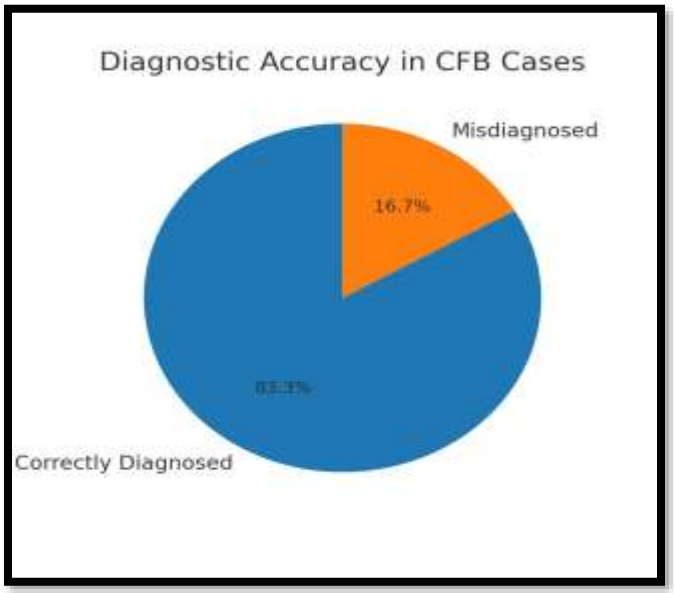

Figure 7: Percentage of misdiagnoses

Discussion

This study demonstrates that corneal foreign bodies (CFBs) represent a significant proportion of red eye presentations, with an incidence of 42.7%, highlighting the substantial burden of ocular trauma in this setting. These findings underscore the importance of considering traumatic etiologies in patients presenting with red eye, rather than assuming infective or inflammatory causes alone.[1,2]

Age and Gender Distribution

Working-age adults (21–40 years) dominated the cohort. Younger children and older adults were less commonly affected, reflecting their lower exposure to high-risk manual work. Male predominance was striking (86.7%), consistent with occupational patterns where men are more frequently employed in industrial, construction, and agricultural sectors.[4]These demographic trends reinforce the need

for targeted preventive strategies in working-age male populations.

Occupational Risks

Industrial occupations, particularly welding and grinding, were associated with the highest risk of CFBs. Beyond ophthalmology, occupational health literature highlights systemic underuse of protective eyewear in manual trades. Kumar et al. reported that compliance with protective devices among small-scale industrial workers rarely exceeds 40%, contributing to disproportionate ocular trauma risks.[6] Lin et al. emphasized that workplace safety interventions significantly reduce injuries when compliance is enforced.[7] These findings underline the global importance of occupational safety enforcement in reducing ocular trauma.

Type and Location of Foreign Bodies

Metallic fragments were the most common foreign bodies, accounting for over half of cases. The predominance of paracentral and central corneal locations in this cohort may relate to the trajectory of high-velocity metallic particles. These sites are clinically significant due to the potential for scarring in or near the visual axis. A global occupational injury survey also noted that high-velocity projectiles in metal industries frequently strike the upper or central visual field, consistent with our findings.[8]

Laterality

The right eye was slightly more frequently involved (56.7%), likely due to right-hand dominance and orientation during manual tasks.[2] Similar patterns have been observed in other studies of occupational ocular surface foreign bodies.

Misdiagnosis and Diagnostic Challenges

A notable finding was that 17.1% of patients had been misdiagnosed at other healthcare facilities, most commonly as conjunctivitis. Misdiagnosis was more frequent in peripheral corneal lesions, where subtle signs can be easily overlooked.[5] Thomas et al. demonstrated that peripheral lesions are prone to diagnostic delays in other specialties, highlighting the generalizable challenge of subtle presentations.[9] Mehta et al. emphasized that lack of diagnostic equipment or low-resource settings significantly increases the risk of misclassification, which parallels challenges seen in peripheral ocular foreign bodies.[10] These observations underscore the critical need for careful slit-lamp evaluation in all red eye presentations to prevent delayed diagnosis and potential morbidity.

Preventive Implications

The study identifies three key preventive priorities:

1. Routine slit-lamp examination for all red eye cases in secondary and tertiary centers.
2. Enhanced occupational safety policies, particularly in industries involving welding, grinding, and metalwork.
3. Education of primary care providers to recognize that not all red eyes are infective.

Protective eyewear is highly effective in reducing ocular trauma. Evidence from occupational safety literature confirms that enforcement of protective interventions is crucial to achieving meaningful reductions in trauma.[6,7]

Strengths and Limitations

Strengths of this study include systematic slit-lamp evaluation of all red eye presentations, detailed classification of foreign body type, site, and occupation, and the identification of prior misdiagnosis. Limitations include a single-center design, which may limit generalizability, potential recall bias regarding prior misdiagnosis, and lack of long-term follow-up to assess sequelae. Despite these limitations, the study provides robust insights into the epidemiology, risk factors, and clinical patterns of CFBs in a high-risk population. [5,6,7,8,9,10]

Conclusion

Corneal foreign bodies are a leading cause of red eye in Kanchipuram, accounting for nearly half of all presentations. They predominantly affect working-age males, particularly industrial labourers exposed to metallic fragments. Paracentral lesions are most common and pose significant risk to vision. Misdiagnosis remains a challenge, especially in peripheral corneal lesions, emphasizing the importance of thorough slit-lamp examination.

Human factors such as fatigue, stress, and insufficient sleep significantly increase the risk of ocular injuries in construction and industrial workers. Extended shifts with limited rest reduce alertness, slow reaction times, and heighten susceptibility to accidents, including corneal foreign bodies (CFBs).[11] Circadian rhythm disruptions further impair cognitive performance, attention, and motor coordination,[11] while high stress and cognitive strain exacerbate poor judgment and risk perception.[12]Disrupted sleep patterns associated with chronic musculoskeletal strain can worsen fatigue and decrease vigilance.[13] In addition, occupational exposure to environmental pollutants, such as smoke, dust, or toxic chemicals, can compromise ocular health, leading to irritation, inflammation, or other eye conditions.[14,15]

While metallic foreign bodies and industrial exposure remain the leading causes of CFBs, a substantial proportion arise from other sources. Stone and sand accounted for over one-fifth of cases, reflecting environmental hazards during agricultural work, construction, or outdoor activities. Plant debris caused approximately 15% of injuries, highlighting

risks associated with gardening, farming, and rural living. Glass, plastic, and miscellaneous materials contributed to a smaller fraction, often related to accidental contact in domestic, educational, or recreational settings. These findings underscore that corneal trauma is not restricted to industrial environments, and preventive strategies should consider environmental, occupational, and lifestyle factors beyond metalwork.

Systematic evaluation and preventive interventions are critical to reducing morbidity, minimizing diagnostic delays, and preserving vision in high-risk occupational populations.[6,8]

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Conflicts Of Interest:
We wish to disclose that there are no conflicts of interest related to this manuscript. All authors have read and approved the final version of the manuscript and agree with its submission.

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