Section: Pulmonary Medicine

Original Research Article

ASSESSMENT OF GLYCAEMIC STATUS IN COPD PATIENTS ON LONG-TERM CORTICOSTEROID THERAPY

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ABSTRACT

Background: Chronic Obstructive Pulmonary Disease (COPD) is a relatively common respiratory condition which is frequently managed with corticosteroid therapy. While corticosteroids are effective in reducing exacerbations, they are associated with significant metabolic side effects including glucose intolerance and diabetes mellitus. This study aimed to evaluate the glycaemic status of COPD patients receiving long-term corticosteroid therapy and to compare glycaemic status based on the type of corticosteroid regimen used.

Materials and Methods: This cross sectional observational study included 80 COPD patients treated with corticosteroids for at least six months' duration. Patients were categorized into three groups based on the type of corticosteroid therapy: inhaled only, systemic only and combined inhaled and systemic. Glycaemic status was assessed using fasting plasma glucose, postprandial glucose, and HbA1c levels. Patients were classified as euglycemic, having impaired glucose tolerance (IGT), or diabetic based on ADA guidelines. Statistical analysis was performed using SPSS v25.0. For statistical purposes P value less than 0.05 was considered significant.

Results: Of the 80 patients, 42 (52.5%) were euglycemic, 24 (30.0%) had IGT, and 14 (17.5%) were diagnosed with diabetes. Glycaemic abnormalities (IGT + diabetes) were most frequent among patients on systemic steroid therapy (88.9%) and those receiving systemic plus inhaled corticosteroids therapy (70%) compared to those on inhaled corticosteroids alone (36.4%). A statistically significant association was found between type of steroid therapy and glycaemic status ($p = 0.01$) as well as increasing age and glycaemic control ($p = 0.014$). No significant association was observed with gender and smoking status ($P>0.05$).

Conclusion: Long-term corticosteroid therapy in COPD patients is associated with a significant risk of glycaemic disturbances. Routine monitoring of glycaemic status is recommended to prevent long-term metabolic complications and inhaled corticosteroids should be preferred when feasible to minimize risk.

Keywords: Chronic Obstructive Pulmonary Disease, Corticosteroids, Hyperglycemia, Inhaled Corticosteroids, Steroid-Induced Diabetes.

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) imposes a significant public health cost globally and is associated with considerable morbidity and mortality. It is characterized by persistent respiratory symptoms and airflow limitation due to airway and alveolar abnormalities. In most instances it is typically caused by significant exposure to noxious particles or gases. According to the Global Burden of Disease Study COPD is now the fourth leading cause of mortality worldwide.[1] It is responsible for approximately 3 million deaths annually. In India the prevalence of COPD is estimated at approximately 3% to 4% which roughly translates into over 15 million individuals with COPD. This number is

projected to rise due to ongoing exposure to biomass fuels, air pollution and the high prevalence of tobacco use. The socioeconomic impact of COPD is also significant contributing not only to the direct healthcare costs but also to indirect costs due to loss of work days and decreased productivity of an individual affected by COPD. As the disease progresses, frequent exacerbations and the presence of comorbidities contribute to the overall disease burden and affect patient prognosis.[2]

Management of COPD involves both pharmacological as well as non-pharmacological approaches. Among the pharmacological agents bronchodilators such as long-acting β2-agonists (LABAs) and long-acting muscarinic antagonists (LAMAs) are most commonly used.[3] Corticosteroids, particularly inhaled corticosteroids (ICS), are commonly used either alone or in combination with inhaled bronchodilators to reduce airway inflammation and prevent acute exacerbations. Systemic corticosteroids are typically kept reserved for acute exacerbations or in individuals with refractory disease due to their potential for more severe systemic side effects. The long-term use of corticosteroids while may be effective in controlling inflammation and reducing exacerbations is associated with several adverse effects. These side effects may include osteoporosis, immunosuppression, adrenal suppression and importantly derangements in glucose metabolism.[4]

Steroid-induced hyperglycemia and diabetes mellitus are increasingly being recognized as accompanying comorbidities in COPD patients who are on either systemic or inhaled corticosteroid therapy. Corticosteroids are known to impair insulin sensitivity and promote gluconeogenesis thereby elevating blood glucose levels and exacerbating underlying metabolic derangements.[5] Studies have demonstrated that systemic corticosteroids (more than inhaled forms) are linked with impaired glucose tolerance and increased incidence of diabetes. Many studies have reported increased blood glucose levels in COPD patients receiving corticosteroids with systemic formulations posing a higher risk. However other studies like the Lung Health Study-2 had failed to prove a significant association between corticosteroid therapy and new-onset diabetes. These conflicting findings have led to ongoing debate about the relative safety of inhaled versus systemic corticosteroids regarding glycaemic control in COPD patients.[6]

The relevance of this issue is particularly important in the Indian context, where the prevalence of both diseases i.e. COPD and diabetes is high and healthcare access remains inconsistent. Compounding this problem is the under-recognition of steroid-induced hyperglycemia in routine COPD management.[7] While several studies have examined the impact of corticosteroids on glycaemic status in Western populations data from Indian population remains limited.[8] Furthermore, the degree to which different corticosteroid delivery methods influence glucose metabolism over time in Indian COPD patients has not been sufficiently studied.

This study was conducted to address these gaps in current literature. By assessing the glycaemic status of COPD patients receiving long-term corticosteroid therapy this study aims to find out the prevalence and severity of hyperglycemia and diabetes in this population, and to compare the effects of different corticosteroid regimens (inhaled, systemic or both).

MATERIALS AND METHODS

This cross-sectional observational study was conducted over a period of 18 months (from January 2024 to June 2025) in the Department of pulmonary medicine of a tertiary care teaching hospital in south India. A total of 80 patients diagnosed with COPD and receiving corticosteroid therapy for at least 6 months were included in this study on the basis of a predefined inclusion and exclusion criteria. Sample size calculation was based on a pilot study and literature review which suggested a prevalence of steroid-induced glycaemic disturbances of approximately 45%. Using a confidence level of 95% and a margin of error of 10%, the estimated sample size required was 80. Informed written consent was obtained from all participants.

Patients were recruited from both outpatient and inpatient departments. Each patient underwent a thorough clinical evaluation including a detailed history and physical examination with particular emphasis on respiratory symptoms. In addition to this history about corticosteroid use (inhaled/systemic) and smoking history (Active smoking as well as exposure to passive smoke) was also asked for and noted. The diagnosis of Chronic Obstructive Pulmonary Disease (COPD) in this study was made on the basis of GOLD 2023 criteria. The components of GOLD 2023 criteria for diagnosis of COPD such as persistent respiratory symptoms including cough, expectoration and breathlessness along with a possible history of exposure to risk factors like smoking or biomass fuel were used for clinical diagnosis.[7] Confirmation of the diagnosis was done by spirometry showing a post-bronchodilator FEV_1/FVC ratio of less than 0.70 which was consistent with persistent airflow limitation. Duration and type of corticosteroid therapy such as inhaled or systemic or both was also noted. For assessment of glycaemic derangement fasting plasma glucose (FPG), postprandial blood sugar level (PPBS) as well as glycated hemoglobin (HbA1c) levels were measured. Patients were categorized as euglycemic (HbA1c <5.7%), impaired glucose tolerance (HbA1c 5.7–6.4%) and diabetic (HbA1c ≥6.5%) on the basis of American Diabetes Association (ADA) criteria.[8]

Clinical data was recorded in a structured case record form. Laboratory investigations included complete blood count, serum creatinine, blood urea, liver function tests, HIV status, and chest X-ray, in addition to the glycaemic markers. Patients were

stratified according to corticosteroid regimen: inhaled corticosteroids only, systemic corticosteroids only or combined therapy.

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to demonstrate the demographic and clinical characteristics of the patients. Continuous variables were shown as mean ± standard deviation (SD) whereas categorical variables were presented as frequencies and percentages. Chi-square test was used to compare proportions. A p-value of less than 0.05 was considered statistically significant. Subgroup analysis was done to evaluate the effect of type of steroid therapy on glycaemic parameters.

Inclusion Criteria

- Adults aged above 18 years diagnosed with COPD based on GOLD criteria.
- COPD patients receiving corticosteroid therapy (inhaled, systemic, or both) for at least 6 months.
- Patients who provided written informed consent.

Exclusion Criteria

- Known cases of type 2 diabetes mellitus before starting corticosteroid therapy for COPD.
- Patients with interstitial lung disease, bronchiectasis or other chronic lung diseases.
- History of coronary artery disease, cardiomyopathy or connective tissue disorders.
- Recipients of solid organ transplant or on immunosuppressive therapy.
- Patients with chronic kidney disease, liver failure, or congestive heart failure.
- Patients taking medications known to affect glucose metabolism (e.g., thiazides, antipsychotics).

RESULTS

The analysis of the gender distribution of the studied cases showed that the majority of the patients were males (72.5%), while females accounted for 22 cases (27.5%). There was a male predominance in the studied cases with M:F ratio of 1:0.37. [Figure 1]

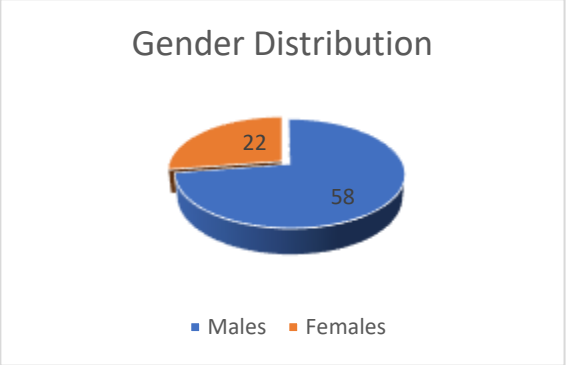

Figure 1: Gender Distribution of Studied cases

The analysis of glycaemic status of the studied cases showed that majority of the studied cases were euglycemic, accounting for 42 individuals (52.5%). This was followed by 24 patients (30%) who had impaired glucose tolerance (IGT), while 14 patients (17.5%) were found to be diabetic. [Figure 2]

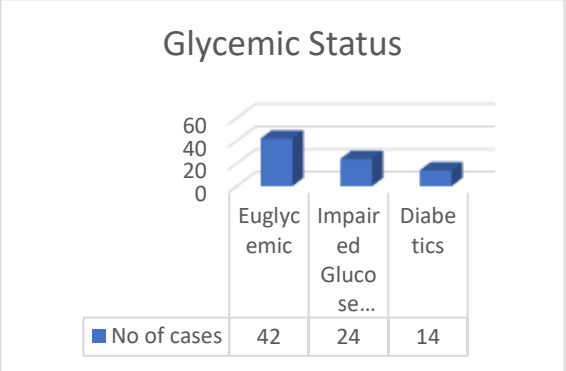

Figure 2: Glycaemic status of the studied cases

The most commonly affected age group was 60–69 years (37.5%), followed by the 50–59 years group (27.5%) and the 70–79 years (20%). Fewer patients belonged to the 40–49 years (7.5%) and ≥80 years (5%) categories, while the <40 years group had the least representation with only 2 patients (2.5%). The overall mean age of the study population was 63.4 ± 8.7 years. [Table 1]

Table 1: Age distribution of studied cases

Age Group (Years)	Number of Patients	Percentage (%)
<40	2	2.50%
40–49	6	7.50%
50–59	22	27.50%
60–69	30	37.50%
70–79	16	20.00%
≥80	4	5.00%
Total	80	100.00%
Mean ± SD	**63.4 ± 8.7 years**	—

Glycaemic status in relation to gender among the studied cases showed that out of 58 male patients, 31 (38.75%) were euglycemic, 17 (21.25%) had impaired glucose tolerance, and 10 (12.50%) were diabetic. Among the 22 female patients, 11 (13.75%) were euglycemic, 7 (8.75%) had IGT, and 4 (5.00%) were diabetic. The distribution of glycaemic abnormalities was comparable between males and females with no statistically significant difference (P=0.96). [Table 2]

Table 2: The distribution of glycemic abnormalities between males and females

Gender	Euglycemic		IGT		Diabetics		Total Patient		P Value
	N	%	N	%	N	%	N	%	
Male	31	38.75%	17	21.25%	10	12.50%	58	72.50%	0.96
Female	11	13.75%	7	8.75%	4	5.00%	22	27.50%	
Total	42	52.50%	24	30.00%	14	17.50%	80	100.00%	

Glycaemic status in relation to age among the studied cases showed that out of 50 patients aged above 60 years, 20 (40.0%) were euglycemic, 18 (36.0%) had impaired glucose tolerance, and 12 (24.0%) were diabetic. Among the 28 patients aged 41–60 years, 20 (71.4%) were euglycemic, 6 (21.4%) had IGT, and 2 (7.1%) were diabetic. In the <40 age group (2 patients), both were euglycemic with no cases of IGT or diabetes. The distribution of glycaemic abnormalities showed a statistically significant association with increasing age, with a higher prevalence of IGT and diabetes in the >60 years group (P = 0.014). [Table 3]

Table 3: The distribution of glycemic abnormalities in different age groups

Age Group (Years)	Euglycemic n (%)	Impaired Glucose Tolerance (IGT) n (%)	Diabetic n (%)	Total (n)	p-value
<40 (n = 2)	2 (100.0%)	0 (0.0%)	0 (0.0%)	2	0.014*
41–60 (n = 28)	20 (71.4%)	6 (21.4%)	2 (7.1%)	28	
>60 (n = 50)	20 (40.0%)	18 (36.0%)	12 (24.0%)	50	
Total (n = 80)	**42 (52.5%)**	**24 (30.0%)**	**14 (17.5%)**	**80**	

The analysis of glycaemic status according to smoking category among COPD patients on long-term corticosteroid therapy showed that among smokers (n = 22), 50.0% were euglycemic, 31.8% had impaired glucose tolerance, and 18.2% were diabetic. Among passive smokers (n = 20), 60.0% were euglycemic, 30.0% had impaired glucose tolerance, and 10.0% were diabetic. In non-smokers (n = 38), 50.0% were euglycemic, 28.9% had impaired glucose tolerance, and 21.1% were diabetic. Although non-smokers showed a slightly higher proportion of diabetes, the overall differences across smoking categories were not statistically significant (p = 0.87). [Table 4]

Table 4: Smoking status and Glycemic derangement in COPD cases receiving steroid therapy

Smoking Status	Euglycemic n (%)	Impaired Glucose Tolerance (IGT) n (%)	Diabetic n (%)	Total (n)	p-value*
Smoker (n = 22)	11 (50.0%)	7 (31.8%)	4 (18.2%)	22	0.87
Passive Smoker (n = 20)	12 (60.0%)	6 (30.0%)	2 (10.0%)	20	
Non-Smoker (n = 38)	19 (50.0%)	11 (28.9%)	8 (21.1%)	38	
Total (n = 80)	**42 (52.5%)**	**24 (30.0%)**	**14 (17.5%)**	**80**	

The analysis of glycaemic status in relation to the mode of steroid therapy among the studied cases showed a clear pattern of increasing glycaemic disturbances with more intensive steroid use. Among patients receiving only inhaled corticosteroids, 63.6% were euglycemic, while 27.3% had impaired glucose tolerance and 9.1% were diabetic. In contrast, the systemic-only group had a markedly higher prevalence of glycaemic abnormalities, with only 11.1% being euglycemic, while 61.1% had IGT and 27.8% were diabetic. The group receiving both inhaled as well as systemic steroid therapy showed an intermediate pattern, with 30.0% being euglycemic, 52.5% having IGT, and 17.5% being diabetic. The glycaemic disturbances were more common in individuals on systemic steroid therapy as compared to those on only inhaled steroid therapy, and the difference was statistically significant (P = 0.01). [Table 5]

Table 5: Mode of steroid therapy and Glycemic derangement in COPD cases

Mode of Steroid Therapy	Euglycemic n (%)	Impaired Glucose Tolerance (IGT) n (%)	Diabetic n (%)	Total (n)	p-value*
Inhaled only (n = 22)	14 (63.6%)	6 (27.3%)	2 (9.1%)	22	0.01*
Systemic only (n = 18)	2 (11.1%)	11 (61.1%)	5 (27.8%)	18	
Inhaled + Systemic (n = 40)	12 (30.0%)	21 (52.5%)	7 (17.5%)	40	
Total (n = 80)	**42 (52.5%)**	**24 (30.0%)**	**14 (17.5%)**	**80**	

DISCUSSION

This study was conducted to evaluate the glycaemic status of COPD patients who had been on long-term corticosteroid therapy. Among 80 patients, 47.5% were found to have glycaemic abnormalities (impaired glucose tolerance (30%) and diabetes (17.5%)). This high proportion of glycaemic derangement emphasizes the metabolic risks associated with prolonged corticosteroid use in

COPD patients. Our findings are in agreement with those of Slatore et al., who found that COPD patients on corticosteroids were significantly more likely to experience impaired glucose control compared to the general population.[9] Similarly, Faul et al. reported a marked rise in hyperglycemia requiring pharmacological intervention among patients receiving corticosteroids for respiratory diseases.[10]

The mean age of our study population was 63.4 ± 8.7 years, and the majority (37.5%) of patients were between the 60–69-year group. Notably, patients above 60 years of age represented a larger proportion of those with glycaemic abnormalities (40.0% euglycemic, 36.0% IGT, and 24.0% diabetic; P = 0.014). Among those aged 41–60 years, 71.4% were euglycemic, 21.4% had IGT, and 7.1% were diabetic, while both patients under 40 years were euglycemic with no glycaemic abnormalities. Though a detailed regression analysis was beyond the scope of our study, prior work by Mkorombindo T et al has indicated that aging along with corticosteroid exposure independently increases insulin resistance and beta-cell dysfunction, predisposing patients to hyperglycemia.[11] Our results support these findings and emphasize the need for more vigilant monitoring of older COPD patients, particularly when systemic corticosteroids are prescribed for long term.

The mode of corticosteroid therapy appeared to significantly influence the glycaemic outcome in our study. Among the 80 patients, 40 (50%) were on combined inhaled and systemic corticosteroids, 22 (27.5%) on inhaled corticosteroids only, and 18 (22.5%) on systemic corticosteroids alone. Among patients treated only with inhaled corticosteroids, 63.6% were euglycemic, 27.3% had impaired glucose tolerance and 9.1% were found to be diabetic. In contrast patients on systemic corticosteroids alone showed much higher glycaemic abnormalities with only 11.1% being euglycemic, 61.1% having impaired glucose tolerance and 27.8% being diabetic. The combined therapy group showed an intermediate pattern, with 30.0% euglycemic, 52.5% having IGT, and 17.5% being diabetic. The observations are similar to the findings of the study done by Suissa et al., who demonstrated that systemic corticosteroids had a stronger association with both the onset and progression of diabetes compared to inhaled corticosteroids.[12] Similarly, Gartlehner et al. concluded that inhaled corticosteroids were comparatively safer in terms of glycaemic outcomes but still carried a measurable risk in susceptible individuals.[13]

Gender distribution in this study showed a clear male predominance which is consistent with the known epidemiology of COPD in India. Although glycaemic abnormalities were observed more frequently among males the difference between genders was not statistically significant (p = 0.96). Overall glycaemic control did not differ significantly between male and female patients indicating that gender does not independently influence either the prevalence or degree of corticosteroid-related glycaemic disturbances in COPD. This observation is similar to that of Dendukuri et al who found that Gender was not an independent predictor of steroid-induced hyperglycemia in elderly COPD patients.[14] Our data, however, reinforce the need for universal glycaemic surveillance in both genders when corticosteroids are prescribed long-term.

The analysis of glycaemic status according to smoking history showed no statistically significant differences in glycaemic profile among smokers, passive smokers, and non-smokers. Although a slightly higher proportion of diabetes was observed among non-smokers, overall glycaemic control did not differ significantly across the smoking categories. (p = 0.87).

Finally, a statistically significant association was observed between the type of corticosteroid therapy and glycaemic status (p = 0.01), reinforcing that systemic and combined therapies substantially increase the risk of glucose abnormalities compared to inhaled therapy alone. However, no significant correlation was found between smoking history and glycaemic abnormalities (p = 0.87). Similarly, no significant association was observed between gender and glycaemic status. These findings are consistent with the study by Verma et al,[15] who also reported higher glycaemic disturbances in patients receiving systemic corticosteroids compared to those on inhaled formulations. Our study thus adds further evidence to recommend routine glycaemic screening and individualized risk–benefit assessment before initiating long-term corticosteroid therapy in COPD patients. This is more important in the older age group, as glycaemic disturbances are more common in this age group compared to relatively younger COPD patients.

CONCLUSION

Long-term corticosteroid therapy (inhaled, systemic or combination of both) in chronic obstructive pulmonary disease (COPD) patients is associated with a significantly increased risk of glycemic disturbances. These metabolic effects are often insidious and may go unnoticed without regular monitoring. Therefore, periodic assessment of glycemic status should be an integral part of the management protocol for all COPD patients receiving corticosteroids. When long-term anti-inflammatory control is required, inhaled corticosteroids should be preferred over systemic corticosteroid therapy due to their relatively lower systemic impact. Early diagnosis and appropriate management of glycemic changes can prevent serious metabolic and cardiovascular complications.

Conflict of Interest: None

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