

Pterygium and Its Correlation with Dry Eye Disease: Comparing Patients from Different Geographical Locations Attending Sub-Himalayan Tertiary Institute

Charvie Gupta¹, Lalit Gupta², Yusaf Rizvi³, Anurag Thakur⁴, Baltaran Singh Bajwa⁵, Prince Goyal⁶

¹Junior Resident, Dr. YSPGMC Nahan HP

²Associate Professor, MMIMSR Mullana, Haryana

³Professor, Govt Medical College Srinagar, Utrakhand

⁴Medical Officer, Himachal Pradesh Health Services

⁵Intern MMIMSR Mullana, Haryana

⁶Assistant Professor cum Statistician, Dr. YSPGMC Nahan HP

Received: 25-02-2024 / Revised: 23-03-2024 / Accepted: 26-04-2024

Corresponding Author: Dr. Yusaf Rizvi

Conflict of interest: Nil

Abstract:

Objective: The aim of this study was to evaluate the correlation between dry eye disease and pterygium and also to compare patients with pterygium from two different geographical locations in this sub-Himalayan region.

Materials and Methods: A total of 80 patients, aged between 21 and 65 years, 40 each from two different geographical regions (locations) namely Transgiri and Cisgiri area were included in this study. Tear film breakup time (TBUT) and Schirmer's test (ST) and Rose Bengal Score (RBS) results were compared in pterygium eye and contra lateral normal eye of the same patient (taken as control). TBUT, ST and RBS results were also compared in eyes with pterygium of different sizes. Pearson's chisquare test was used to evaluate differences between groups for categorized variables. Unpaired "t" test used to calculate difference of means for quantitative variables. Paired "t" test and mcnemar test were used to analyze group -2 patients who had undergone surgery.

Results: On analysis, the overall difference in the mean TBUT between the pterygium eyes, and the contra lateral control eyes was highly significant ($P < 0.01$). The difference in the ST between the pterygium eyes and the contra lateral eyes was highly significant for size < 2 mm ($P < 0.001$). Most patients with pterygium complained of redness and mild-to-severe ocular discomfort. The respective scores of TBUT, ST and RBS improved after surgery significantly (p -value < 0.005).

Conclusion: Results of the present study strongly suggest that different geographic locations, size of pterygium, exposure to UV rays, gender, prolonged outdoor work and dusty environment leads to development of pterygium. Pterygium induces abnormal ocular surface conditions which results in development of the dry eye and dry eye is also responsible for development of pterygium. Use of protective eye wears is to be encouraged.

Keywords: Pterygium ST, TBUT, RBS, Dry eye, Cisgiri, Transgiri.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Pterygium is a common external ocular surface finding described as an encroachment of altered bulbar conjunctiva onto the cornea, the name being originated from the Greek word referring to its characteristic wing-like growth pattern. [1] Pterygium is elastotic degeneration of conjunctiva typically characterized by proliferation of the subconjunctival tissue as vascularized granulation tissue, which destroys the superficial layer of stroma and Bowman's membrane as it invades the cornea.

Generally, it is asymptomatic but may cause redness, lacrimation, photophobia, foreign body sensation and astigmatism. It is a potentially blinding

disease in the advanced stage when it encroaches the visual axis, which can have significant impact on vision and requires surgery for visual rehabilitation. [2]

Patients with pterygium are having decreased tear production, decreased Tear film break up time (TBUT) and decreased Schirmer's test (ST) value [3,4] and unstable tear film may contribute to the initiation of pterygium. Patients with decreased tear production are more prone to the damaging effects of UV rays in the sun. [5] A strong positive correlation between climatic UV radiation and the prevalence of pterygium has been found in many studies.

There is a statistically significant association between outdoor work and pterygium formation, which may be related to the higher exposure to sunlight and dust in outdoor workers. [6,7]

Ocular dryness in the presence of pterygium and its improvement after surgery favors the hypothesis that pterygium itself contributes to the phenomenon of disturbed tear film functions in such patients.

Aims and Objectives

1. To study incidence of pterygium in this sub-Himalayan area.
2. To study the correlation of Pterygium with Dry eye disease.
3. To compare the prevalence of Pterygium and dry eye disease between two geographical regions in this sub-Himalayan area.

Materials and Methods:

This was a clinical cross sectional case control study, conducted in a period of 4 months from 1st June 2023 to 30th November 2023. All patients with Pterygium were included in this study. Study started after obtaining an approval from the ethical committee of this institution. Before enrolling patients in this study, informed consent was taken in writing from all the patients in Hindi.

This Medical College, where this study was done is in Sirmour district of Himachal Pradesh being located in the sub-Himalayan range which is divided into two regions (locations) by holy river Giri namely Transgiri and Cisgiri regions. Both regions are having a different geographic pattern and climatic diversity. Transgiri region has a high altitude, clear sky, bright sunlight and is a snow laden area in winters, with more UV radiations with comparatively hard life where as Cisgiri region is a plain or has very small mountains but has more pollution and hot climates. In Transgiri area patients usually are from farming and are of laborer background and spend 4-5 hours outdoor daily, average time of 4.35 hrs, whereas Cisgiri population are spend less times outdoors.

This study was designed to study the prevalence of dry eye among the patients of pterygium and to find the clinical correlation between dry eye disease and Pterygium in total and location wise.

All new patients attending eye OPD for treatment, during this period, were enrolled for study so as to calculate prevalence of pterygium in this region. 40 cases from each location, Transgiri region and Cisgiri region (total 80), willing to participate were included in this study and tested on same parameters. The results were analyzed first for both locations (combined) and then separately and then those were compared. Only unilateral Pterygium cases were taken in study. The eye with Pterygium treat-

ed as case and other eye of same patient without Pterygium taken as control. Equal number of Transgiri region and Cisgiri region patients having unilateral pterygium were studied and compared.

16 patients had undergone surgery for removal followed by suture less auto graft from superior conjunctiva of same eyes. Tear film breakup time (TBUT) and Schirmer's test (ST) and Rose Bengal Score (RBS) evaluated before and after surgery and compared.

Inclusion Criteria

All patients with Pterygium and who were ready to participate in study were subjected to ocular examination and were included in study.

Exclusion Criteria

Following patients were excluded from study.

- Ocular disease such as ocular injuries, chemical conjunctivitis, viral and bacterial conjunctivitis, immunological diseases that might interfere with evaluation.
- Hypersensitivity to xylocaine, rose bengal, and fluorescein.
- Contact lens wearer.
- Patients previously diagnosed as cases of keratoconjunctivitis sicca i.e. with arthritis, xerostomia, parotid & lacrimal gland enlargement and abnormal Schirmer Test-I.
- Use of any other systematic antibiotic, topical eye drops including lubricants during and preceding eight weeks.
- Exposure resulting from lagophthalmos, neurotropy and neuroparalysis.
- All red itchy eyes having eosinophilia on conjunctival smear examination.
- Blepharitis involving anterior eyelid and cilia line and without any other symptoms or signs as detailed below.
- Patients with primary and secondary Sjogrens syndrome,
- Patients with ocular diseases other than Pterygium leading to dry eye.

After taking a detailed history especially regarding the symptoms, standard ophthalmological examination was done for visual acuity, ocular surface examination, anterior segment and posterior segment evaluation was done.

Age, gender, occupation, duration of growth of pterygium, history of exposure to sunlight was noted. The ocular symptoms including Dryness, Itching, Blurred Vision, Irritation, Foreign body sensation, Tearing/Watering, redness and Swelling of bulbar conjunctiva were taken into consideration. On the basis of symptoms, severity of dry eye was assessed in the form of Ocular Surface Disease Index (OSDI) calculated in both groups. This 12-item questionnaire assessed the dry eye symptoms

and the effect it has on vision-related function in the past week of the patient's life. [8] The questionnaire has 3 subscales: ocular symptoms, vision-related function, and environmental triggers. Patients rate their responses on a 0 to 4 scale with 0 corresponding to "none of the time" and 4 corresponding to "all of the time." A final score is calculated which ranges from 0 to 100 with scores 0 to 12 representing normal, 13 to 22 representing mild dry eye disease, 23 to 32 representing moderate dry eye disease, and greater than 33 representing severe dry eye disease. [9]

The presence of fibro vascular tissue extending from the bulbar conjunctiva onto the cornea either nasally or temporally was accepted as pterygium. The size of pterygium was measured from corneal limbus to apex of pterygium on a horizontal basis in millimeters by slit lamp biomicroscopy. Grading of the pterygium was done according to Tan et al slit-lamp grading based on relative translucency of the body of the pterygium. [10]

Tear secretion and its stability was evaluated in both eyes of patients with unilateral pterygium and in controls of same age and sex and same area by performing the The TBUT, Schirmer's test, basal tear secretion and Rose Bengal staining.

In preparation for slit-lamp microscopy of the ocular surface, touched saline-moistened Rose Bengal strip and Fluorescein strip were impregnated into the conjunctival sac. Fluorescein staining was assessed through Cobalt blue filter and was graded from 0 to 3 for each of the upper, middle, and lower thirds of the cornea. Rose Bengal staining with 1% impregnated strip of the temporal conjunctiva, cornea, and nasal conjunctiva was graded from 0 to 3 after examination with ordinary light without any filter. The grading scale was defined according to the staining extent: 0 for negative; 1, scattered minute; 2, moderate spotty; and 3, diffuse blotchy staining. Van Bijsterveld grading scale was used which evaluates the intensity of staining based on a scale of 0-3 in three areas: nasal conjunctiva, temporal conjunctiva and cornea. Score 0-3 for each zone. 1+ = few separated spots, 2+ = many separated spots, 3+ : confluent spots and Maximum possible score is 9. Rose Bengal staining score of more than 3 was considered abnormal. [3,32] Schirmer's Test, without topical anesthesia, was done to assess

tear volume in each eye at each visit with No. 41 Whatman filter paper strip (5 x 35 mm), designed for same. Wetting of tear strip after 5 minutes was measured. A value above 10mm was considered normal.

Tear Break Up Time (TBUT): Done with saline-moistened Fluorescein strip touched the tear film and observed with cobalt blue light, for the development of a dry spot on the cornea.

The test was repeated 3 times in each eye and average TBUT was taken. An attempt was made to maintain constant temperature humidity and air-flow. A normal TBUT greater than 10 seconds was taken as normal.

Data analysis

Total 80 cases were compared first with controls and then location wise also. Percentages and proportions were calculated for various categories. Pearson's chisquare test X^2 was used to evaluate differences between groups for categorized variables. Unpaired "t" test used to calculate difference of means for quantitative variables. Paired "t" test and mcnemar test were used to analyze group -2 patients who had undergone surgery. Data presented as mean and standard deviation, or 95% confidence intervals (CI). All tests were performed at a 5% level of significance; thus an association was considered significant if the p value was less than 0.05.

Results:

Among total 5284 patients screened, Pterygium was present in 612 patients (11.58%). When calculated region wise, 395 patients were found (13.92%) in Transgiri area whereas 217 patients were found (8.86%) in Cisgiri area. Prevalence among females was found to be more than in males in both regions but statistically insignificant. Prevalence of unilateral pterygium was more as compared to bilateral pterygium in both regions. However bilateral pterygium was observed to be more in Transgiri patients (p value<0.005) as compared to Cisgiri area.

Main symptoms reported by patients were redness, burning sensations, foreign body sensations, eye aches and some reported blurred vision also.

Table 1: Profile of 612 pterygium patients from total 5284

| | Transgiri | Cisgiri | Total |
|-------------------------|---------------|--------------|--------------|
| No of patients | 2836(53.67%) | 2448(46.33%) | 5284 |
| Patients with pterygium | 395 (13.92%) | 217(8.86%) | 612 (11.58%) |
| Males | 1183 (41.71%) | 1143(46.69%) | 2326(44.02%) |
| Females | 1656(58.39%) | 1305(53.31%) | 2961(56.03%) |
| Unilateral pterygium | 303(76.70%) | 194(89.40%) | 497(81.20%) |
| Bilateral pterygium | 92(23.30%) | 23(10.60%) | 115(18.80%) |

On statistical analysis of above, relation between area and gender (male and female, chisquare, $X^2=13.45$, P value=0.0002), between area and pterygium patients (chisquare, $X^2=32.89$, P value=9.72E-09) and between area and types of pterygium, unilateral and bilateral in both areas(chisquare, $X^2=14.80$, P value=0.0001) found statistically significant meaning that there is corre-

lation between area and sex,number of pterygium patients and laterality of pterygium unilateral more in Cisgiri area and bilateral more in Transgiri area. Mostly patients presented in age group of 31-40 yrs from Transgiri area and female preponderance was there in this age group. Patients from Cisgiri area were equal in 31-40 and 41-50 age groups. In both areas the female outnumbered males.

Table 2: Age and location wise male and female patients

| Area/ location | 20-30yrs | | 31-40yrs | | 41-50 yrs | | > 50yrs | |
|----------------|----------|--------|----------|-----------|-----------|--------|---------|--------|
| | Male | Female | Male | Female | Male | Female | Male | Female |
| Transgiri area | 0(0%) | 2(5%) | 4(10%) | 13(32.5%) | 7(17.5%) | 8(20%) | 2(5%) | 4(10%) |
| Cis giri area | 0(0%) | 6(15%) | 3(7.5%) | 10(25%) | 7(17.5%) | 6(15%) | 6(15%) | 2(5%) |

In our study prevalence rate of pterygium was 11.58% which is geographically more in Transgiri area (13.92%) as compared to Cisgiri area (8.86%). We found pterygium on nasal side in 62 (77.5%), both nasal and temporal in 13 (16.25%) and temporal location only in 5 (6.25%) eyes

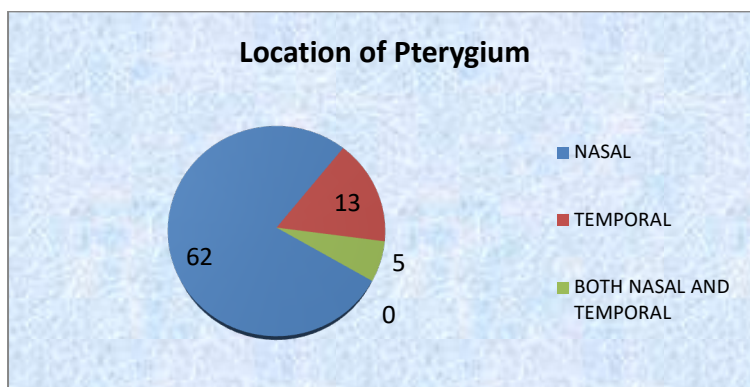


Figure 1: Pie chart showing location of Pterygium

Table 3: Showing mean value ST, TBUT and RBS (Rose Bengal Score) in total 40 cases and 40 controls in Transgiri area (Unpaired t-test)

| Tests | Cases | Controls | P-Value | Statistical significance |
|-------|------------|------------|-----------------------|--------------------------|
| ST | 9.92± 2.99 | 14.92±3.38 | 8.128E-10, $P= <0.05$ | Highly significant |
| TBUT | 7.70± 2.22 | 11.02±1.49 | $P= 1,25E-11$ | Highly significant |
| RBS | 2.3±2.17 | 0±0 | 2.19E-09 | Significant |

Table 4: Showing mean value ST, TBUT and RBS (Rose Bengal Score) in total 40 cases and 40 controls in Cisgiri area

| Tests | Cases | Controls | P-Value | Statistical significance |
|-------|-------------|------------|----------|--------------------------|
| ST | 12.67± 4.57 | 18.97±4.69 | 8.04E-08 | Significant |
| TBUT | 9.82± 3.28 | 11.85±2.65 | 0.005 | Significant |
| RBS | 1.60±1.95 | 0±0 | 4.51E-06 | Significant |

Table 5: Showing mean value ST, TBUT and RBS (Rose Bengal Score) in 80 cases and 80 controls (Total Transgiri &Cisgiri)

| Tests | Cases | Controls | P-Value | Statistical significance |
|-------|------------|------------|-------------|--------------------------|
| ST | 11.3± 4.08 | 16.95±4.55 | 5.78E-14 | Highly significant |
| TBUT | 8.76± 2.98 | 11.43±2.18 | $= 1,25E-9$ | Significant |
| RBS | 1.85±2.08 | 0±0 | 1.25E-9 | Significant |

ST and TBUT values when compared in total 80 cases and 80 controls, it is noticed that SD (Slandereddeviation) is high in case of ST as compared to TBUT showing more authenticity of TBUT results as compared to ST results. Further mean value is less in TBUT as compared to ST, thereby suggesting that TBUT results are more significant than ST in assessing the dry eye parameter.

Table 6: Frequency and percentage of size of pterygium among cases of two regions

| Size of pterygium | Transgiri cases | Cisgiri cases | Total |
|-------------------|-----------------|---------------|--------|
| < 1mm | 7 (17.5%) | 15 (37.5%) | 22 (%) |
| 1-2mm | 25 (62.5%) | 21 (52.5%) | 46 (%) |
| >2 mm | 8 (20%) | 4 (10 %) | 12 (%) |

The mean value of ST in Transgiri cases was 9.92 ± 2.99 and in comparison, the mean value of ST among control group of same population was 14.92 ± 3.38 (p-value <0.05 , statistically significant) whereas the mean value of ST in Cisgiri cases was 12.67 ± 4.57 and in comparison, the mean value of ST among control group of same population was 18.47 ± 4.69 (p-value $8.04E-08$, statistically significant).

The mean value of TBUT in Transgiri cases was 7.7 ± 2.22 and in control population was 11.02 with SD 1.49 (p-value $1.25E-1$, highly statistically significant). In Cisgiri patients the mean value of

TBUT in cases was 9.82 ± 3.28 and control population with mean 11.85 ± 2.65 (p-value 0.005 statistically significant). The mean value of RBS in cases was 2.3 ± 2.17 and control population with mean 0 ± 0 (p-value $2.19 E-09$, statistically significant).

Mean value of RBS in Transgiri cases was 1.6 ± 1.95 and control population 0 ± 0 (p-value $4.51 E-06$, statistically significant). This data shows that Transgiri population was more affected than Cisgiri population. The ST, TBUT and RBS scores were affected more in case group as compared to the controls. All these altered scores were responsible for dry eye features and symptoms.

Table 7: Showing comparison of ST, TBUT and RBS (Rose Bengal Score) before and after surgery

| Before surgery | After surgery | P-Value | Statistical significance |
|-----------------------|-----------------------|--------------|--------------------------|
| Mean= 8.12 ± 2.57 | Mean= 9.56 ± 1.26 | 0.025 | Significant |
| Mean= 6.73 ± 1.35 | Mean= 1.06 ± 1.0 | $7.714 E-08$ | Significant |
| Mean= 3.50 ± 1.75 | Mean= 0 ± 0 | $2.124E-06$ | Significant |

On comparing ST, TBUT and RBS (Rose Bengal Score) before and after surgery using paired t-test, we found that there was significant improvement of dry eye disease depicted by marked reductions in symptoms after surgery and improvement in assessed parameters which were statistically significant. This clearly suggests that pterygium itself was responsible for these symptoms of dry eye. Only 3 patients had very slight improvement in ST, TBUT and RBS and after 3 months of follow up. Evidence of recurrence was noted to be $<1\text{mm}$ in these 3 patients suggesting that dry eye is responsible for formation of pterygium.

There was a statistically significant difference in the dry eye tests results between the pterygium eyes(cases) and the second eye without pterygium of same person (controls).

Discussion:

In our study we found that pterygium was present in 612 patients from 5284 patients screened (11.58%) with location/area wise 13.92% in Transgiri area and 8.86% in Cisgiri area. Prevalence among females was found more than in males in both regions and statistically insignificant in total but significant location/area wise. Unilateral pterygium was seen more in both regions as compared to bilateral pterygium with bilateral pterygium more in Transgiri patients statistically significant (p value <0.005) as compared to Cisgiri area. Manhas A .et al [15] reported in their study that the maximum number of pterygium patients present with redness 57 (63.33%), followed by cosmosis 49

(54.44%), grittiness 35 (38.89%). Roka N et al. [6] also found that redness was the most common symptom of pterygium patients followed by grittiness and burning sensation. Ganeshpuri AS et al also found that burning sensation, grittiness and redness were the common symptoms of pterygium patients. [20] Main symptoms reported by our patients in this study were redness, burning sensations, foreign body sensations, gritty and stony sensations, eye-ache and some reported blurred vision also. The OSDI score in our study for Transgiri cases was 32.3 and Cisgiri cases was 25.4 in comparison to 30.6 as reported by Gupta et al [21].

Yuhan Wang et al. [18] reported that the overall prevalence of pterygium in their study was 6.4%. In our study prevalence rate of pterygium was 11.58%. Yuhan Wang et al also reported that the outdoor occupation, and more time spent in rural areas (>30 yrs) were risk factors for pterygium [18]. It is found in areas of bright sunlight and may be linked to ultraviolet (UV) radiation. It is thought that UV radiation causes destruction of the tear film due to rapid evaporation. Tear film dysfunction has been found in subjects with pterygium. In India investigators have found abnormalities of tear function in eyes with pterygium while others have found no abnormalities. The differences in findings might be related to the differences in methodology used, or the differences in geographical locations. [13] Our study also agrees to it. In our study, on comparing climatically two different geographical locations, Tansgiri group patients more involved in outdoor activities as farming or laborers, have more

outdoor work, exposure to sunlight. We found more cases of pterygium in females and in age group 31-40 yrs as these females work as farmers in this location but Khoo et al. [7] and Gupta et al [19] and in their study observed that pterygium was more common in males and in the age group of 40–50 years.

Gupta et al [21] in their study observed that the difference in the TF-BUT between the pterygium eyes and the contralateral control eyes was statistically significant ($P < 0.05$).²¹ and Manhas et al. 15 Wang et al.¹⁸ and also found that TF-BUT in the eyes with pterygium when compared with the opposite healthy eyes was significantly different.

Gupta et al. [21], Rajiv et al. [22] and El-Sersy TH et al. [23] Chaidaroon and Pongmoragot, [24] Rahman et al. [25] and Anthony et al, [26] in their study of unilateral pterygium cases found that the difference in the mean ST between the pterygium eyes and the contra lateral control eyes was significant. They also reported that the ST was decreased significantly in the eye with pterygium. Roka et al. [6] and Moreno et al. [28] also found that ST values were lower among cases than their corresponding control eyes. Whereas Biedner et al. [29] performed ST in cases with unilateral pterygium and found no difference between the mean basic secretion of tears in the diseased eyes and the fellow eyes and suggested that dryness of the eyes cannot be regarded as the cause of pterygium and Bandyopadhyay et al. [30] and Ergin A30 did not find the difference in pterygium and control group and concluded that there were no tear function abnormalities in pterygium. In our study we also found decreased values of ST, in case group of unilateral pterygium as compared to control group. This decrease in value is more significant in Transgiri group than Cisgiri group (P Value < 0.005). Gupta et al [21] concluded that dry eye is known to be caused due to environmental and habitual factors, but exposure to both the eyes to the environment remains the same. If there is unilateral pterygium, along with significantly more incidence of dry eye lateralized to the pterygium eye, as found in their study, it is suggested that pterygium appears to induce abnormal ocular surface conditions which leads to dysfunctional TF and development of the dry eye and we agree to it after analyzing results of our study.

Anthony et al. [24] and Kampitak and Leelawongtawun [25] found that both tear BUT and ST results had no correlation with the horizontal size of pterygium. In their study Gupta et al. [19] evaluated the relationship between pterygium size and TF-BUT and STs. On analysis, they found that TF-BUT is reduced overall and is statistically significant ($P < 0.05$). The ST results showed statistically significant differences with different sizes of pterygium, which was more

significant for size > 2 mm. Our study is also consistent to these findings and we found significantly decreased TBUT score (P value < 0.005)

We found that in this study our three patients after surgery in whom TBUT value remained high post-operatively had recurrence. Antony AT et al. [24] in their study concluded that pterygium leads to abnormal tear film and development of dry eye and here is a strong relationship between dry eye and pterygium. Patients with unstable tear film are more prone to the damaging effects of UV rays in the sunlight. Ishioka et al. [13] found that TF-BUT was shortened significantly in the eye with pterygium in unilateral cases. He concluded that there is a correlation between pterygium formation and shortened TBUT, and unstable TF may contribute to the initiation of pterygium. Whether tear dysfunction is a precursor to pterygium growth or pterygium causes tear dysfunction is still not clear. Research and clinical evidence, however, suggest that there is a relationship between the two.

Conclusions:

Results of the present study strongly suggest that different geographic locations, size of pterygium, exposure to UV rays, prolonged outdoor work and dusty environment leads to development of pterygium. Also pterygium induces abnormal ocular surface conditions which results in development of the dry eye and dry eye is also responsible for development of pterygium. Use of protective eye wears to be encouraged.

Bibliography

1. Coroneo MT, Chui J, Ocular Surface Disease: Cornea, Conjunctiva and Tear Film. 2nd Edition; 125-144.
2. Sihota R, Tandon R. Diseases of the conjunctiva. In: Parson's diseases of the eye. 22nd ed. Sihota R, Tandon R. India; Elsevier. 2015:184.
3. Lu P, Chen XM. Prevalence and risk factors of pterygium. Int J Ophthalmol. 2009;2(1):82-5.
4. Saleem M, Muhammad L, Islam ZU. Pterygium and dry eye-a clinical study. JPMI. 2004;18(4):558-62 Ophthalmologica. 2001 May-Jun;215(3):209-11.
5. Pterygium and dry eye. Ishioka M, Shimmura S, Yagi Y, Tsubota K Roka N, Shrestha SP. Assessment of tear secretion and tear film instability in cases with pterygium and normal subjects. Nepal J Ophthalmol. 2013;5(9):16-23.
6. Khoo J, Saw SM, Banerjee K, Chia SE, Tan D. Outdoor work and the risk of pterygia: a case control study. Int Ophthalmol. 1998;22(5):293-8.
7. Bottomley A, Jones D, Claassens L. Patient-reported outcomes: Assessment and current perspectives of the guidelines of the Food and

- Drug Administration and the reflection paper of the European Medicines Agency. *European Journal of Cancer*. 2009;45(3):347-353.
8. Grubbs JR, Tolleson-Rinehart S, Huynh K, Davis RM. A Review of Quality-of-Life Measures in Dry Eye Questionnaires. *Cornea*. 2014;33(2):215-218.
 9. Paton D. Pterygium management based upon a theory of pathogenesis. *Trans Am Acad Ophthalmol Otolaryngology*. 1975; 79:603.
 10. Lu P, Chen X, Kang Y, Ke L, Wei X, Zhang W. Pterygium in Tibetans: a population-based study in China. *Clin Experiment Ophthalmol*. 2007;35(9):828-3.
 11. Goldberg L, David R. Pterygium and its relationship to the dry eye in the Bantu. *Br J Ophthalmol*. 1976; 60:720-1.
 12. Ishioka M, Shimmura S, Yagi Y, Tsubota K. Pterygium and dry eye. *Ophthalmologica*. 2001;215(3):209-11.
 13. El-Sersy TH. Role of pterygium in ocular dryness. *J Egypt Ophthalmol Soc*. 2014; 107(4): 205-08.
 14. Manhas A et al. Clinical correlation between dry eye and pterygium: a study done at government medical college Jammu, Jammu and Kashmir, North India *Int J Res Med Sci* 2017 July; 5(7):3087-3094
 15. Oh HJ, Park YG, Yoon KC. Changes of ocular surface and tear film in patients with pinguecula and pterygium. *J Korean Ophthalmol Soc*. 2006;47(5):717-24.
 16. Bhardwaj Veena M.S., Das AlakaPriyadarshani, Bhardwaj Gaurav. Pterygium – A Study Which Was Done on A Rural Based Population. *J ClinDiagn Res*. 2013 Sep; 7(9): 1936–1937.
 17. Yuhan Wang, Guangliang Shan, Linyang Gan, Yonggang Qian et al. Prevalence and associated factors for pterygium in Han and Mongolian adults: a cross-sectional study in inner Mongolian, China. *BMC Ophthalmol*. 2020; 20: 45.
 18. Rezvan F, Khabazkhoob M, Hooshmand E, Yekta A, Saatchi M, Hashemi H. Prevalence and risk factors of pterygium: a systematic review and meta-analysis. *Surv Ophthalmol*. 2018;63(5):719–735.
 19. Ganeshpuri AS, Kamble BS, Patil P, Wadgaonkar SP. A comparative study of tear film stability and secretion in pterygium patients - Diabetic vs. nondiabetic. *Int J of Health Sci Res*. 2014;4(4):86-97.
 20. Gupta, Aruna Kumari R.; Nathwani, Yashvi. Correlation between pterygium and dry eye. *Kerala Journal of Ophthalmology* 3 Sep–Dec 2019(3): 217-220.
 21. Rajiv, Mithal S, Sood AK. Pterygium and dry eye – A clinical correlation *Indian J Ophthalmol*. 1991; 39:15–6
 22. El-Sersy TH. Role of pterygium in ocular dryness *J Egypt Ophthalmol Soc*. 2014; 107:205–8
 23. Chaidaroon W, Pongmoragot N. Basic tear secretion measurement in pterygium *J Med Assoc Thai*. 2003;86:348–52
 24. Rahman A, Yahya K, Fasih U, Waqar-ul-Huda, Shaikh A. Comparison of Schirmer's test and tear film breakup time test to detect tear film abnormalities in patients with pterygium *J Pak Med Assoc*. 2012;62:1214–6
 25. Antony AT, Mini PA, Dalia S. Pterygium and dry eye-a clinical correlation *J Med Sci Clin Res*. 2017;5:23654–9
 26. Kampitak K, Leelawongtawun W. Precorneal tear film in pterygium eye *J Med Assoc Thai*. 2014;97:536–9
 27. Moreno JC, Garcia VG, Garcia L. Evaluation of tear film in patients with pterygium *Eur J Ophthalmol*. 2011
 28. Biedner B, Biger Y, Rothkoff L, Sachs U. Pterygium and basic tear secretion *Ann Ophthalmol*. 1979; 11:1235–6
 29. Bandyopadhyay R, Nag D, Mondal SK, Gangopadhyay S, Bagchi K, Bhaduri G. Ocular surface disorder in pterygium: Role of conjunctival impression cytology. *Indian J Pathol Microbiol*. 2010; 53:692–5
 30. Ergin A, Bozdoğan O. Study on tear function abnormality in pterygium *Ophthalmologica*. 2001; 215:204–8
 31. Van Bijsterveld OP. Diagnostic tests in the Sicca syndrome. *Arch Ophthalmol*. 1969; 82:14.