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PREVALENCE AND CLINICAL AETIOLOGY OF CORNEAL BLINDNESS IN ADULT POPULATION – A CROSS-SECTIONAL OBSERVATIONAL STUDY

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Abstract:
Background: Corneal blindness remains a significant cause of visual impairment and blindness in developing nations, particularly in rural populations with limited access to healthcare. This study was undertaken to determine the prevalence and aetiology of corneal blindness in adults attending a tertiary care hospital. **Methods:** A cross-sectional observational study was conducted over a period of one year at the Department of Ophthalmology, SVRRGG Hospital. A total of 138 adult patients (aged 18–70 years) with best corrected visual acuity (BCVA) ≤3/60 in either or both eyes due to corneal causes were included. Data were collected using structured case forms, and clinical evaluation included slit-lamp examination, visual acuity assessment, and microbiological investigations where indicated. **Results:** The prevalence of corneal blindness was found to be 1.2%. The majority of the affected individuals were in the 41–50 year age group (28.3%), male (55.8%), from rural backgrounds (73.9%), and of lower socioeconomic status (81.1%). The most common occupations were farming and agricultural labor. Trauma (44.2%) was the leading cause of corneal blindness, followed closely by infectious keratitis (42.8%), with fungal ulcers being the most prevalent among infections. The most common clinical diagnosis was leucomatous corneal opacity (48.6%). **Conclusion:** Corneal blindness predominantly affects economically disadvantaged rural populations, with trauma and infectious keratitis being the leading causes. Preventive measures, improved access to eye care services, and awareness programs targeting rural agricultural communities are essential to reduce the burden of corneal blindness.

Keywords: Corneal blindness, Visual impairment, Infectious keratitis, Trauma, Rural health, Leucomatous opacity, Prevalence, Aetiology, Ophthalmology, Cross-sectional study

Introduction

Blindness continues to be one of the major public health problems in developing countries. According to the World Health Organization (WHO), visual acuity of less than 3/60 or a corresponding visual field loss of less than 10 degrees in the better eye with best possible correction is defined as blindness. The inability of a person to count fingers from a distance of six meters or 20 feet is referred to as economic blindness. Central visual acuity of 20/200 or less in the better eye or a visual field of 20 degrees or less is termed legal blindness. A decrease in visual acuity and/or visual field loss not caused

by any organic lesion is described as functional blindness, while manifest blindness is defined as vision ranging from 1/60 to perception of light.

Cataract and corneal diseases are major causes of blindness in countries with underdeveloped economies. According to the WHO, corneal diseases are among the leading causes of vision loss and blindness globally, ranking second only to cataract and glaucoma. In India, it is estimated that around 6.8 million people have vision less than 6/60 in at least one eye due to corneal diseases, with nearly one million having bilateral involvement. As per the National Programme for Control of Blindness (NPCB), approximately 120,000 people in the country are currently blind due to corneal diseases, with an annual addition of 25,000 to 30,000 new cases. The burden is particularly severe in developing countries, which account for 90% of the global cases of ocular trauma and corneal ulceration that lead to corneal blindness.

The term “avoidable” encompasses both preventable and treatable causes of blindness. The Andhra Pradesh Eye Disease Study (APEDS) reported that a significant proportion of corneal blindness in the rural population of Andhra Pradesh was avoidable. In this population, 95% of corneal blindness was deemed avoidable, with a prevalence of 0.66% in at least one eye. Treatable or curable blindness can be effectively managed through a robust and accessible healthcare delivery network. Approximately 50% of corneal blindness is considered treatable. However, there is a lack of extensive studies evaluating the economic burden of corneal blindness.

The WHO has reported changes in the national prevalence of blindness across survey periods. The prevalence was 1.1% in the 2001–02 survey, 1.0% in the 2006–07 survey, with a target of reducing it to 0.3% by 2020. The aetiology of corneal blindness includes a wide variety of infectious and inflammatory eye diseases such as keratitis, xerophthalmia, eye trauma, trachoma, congenital conditions, and the harmful use of traditional eye medicines. These home remedies often damage the eye rather than providing relief or improving vision.

The causes of corneal blindness vary by age group. In adults residing in less-developed economies, the most common causes based on indications for keratoplasty include corneal scars (28.1%) and active keratitis (12.2%). In the pediatric age group, acquired non-traumatic scars have been reported as the most common indication for keratoplasty, accounting for 71.32% of cases.

The APEDS was conducted in the state of Andhra Pradesh, one of the largest Indian states with a significant population. The demographic distribution of the state is pyramidal, with an estimated 35.6% of the population aged 15 years or younger, 25.7% between 16 to 29 years, and 38.7% aged 30 years or older. Approximately 73% of the state's population resides in rural areas, where agriculture is the predominant occupation.

The objectives of the APEDS were to determine the prevalence and causes of blindness and visual impairment, assess risk factors associated with major eye diseases, evaluate barriers to accessing eye care services, and understand the quality of life among the visually impaired. The study estimated the prevalence of blindness, defined as presenting visual acuity less than 20/200 or a central visual field of less than 20 degrees in the better eye, to be 1.84%. Among these cases, 7% were attributed to corneal diseases.

Aim

To identify the prevalence and aetiology of corneal blindness in the adult population.

Objectives

To estimate the prevalence of corneal blindness among the adult population and to identify the aetiology of corneal blindness among the adult population.

Methodology

Study design

This study was designed as a cross-sectional observational study conducted over a period of one year from the date of approval by the Institutional Ethical and Scientific Committee.

Study Population
The study included adult patients aged between 18 and 70 years who presented with diminution of vision due to corneal causes and had a best corrected visual acuity (BCVA) of less than 3/60 in either or both eyes (as measured by Snellen's chart). These patients attended the Department of Ophthalmology at SVRRGG Hospital.

Sample Size
The required sample size was calculated using the formula: $\mathbf{n = Z^2P(1-P)/d^2}$, where *n* is the sample size, *Z* is the statistic corresponding to the desired confidence level, *P* is the expected prevalence, and *d* is the desired precision. With an expected prevalence of 1.5% and a precision error of 75%, the calculated sample size was 138 subjects.

Inclusion criteria:
The study included adult patients aged between 18 and 70 years with defective vision due to corneal causes, best corrected visual acuity in either or both eyes ≤3/60, and those who were willing to participate in the study after providing informed consent.

Exclusion Criteria:
Patients with blindness due to causes other than corneal disease were excluded from the study.

Materials and Methods:
Following ethical approval, written and informed consent was obtained from each patient in their vernacular language. A detailed history was taken regarding the visual impairment and contributing factors. This was followed by a general physical and systemic examination. A comprehensive ophthalmic evaluation was performed, including assessment of visual acuity using Snellen's chart at a distance of six meters.
Each patient underwent the following procedures:
1. Best corrected visual acuity assessment using the Snellen's chart.
2. Anterior segment examination using slit-lamp biomicroscopy (Carl Zeiss Meditec AG07740, Jena, Germany).
3. Fundus examination conducted via both direct and indirect ophthalmoscopy, along with a +90 diopter lens.
4. In cases of active infective keratitis, corneal scrapings were performed. Under slit-lamp guidance and topical local anesthesia, material was obtained from the edge and base of the ulcer using a sterile No. 15 blade. Samples were mounted on glass slides and sent for microbiological evaluation, including Gram staining, KOH mount, and culture and sensitivity testing.

Data Collection and Statistical Analysis:
Data from each case was recorded in a structured data capture sheet that included the informed consent. Data was collected continuously over the 12-month study period and included variables such as age, sex, visual acuity, eye involved, laterality, occupation, place of residence, socioeconomic status, provisional diagnosis, and aetiology. For statistical analysis, the data was processed using the Statistical Package for the Social Sciences (SPSS), version 22 (Student Edition for Windows). Frequencies and percentages were calculated for categorical variables as appropriate.

Results
This is a cross-sectional observational study done in the department of Ophthalmology SVRRGG Hospital. During the study period, out of 11,322 cases, a total of 138 subjects with unilateral corneal blindness were included in the study with a prevalence of 1.2%. After detailed evaluation, data obtained in a case proforma sheet and entered into the excel sheet and statistical analysis was done using SPSS. The cases were studied according to age, gender, visual acuity, occupation, place of residence, laterality, socioeconomic status, provisional diagnosis and aetiology of corneal blindness.

Table 1: Descriptive statistics

Variable	Category	Frequency	Percentage
Age Group	**18–30**	19	13.80%
	31–40	14	10.10%
	41–50	39	28.30%
	51–60	34	24.60%
	61–70	32	23.20%
Gender	**Male**	77	55.80%
	Female	61	44.20%
Occupation	**Farmer**	48	34.80%
	Agricultural Labourer	34	24.60%
	Daily Labourer	29	21.00%
	Driver	3	2.20%
	House Wife	8	5.80%
	Student	16	11.60%
Residence	**Rural**	102	73.90%
	Urban	36	26.10%
Socioeconomic Status	**Lower Class**	112	81.10%
	Upper Lower	4	2.90%
	Lower Middle	7	5.10%
	Upper Middle	15	10.90%

Distribution of subjects with corneal blindness into various age groups. In this study, the most commonly affected individuals were in the age group of 41-50 with 39 (28.3%), closely followed by age group of 51-60 with 34 (24.6%) and 61-70 with 32 (23.2%). The least affected age group was of 31-40 with 14 (10.1%). Gender distribution in subjects having corneal blindness . In this study males were 77 in number out of 138 study participants when compared to females who were 61 in number out of 138 study subjects. Males (55.80%) were slightly commonly affected than females (44.20%). The various occupations of subjects having corneal blindness .This study shows that the farmers (34.8%) were most commonly affected and closely followed by agricultural labourers (24.6%) and then daily labourers (21.0%). Students were 11.6% and housewifes were 5.8% and least commonly affected were drivers (2.2%) The place of residence of subjects having corneal blindness. Most of the patients 102 out of 138 study subjects were belonging to the rural area when compared to the 36 out of 138 study participants in urban area. Majority of the patients were predominantly from rural areas 73.90% whereas only 26.10% were from urban region. People living in rural areas were more commonly affected than those in urban areas. The socioeconomic status of the corneal blindness patients. This study shows majority of the subjects belong to lower class (81.1%), followed by upper middle (10.9%), lower middle class (5.1%), and least commonly involved were upper lower class(4%).

Table 2: Clinical characteristics

Variable	Category	Frequency	Percentage
Eye Involved	**Right**	83	60.10%
	Left	55	39.90%
Visual Acuity	**1//60**	31	22.50%
	1//60	11	8.00%
	HM +ve	19	13.80%
	PL +ve	20	14.50%
	PL -ve	57	41.30%

Provisional Diagnosis	**Acid corneal burn**	4	2.90%
	Bacterial corneal ulcer	10	7.20%
	Full thickness corneal laceration	8	5.80%
	Fungal corneal ulcer	29	21.00%
	Leucomatous corneal opacity	67	48.60%
	Neurotrophic keratitis	4	2.90%
	Pseudophakic bullous keratopathy	14	10.20%
	Stromal keratitis	2	1.40%
Aetiology of Corneal Blindness	**Chemical injuries**	4	2.90%
	Infectious keratitis	59	42.80%
	Pseudophakic bullous keratopathy	14	10.10%
	Trauma	61	44.20%

The involvement of the eye in the corneal blindness subjects. In this study, right eye was most commonly involved (60.10%), in comparison to the left eye (39.90%).

The distribution of subjects with corneal blindness in visual acuity. Most of the subjects had visual acuity of PL -VE (41.3%) followed by the visual acuity of 1/60 (22.5%). Distribution of the subjects were similar in between HM +VE (13.8%) and PL +VE (14.5%). Least number of the patients had visual acuity of 2/60 (8%).

The distribution in various types of provisional diagnosis leading to corneal blindness. Majority of the patients had leucomaotus corneal opacity (48.6%) leading to corneal blindness. Second most common diagnosis was fungal corneal ulcer (21%). Other diagnoses were bacterial corneal ulcer (7.2%), full thickness corneal laceration (5.80%), acid corneal burn (2.90%), neurotrophic keratitis (2.9%) and the least of all was stromal keratitis (1.40%).

The aetiology of corneal blindness in various subjects. In this study, the cause of corneal blindness in majority of subjects was trauma(44.2%), followed by infectious keratitis(42.8%) which were seen more commonly than other causes like pseudophakic bullous keratopathy(10.1%) and chemical injuries(2.9%) which was the least of all.

Discussion

Corneal blindness continues to be the second most common cause of blindness in developing countries. Among various aetiologies, the most common causes of corneal blindness in developing nations are trauma and corneal ulceration. In the present study, out of 11,322 patients, 138 subjects had unilateral corneal blindness, amounting to a prevalence of 1.2%. The majority of the study population belonged to the middle age group (41–50 years), with a predominance of males over females. Most affected individuals were agricultural workers, including farmers, and the majority were of low socioeconomic status, residing in rural areas (73.90%).

The most common aetiology identified was trauma (44.2%) followed by infectious keratitis (42.8%). Among the infectious causes, fungal corneal ulcers were the most prevalent (21.0%). The most frequent provisional diagnosis was leucomatous corneal opacity (48.6%), typically resulting from trauma and infectious keratitis.

In terms of age distribution, most patients were in the 41–50 year range (28.3%), and 77% were older than 40 years. The mean age was 49.59 years with a standard deviation of 13.64 years. Previous studies have shown similar age trends. Kalaivani et al. reported that 38% of patients were aged 41–

60 years, with 60% above 40 years [8]. Pratik Narendra Mohod et al. found 41% of their patients in the 41–60 age range, followed by 23% in the 21–40 group [9]. Radhika Tandon et al. observed that 42% of cases were above 50 years, and 44% were aged 21–50 [10]. Manisha Acharya et al. reported a median age of 50 years, with the majority in the sixth decade [11]. Manisha Singh et al. studied a pediatric cohort under the age of 16 [12]. Most studies consistently show corneal blindness to be more common in older individuals, particularly beyond the fourth decade of life.

Regarding gender distribution, 55% of subjects in the current study were male and 45% were female. This aligns with findings by Kalaivani et al., who reported a male-to-female ratio of 54:46 [8]. Bharathi et al. found 59.03% of their subjects to be male [13]. Radhika Tandon et al. observed 75% male predominance [10], while Pratik Narendra Mohod et al. reported 61% male patients [9]. Nagpal et al. found 60% males [14], Manisha Acharya et al. observed 68.2% male participants [11], and Devi et al. noted a male majority of 66.13% [15]. Across these studies, there is often a male predominance, though it is not always statistically significant, and in some cases the difference is minimal.

Occupational analysis revealed that 34.8% of participants were farmers, 24% agricultural labourers, and 21% daily wage labourers. Most of the affected individuals worked in the agricultural sector. Pratik Narendra Mohod et al. found that 42.04% were farmers, followed by 29.54% involved in household work and 15.90% as labourers [9]. Radhika Tandon et al. found that only 31% of subjects were gainfully employed [10]. Srinivasan et al. showed that 56.4% of patients with corneal ulcers were farmers, with vegetative trauma being the most common cause [16]. Bharathi et al. similarly reported that 59.03% were agricultural workers, frequently injured by rice stalks, tree branches, or thorns [13]. Kalaivani et al. found 16% of patients were farmers and 20% were labourers [8]. These findings consistently point to agricultural work as a significant risk factor for corneal injury and subsequent blindness.

In terms of residence, 73.90% of the patients in this study were from rural areas, while 26.10% were from urban settings. Bharathi et al. reported 70.03% of cases were from rural regions [13]. Murthy et al. observed a 74.7% rural residency rate [17], and Vijaya et al. recorded 81.75% [18]. Nirmalan et al. also found that 75.83% of their patients came from rural areas [19]. Radhika Tandon et al. noted an even higher percentage, with 91.50% of subjects from rural settings [10]. Devi et al. reported 83.87% rural patients [15], while Nagpal et al. recorded 74.67% [14]. Across the literature, there is overwhelming agreement that corneal blindness is more prevalent among rural populations, likely due to occupational exposure and limited access to healthcare.

Regarding socioeconomic status, 81.1% of subjects in this study were from the lower class, with only 2.9% in the upper lower class. Devi et al. found 80.65% of patients were from the upper lower class [15]. Sharma et al. noted 67.8% were lower class, and 4.9% were from the upper class [20]. Dandona et al. reported that most patients with corneal blindness belonged to the lower class [21]. These findings support the association between lower socioeconomic status and increased risk of corneal blindness.

In terms of visual acuity, 41.3% of patients presented with no perception of light, while 22.5% had a visual acuity of 1/60. Only 8.0% had 2/60 vision. Nangalia et al. reported that 43% of their patients had only perception of light [22]. Devi et al. noted most patients had a visual acuity of ≤3/60, with a few retaining hand movement or light perception [15]. Delayed presentation at tertiary centers may explain the poor visual acuity seen in many patients.

Right eye involvement was observed in 60.1% of the cases, with 39.9% affecting the left eye. No patients had bilateral blindness in this study. In contrast, Kalaivani et al. reported 38% right eye, 28% left eye, and 34% bilateral involvement [8]. Devi et al. recorded 40.32% right, 45.16% left, and 14.52% bilateral blindness [15]. Nagpal et al. found 40% right, 52% left, and 8% bilateral cases [14]. Kounser et al. noted 92.8% of patients had unilateral blindness [26]. These findings show varying laterality across studies, with no clear pattern in terms of right or left eye predominance.

In this study, 48.6% of subjects were diagnosed with leucomatous corneal opacity, resulting from various causes including infectious keratitis and trauma. Kalaivani et al. found 42% of corneal opacity cases were due to infectious keratitis [8]. Feng et al. reported 17.4% of cases were bacterial keratitis [23], while Kounser et al. noted 23.2% [26]. Fungal corneal ulcers were observed in 21% of our cases,

compared to 38.2% reported by Gopinathan et al. [24], 48.7% by Bharathi et al. [13], and 16% by Hsiao et al. [25]. Kounser et al. found only 8.5% with fungal keratitis [26]. Full thickness corneal laceration was noted in 5.8% of patients in this study, and acid burns in 2.9%. Kalaivani et al., Dandona et al., Feng et al., and Kounser et al. all reported trauma-related corneal blindness in 10–28.6% [8, 21, 23, 26].

Trauma accounted for 44.2% of cases in the present study, closely followed by infectious keratitis at 42.8%. Pseudophakic bullous keratopathy contributed to 10.1% and chemical injuries to 2.9%. Maurin et al. emphasized that in tropical regions, corneal disease is second only to cataract as a cause of blindness [27]. Radhika Tandon et al. found 63.6% of cases were due to infectious keratitis [10]. Other studies from Ghana, Nepal, and Bangladesh reported even higher rates. Devi et al., Kounser et al., Nangalia et al., Kalaivani et al., and Nagpal et al. all identified infectious keratitis as a major factor [15, 26, 22, 8, 14].

Of the 42.8% of infectious keratitis cases in our study, 21% were fungal and the remainder bacterial. Trauma-related blindness was observed in 44.2% of patients, which is in line with studies from Kalaivani et al. (22%) [8], Kounser et al. (6.29%) [26], Nagpal et al. (13.33%) [14], Atti et al. (37%) [28], Veldanda et al. (59.3%) [29], and Dandona et al. (28.6%) [21]. High trauma rates were also noted in Paraguay (48%), Eastern Nepal (53%), South India (65%) [16], and Eastern India (83%). Sitoula et al. also reported trauma as the leading risk factor [30]. Given the rural, manual labour-intensive lifestyle of many patients, trauma is a frequent and significant cause. Education, awareness, and rehabilitation are critical, especially in preventing similar injuries in the unaffected eye.

Pseudophakic bullous keratopathy was identified in 10.1% of patients. Kounser et al. found 14.15% [26], Tandon et al. 8.9% [10], Nangalia et al. 5% [22], Devi et al. 4.8% [15], Sony et al. 6.18% [31], and Veldanda et al. 5.5% [29]. These findings are consistent across various studies.

Chemical injuries accounted for 2.9% of cases. These were more common in younger patients, with alkali injuries more prevalent than acid injuries. Studies suggest chemical injuries constitute 7.7% to 18% of ocular trauma cases. Kalaivani et al. found 6% [8], Nagpal et al. 13.33% [14], Devi et al. and Tandon et al. also reported similar findings [15, 10].

Conclusion

Corneal blindness is an important cause of blindness in India. The study of corneal blindness becomes important as it is preventable and curable to a large extent and preventive measures prove to be the most cost-effective means of decreasing the global burden of corneal blindness. Infectious keratitis and trauma are the most common cause of corneal blindness. Timely management of infectious keratitis and trauma can decrease the permanent damage to cornea and decrease corneal opacity and blindness.

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