ORIGINAL RESEARCH

The Role of Ocular Surface Microbiota in Psychiatric Symptoms Among Contact Lens Wearers: A Microbiological and Psychological Perspective

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ABSTRACT

Aim: This study aims to explore the relationship between psychiatric symptoms and ocular surface microbiota diversity in contact lens wearers, focusing on whether psychiatric symptoms such as anxiety, depression, and somatization influence the microbial composition of the ocular surface. **Materials and Methods:** A cohort of 80 contact lens wearers aged 18 to 65 years was recruited from a tertiary care center. Participants were grouped based on the presence or absence of psychiatric symptoms, assessed using the DSM-5 criteria. Ocular surface samples were collected and analyzed for bacterial diversity using next-generation sequencing (NGS) of the 16S ribosomal RNA gene. The psychiatric symptoms were assessed using the Symptom Checklist-90 Revised (SCL-90-R). Statistical analysis included univariate and multivariate methods to assess the correlation between microbial diversity and psychiatric symptoms. **Results:** The group with psychiatric symptoms exhibited significantly higher rates of anxiety (70% vs. 10%), depression (62.5% vs. 7.5%), somatization (55% vs. 15%), and obsessive-compulsive symptoms (45% vs. 12.5%) compared to the group without psychiatric symptoms ($p < 0.001$). A significant reduction in microbial diversity was observed in the psychiatric symptom group (Shannon Diversity Index: 1.45 ± 0.22 vs. 1.76 ± 0.25, $p < 0.001$). Multiple regression analysis revealed significant negative correlations between microbial diversity and both anxiety ($B = -0.29$, $p = 0.025$) and depression ($B = -0.24$, $p = 0.032$). **Conclusion:** Psychiatric symptoms, particularly anxiety and depression, are significantly associated with reduced ocular surface microbiota diversity in contact lens wearers. While the prevalence of individual bacterial species did not differ significantly, the overall microbial diversity was notably affected. These findings suggest that psychological health may influence the ocular microbiome, potentially impacting ocular health.

Keywords: Ocular microbiota, psychiatric symptoms, contact lens wearers, microbial diversity, anxiety, depression

INTRODUCTION

The ocular surface microbiota refers to the collection of microorganisms, including bacteria, fungi, viruses, and other microbes, that reside on the surface of the eye. This complex ecosystem plays a crucial role in maintaining the health and integrity of the ocular surface by contributing to immune defense, modulating inflammation, and preventing pathogen colonization. While the importance of the ocular surface microbiota in maintaining ocular health has been well established, emerging evidence suggests that these microbial communities may also influence systemic health, including psychiatric conditions. In recent years, a growing body of research has begun to explore the potential connection between the ocular surface microbiota and psychiatric symptoms, particularly among individuals who wear contact lenses.[1]

Contact lenses are a popular and widely used form of vision correction, but their use is associated with both ocular and systemic health concerns. Prolonged contact lens wear can disrupt the natural balance of

the ocular microbiota, leading to an overgrowth of pathogenic bacteria or fungi, resulting in a range of ocular surface diseases such as dry eye, conjunctivitis, and keratitis. These ocular conditions are known to cause discomfort, visual disturbances, and even psychological distress, which may be compounded by the additional psychological burden of managing a chronic health issue. For individuals who wear contact lenses, managing the discomfort and inconvenience of eye-related symptoms can have profound effects on their emotional well-being, potentially contributing to psychiatric symptoms such as anxiety, depression, and stress.[2]

Research into the relationship between the ocular surface microbiota and psychiatric symptoms is still in its early stages. However, the concept that changes in the ocular microbiota may influence mental health is grounded in the broader understanding of the gut-brain axis. The gut-brain axis refers to the bidirectional communication between the gastrointestinal system and the brain, which is mediated by microbial populations in the gut. Similar mechanisms may exist between the ocular microbiota and the brain, potentially explaining how disruptions in the ocular microbial ecosystem could impact mental health. The ocular surface, like the gut, is home to a diverse range of microorganisms that may influence systemic immune responses, inflammation, and neurotransmitter production, all of which are implicated in psychiatric conditions.[3]

One of the key mechanisms through which the ocular microbiota could influence psychiatric symptoms is through its role in immune modulation. The ocular surface is constantly exposed to external pathogens, allergens, and environmental factors, which can trigger immune responses. A balanced ocular microbiota helps maintain immune homeostasis, preventing excessive inflammation that could lead to ocular discomfort or more severe conditions such as dry eye disease. However, when the balance of the ocular microbiota is disturbed, it can result in dysbiosis, a condition characterized by an overgrowth of harmful microbes and a decrease in protective ones. Dysbiosis of the ocular microbiota could lead to chronic inflammation of the ocular surface, which may, in turn, trigger systemic immune responses. These immune responses may affect the central nervous system, influencing brain function and contributing to psychiatric symptoms such as anxiety and depression.[4]

Additionally, the ocular surface microbiota may influence mental health through its impact on neurotransmitter production. Microbes in various parts of the body, including the ocular surface, have been shown to influence the production of neurotransmitters such as serotonin and dopamine, which play critical roles in mood regulation, stress response, and mental health. A disruption in the balance of the ocular microbiota could lead to alterations in the production or regulation of these neurotransmitters, contributing to the development of psychiatric symptoms. Furthermore, individuals who experience chronic ocular discomfort due to contact lens wear may experience disruptions in sleep patterns, further exacerbating psychiatric conditions such as depression and anxiety.[5]

The potential link between ocular microbiota imbalances and psychiatric symptoms in contact lens wearers also highlights the need for personalized approaches to ocular health management. Understanding the unique microbial communities present on the ocular surface of each individual, as well as how these communities interact with the immune system and the brain, could provide valuable insights into personalized treatment strategies for managing both ocular health and mental health. For example, if certain microbial imbalances are found to be associated with psychiatric symptoms in contact lens wearers, interventions aimed at restoring a healthy ocular microbiota could not only improve eye health but also alleviate some of the psychiatric symptoms associated with these microbial imbalances.[6,7]

However, it is important to acknowledge the complexity of the relationship between the ocular microbiota and psychiatric symptoms. Many factors, including genetics, environmental exposures, lifestyle choices, and underlying health conditions, can influence the composition and function of the ocular microbiota. Moreover, psychiatric symptoms among contact lens wearers may not be solely attributed to microbial imbalances on the ocular surface. Factors such as the physical discomfort associated with contact lens wear, the psychological stress of managing an ocular health condition, and the impact of chronic illness on mental health may all contribute to the development of psychiatric symptoms. Therefore, it is crucial to take a comprehensive, multidisciplinary approach when considering the potential role of the ocular surface microbiota in mental health.

MATERIALS AND METHODS

This study was conducted with a cohort of 80 patients who were contact lens wearers, recruited from a tertiary care center. The inclusion criteria consisted of patients aged 18 to 65 years who had been using contact lenses for at least six months and had no history of significant ocular disease or psychiatric disorders prior to enrollment. Exclusion criteria included patients with systemic or ocular conditions known to affect the ocular microbiome (e.g., autoimmune disorders, recent ocular surgery, or the use of systemic antibiotics), as well as those who were pregnant or breastfeeding. Participants were divided into two groups based on the presence or absence of psychiatric symptoms as assessed by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) criteria.

Ocular samples were collected from both eyes of each participant using sterile swabs to assess the ocular surface microbiota. The swabs were cultured on selective media to identify bacterial species, and the microbial diversity was evaluated using next-generation sequencing (NGS) of the 16S ribosomal RNA gene. These microbial profiles were analyzed to determine the abundance and diversity of bacteria, and correlations were drawn between microbial patterns and the psychiatric symptoms reported by the patients. The psychiatric symptoms were assessed using the Symptom Checklist-90 Revised (SCL-90-R), which evaluates various psychological domains, including anxiety, depression, and somatization.

Demographic and clinical data were obtained through structured interviews and medical records review. Statistical analysis was performed to determine significant differences in microbiota composition and psychological symptom severity between groups. This was achieved using univariate and multivariate analysis, including correlation and regression modeling. Ethical approval was obtained from the institutional review board, and all participants provided informed consent prior to enrollment.

RESULTS

Table 1: Demographic Characteristics of Participants

This table shows the demographic characteristics of the participants, comparing those with psychiatric symptoms and those without. The mean age of the participants in both groups is similar, with a slight difference: 30.2 ± 7.4 years in the psychiatric group and 31.1 ± 8.1 years in the non-psychiatric group. The p-value for age (0.482) indicates no significant difference between the two groups. The gender distribution between both groups is also comparable, with 18 males and 22 females in the psychiatric group, and 20 males and 20 females in the non-psychiatric group, with a p-value of 0.850, suggesting no gender-based differences between groups. The duration of contact lens use is also nearly identical between the two groups, with a mean of 24.3 ± 14.7 months in the psychiatric group and 23.7 ± 13.8 months in the non-psychiatric group, with no significant difference ($p = 0.795$). Overall, there were no significant demographic differences between the two groups.

Table 2: Prevalence of Psychiatric Symptoms among Participants

Table 2 presents the prevalence of various psychiatric symptoms among the participants. The group with psychiatric symptoms exhibited significantly higher rates of anxiety (70% vs. 10%, $p < 0.001$), depression (62.5% vs. 7.5%, $p < 0.001$), somatization (55% vs. 15%, $p < 0.001$), and obsessive-compulsive symptoms (45% vs. 12.5%, $p = 0.002$) compared to the group without psychiatric symptoms. These findings suggest that participants with psychiatric symptoms had a notably higher prevalence of these conditions, with all comparisons showing statistically significant differences. This highlights a clear association between psychiatric symptoms and the presence of these specific psychological disorders in contact lens wearers.

Table 3: Microbial Diversity of Ocular Surface Bacteria (Measured by Shannon Index)

This table assesses the microbial diversity of the ocular surface in both groups. The Shannon Diversity Index, which quantifies microbial diversity, was significantly lower in the group with psychiatric symptoms (1.45 ± 0.22) compared to the group without psychiatric symptoms (1.76 ± 0.25), with a p-value of <0.001. This result suggests that individuals with psychiatric symptoms had reduced microbial diversity on their ocular surface compared to those without psychiatric symptoms. This finding points to a potential relationship between reduced ocular microbiota diversity and the presence of psychiatric symptoms in contact lens wearers.

Table 4: Prevalence of Bacterial Species Identified in Ocular Samples

Table 4 shows the prevalence of specific bacterial species identified in ocular samples. The prevalence of *Staphylococcus aureus* (30% vs. 25%), *Staphylococcus epidermidis* (87.5% vs. 95%), *Propionibacterium acnes* (45% vs. 50%), *Corynebacterium spp.* (40% vs. 35%), and *Streptococcus spp.* (22.5% vs. 32.5%) was compared between the two groups. However, none of these differences reached statistical significance, with p-values ranging from 0.257 to 0.671. This indicates that, while there are slight differences in the prevalence of these bacterial species, the microbial composition in terms of species presence does not significantly differ between those with and without psychiatric symptoms.

Table 5: Multiple Regression Analysis for Microbial Diversity and Psychiatric Symptoms

Table 5 shows the results of a multiple regression analysis evaluating the relationship between microbial diversity and psychiatric symptoms. The analysis reveals that psychiatric symptoms, specifically anxiety and depression, are negatively correlated with microbial diversity on the ocular surface. For anxiety, the B-coefficient is -0.29 ($p = 0.025$), indicating a significant negative relationship between higher anxiety scores and reduced microbial diversity. Similarly, depression shows a significant negative relationship with microbial diversity (B-coefficient = -0.24, $p = 0.032$). The relationship between microbial diversity and somatization ($B = -0.18$, $p = 0.06$) and obsessive-compulsive symptoms ($B = -0.15$, $p = 0.09$) is also negative, but the results are not statistically significant. This regression analysis provides further evidence of a significant association between

psychiatric symptoms, particularly anxiety and depression, and decreased ocular microbiota diversity in contact lens wearers.

Table 1: Demographic Characteristics of Participants

Characteristic	Group with Psychiatric Symptoms (n = 40)	Group without Psychiatric Symptoms (n = 40)	Total (n = 80)	p-value
Age (years), Mean ± SD	30.2 ± 7.4	31.1 ± 8.1	30.7 ± 7.8	0.482
Gender (Male/Female)	18/22	20/20	38/42	0.850
Duration of Contact Lens Use (months), Mean ± SD	24.3 ± 14.7	23.7 ± 13.8	24.0 ± 14.2	0.795

Table 2: Prevalence of Psychiatric Symptoms among Participants

Psychiatric Symptom Category	Group with Psychiatric Symptoms (n = 40)	Group without Psychiatric Symptoms (n = 40)	p-value
Anxiety (SCL-90-R Score ≥ 1.5)	28 (70%)	4 (10%)	<0.001
Depression (SCL-90-R Score ≥ 1.5)	25 (62.5%)	3 (7.5%)	<0.001
Somatization (SCL-90-R Score ≥ 1.5)	22 (55%)	6 (15%)	<0.001
Obsessive-Compulsive Symptoms (SCL-90-R Score ≥ 1.5)	18 (45%)	5 (12.5%)	0.002

Table 3: Microbial Diversity of Ocular Surface Bacteria (Measured by Shannon Index)

Group	Mean Shannon Diversity Index ± SD	p-value
Group with Psychiatric Symptoms (n = 40)	1.45 ± 0.22	<0.001
Group without Psychiatric Symptoms (n = 40)	1.76 ± 0.25	
Total (n = 80)	1.61 ± 0.23	

Table 4: Prevalence of Bacterial Species Identified in Ocular Samples

Bacterial Species	Group with Psychiatric Symptoms (n = 40)	Group without Psychiatric Symptoms (n = 40)	p-value
Staphylococcus aureus	12 (30%)	10 (25%)	0.671
Staphylococcus epidermidis	35 (87.5%)	38 (95%)	0.257
Propionibacterium acnes	18 (45%)	20 (50%)	0.629
Corynebacterium spp.	16 (40%)	14 (35%)	0.641
Streptococcus spp.	9 (22.5%)	13 (32.5%)	0.347

Table 5: Multiple Regression Analysis for Microbial Diversity and Psychiatric Symptoms

Psychiatric Symptom	B-coefficient	Standard Error	p-value
Anxiety	-0.29	0.12	0.025
Depression	-0.24	0.10	0.032
Somatization	-0.18	0.09	0.06
Obsessive-Compulsive Symptoms	-0.15	0.08	0.09

DISCUSSION

The findings of this study provide valuable insights into the relationship between psychiatric symptoms and ocular surface microbial diversity in contact lens wearers. Specifically, we observed that individuals with psychiatric symptoms, particularly anxiety and depression, exhibited a significant reduction in microbial diversity on the ocular surface compared to those without psychiatric symptoms.

The demographic characteristics of the participants, such as age, gender, and duration of contact lens use, were similar between the two groups, with no significant differences. The mean age for those with psychiatric symptoms was 30.2 ± 7.4 years, compared to 31.1 ± 8.1 years for those without psychiatric symptoms (p = 0.482). The gender distribution was also balanced, with 18 males and 22 females in the psychiatric group, and 20 males and 20 females in the non-psychiatric group (p = 0.850). Furthermore, the duration of contact lens use was comparable between groups, with a mean of 24.3 ± 14.7 months for those with psychiatric symptoms and 23.7 ± 13.8 months for those without psychiatric symptoms (p = 0.795). These demographic results align with those of McLaughlin-Borlace et al. (1998), who also found no significant demographic differences between groups when investigating the microbiota of contact lens wearers with microbial keratitis (McLaughlin-Borlace et al., 1998). This suggests that the differences observed in microbial diversity were not due to age, gender, or duration of contact lens use but are more likely attributed to psychiatric symptoms.[8]

The prevalence of psychiatric symptoms was significantly higher in the group with psychiatric symptoms, as shown in Table 2. Specifically, 70% of participants in the psychiatric group experienced anxiety (vs. 10% in the non-psychiatric group, $p < 0.001$), 62.5% experienced depression (vs. 7.5%, $p < 0.001$), 55% experienced somatization (vs. 15%, $p < 0.001$), and 45% exhibited obsessive-compulsive symptoms (vs. 12.5%, $p = 0.002$). These results are consistent with the findings of Behlau and Gilmore (2008), who also reported that psychiatric symptoms, including anxiety and depression, can influence various aspects of health, including microbiota (Behlau& Gilmore, 2008). [9]

Participants with psychiatric symptoms exhibited a significantly lower Shannon Diversity Index (1.45 ± 0.22) compared to those without psychiatric symptoms (1.76 ± 0.25), with a p-value of <0.001. This suggests that reduced microbial diversity on the ocular surface is associated with psychiatric symptoms, particularly anxiety and depression. This finding is consistent with Shin et al. (2016), who showed that contact lens wearers exhibit changes in their ocular microbiota, which may be influenced by both environmental and psychological factors. [10]

The prevalence of specific bacterial species in ocular samples from both groups. The prevalence of *Staphylococcus aureus* was 30% in the psychiatric group compared to 25% in the non-psychiatric group ($p = 0.671$), and *Staphylococcus epidermidis* was present in 87.5% of participants with psychiatric symptoms versus 95% in those without psychiatric symptoms ($p = 0.257$). Other species, including *Propionibacterium acnes*, *Corynebacterium spp.*, and *Streptococcus spp.*, showed no statistically significant differences between the two groups (p-values ranging from 0.257 to 0.671). These findings are in line with the work of Zhang et al. (2017), who observed no significant differences in the prevalence of specific bacterial species between different groups of contact lens wearers .[11] The lack of significant differences in the bacterial species may suggest that while the overall diversity is reduced in individuals with psychiatric symptoms, the prevalence of individual bacterial species is not directly influenced by these symptoms. This aligns with findings from Galdiero et al. (2020), who indicated that while microbial diversity can be altered by various factors, the prevalence of specific species may not show the same patterns.[12]

The analysis revealed a significant negative correlation between microbial diversity and both anxiety ($B = -0.29$, $p = 0.025$) and depression ($B = -0.24$, $p = 0.032$), suggesting that higher anxiety and depression scores are associated with reduced ocular microbiota diversity. This result supports the findings of Kugadas et al. (2016), who reported that psychological stress and microbial dysbiosis may influence ocular health by altering the immune response.[13]Additionally, while somatization ($B = -0.18$, $p = 0.06$) and obsessive-compulsive symptoms ($B = -0.15$, $p = 0.09$) showed negative correlations with microbial diversity, these relationships were not statistically significant. This highlights that anxiety and depression may have a more substantial impact on the ocular microbiota compared to other psychiatric symptoms. The negative correlation between psychiatric symptoms and microbial diversity in our study aligns with studies by Fleiszig and Evans (2010), who suggested that stress and immune system dysfunction can contribute to microbial changes in the eye.[14]

CONCLUSION

In conclusion, this study demonstrates a significant association between psychiatric symptoms, particularly anxiety and depression, and reduced ocular surface microbiota diversity in contact lens wearers. Individuals with psychiatric symptoms exhibited lower microbial diversity, suggesting that psychological health may influence the ocular microbiome. Although the prevalence of individual bacterial species did not significantly differ between groups, the overall microbial diversity was notably impacted.

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