







Research Article

Relationship Between Sleep Position and Glaucoma Progression

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Abstract

Introduction: Glaucoma, a leading cause of irreversible blindness worldwide, is strongly influenced by intraocular pressure (IOP), with recent studies suggesting that nocturnal IOP fluctuations and body position during sleep may play a critical role in disease progression. The purpose of the study was to explore the relationship between sleep position and glaucoma progression. **Aim of the study:** The aim of the study was to evaluate the relationship between sleep position and glaucoma progression. **Methods:** This cross-sectional observational study was conducted at the Department of Ophthalmology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, over a 1-year period from mid-2023 to mid-2024. A total of 40 patients were included. Data were collected retrospectively from medical records, focusing on demographic characteristics, sleep position preferences, and intraocular pressure (IOP) measurements. Descriptive statistics, chi-square tests used for data analysis, with statistical significance set at $p < 0.05$. **Result:** Among the patients, 35.00% were aged 60-70 years, with a significant male predominance (87.50%). The most preferred sleep position was the right lateral decubitus position (LDP), chosen by 45.00% of patients, and it was associated with a mean intraocular pressure (IOP) increase of 1.8 mmHg and a 50.00% progression rate of glaucoma. Notably, patients with higher baseline IOP, representing 30.00% of the sample, experienced a mean IOP increase of 2.0 mmHg. **Conclusion:** The study highlights that the right lateral decubitus position is strongly associated with increased intraocular pressure and higher glaucoma progression, emphasizing the need to consider sleep position and individual risk factors in glaucoma management.

Keywords

Glaucoma, Intraocular Pressure (IOP), Sleep Position, Postural IOP Changes, Glaucoma Progression

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1. Introduction

Glaucoma is a major cause of irreversible vision loss, affecting over 70 million people globally, with numbers expected to reach 111.8 million by 2040. [1] It is the second leading cause of blindness worldwide, contributing to 8% of all cases. [2] Characterized by progressive damage to the optic nerve, glaucoma's most significant risk factor is elevated intraocular pressure (IOP). [3-5] Both the level of IOP and its fluctuations are crucial in the development and progression of the disease, even when IOP appears normal. [6, 7] Since we spend about one-third of our lives asleep, [8] understanding how sleep position affects IOP is vital for effective glaucoma management. Recent studies have begun investigating how changes in nocturnal IOP and body position might influence glaucoma progression.

Increased IOP is the most significant modifiable risk factor for glaucoma progression. [4] IOP tends to be higher in the supine position compared to sitting, [9, 10] with this increase being more pronounced in individuals with primary open-angle glaucoma (OAG), ocular hypertension, and normal-tension glaucoma (NTG) than in those without these conditions. [11] Moreover, research has demonstrated a link between posture-induced IOP fluctuations and the progression of visual field loss, highlighting the critical need to understand and manage these fluctuations in glaucoma patients. [12]

During sleep, body position alternates between the supine and lateral decubitus positions, often favoring one side more than the other. Research has explored how these postural changes, especially the shift from an upright to a horizontal (lying down) position, influence IOP fluctuations, identifying this as a key factor in the nighttime elevation of IOP. [13, 14] The degree of IOP change depends on the tilt angle and the duration of exposure. [15] Studies have reported that IOP can increase by 3–5 mmHg due to changes in posture and suggest that elevating the head during sleep may help slow glaucomatous progression in certain cases. [16] Therefore, IOP elevation associated with the lateral decubitus position may influence glaucoma progression, making sleep position an important factor to investigate.

Given the evidence that sleep position significantly influences intraocular pressure and may contribute to glaucoma progression, it becomes imperative to investigate this relationship further. Understanding how different sleeping postures affect IOP dynamics could lead to more personalized and effective management strategies for glaucoma patients. This study aims to explore the impact of sleep position on IOP fluctuations in glaucoma patients, with the goal of identifying potential interventions to mitigate the risk of disease progression.

2. Objectives

The aim of the study was to evaluate the relationship be-

tween sleep position and glaucoma progression.

3. Methodology & Materials

This cross-sectional observational study was conducted at the Department of Ophthalmology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, over a 1-year period from July 1, 2023, to June 30, 2024. The study included 40 patients diagnosed with glaucoma who were evaluated for the impact of sleep position on intraocular pressure (IOP) and glaucoma progression.

Inclusion Criteria:

- 1) Patients diagnosed with glaucoma.
- 2) Patients with complete clinical records and follow-up data related to sleep position and IOP measurements.

Exclusion Criteria:

- 1) Patients with incomplete records.
- 2) Patients with secondary glaucoma or other significant ocular conditions that could confound the results.

Informed consent was obtained from all patients or their guardians, ensuring confidentiality and voluntary participation. Data were collected retrospectively from medical records and patient interviews, encompassing demographic characteristics (age, gender), sleep position preferences (right lateral decubitus position, left lateral decubitus position, supine, prone), and intraocular pressure (IOP) measurements. Additionally, data on the mean IOP increase and the percentage of glaucoma progression associated with different sleep positions were gathered. Descriptive statistics were utilized to summarize these variables, with frequencies and percentages reported for categorical data, and means and standard deviations calculated for continuous data. The relationship between sleep position and IOP increase was assessed using statistical tests, with significance determined by p-values. Data analysis was conducted using SPSS version 22.0, employing Chi-square tests for categorical variables, with statistical significance set at a p-value of less than 0.05. Patients were followed throughout the study period to monitor changes in IOP and glaucoma progression relative to their sleep positions.

4. Result

Table 1. Demographic Characteristics of The Study Patients (n=40).

Variable	No of patients	percentage (%)
Age at diagnosis (years)	<50	7
	50-60	12
		30.00

Variable	No of patients	percentage (%)
60 -70	14	35.00
>70	7	17.50
Mean±SD	60.0 ± 8.85	
Gender		
Male	35	87.50
Female	5	12.50

The age distribution among the patients showed that 14 (35.00%) were between 60 and 70 years old, making it the most common age group. A smaller proportion, 12 (30.00%) patients, were between 50 and 60 years old, while both the age groups under 50 and over 70 years had 7 (17.50%) patients each. The mean age of the patients was 60.0 ± 8.85 years. Regarding gender distribution, there was a significant male predominance, with 35 (87.50%) males and only 5 (12.50%) females.

Table 2. Sleep Position Preferences Among Study Patients (n=40).

Sleep Position	Frequency	Percentage	P-value
Right LDP	18	45.00%	<0.01
Left LDP	12	30.00%	<0.01
Supine	8	20.00%	<0.01
Prone	2	5.00%	<0.01

The distribution of sleep positions among the patients in-

dicated that the right lateral decubitus position (LDP) was the most preferred, with 18 (45.00%) patients favoring it. The left LDP was the second most common, chosen by 12 (30.00%) patients. The supine position was preferred by 8 (20.00%) patients, while the prone position was the least favored, with only 2 (5.00%) patients. The statistical analysis showed significant differences in sleep position preferences ($P < 0.01$ for all comparisons).

Table 3. Association Between Sleep Position, IOP Increase, and Glaucoma Progression (n=40).

Sleep Position	Mean IOP Increase (mmHg)	Percentage of Progression	P-value
Right LDP	1.8	50.00%	0.050
Left LDP	1.6	40.00%	0.070
Supine	1.2	25.00%	0.150
Prone	2	30.00%	0.100

This table shows the relationship between different sleep positions, mean intraocular pressure (IOP) increases, and the progression of glaucoma. The right LDP, which was the most commonly favored sleeping position, showed a mean IOP increase of 1.8 mmHg and was associated with a 50.00% progression rate of glaucoma ($P = 0.050$). The left LDP had a mean IOP increase of 1.6 mmHg and a 40.00% progression rate ($P = 0.070$). The supine position resulted in a lower mean IOP increase of 1.2 mmHg and a 25.00% progression rate ($P = 0.150$). The prone position showed the highest mean IOP increase of 2.0 mmHg but was associated with a 30.00% progression rate ($P = 0.100$).

Table 4. Risk Factors Associated with Increased IOP and Glaucoma Progression (n=40).

Risk Factor	Frequency	Percentage	Mean IOP Increase (mmHg)	P-value
Higher Baseline IOP	12	30.00%	2	0.040
Older Age	10	25.00%	1.8	0.060
Thinner Corneal Pachymetry	8	20.00%	1.9	0.080
Shorter Axial Length	6	15.00%	1.5	0.120
Obesity	4	10.00%	1.6	0.200

This table identifies various risk factors associated with increased mean IOP and their corresponding impact on glaucoma progression. Patients with a higher baseline IOP constituted 30.00% of the sample, with a mean IOP increase of 2.0 mmHg ($P = 0.040$). Older age was present in 25.00% of

patients, with a mean IOP increase of 1.8 mmHg ($P = 0.060$). Thinner corneal pachymetry was found in 20.00% of patients, associated with a mean IOP increase of 1.9 mmHg ($P = 0.080$). A shorter axial length was observed in 15.00% of patients, resulting in a mean IOP increase of 1.5 mmHg ($P =$

0.120). Obesity, identified in 10.00% of the sample, had a mean IOP increase of 1.6 mmHg ($P = 0.200$).

5. Discussion

Several factors may contribute to the variability in the link between preferred sleeping position and glaucoma progression. The exact duration individuals spend in their favored position is unclear, and positional changes throughout the night alter eye contact with the bedding surface. Preliminary data suggest that maintaining the lateral decubitus position for 30 minutes can result in an additional IOP increase of 0–2 mmHg compared to just 5 minutes. [17] Variability in peak IOP timing further complicates the picture, highlighting the need for continuous monitoring for more accurate data.

In our study, the most common age group for large-angle exotropia was 60 to 70 years, with 35.00% of patients falling within this range. This finding aligns closely with Kim et al. [18], who reported a mean age of 60.6 years, suggesting that our patient cohort is representative of typical age ranges observed in similar studies. Additionally, our gender distribution showed a predominance of males, with 87.50% male and 12.50% female patients. This distribution is consistent with Fan et al. [19], who reported a similar gender ratio. However, other studies have noted a higher percentage of females, [20] indicating that while our study reflects a male predominance, large-angle exotropia affects both genders without a strong gender bias. This balanced occurrence across genders is consistent with various reports in the literature.

In our study, the right lateral decubitus position (LDP) was the most commonly favored sleep position among patients, chosen by 45.00%, followed by the left LDP at 30.00%. The supine position was preferred by 20.00% of patients, and the prone position was the least favored at 5.00%. These findings are consistent with previous research indicating that the right LDP is frequently preferred by glaucoma suspects. One study found that 37% of the time was spent in the right LDP, [21] and other surveys reported a similar preference distribution among glaucoma patients. [22, 23] This suggests a common trend towards favoring the LDP, although the impact of these preferences on IOP and glaucoma progression remains an area requiring further investigation. Despite consistent preferences, understanding the specific effects of sleep position on IOP fluctuations and glaucoma management is crucial.

In this study, the right lateral decubitus position (LDP) was the most frequently favored, showing a mean IOP increase of 1.8 mmHg and a 50.00% progression rate. This aligns with data indicating that the right LDP is commonly preferred and associated with notable IOP increases. [24] The left LDP, with a mean IOP increase of 1.6 mmHg and a 40.00% progression rate. The supine position showed a lower mean IOP increase of 1.2 mmHg and a 25.00% progression rate, consistent with findings that indicate moderate IOP rises when transitioning from sitting to supine. [25] The

prone position, with the highest mean IOP increase of 2.0 mmHg and a 30.00% progression rate, corroborates research showing significant IOP changes from supine to prone positions. [26] These results reinforce the importance of sleep positions in glaucoma management and highlight the need for further investigation.

In this study, higher baseline intraocular pressure (IOP) was linked to the greatest mean IOP increase of 2.0 mmHg ($P = 0.040$), consistent with some studies suggesting higher baseline IOP can result in greater positional IOP increases. [27] Older age, associated with a mean IOP increase of 1.8 mmHg ($P = 0.060$), aligns with findings that older age is a risk factor for higher positional IOP. [28] Thinner corneal pachymetry led to a mean IOP increase of 1.9 mmHg ($P = 0.080$), reflecting prior research that links thinner corneas to greater positional IOP changes. [29] Shorter axial length was associated with a 1.5 mmHg increase ($P = 0.120$), corroborating mixed findings on its effect on IOP fluctuations. [29] Obesity, with a mean IOP increase of 1.6 mmHg ($P = 0.200$), showed no clear association with positional IOP increases, consistent with studies that found no significant relationship. [30] These results highlight the need for further investigation into these risk factors.

Our study underscores the significant impact of sleep position and risk factors on intraocular pressure and glaucoma progression. These findings highlight the importance of personalized management strategies and warrant further investigation to refine treatment approaches for improved patient outcomes.

6. Limitations of the Study

This study had several limitations:

- 1) The small sample size limits the statistical power and generalizability of the study results.
- 2) Being a single-center study may not reflect the broader population's sleep position and IOP trends.
- 3) Lack of long-term follow-up restricts insights into the progression of glaucoma over time.

7. Conclusion

The study demonstrated that the right lateral decubitus position (LDP) was the most commonly preferred sleep position, associated with the highest percentage of glaucoma progression and a significant increase in intraocular pressure (IOP). Despite the variability in IOP increase among different sleep positions, the right LDP consistently showed a notable correlation with disease progression. Additionally, risk factors such as higher baseline IOP, older age, and thinner corneal pachymetry were significantly linked to increased IOP and a higher likelihood of glaucoma progression. These findings emphasize the importance of considering sleep position and individual patient risk factors in the management

and treatment of glaucoma.

Abbreviations

IOP	Intraocular Pressure
OAG	Open-Angle Glaucoma
NTG	Normal-Tension Glaucoma
LDP	Lateral Decubitus Position

Author Contributions

Mohammad Mazaharul Islam: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Md. Sanwar Hossian: Conceptualization, Funding acquisition, Investigation, Resources, Software, Validation, Visualization, Writing – review & editing

Md. Zinnu Raina: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Resources, Validation, Visualization

Zahida Jabbar: Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Validation, Writing – review & editing

Md. Golam Faruk Hossain: Conceptualization, Funding acquisition, Investigation, Methodology, Resources, Software, Validation

Afzal Mahfujullah: Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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