

## Correlation of Ocular rubbing, Tear film stability, and Irregular astigmatism in Allergic Conjunctivitis

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**Background:** A common inflammatory condition of the eyes, allergic conjunctivitis is characterized by persistent itching, which often results in habitual rubbing of the eyes. The purpose of this study was to look into the relationship between tear film stability, irregular astigmatism, and ocular rubbing behavior in allergic conjunctivitis patients.

**Objective:** To investigate the correlation between ocular rubbing frequency, tear film stability and irregular astigmatism in patients with Allergic Conjunctivitis. To determine whether patients with allergic conjunctivitis have irregular astigmatism and how often they rub their eyes. To assess how patients with allergic conjunctivitis'

tear film stability and irregular astigmatism relate to one another.

**Methodology:** This cross-sectional observational study was carried out at District Headquarter Hospital Khushab's outpatient department. Over the course of four months, convenience sampling was used to enroll 124 patients who had been diagnosed with allergic conjunctivitis. Individuals with a confirmed diagnosis of allergic conjunctivitis between the ages of 10 and 40 were included; those with corneal ectasia, previous ocular surgery, dry eye unrelated to allergies, or systemic eye diseases were not. Keratometry readings were used to measure irregular astigmatism, Tear Break Up Time was used to assess tear film stability, and a standardized scoring system was used to measure ocular rubbing behavior.

**Results:** This study included 124 allergic conjunctivitis patients in total. Both the right eye ( $r = -0.573$ ,  $p < 0.001$ ) and the left eye ( $r = -0.534$ ,  $p < 0.001$ ) showed a significant negative correlation between the ocular rubbing score and TBUT, according to Spearman correlation analysis. The ocular rubbing score and irregular astigmatism in the right eye ( $r = 0.496$ ,  $p < 0.001$ ) and left eye ( $r = 0.570$ ,  $p < 0.001$ ) were found to significantly positively correlate. Additionally, there was a

significant negative correlation between astigmatism and tear film stability in both eyes (RE:  $r = -0.564$ , LE:  $r = -0.516$ ,  $p < 0.001$ ), suggesting that increased corneal astigmatism is linked to decreased tear film stability.

**Conclusion:** In patients with allergic conjunctivitis, the current study showed strong associations between tear film stability, irregular astigmatism, and ocular rubbing behavior. Greater corneal astigmatism and decreased tear film stability were linked to increased ocular rubbing, while irregular astigmatism was further linked to decreased tear film stability. These results highlight the significance of early detection and management of ocular rubbing behavior to prevent visual deterioration by suggesting that habitual eye rubbing in allergic conjunctivitis patients contributes to progressive ocular surface and corneal changes.

## INTRODUCTION

The eyes are among the most vital organs in the human body. They make it possible for us to see and comprehend our environment. However, a variety of conditions can create life-threatening issues and significantly decrease eye function. One such condition that can gravely harm the eyes and overall health if left untreated is conjunctivitis <sup>(1)</sup>. An ocular manifestation of the body's immune reaction to other normally innocuous substances known as allergens is allergic eye disease. Genetics, air pollution, atopy, pollen exposure, inflammation, and pet hair are some of the contributing factors that can cause allergic conjunctivitis. Mold spores, house dust mites, animal/pest dander, and tree/grass pollen are a few common allergens to the conjunctival surface <sup>(2)</sup>. Atopic, vernal, seasonal/perennial, and large papillary conjunctivitis are some of the subtypes of allergic conjunctivitis. Different clinical manifestations and underlying pathophysiological mechanisms are distinguished by these classifications <sup>(3)</sup>. The signs and symptoms of allergic conjunctivitis vary and can be quite severe, affecting one's quality of life and possibly endangering one's vision. Clinical symptoms like itching, burning, tearing, chemosis, and papillae appear in the early stages of allergic conjunctivitis when histamine binds to its receptor. Chronic inflammation results from the invasion of the conjunctiva by immune cells like eosinophils. This may have an

impact on vision <sup>(4)</sup>. One common behavioral manifestation is rubbing one's eyes. It usually happens in reaction to an unpleasant sensory stimulus, such as ocular pruritus or irritation <sup>(5)</sup>. Regular eye rubbing can weaken the corneal epithelial barrier, raising the risk of infection. It can also cause structural irregularities and mechanical changes in the cornea. In patients with AC, prolonged eye rubbing may temporarily raise intraocular pressure (IOP) and damage the cornea's collagen structure <sup>(6)</sup>. The cornea's outer layer, conjunctiva, eyelid margin, and tear film are all parts of the ocular surface. The ocular surface's health, comfort, mechanical, environmental, and immunological protection are all attributed to tear film <sup>(7)</sup>. Unstable tear film, elevated tear osmolarity, and ongoing inflammation are characteristics of dry eye disease (DED), a complicated condition affecting the ocular surface. Depending on diagnostic standards and demographic variables, the condition affects 5% to 35% of people worldwide. There is a considerable overlap between dry eye disease and allergic conjunctivitis, especially in long term cases where inflammation impairs mucins production, goblet cell function, and tear film stability. Furthermore, by decreasing tear production, antihistamines that are frequently prescribed to treat the symptoms of allergic conjunctivitis can make dry eye disease worse <sup>(8)</sup>. One of the most prevalent refractive errors in ophthalmic practice is astigmatism, which has a major impact on visual performance by lowering the quality of the image and making the eyes more uncomfortable <sup>(9)</sup>. One of the main reasons why apparently healthy eyes have inferior visual function, such as corrected visual acuity and contrast sensitivity, is irregular astigmatism, which is defined as astigmatism that cannot be corrected by spherocylindrical spectacle lenses. Both ocular procedures and a variety of corneal illnesses can cause pathological alterations in corneal irregular astigmatism. In normal human eyes, corneal uneven astigmatism is known to physiologically grow with aging <sup>(10)</sup>. There is growing evidence that climate change and air pollution are major risk factors for the development of Allergic Conjunctivitis. It not only makes Allergic Conjunctivitis symptoms worse, but it also raises the prevalence of its severe manifestations <sup>(11)</sup>. Itching, redness, and pain are symptoms of allergic conjunctivitis (AC), which frequently results in continuous scratching of the eyes. This may lead to

uneven astigmatism, collagen disruption, and corneal stress. Additionally, allergic conjunctivitis causes the tear film to become unstable, which exacerbates discomfort and encourages additional rubbing, resulting in a vicious cycle of corneal deformation. Although each of these elements is well-known, little research has been done on how they work together, particularly in Pakistan. Early detection, patient education, and the avoidance of long term visual issues can all be aided by an understanding of the connection between irregular astigmatism, tear film stability, and eye rubbing.

### Methodology

This cross-sectional observational study was carried out in the outpatient department of District Headquarter (DHQ) Hospital Khushab, Punjab Pakistan. Convenience sampling was used to enroll 124 patients with a diagnosis of allergic conjunctivitis. Patients between the ages of 10 and 40 who gave written informed consent and had a verified long-term diagnosis of allergic conjunctivitis were included. Individuals with systemic diseases affecting the eyes, dry eye unrelated to allergies, corneal ectasia, or previous ocular surgery were not included. A structured proforma was used to record demographic data, such as age and gender. A standardized scoring system with a maximum score of 12 was used to evaluate the frequency, intensity, duration per episode, and chronicity of ocular rubbing behavior. Using fluorescein strips and slit lamp biomicroscopy, the Tear Break Up Time test was used to assess the stability of the tear film. Tear film instability was indicated by values less than 10 seconds, which were measured in seconds between the last full blink and the first dry spot to appear on the corneal surface. Keratometry was used to measure irregular astigmatism; astigmatism was computed as the difference between K2 and K1 readings. For statistical analysis, all data were input into SPSS version 25.0. For every continuous variable, descriptive statistics such as the mean and standard deviation were computed. The Shapiro-Wilk test was used to evaluate the data's normality, and the results showed that all variables had non-normal distributions. Thus, the association between ocular rubbing score, TBUT, and irregular astigmatism was assessed using the Spearman rank correlation coefficient. A statistically significant

p-value was defined as less than 0.05. All participants provided written informed consent, and the Superior University Lahore, Sargodha Campus Research Ethical Committee granted ethical permission (Ref: SU/SGD/AHS/26/0018).

**Results**

**Descriptive Statistics**

The total ocular rubbing score, tear breakup time (TBUT) for both eyes, and keratometry astigmatism values for both eyes were among the primary study variables for which descriptive statistics were computed. Measures of dispersion (standard deviation, minimum and maximum values) and central tendency (mean) were used to summarize the data. The average ocular rubbing score was  $7.63 \pm 2.054$ , astigmatism in the right eye was  $0.92 \pm 0.75$  diopters, astigmatism in the left eye was  $0.98 \pm 0.82$  diopters, and TBUT right eye was  $6.81 \pm 3.595$  seconds, TBUT left eye was  $7.14 \pm 3.623$  seconds."

**Table 1: Descriptive Statistics of Main Variables**

		Statistic	Std. Error	
Total Ocular Rubbing Score(Sum of 4 parameters)	Mean	7.63	.184	
	95% Confidence Interval for Mean	Lower Bound	7.26	
		Upper Bound	7.99	
	5% Trimmed Mean		7.68	
	Median		7.00	
	Variance		4.219	
	Std. Deviation		2.054	
	Minimum		1	
	Maximum		12	
	Range		11	

	Interquartile Range		3	
	Skewness		-.242	.217
	Kurtosis		.052	.431
TBUT Right Eye	Mean		6.81	.323
	95% Confidence Interval for Mean	Lower Bound	6.17	
		Upper Bound	7.45	
		5% Trimmed Mean	6.73	
	Median		7.00	
	Variance		12.922	
	Std. Deviation		3.595	
	Minimum		1	
	Maximum		18	
	Range		17	
	Interquartile Range		6	
	Skewness		.205	.217
	Kurtosis		-.443	.431
TBUT Left Eye	Mean		7.14	.325
	95% Confidence Interval for Mean	Lower Bound	6.49	
		Upper Bound	7.78	
		5% Trimmed Mean	7.06	
	Median		7.00	

	Variance		13.127	
	Std. Deviation		3.623	
	Minimum		1	
	Maximum		18	
	Range		17	
	Interquartile Range		6	
	Skewness		.115	.217
	Kurtosis		-.560	.431
Keratometry (K2-K1)Right Eye	Mean		.9201	.06742
	95% Confidence Interval for Mean	Lower Bound	.7866	
		Upper Bound	1.0535	
	5% Trimmed Mean		.8664	
	Median		.7500	
	Variance		.564	
	Std. Deviation		.75075	
	Minimum		.00	
	Maximum		6.00	
	Range		6.00	
	Interquartile Range		.75	
	Skewness		2.844	.217
	Kurtosis		16.064	.431
Keratometry (K2-K1)Left Eye	Mean		.9777	.07348
	95% Confidence Interval	Lower	.8322	

	for Mean	Bound		
		Upper Bound	1.1231	
	5% Trimmed Mean		.9071	
	Median		.7500	
	Variance		.670	
	Std. Deviation		.81825	
	Minimum		.00	
	Maximum		6.00	
	Range		6.00	
	Interquartile Range		.75	
	Skewness		2.361	.217
	Kurtosis		10.719	.431

Table 2: Percentiles of Main Variables

		Percentiles						
		5	10	25	50	75	90	95
Weighted Average (Definition 1)	Total Ocular Rubbing Score(Sum of 4parameters)	4.00	5.00	6.00	7.00	9.00	10.00	11.00
	TBUT Right Eye	1.00	2.00	4.00	7.00	10.00	11.00	12.00
	TBUT Left Eye	2.00	2.00	4.00	7.00	10.00	11.00	12.75
	Keratometry	.0000	.2500	.5000	.7500	1.250	2.000	2.000

	(K2-K1)Right Eye						0	0
	Keratometry (K2-K1)Left Eye	.0000	.2500	.5000	.7500	1.250	2.000	2.500
						0	0	0
<b>Tukey's Hinges</b>	Total Ocular Rubbing Score(Sum of 4parameters)			6.00	7.00	9.00		
	TBUT Right Eye			4.00	7.00	10.00		
	TBUT Left Eye			4.00	7.00	10.00		
	Keratometry (K2-K1)Right Eye			.5000	.7500	1.250	0	
	Keratometry (K2-K1)Left Eye			.5000	.7500	1.250	0	

**Normality Testing**

The Shapiro-Wilk test was used to evaluate the normality of the data. The total ocular rubbing score (p=0.002), TBUT right eye (p=0.001), TBUT left eye (p=0.001), and keratometry right eye (p=0.000) were all found to be non-normally distributed (p<0.05). For additional statistical analysis, the Spearman rank correlation coefficient was employed because the majority of variables did not meet the normalcy assumption.

Table 3: Test of Normality

Parameters	Statistic	df	Sig.	Statistic	df	Sig.
Total Ocular Rubbing Score(Sum of 4parameters)	.136	124	.000	.964	124	.002
TBUT Right Eye	.135	124	.000	.956	124	.001
TBUT Left Eye	.132	124	.000	.958	124	.001
Keratometry (K2-K1)Right Eye	.191	124	.000	.785	124	.000
Keratometry (K2-K1)Left Eye	.183	124	.000	.822	124	.000
a. Lilliefors Significance Correction						
b. First three columns show Kolmogorov Smirnov results ,last three columns show Shapiro -Wilk results.						

## Correlation analysis

Data was not normally distributed, so Spearman rank correlation was used. Both the right eye ( $r = -0.573$ ,  $p < 0.001$ ) and the left eye ( $r = -0.534$ ,  $p < 0.001$ ) showed a significant negative correlation with the ocular rubbing score. The ocular rubbing score was found to be significantly positively correlated with astigmatism in both the right and left eyes ( $r = 0.496$ ,  $p < 0.001$  and  $r = 0.570$ ,  $p < 0.001$ ). Every correlation had a p-value of less than 0.001.

Table 4: Spearman Rank of Correlations Analysis

			Total Ocular Rubbing Score(Sum of 4parameters)	TBUT Right Eye	TBU T Left Eye	Kerato metry (K2-K1)Right Eye	Kerato metry (K2-K1)Left Eye
Spearman's rho	Total Ocular Rubbing Score(Sum of 4parameters)	Correlation Coefficient	1.000	-.573**	-.534**	.496**	.570**
		Sig. (2-tailed)	.	.000	.000	.000	.000
		N	124	124	124	124	124
	TBUT Right Eye	Correlation Coefficient	-.573**	1.000	.922**	-.564**	-.558**
		Sig. (2-tailed)	.000	.	.000	.000	.000
		N	124	124	124	124	124
	TBUT Left Eye	Correlation Coefficient	-.534**	.922**	1.000	-.532**	-.516**
		Sig. (2-tailed)	.000	.000	.	.000	.000
		N	124	124	124	124	124

		Sig. (2-tailed)	.000	.000	.	.000	.000
		N	124	124	124	124	124
	Keratometry (K2-K1)Right Eye	Correlation Coefficient	.496**	-.564**	-.532**	1.000	.721**
		Sig. (2-tailed)	.000	.000	.000	.	.000
		N	124	124	124	124	124
	Keratometry (K2-K1)Left Eye	Correlation Coefficient	.570**	-.558**	-.516**	.721**	1.000
		Sig. (2-tailed)	.000	.000	.000	.000	.
		N	124	124	124	124	124
**. Correlation is significant at the 0.01 level (2-tailed).							

### Demographics Characteristics

This study included 124 patients with allergic conjunctivitis. Patients ranged in age from 10 to 40 years, with a mean age of  $25.42 \pm 9.407$  years. In terms of gender distribution, 48 patients (38.7%) were men and 76 patients (61.3%) were women.

Seasonal/Perennial Allergic Conjunctivitis (SAC/PAC) was the most frequently diagnosed type of allergic conjunctivitis, occurring in 75 patients (60.5%), followed by Vernal Keratoconjunctivitis (VKC) in 20 patients (16.1%), Atopic Keratoconjunctivitis (AKC) in 18 patients (14.5%), and

Giant Papillary Conjunctivitis in 11 patients (8.9%). Ten patients (8.1%) had left eye involvement, four patients (3.2%) only had right eye involvement, and 110 patients (88.7%) had bilateral eye involvement.

Table 5: Gender of patients

Gender	Frequency	Percent
Male	48	38.7
Female	76	61.3
Total	124	100.0

Table 6: Types of allergic conjunctivitis

	Frequency	Percent
SAC, PAC	75	60.5
VKC	20	16.1
AKC	18	14.5
GPC	11	8.9
Total	124	100.0

Table 7: Eye Involved

	Frequency	Percent
Right	4	3.2
Left	10	8.1
Both	110	88.7
Total	124	100.0

#### Clinical Symptoms and Signs

A standardized grading scale ranging from 0 to 3 was used to evaluate the severity of ocular symptoms in all 124 patients. In 56 patients (45.2%), itching was the most common symptom with

moderate severity. 63 patients (50.8%) had moderate redness. 55 patients (44.4%) reported having a moderate foreign body sensation. Additionally, burning and tearing sensations were mostly mild in intensity.

**Table 8: Itching Severity**

		Frequency	Percent
	None	2	1.6
	Mild	33	26.6
	Moderate	56	45.2
	Severe	33	26.6
	Total	124	100.0

**Table 9: Redness Severity**

		Frequency	Percent
	None	6	4.8
	Mild	29	23.4
	Moderate	63	50.8
	Severe	26	21.0
	Total	124	100.0

**Table 10: Discharge Severity**

		Frequency	Percent
	None	30	24.2
	Mild	27	21.8
	Moderate	34	27.4
	Severe	33	26.6

	Total	124	100.0
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**Table 11: Foreign Body Sensation Severity**

		Frequency	Percent
	None	18	14.5
	Mild	27	21.8
	Moderate	55	44.4
	Severe	24	19.4
	Total	124	100.0

**Table 12: Tearing Severity**

		Frequency	Percent
	None	14	11.3
	Mild	25	20.2
	Moderate	53	42.7
	Severe	32	25.8
	Total	124	100.0

**Table 13: Burning Severity**

		Frequency	Percent
	None	9	7.3
	Mild	30	24.2
	Moderate	49	39.5
	Severe	36	29.0
	Total	124	100.0

All 124 patients had their ocular signs evaluated in both eyes. Each sign's presence or absence was noted independently for the left and right eyes. Clinical evaluations were conducted on conjunctival hyperemia, papillae on the tarsal conjunctiva, chemosis, follicles, lid edema, corneal involvement, and mucous discharge.

**Table 14: Hyperemia**

	Right Eye		Left Eye	
	Frequency	Percent	Frequency	Percent
Absent	4	3.2	6	4.8
Present	120	96.8	118	95.2
Total	124	100.0	124	100.0

**Table 15: Papillae Right Eye**

	Right Eye		Left Eye	
	Frequency	Percent	Frequency	Percent
Absent	89	71.8	94	75.8
Present	35	28.2	30	24.2
Total	124	100.0	124	100.0

**Table 16: Chemosis**

	Right Eye		Left Eye	
	Frequency	Percent	Frequency	Percent
Absent	87	70.2	87	70.2
Present	37	29.8	37	29.8
Total	124	100.0	124	100.0

**Table 17: Follicles**

	Right Eye		Left Eye	
	Frequency	Percent	Frequency	Percent
Absent	121	97.6	120	96.8
Present	3	2.4	4	3.2
Total	124	100.0	124	100.0

**Table 18: Lid Edema**

	Right Eye		Left Eye	
	Frequency	Percent	Frequency	Percent
Absent	86	69.4	86	69.4
Present	38	30.6	38	30.6
Total	124	100.0	124	100.0

**Table 19: Cornea Involvement**

	Right Eye		Left Eye	
	Frequency	Percent	Frequency	Percent
Absent	115	92.7	117	94.4
Present	9	7.3	7	5.6
Total	124	100.0	124	100.0

**Table 20: Mucus Discharge**

	Right Eye		Left Eye	
	Frequency	Percent	Frequency	Percent
Absent	58	46.8	57	46.0

Present	66	53.2	67	54.0
Total	124	100.0	124	100.0

**Ocular Rubbing Assessment**

A standardized scoring system based on four parameters frequency, intensity, duration per episode, and chronicity of rubbing habit was used to evaluate ocular rubbing behavior. The maximum possible total score was 12, with each parameter receiving a score between 0 and 3. Three categories of scores were used: mild (1-4), moderate (5-8), and severe (9-12). With a mean ocular rubbing score of  $7.63 \pm 2.054$ , the study population exhibited moderate rubbing behavior.

**Table 21: Ocular Rubbing Severity**

		Frequency	Percent
	Mild	9	7.3
	Moderate	74	59.7
	Severe	41	33.1
	Total	124	100.0

**Tear Film Stability**

For both eyes, the Tear Break Up Time (TBUT) test was used to evaluate tear film stability. TBUT was measured in seconds and classified as Normal (>10 seconds), Unstable (<5 seconds), and Borderline/Marginal (5-10 seconds). The study population had borderline tear film stability, as evidenced by the mean TBUT of  $6.81 \pm 3.595$  seconds for the right eye and  $7.14 \pm 3.623$  seconds for the left.

Table 22: TBUT interpretation Right Eye

	Frequency	Percent
Normal(>10)	11	8.9
Marginal(5-10s)	69	55.6
Unstable(<5s)	44	35.5
Total	124	100.0

Table 23: TBUT interpretation Left Eye

	Frequency	Percent
Normal(>10)	12	9.7
Marginal(5-10s)	68	54.8
Unstable(<5s)	44	35.5
Total	124	100.0

### Irregular Astigmatism

Keratometry readings were used to evaluate irregular astigmatism. The difference between the K2 and K1 readings was used to calculate astigmatism. The average astigmatism was  $0.92 \pm 0.75$  diopters for the right eye and  $0.98 \pm 0.82$  diopters for the left.

### Discussion

The current study examined the relationship between ocular rubbing behavior, tear film stability, and irregular astigmatism in 124 patients with allergic conjunctivitis. Ocular rubbing was found to be significantly positively correlated with astigmatism (Right Eye :  $r = 0.496$ , Left Eye :  $r = 0.570$ ,  $p < 0.001$ ) and negatively correlated with TBUT in both eyes (Right Eye :  $r = -0.573$ , Left Eye :  $r = -0.534$ ,  $p < 0.001$ ). In previous study Lo and Lo in 2023, performed a meta-analysis of fourteen studies and found that eye rubbing was significantly associated with keratoconus (OR = 4.48, 95% CI = 2.92-6.86) and that allergic conjunctivitis conferred more than four times increased odds of

keratoconus, corroborate these findings. These results are consistent with the present study, suggesting that habitual eye rubbing in allergic conjunctivitis acts as a mediator contributing to both tear film instability and progressive corneal changes <sup>(12)</sup>.

With mean TBUT values of  $6.81 \pm 3.59$  seconds in the right eye and  $7.14 \pm 3.62$  seconds in the left, patients with allergic conjunctivitis were found to have compromised tear film stability in the current study. In a similar vein, previous study of Kulkarni et al. in 2026 found that patients with allergic rhinitis had significantly lower TBUT ( $8.4 \pm 2.1$  seconds) than healthy controls ( $12.6 \pm 2.4$  seconds), indicating tear film instability in allergic conditions. Since both studies show lower TBUT in patients with allergic disorders, these results are in line with the current investigation. The inclusion of patients with more severe ocular involvement, such as allergic conjunctivitis, where direct ocular surface inflammation is more noticeable than in allergic rhinitis, may be the reason for the relatively lower TBUT values seen in the current study. Chronic inflammation, increased tear evaporation, and frequent ocular rubbing all contribute to disruption of the tear film and ocular surface integrity, which may account for the decrease in tear film stability in both studies <sup>(13)</sup>.

Ocular rubbing and corneal astigmatism in both eyes were found to be significantly positively correlated in the current study, suggesting that increased eye rubbing is linked to larger changes in corneal curvature. According to a previous study by Yang Y in 2025, patients with allergic conjunctivitis may have structural changes in their corneas because eye-rubbing frequency was positively correlated with corneal topographic parameters like front elevation and front difference deviation. These results are in line with the current investigation since both studies show that ocular rubbing affects corneal morphology. The underlying mechanism is the same even though the parameters evaluated are different Yang Y focuses on advanced tomographic indices, while the current study evaluates keratometric astigmatism. Increased astigmatism and early ectatic changes may result from repeated mechanical trauma from rubbing the eyes, which can cause corneal deformation, weakening of the stromal structure, and alteration in corneal curvature <sup>(14)</sup>.

Positive correlation between ocular rubbing and corneal astigmatism found in current study , suggesting that changes in corneal curvature are linked to increased rubbing. However, in previous study Torres-Netto et al. in 2022 found no significant difference in corneal stiffness between controls and those who rub their eyes frequently ( $P = 0.984$ ), indicating that eye rubbing may not always result in detectable biomechanical changes. The current study, which showed notable corneal changes linked to rubbing behavior, contradicts this conclusion. The disparity could be explained by the fact that Torres-Netto et al. concentrated on biomechanical stiffness parameters, while the current study evaluated keratometric astigmatism, a clinical indicator of corneal shape. Before noticeable changes in biomechanical characteristics take place, it's possible that early or moderate eye rubbing primarily affects corneal shape and surface regularity. These discrepancies may also be caused by differences in the study population, rubbing duration, and intensity<sup>(15)</sup>.

The current study found a significant positive correlation between ocular rubbing and corneal astigmatism, suggesting that changes in corneal curvature are linked to increased eye rubbing. On the other hand, in previous study only 0.5% of children with allergic conjunctivitis had probable keratoconus, according to Balogun and Fashola in 2023, who found that most children had normal keratometry results. This discrepancy could be explained by differences in the study population, since their research was on children, whose corneal structural alterations might not have fully developed. Furthermore, Balogun and Fashola mainly evaluated overt keratoconus, a more advanced stage of corneal pathology, whereas the current study assessed astigmatism as an early indicator of corneal alteration. These results imply that ocular rubbing may first cause minor alterations in corneal curvature, such as astigmatism, before developing into keratoconus that is clinically noticeable. Individual susceptibility, duration, and the intensity of eye rubbing are some of the variables that may affect the progression<sup>(16)</sup>.

Reduced TBUT is linked to increased irregular astigmatism, according to the current study, which found a significant negative correlation between tear film stability and corneal astigmatism in both the right eye ( $r = -0.564$ ,  $p < 0.001$ ) and left eye ( $r = -0.516$ ,  $p < 0.001$ ). In a similar vein, a previous

study by Yang et al. in 2024 found that keratometry variation was significantly higher in dry eye patients than in non-dry eye controls, with mean  $\Delta K_m$  of 0.28D in the dry eye group versus 0.09D in the control group ( $p = 0.005$ ). This indicates that significant corneal surface changes are caused by reduced tear film quality. These results are in line with the current investigation since both studies show that changes in corneal measurements are linked to tear film instability. The observed negative correlation between TBUT and astigmatism in the present study may be explained by the fact that reduced tear film stability leads to irregular corneal surface wetting, chronic epithelial changes, and altered corneal curvature, ultimately contributing to increased irregular astigmatism in allergic conjunctivitis patients<sup>(17)</sup>.

In current study patients with allergic conjunctivitis, irregular astigmatism was significantly correlated with ocular factors ( $p < 0.001$ ). Similarly, astigmatism increased significantly from 7.53% at baseline to 56.26% at 6-month follow-up ( $p < 0.001$ ), according to a previous study by Naseer MS et al. in 2026. These results align with the current investigation. This could be brought on by persistent inflammation and frequent eye rubbing, which change the stability of the tear film and corneal curvature, increasing astigmatism. However, the current study shows association, whereas their longitudinal design shows progression over time<sup>(18)</sup>.

### Conclusion

In patients with allergic conjunctivitis, the current study showed strong associations between tear film stability, irregular astigmatism, and ocular rubbing behavior. Greater corneal astigmatism and decreased tear film stability were linked to increased ocular rubbing, while irregular astigmatism was further linked to decreased tear film stability. These results highlight the significance of early detection and management of ocular rubbing behavior to prevent visual deterioration by suggesting that habitual eye rubbing in allergic conjunctivitis patients contributes to progressive ocular surface and corneal changes

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