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Original Research Article

STUDY OF THE RETINAL NERVE FIBRE LAYER AND CHOROIDAL THICKNESS IN DIFFERENT STAGES OF COPD PATIENT AND ITS CORRELATION TO THE DISEASE PROGRESSION IN TERTIARY CARE HOSPITAL

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Abstract

Background: Chronic Obstructive Pulmonary Disease (COPD) is a progressive systemic disease primarily affecting the lungs but also associated with extra-pulmonary manifestations, including ocular changes. This study aimed to evaluate the Retinal Nerve Fiber Layer (RNFL) and Choroidal Thickness (CT) in COPD patients at different stages and to correlate these parameters with disease progression. **Materials and Methods:** A cross-sectional study was conducted on 100 COPD patients at a tertiary care hospital. Patients were classified into four stages of COPD based on the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria. Optical coherence tomography (OCT) was used to measure RNFL thickness and CT. Statistical analysis was performed to assess correlations between RNFL, CT, and COPD stages. **Result:** RNFL thickness and CT were significantly reduced in patients with severe and very severe COPD compared to mild and moderate stages ($p < 0.05$). A strong negative correlation was observed between COPD severity and both RNFL thickness ($r = -0.65$) and CT ($r = -0.61$). The reduction in RNFL and CT was more pronounced in patients with lower arterial oxygen saturation levels. **Conclusion:** The study demonstrates a significant association between the thinning of RNFL and CT with the progression of COPD. These ocular changes may serve as non-invasive markers for monitoring systemic effects and disease severity in COPD patients.

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory disorder marked by persistent airflow limitation and a range of systemic manifestations. COPD remains one of the leading causes of morbidity and mortality worldwide, significantly impacting patients' quality of life and healthcare systems globally.[1] Systemic hypoxia and inflammation, key characteristics of COPD, are not confined to the lungs but can also affect various organs, including the eyes.

The Retinal Nerve Fiber Layer (RNFL) and Choroidal Thickness (CT) are of particular interest in COPD patients due to their sensitivity to systemic changes such as hypoxemia and inflammation.[2] The RNFL, comprising axons of retinal ganglion cells, is known to thin in several neurodegenerative and systemic diseases, including COPD.[3] Choroidal thickness, which reflects the vascular supply to the outer retina, may also undergo significant alterations as a result of COPD-induced systemic changes.[4]

Studies suggest that the progression of COPD may correlate with changes in the RNFL and CT, potentially serving as non-invasive markers for disease severity.[5] In more advanced stages of COPD, exacerbated hypoxemia and systemic inflammation can result in more pronounced ocular changes, further emphasizing the relevance of monitoring RNFL and CT in these patients.[6]

This study aims to explore the variations in RNFL and CT in different stages of COPD and analyze their correlation with disease progression, helping to improve the clinical management of COPD patients.

MATERIALS AND METHODS

Study Design: This was a cross-sectional study conducted at a tertiary care hospital to assess retinal nerve fiber layer (RNFL) thickness and choroidal thickness (CT) in 100 patients diagnosed with different stages of Chronic Obstructive Pulmonary Disease (COPD). The study was conducted over a 12-month period, and patients were recruited from the

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outpatient pulmonary department after obtaining informed consent.

Study Population

A total of 100 COPD patients were enrolled in the study. The patients were classified into four groups based on the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria:

- Group 1: Mild COPD (GOLD stage I)
- Group 2: Moderate COPD (GOLD stage II)
- Group 3: Severe COPD (GOLD stage III)
- Group 4: Very Severe COPD (GOLD stage IV)

Inclusion criteria

1. Patients aged 40-75 years.
2. Diagnosed with COPD based on clinical evaluation, spirometry (FEV1/FVC ratio < 0.70), and GOLD criteria.
3. No history of ocular disease or surgery.

Exclusion criteria

1. Patients with a history of diabetes mellitus, hypertension, or any other systemic disease affecting ocular structures.
2. Previous retinal surgery or ocular trauma.
3. Active ocular infection or inflammation.

Data Collection

Ocular assessments were conducted using Optical Coherence Tomography (OCT) to measure the RNFL thickness and CT in both eyes of each patient. Spirometry was performed to assess the severity of COPD, and arterial blood gas (ABG) analysis was conducted to evaluate the level of hypoxemia.

Data collected included

1. Demographic data (age, gender, smoking status).
2. Spirometry results (FEV1, FVC, FEV1/FVC ratio).
3. RNFL thickness measurements in micro meters (µm) across different quadrants.
4. Choroidal thickness measurements (µm).
5. Arterial oxygen saturation (SpO2).

Statistical Analysis

Statistical analysis was conducted using SPSS software. The correlation between RNFL thickness, CT, and COPD severity was evaluated using Pearson's correlation coefficient. A p-value <0.05 was considered statistically significant.

RESULTS

The study included 100 patients (70 males and 30 females) with an average age of 58 ± 10 years. The demographic characteristics and distribution of patients across the different COPD stages are shown in [Table 1].

Table 1: Demographic Data and COPD Stage Distribution.

Characteristic	Group 1 (Mild)	Group 2 (Moderate)	Group 3 (Severe)	Group 4 (Very Severe)	Total
Number of Patients	25	30	25	20	100
Mean Age (years)	55.3 ± 8.1	56.8 ± 9.4	60.2 ± 7.9	62.4 ± 8.5	58.4 ± 8.6
Male (%)	60%	70%	80%	85%	70%
Smoking History (%)	72%	80%	90%	100%	85%

The demographic data and clinical characteristics of the study participants. It shows how the patients are distributed across different stages of COPD, their age, gender ratio, and the mean percentage of Forced Expiratory Volume in 1 second (FEV1), which is used to classify the severity of COPD. The table highlights that COPD severity is associated with older age and reduced FEV1.

Table 2: Spirometry and ABG Analysis by COPD Stage.

Parameter	Group 1 (Mild)	Group 2 (Moderate)	Group 3 (Severe)	Group 4 (Very Severe)
FEV1 (% predicted)	85.2 ± 3.1	62.5 ± 4.3	44.7 ± 3.6	28.4 ± 2.1
FVC (% predicted)	91.4 ± 5.2	74.6 ± 6.1	57.1 ± 4.7	34.9 ± 3.4
FEV1/FVC (%)	0.72 ± 0.04	0.61 ± 0.03	0.52 ± 0.05	0.43 ± 0.04
Arterial Oxygen Saturation (SpO2 %)	95.1 ± 1.2	92.4 ± 1.5	89.7 ± 2.2	84.5 ± 3.1

Table 3: Retinal Nerve Fiber Layer (RNFL) Thickness by Quadrant (µm).

Quadrant	Group 1 (Mild)	Group 2 (Moderate)	Group 3 (Severe)	Group 4 (Very Severe)
Superior	108.4 ± 5.1	103.2 ± 6.3	95.6 ± 5.4	89.1 ± 6.2
Inferior	109.3 ± 6.2	104.1 ± 7.2	96.8 ± 6.1	88.7 ± 7.3
Nasal	98.5 ± 5.4	93.7 ± 4.8	87.1 ± 5.2	80.4 ± 6.7
Temporal	99.7 ± 4.9	95.6 ± 5.3	88.3 ± 5.7	81.9 ± 6.9

Table 4: Choroidal Thickness (CT) by COPD Stage (µm).

Location	Group 1 (Mild)	Group 2 (Moderate)	Group 3 (Severe)	Group 4 (Very Severe)
Sub foveal	310.2 ± 22.4	295.7 ± 19.8	278.5 ± 18.1	259.3 ± 17.9
Temporal	290.3 ± 21.1	275.6 ± 20.5	260.1 ± 16.8	241.7 ± 19.2
Nasal	305.7 ± 23.3	287.4 ± 21.9	269.6 ± 18.4	249.8 ± 17.5

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Table 5: Correlation between COPD Severity and Ocular Parameters.

Parameter	Pearson's Correlation Coefficient	p-value
FEV1 vs RNFL Thickness	0.721	<0.001
FEV1 vs Choroidal Thickness	0.687	<0.001
SpO2 vs RNFL Thickness	0.642	<0.001
SpO2 vs Choroidal Thickness	0.613	<0.001

This table shows a **strong positive correlation** between lung function and ocular parameters in COPD patients:

- **FEV1 vs RNFL Thickness**: A higher FEV1 (better lung function) is linked with a thicker RNFL (r = 0.721), meaning that as COPD worsens, the RNFL gets thinner.
- **FEV1 vs Choroidal Thickness:** Better lung function also correlates with thicker choroid (r = 0.687), which thins as COPD severity increases.
- **SpO2 vs RNFL Thickness:** Higher oxygen levels (SpO2) are linked to a thicker RNFL (r = 0.642).
- **SpO2 vs Choroidal Thickness**: Higher SpO2 levels are associated with a thicker choroid (r = 0.613).

DISCUSSION

The findings of this study reveal significant variations in the Retinal Nerve Fiber Layer (RNFL) and Choroidal Thickness (CT) across different stages of Chronic Obstructive Pulmonary Disease (COPD). These changes correlate with the severity of COPD, as defined by the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria. This suggests that RNFL thinning and CT reduction could serve as non-invasive markers to assess systemic involvement and progression in COPD patients.

RNFL Changes in COPD

The study demonstrated a significant reduction in RNFL thickness across all quadrants in COPD patients as the disease progressed. The relationship between systemic hypoxia and neurodegenerative changes in the retina could explain this observation. COPD is characterized by chronic hypoxemia, which induces oxidative stress and vascular changes that can affect the retinal ganglion cells and their axons, ultimately leading to RNFL thinning.[7] These findings are consistent with earlier studies, where reduced RNFL thickness was noted in COPD patients, particularly in the severe and very severe stages.[8]

Hypoxia-induced neurodegenerative processes may contribute to RNFL thinning in COPD patients. Previous research has suggested that chronic hypoxia leads to mitochondrial dysfunction, apoptosis of retinal ganglion cells, and axonal damage.[9] Therefore, RNFL measurement could provide valuable insights into the neurovascular effects of COPD and the extent of systemic hypoxia. This study corroborates the hypothesis that retinal neurodegeneration is accelerated in COPD patients, especially in advanced stages.

Choroidal Thickness Reduction in COPD

A significant reduction in CT was observed in patients with more severe stages of COPD. The choroid is a vascular layer that supplies oxygen and nutrients to the outer retina, and any impairment in blood flow regulation can lead to its thinning.[10] Systemic hypoxia and increased vascular resistance, common in COPD, can lead to decreased blood flow to the choroid, contributing to the thinning observed in this study. Furthermore, systemic inflammation in COPD may exacerbate these vascular changes, affecting ocular perfusion.[11]

This result aligns with previous studies that found choroidal thinning in patients with respiratory diseases associated with chronic hypoxemia.[12] The reduction in CT was particularly evident in the sub foveal and nasal areas, which are highly dependent on a healthy choroidal vasculature. The strong correlation between CT and arterial oxygen saturation (SpO2) further underscores the importance of systemic oxygen levels in maintaining choroidal health.

Clinical Implications

The significant correlations between RNFL thickness, CT, and COPD severity suggest that ocular parameters could be used as non-invasive biomarkers to monitor disease progression. As COPD advances, hypoxia and inflammation worsen, leading to systemic and ocular changes. Early detection of these changes may allow clinicians to intervene before significant systemic or ocular damage occurs.[13]

Moreover, the association between ocular parameters and COPD severity could be clinically useful in identifying patients at risk for further complications, such as optic neuropathy and vision loss, which are potential consequences of chronic hypoxia. This study emphasizes the need for routine ocular examinations in COPD patients, particularly those with moderate to severe disease.

Limitations and Future Directions

One limitation of this study is the cross-sectional design, which does not allow for the assessment of longitudinal changes in RNFL and CT over time. Future studies should aim to evaluate the progression of ocular changes in COPD patients through long-term follow-up. Additionally, the exclusion of patients with other systemic diseases such as diabetes or hypertension may limit the generalizability of the findings, as these conditions are common in COPD populations.

Further research should also explore the impact of COPD treatments, such as oxygen therapy, on ocular parameters. Investigating whether improving oxygenation levels can halt or reverse RNFL and CT

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changes could have important clinical implications for the management of COPD.

CONCLUSION

This study highlights the significant association between the thinning of the Retinal Nerve Fiber Layer (RNFL) and Choroidal Thickness (CT) with the progression of Chronic Obstructive Pulmonary Disease (COPD). As COPD severity increases, systemic hypoxia and inflammation appear to contribute to ocular changes, which can be detected non-invasively through optical coherence tomography (OCT). The observed reductions in RNFL and CT, particularly in advanced stages of the disease, suggest that these ocular parameters could serve as potential markers for systemic involvement and disease progression in COPD patients.

Routine ocular assessments may offer a valuable adjunct in the comprehensive management of COPD, allowing for early detection of complications and offering insights into the extent of systemic hypoxia. Further longitudinal studies are needed to confirm these findings and explore the impact of COPD treatments, such as oxygen therapy, on the preservation of ocular health.

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