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Correlation Of Venous Blood Lactate Levels And Six-Minute Walk Test In Chronic Obstructive Pulmonary Disease Patients.

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Abstract

Chronic Obstructive Pulmonary Disease (COPD) is associated with reduced exercise capacity and early onset of anaerobic metabolism. Blood lactate serves as a marker of metabolic stress during exertion. The Six-Minute Walk Test (6MWT) is a practical tool to assess functional capacity in COPD patients. To evaluate the correlation between COPD stage and change in venous blood lactate levels following the 6MWT. This observational study included diagnosed COPD patients aged 40–65 years. After obtaining informed consent, baseline venous blood lactate, heart rate, and SpO₂ were recorded. Patients performed a standardized 6MWT, and post-exercise parameters were measured. Venous lactate levels were reassessed three minutes after exercise. Correlation between COPD stage and lactate change was analyzed using Pearson's correlation coefficient. A statistically significant weak positive correlation was observed between COPD stage and change in lactate levels after 6MWT ($r = 0.292$, $p < 0.05$). The coefficient of determination ($r^2 = 0.0854$) indicated that 8.54% of variability in lactate change was explained by disease severity. Increasing COPD severity is associated with a rise in exercise-induced lactate levels; however, the correlation is weak, suggesting the influence of additional factors. Lactate measurement may complement functional assessment in COPD.

Keywords: COPD, Lactate, Six-Minute Walk Test

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INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory disorder characterized by persistent airflow limitation, chronic inflammation, and impaired gas exchange [1]. It remains a major cause of morbidity and mortality worldwide, significantly affecting patients' functional capacity and quality of life. One of the key features of COPD is exercise intolerance, which results from a complex interplay of ventilatory limitation, muscle deconditioning, and altered metabolic responses [2, 3].

The Six-Minute Walk Test (6MWT) is a simple, non-invasive, and widely used tool to assess functional exercise capacity in COPD patients. It reflects the integrated response of the pulmonary, cardiovascular, and musculoskeletal systems. Reduced walking distance in the 6MWT is associated with disease severity and poor prognosis [4-6].

Lactate, a byproduct of anaerobic metabolism, serves as an important biochemical marker of tissue hypoxia and metabolic stress. In COPD patients, early onset of anaerobic metabolism during physical activity leads to elevated venous blood lactate levels, even at submaximal exertion. This rise in lactate may correlate with reduced exercise tolerance and disease severity [7].

Understanding the relationship between venous blood lactate levels and 6MWT performance can provide valuable insights into the functional and metabolic limitations in COPD patients [8]. This correlation may help in better assessment of disease severity, prognostication, and tailoring individualized rehabilitation strategies.

METHODOLOGY

The present study was conducted after obtaining approval from the Institutional Ethics Committee. Patients with a clinical history suggestive of Chronic Obstructive Pulmonary Disease (COPD) and confirmed by spirometry were recruited. A detailed medical history was obtained, and a thorough clinical examination was performed for all participants. The study included diagnosed cases of COPD aged between 40 and 65 years. Patients were excluded if they were in acute exacerbation, had contraindications to the Six-Minute Walk Test (6MWT) such as recent myocardial infarction or unstable angina, had resting tachycardia (>120/min), uncontrolled hypertension, significant cardiovascular or peripheral vascular comorbidities, or any musculoskeletal or orthopedic limitations affecting walking. Patients on long-term oxygen therapy were also excluded.

After obtaining written informed consent, all participants were instructed to rest in a seated position for twenty minutes prior to evaluation. Under aseptic precautions, 2 ml of venous blood was collected from the median cubital vein of the non-dominant hand and analyzed for lactate concentration using the Cobas b 221 system (Roche Diagnostics). Baseline physiological parameters including heart rate and peripheral oxygen saturation (SpO₂) were recorded using a pulse oximeter.

Each subject then underwent a single Six-Minute Walk Test according to standardized international guidelines. Patients were instructed to walk as far as possible along a 20-meter corridor for six minutes without running, with standardized encouragement provided at regular intervals. The total distance covered was recorded at the end of the test. Immediately after the test, heart rate and SpO₂ were measured again. Three minutes post-exercise, a second venous blood sample was collected to assess post-exercise lactate levels, which were considered representative of peak exercise values.

RESULTS

Table: Demographic Profile of Study Participants (n = 50)

Variable	Category	Number (n)	Percentage (%)
Age Group (years)	40-49	14	28.0
	50-59	20	40.0
	60-65	16	32.0
Gender	Male	32	64.0
	Female	18	36.0

Smoking Status	Current Smokers	26	52.0
	Ex-Smokers	18	36.0
	Non-Smokers	6	12.0
BMI (kg/m²)	<18.5 (Underweight)	8	16.0
	18.5–24.9 (Normal)	24	48.0
	≥25 (Overweight)	18	36.0
COPD Stage (GOLD)	Stage I	6	12.0
	Stage II	18	36.0
	Stage III	16	32.0
	Stage IV	10	20.0

Table 2: Correlation between COPD Stage and Change in Lactate Levels after 6MWT

Parameter	Value
Pearson Correlation Coefficient (r)	0.292
Direction of Correlation	Positive
Strength of Correlation	Weak
P-value	< 0.05
Statistical Significance	Significant

Table 3: Coefficient of Determination (r²) Analysis

Parameter	Value
Coefficient of Determination (r ²)	0.0854
Percentage Variation Explained (%)	8.54%
Interpretation	Low explanatory power
Clinical Implication	Other factors also influence lactate levels

Table 4: Overall Outcome Interpretation

Variable Compared	Outcome Description
COPD Stage vs Lactate Change (Post 6MWT)	Weak positive correlation observed
Statistical Significance	Significant association (p < 0.05)
Clinical Interpretation	Higher COPD stage associated with increased lactate rise
Strength of Association	Weak relationship
Overall Conclusion	Lactate rise partially reflects disease severity

DISCUSSION

The present study evaluated the correlation between COPD stage and the change in venous blood lactate levels following the Six-Minute Walk Test (6MWT), with findings demonstrating a statistically significant but weak positive correlation ($r = 0.292$, $p < 0.05$). This suggests that as the severity of COPD increases, there is a corresponding rise in lactate levels after exertion, although the strength of this relationship remains modest. The coefficient of determination ($r^2 = 0.0854$) further indicates that approximately 8.5% of the variability in post-exercise lactate levels can be explained by the stage of COPD alone, implying the influence of additional physiological and systemic factors.

The observed increase in lactate levels with advancing COPD stage can be explained by the pathophysiological mechanisms underlying the disease. COPD is characterized by airflow limitation, impaired gas exchange, and reduced oxygen delivery to peripheral tissues. During exercise, these patients experience early onset of anaerobic metabolism due to inadequate oxygen availability, resulting in increased production of lactate. Additionally, skeletal muscle dysfunction, which is commonly seen in COPD due to chronic hypoxia, inflammation, and physical inactivity, contributes to reduced oxidative capacity and a shift toward glycolytic metabolism. This leads to an earlier and more pronounced rise in lactate even during submaximal exercise such as the 6MWT.

Despite this physiological basis, the weak strength of correlation observed in the study highlights that COPD stage alone is not a strong predictor of lactate response to exercise. This finding is clinically

important, as it emphasizes that disease severity assessed by spirometry (GOLD staging) does not fully capture the functional and metabolic limitations experienced by patients. Factors such as muscle mass, physical conditioning, nutritional status, mitochondrial function, and comorbid conditions may significantly influence lactate production and clearance. For instance, patients with better physical conditioning may demonstrate improved aerobic capacity and delayed lactate accumulation, even in higher stages of COPD.

The demographic profile of the study population also provides important context for interpretation. The majority of participants were males and either current or ex-smokers, reflecting the known epidemiological pattern of COPD. Smoking contributes not only to pulmonary damage but also to systemic inflammation and skeletal muscle dysfunction, which can exacerbate exercise intolerance and lactate production. The predominance of patients in moderate to severe stages (Stage II and III) further supports the observation that functional impairment becomes more evident as the disease progresses.

The use of the 6MWT as a functional assessment tool in this study is particularly relevant, as it reflects the integrated response of the cardiopulmonary and musculoskeletal systems. The test is simple, reproducible, and correlates well with daily activity levels. The measurement of lactate before and after the test adds a metabolic dimension to the functional assessment, allowing for a more comprehensive evaluation of exercise limitation. The finding that post-exercise lactate levels rise significantly with disease severity reinforces the utility of combining biochemical markers with functional tests in COPD assessment.

However, the weak correlation also suggests limitations in using lactate levels as a standalone marker for disease severity. The relatively low r^2 value indicates that a large proportion of variability remains unexplained. This could be due to individual differences in effort during the test, variations in muscle metabolism, or differences in recovery kinetics. Additionally, the measurement of venous lactate, although practical, may not fully reflect arterial or tissue-level lactate dynamics [9-11].

From a clinical perspective, these findings suggest that while lactate levels can provide insight into exercise-induced metabolic stress, they should be interpreted in conjunction with other clinical parameters such as spirometry, exercise capacity, and symptom assessment. The significant association observed in this study indicates that lactate measurement may have a role in identifying patients with reduced exercise tolerance and higher metabolic strain, which can be useful in tailoring pulmonary rehabilitation programs.

CONCLUSION

In conclusion, our study demonstrates a significant but weak positive correlation between COPD stage and change in lactate levels following the 6MWT. While higher disease severity is associated with increased lactate production during exercise, the relationship is influenced by multiple factors beyond pulmonary function alone. These findings highlight the complex interplay between respiratory impairment and peripheral muscle metabolism in COPD and underscore the need for a multidimensional approach in the assessment and management of these patients.

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