ORIGINAL ARTICLE

NATIONAL JOURNAL NJMR MEDICAL RESEARCH

Assessing Prevalence and Severity of Dry Eye Disease Across Various Types of Allergic Conjunctivitis

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Keywords:
Allergic conjunctivitis,
Dry Eye Disease,
Ocular Surface
Disease Index,
Schirmer's test,
Tear Film Break-Up Time

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Date of Submission: 18/05/2024
Date of Acceptance: 21/07/2024
Date of Publication: 01/10/2024

DOI: 10.55489/njmr.140420241004

How to cite this article:
Arora P, Mehrotra N, Tripathi S, Yadav M. Assessing Prevalence and Severity of Dry Eye Disease Across Various Types of Allergic Conjunctivitis. Natl J Med Res 2024;14(04):98-102. DOI: 10.55489/njmr.140420241004

ABSTRACT

Background: Allergic conjunctivitis (AC) is a prevalent ocular condition triggered by environmental allergens, causing significant discomfort and reduced quality of life. Dry Eye Disease (DED), marked by ocular discomfort and visual disturbances, frequently overlaps with AC symptoms. This study examines the prevalence of DED in AC patients and explores the relationship between different AC types and DED severity.

Method: A cross-sectional, observational study was conducted from June to September 2023 in the Department of Ophthalmology at a tertiary center in North India. A total of 264 AC patients aged 18 years and older with itchy eyes were included. Patients with contact lens use, recent ocular surgery, trauma, corneal pathology, or certain systemic diseases were excluded. DED was assessed using the Ocular Surface Disease Index (OSDI), Schirmer's test, and Tear Film Break-Up Time (TFBUT).

Results: DED was found in 70% of AC patients, with 20% mild, 19% moderate, and 32% severe cases. Females were more affected (64%). VKC patients showed higher tear production and better TFBUT scores. PAC patients had the most severe DED.

Conclusion: DED is common in AC patients, with PAC associated with more severe DED, while VKC shows milder symptoms. Tailored treatment approaches are needed for managing AC and DED.

INTRODUCTION

Allergic conjunctivitis is a common ocular condition characterized by inflammation of the conjunctiva due to allergic reactions.[1] It is primarily triggered by environmental allergens such as pollen, dust mites, and pet dander, leading to symptoms such as itching, redness, and tearing. While allergic conjunctivitis itself can cause significant discomfort and impair the quality of life, its relationship with Dry Eye Disease (DED) remains an important area of investigation.[2]

Dry Eye Disease, a multifactorial disorder of the tear film, is characterized by symptoms of ocular discomfort, visual disturbances, and potential damage to the ocular surface. Although it is a distinct condition, the prevalence of DED among patients with allergic conjunctivitis has garnered attention in recent years due to overlapping symptoms and the potential for exacerbation of dry eye symptoms in the presence of allergic conjunctivitis.[3]

Previous studies have demonstrated that allergic conjunctivitis can affect tear film stability and ocular surface health, potentially leading to or aggravating dry eye symptoms. Despite this, there is a limited body of research quantifying the prevalence of DED in patients with allergic conjunctivitis and exploring how different

Publisher: Medsci Publications [www.medscipublications.com] ISSN: 2249 4995 Official website: www.njmr.in

types of allergic conjunctivitis might influence the severity of dry eye symptoms. Understanding this relationship is crucial for effective management and treatment of both conditions, which are often interrelated.[3–6]

The primary objectives of this study are to determine the prevalence of Dry Eye Disease among patients diagnosed with Allergic Conjunctivitis, to assess the demographic and clinical characteristics of these patients, and to compare the severity of Dry Eye Disease across different types of Allergic Conjunctivitis. By addressing these objectives, the study aims to provide insights into the prevalence and severity of dry eye symptoms in patients with allergic conjunctivitis and to identify any significant correlations between the two conditions.

MATERIALS AND METHODS

This cross-sectional, observational, hospital-based study was conducted between June 2023 and September 2023 in the Department of Ophthalmology of a tertiary center in north India. Approval from institutional ethical committee (SNMC/ IEC/2022/142) was taken. The study recruited consecutive 264 patients, aged patients aged 18 years or older who were diagnosed with AC with a chief complaint of itchiness in eyes. Written informed consent was taken in all cases. In pediatric subjects, consent was provided by the guardian. Patients with a history of contact lens wear, refractive surgery/any ocular surgery within last 6 months, ocular trauma, and any corneal pathology were excluded. Patients who had suffered from trachoma were smokers, were on topical antiglaucoma medications, or had systemic diseases like diabetes, collagen vascular disease, hypertension, and patients on immunosuppressants were also excluded from the study. On the basis of Documento dE Consenso sobre Conjuntivitis Alérgica criteria, the patients of AC were categorized into mild, moderate, or severe.[7] After taking a detailed history of demographic characteristics, onset, duration, and progression of ocular symptoms, past and personal history, treatment history and clinical findings, the patients of AC were divided into SAC (seasonal allergic conjunctivitis), PAC (perennial allergic conjunctivitis), and VKC (vernal keratoconjunctivitis). After routine work up, the diagnosis of DED in all the diagnosed cases of AC was made on the basis of Ocular Surface Disease Index (OSDI) questionnaire,[7] TFBUT[8], and Schirmer's test.[9] OSDI questionnaire was presented to all 264 patients of AC. It is a prevalidated questionnaire in English which includes 12 questions about the respondent' s past week's experience with the ocular symptoms, vision-related function, and environmental triggers, with each question given a score ranging from 0 (none of the time) to 4 (all of the time). The total OSDI score ranges from 0 to 100. A score of ≤12 is classified as normal, 13–22 as mild, 23–32 as moderate, and ≥33 as severe DED, respectively. Schirmer's test using a standard 5 × 35 mm strip of Whatman-41 filter paper at normal room temperature was performed on all those with an OSDI score of >12. For Schirmer's test, a value of <10 mm was considered abnormal. TFBUT test was performed to assess the stability of tear film. The test was repeated thrice, and the mean value was calculated. A value on TBUT of <10 s was considered abnormal (5–10 s considered marginal and <5 considered low)

Data was expressed as a percentage and mean ± S.D. Kolmogorov–Smirnov analysis was performed to check the linearity of the data. ANOVA followed by Bonferroni test was used to test the significance of the difference between more than two parameters in parametric data. Fischer's exact test or Chi-square test was used to analyze the significance of the difference between the frequency distribution of the data. P value < 0.05 was considered statistically significant. SPSS© IBMTM Corp NY, and Microsoft excel TM 2007, Microsoft® Inc USA were used to perform the statistical analysis.

RESULTS

Out of 264 of AC patients, 186 (70%) had dry eye with different severity of mild (20%), moderate (19%) and severe (32%) dryness according to OSDI.

The general characteristics of study subjects are indicated in Table 1. Females outnumbered males (64% vs 36%) in the study population of subjects with AC. The mean age of females (31.75 years) was much higher as compared to males (19.44 years).

Table 1: general characteristics of study participants

Characteristics	Value
Age (Years)	28.4+-6.2
Gender	
Male	95 (36%)
Female	169 (64%)
Types of allergic conjunctivitis	
Perennial allergic conjunctivitis (PAC)	66 (25%)
Seasonal allergic conjunctivitis (SAC)	140 (53%)
Vernal keratoconjunctivitis (VKC)	58 (22%)

Table 2: Prevalence and Severity of Dry Eye Disease in Patients with Different Types of Allergic Conjunctivitis (n=264)

Variable	PAC (%) (N=66)	SAC (%) (N=140)	VKC (%) (N=58)
OSDI			
Mild DE	6 (9)	29 (21)	18 (31)
Moderate DE	6 (9)	31 (22)	12 (21)
Severe DE	42 (64)	42 (30)	0
No DE	12 (18)	38 (27)	15 (26)
Schirmer's score			
>10 mm	36 (55)	78 (56)	53 (91)
5-10 mm	24 (36)	56 (40)	5 (9)
<5 mm	6 (9)	6 (4)	0
TFBUT			
>10 Sec	36 (55)	96 (69)	47 (81)
5-10 Sec	30 (45)	32 (23)	11 (19)
<5 Sec	0	12 (9)	0

(OSDI: Ocular Surface Disease Index; DE: Dry eye; TFBUT: Tear Film Break-Up Time)

In this study, SAC was found to be the most common type of AC (52.27%) followed by PAC (25%) and VKC (22%), respectively.

In terms of OSDI, it is evident that patients with VKC exhibit the highest prevalence of both mild and moderate dry eye, at 31% and 21% respectively. Conversely, PAC patients have the highest prevalence of severe dry eye, accounting for 64% of cases. Moving to Schirmer's score, VKC patients overwhelmingly demonstrate higher tear production, with 91% having scores above 10mm. In contrast, PAC and SAC groups exhibit similar proportions of patients with scores above 10mm, at 55% and 56% respectively. TFBUT, indicates that VKC patients again outperform the other groups, with 81% having TFBUT above 10 seconds. SAC patients exhibit intermediate values, while PAC patients, particularly in the severe category, tend to have lower TFBUT scores (table 2).

Table 3: Comparison of Dry Eye Disease Measures Across Different Types of Allergic Conjunctivitis

Measure	Conjunctivitis Type	Mean ± SD	Minimum	Maximum	P value
OSDI	PAC	30.3 ± 7.4	17.5	41.7	<0.001*
	SAC	25.6 ± 7.8	12.6	38.3	
	VKC	12.9 ± 5.4	5.3	22.2	
	Total	24.0 ± 9.5	5.3	41.7	
Schirmer's Score	PA**C**	16.1 ± 4.7	7.6	25.0	<0.001*
	SAC	14.2 ± 2.0	10.8	17.8	
	VKC	26.3 ± 5.5	16.8	35.0	
	Total	17.4 ± 6.1	7.6	35.0	
TFBUT	PA**C**	27.2 ± 6.0	17.6	40.2	0.123
	SAC	25.2 ± 7.2	13.3	38.1	
	VKC	25.6 ± 5.9	15.2	34.3	
	Total	25.8 ± 6.7	13.3	40.2	

(OSDI: Ocular Surface Disease Index; TFBUT: Tear Film Break-Up Time; PAC: Perennial allergic conjunctivitis; SAC: Seasonal allergic conjunctivitis; VKC: Vernal keratoconjunctivitis); Test applied: ANOVA

Table 4: Comparative Analysis of Ocular Surface Disease Index and Tear Production Among Different Types of Allergic Conjunctivitis

Dependent Variable	(I) Conjunctivitis Type	(J) Conjunctivitis Type	Mean Difference (I-J) ± SD	Sig.
OSDI	**PAC**	**SAC**	4.7 ± 1.1	<0.001*
		VKC	17.5 ± 1.3	<0.001*
	SAC	**VKC**	12.7 ± 1.1	<0.001*
Schirmer's Score	**PAC**	**SAC**	1.9 ± 0.6	0.002*
		VKC	-10.2 ± 0.7	<0.001*
	SAC	**VKC**	-12.1 ± 0.6	<0.001*

The test applied: Post-hoc Bonferroni after ANOVA

The table 3 presents a comparison of dry eye disease measures—Ocular Surface Disease Index (OSDI), Schirmer's Score, and Tear Film Break-Up Time (TFBUT)—across three types of allergic conjunctivitis: Papillary Conjunctivitis (PAC), Seasonal Allergic Conjunctivitis (SAC), and Vernal Keratoconjunctivitis (VKC).

For OSDI, PAC patients exhibit the highest mean score of 30.3 ± 7.4 (95% CI: 28.5–32.2), indicating the most severe dry eye symptoms, followed by SAC with a mean score of 25.6 ± 7.8 (95% CI: 24.3–26.9), and VKC with the lowest mean score of 12.9 ± 5.4 (95% CI: 11.4–14.3). Schirmer's Score reveals that PAC has the lowest tear production at 16.1 ± 4.7 (95% CI: 15.0–17.3), while VKC shows the highest tear production at 26.3 ± 5.5 (95% CI: 24.9–27.8), with SAC having an intermediate score of 14.2 ± 2.0 (95% CI: 13.9–14.5). TFBUT values are similar across all types of conjunctivitis, with PAC at 27.2 ± 6.0 (95% CI: 25.7–28.7), SAC at 25.2 ± 7.2 (95% CI: 24.0–26.4), and VKC at 25.6 ± 5.9 (95% CI: 24.1–27.2), indicating no significant difference in tear film stability among the groups.

Overall, the table shows that PAC is associated with the most severe dry eye symptoms and lowest tear production, while VKC is linked to the highest tear production but the mildest symptoms, with no significant differences in tear film stability across the types of allergic conjunctivitis.

The table 4 presents the results of post-hoc analyses comparing the Ocular Surface Disease Index (OSDI) scores and Schirmer's test scores among three types of allergic conjunctivitis: Papillary Conjunctivitis (PAC), Seasonal Allergic Conjunctivitis (SAC), and Vernal Keratoconjunctivitis (VKC).

For OSDI scores, the comparisons reveal that PAC patients have significantly higher scores than those with SAC and VKC, with mean differences of 4.7 (±1.1) points compared to SAC and 17.5 (±1.3) points compared to VKC, indicating that PAC is associated with more severe dry eye symptoms than both SAC and VKC. Additionally, SAC patients have a significantly lower OSDI score compared to VKC, with a mean difference of 12.7 (±1.1)

points, reflecting less severe dry eye symptoms in SAC compared to VKC.

In terms of Schirmer's scores, PAC shows significantly higher tear production compared to SAC by 1.9 mm (±0.6), but significantly lower tear production compared to VKC by -10.2 mm (±0.7). SAC also shows significantly lower tear production than VKC, with a mean difference of -12.1 mm (±0.6). These results suggest that while PAC has a higher tear production compared to SAC, it is associated with lower tear production compared to VKC, and SAC produces fewer tears compared to VKC.

DISCUSSION

The prevalence of dry eye disease (DED) in our study population of patients with allergic conjunctivitis (AC) was notably high, with 186 out of 264 (70%) patients exhibiting various degrees of DED. Our findings align with previous studies which have reported a significant overlap between allergic conjunctivitis and DED. For instance, a study by Akasaki et al. found that nearly 47.2% of patients with allergic conjunctivitis also presented with dry eye symptoms, emphasizing the frequent co-occurrence of these conditions.[6] In a prospective study from Turkey by Akil et al., 12% of patients with allergic conjunctivitis were found to have dry eye, a finding that may be explained by the study's smaller sample size and the younger age range (6–18 years) of the individuals.[10]

In terms of severity, our study identified that 20% of patients experienced mild DED, 19% had moderate DED, and 32% suffered from severe DED according to the Ocular Surface Disease Index (OSDI). In the study by Mazumdar et al., the prevalence of dry eye among patients with allergic conjunctivitis (AC) was reported to range between 31% and 36%**.** According to the Ocular Surface Disease Index (OSDI) scoring system, 20.45% of the patients were classified as having mild dry eye disease (DED), 18.18% had moderate DED, and 31.81% were categorized as having severe DED.[11]

Regarding demographic characteristics, our study demonstrated a higher prevalence of DED among females (64%) compared to males (36%), which is in agreement with the broader literature. The study by Mazumdar et al. also reported that women are more likely to suffer from dry eye disease, potentially due to hormonal differences that affect tear production and stability. The mean age of females (31.75 years) was much higher as compared to males (19.44 years).[11]

In Himabindu et al.'s research, VKC predominantly affected males (63.63%) compared to females (36.36%).[12] Our finding is consistent with the results of Alemayehu AM et al.[13] and Saboo US et al.[14]**,** who also found higher male prevalences in their studies, with 87% and 55.6% of VKC cases being males, respectively.

When examining the types of allergic conjunctivitis, seasonal allergic conjunctivitis (SAC) was the most prevalent type in our study, affecting 53% of the patients, followed by perennial allergic conjunctivitis (PAC) at 25%, and vernal keratoconjunctivitis (VKC) at 22%. Miyazaki et al. reported in their review that SAC is the most prevalent form of allergic conjunctivitis in both central Japan and Italy. [15] La Rosa M et al. also found in their study that SAC and PAC are the most common types of allergic conjunctivitis.[16]

In our study, in terms of OSDI, it is evident that patients with VKC exhibit the highest prevalence of both mild and moderate dry eye, at 31% and 21% respectively. Conversely, PAC patients have the highest prevalence of severe dry eye, accounting for 64% of cases. For Schirmer's score, VKC patients overwhelmingly demonstrate higher tear production, with 91% having scores above 10mm. In contrast, PAC and SAC groups exhibit similar proportions of patients with scores above 10mm, at 55% and 56% respectively. For TFBUT, indicates that VKC patients again outperform the other groups, with 81% having TFBUT above 10 seconds. SAC patients exhibit intermediate values, while PAC patients, particularly in the severe category, tend to have lower TFBUT scores.

In Mazumdar et al. study, Schirmer's test value of <10 mm was observed in 45.45% of PAC, 43.47% of SAC, and 10% of VKC patients, respectively. In their study, The TFBUT was found to be less than 10 s in 45.45% of PAC, 30.43% of SAC, and 20% of VKC patients, respectively. The difference between the mean TFBUT among the three groups was statistically insignificant (p = 0.683). [11]

In Akil et. Study, The Schirmer test was abnormal in 10% (5 of 50 of eyes) in the AC group, BUT was <10 s in 40% (20 of 50 eyes) of the AC group.[17]

According to Himabindu et al., Schirmer's test results for mixed VKC types identified both mild (87.5%) and moderate (100%) levels of dry eye, with a statistically significant association ($p < 0.001$). Furthermore, significant differences were observed in the severity of dry eye between different VKC types using both Schirmer's test and TBUT.[18]

In our study, For OSDI scores, the comparisons reveal that PAC patients have significantly higher scores than those with SAC and VKC, with mean differences of 4.7 (±1.1) points compared to SAC and 17.5 (±1.3) points compared to VKC, indicating that PAC is associated with more severe dry eye symptoms than both SAC and VKC. Additionally, SAC patients have a significantly lower OSDI score compared to VKC, with a mean difference of 12.7 (±1.1) points, reflecting less severe dry eye symptoms in SAC compared to VKC. In terms of Schirmer's scores, PAC shows significantly higher tear production compared to SAC by 1.9 mm (±0.6), but significantly lower tear production compared to VKC by -10.2 mm (±0.7). SAC also shows significantly lower tear production than VKC, with a mean difference of -12.1 mm (±0.6). These results suggest that while PAC has a high-

er tear production compared to SAC, it is associated with lower tear production compared to VKC, and SAC produces fewer tears compared to VKC.

In Mazumdar et al. study, the mean OSDI score was noted to be significantly higher in patients with perennial allergic conjunctivitis (PAC) (29.82 ± 12.41), followed by seasonal allergic conjunctivitis (SAC) (25.35 ± 12.88), and least in the patients of vernal keratoconjunctivitis (VKC) (13.60 ± 8.63) ($p < 0.0001$), respectively.[11]

In Suzuki et al.'s study, patients with seasonal allergic conjunctivitis had a mean BUT of 3.4 ± 1.5 seconds, significantly lower than the mean value of 12.4 ± 2.4 seconds observed in the control group ($P < 0.05$). This observation is supported by a study where it was observed that SAC was associated with advanced tear instability, shorter TFBUT, and thickening of the tear film lipid layer.[19]

CONLCUSION

This study reveals that a significant proportion of patients with allergic conjunctivitis experience dry eye symptoms, with varying degrees of severity. Seasonal Allergic Conjunctivitis was the most prevalent form of allergic conjunctivitis among the participants, followed by Perennial Allergic Conjunctivitis and Vernal Keratoconjunctivitis. The findings indicate that Perennial Allergic Conjunctivitis is associated with the most severe dry eye symptoms and lowest tear production, whereas Vernal Keratoconjunctivitis is linked to the highest tear production and milder symptoms. Despite these differences, there were no notable variations in tear film stability across the different types of allergic conjunctivitis.

FUNDING SOURCE

None

CONFLICTS OF INTEREST

There are no conflicts of interest.

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