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Pulled Visible-Spectrum Pulsed Phototherapy Combined With Magnetotherapy In The Comprehensive Rehabilitation Of Patients With Chronic Obstructive Pulmonary Disease

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Abstract: Background: Chronic obstructive pulmonary disease (COPD) remains a major cause of morbidity and mortality worldwide, with limited therapeutic efficacy in current treatment regimens. Non-pharmacological approaches such as phototherapy and magnetotherapy may offer adjunctive benefits.

Objective: To evaluate the clinical efficacy, immune response modulation, and bronchial patency improvement associated with pulsed visible-spectrum phototherapy combined with magnetotherapy in COPD patients at early rehabilitation stages, and to assess the corresponding effects on macrophage function in an experimental COPD rat model.

Methods: Sixty-three patients with COPD stages I–II were enrolled and divided into main (n = 28) and control (n = 35) groups. The main group received pulsed phototherapy using a “SLU-2” device on lung root projections in addition to standard magnetotherapy, while the control group received magnetotherapy alone. Both groups underwent functional, immunological, and cytological evaluations pre- and post-treatment. An experimental COPD model in rats was induced via chronic tobacco smoke exposure, followed by similar phototherapy protocols for macrophage assessment.

Results: Post-treatment, the main group exhibited significant reductions in cough severity, dyspnea, and obstructive symptoms ($p < 0.05$). Forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) increased by 1.5-fold and 1.2-fold, respectively. Mid-expiratory flows improved significantly. Immunological assays showed enhanced T-lymphocyte proliferation and helper cell counts. Cytological analysis revealed increased phagocytic leukocyte activity and progression to epithelialization stages. In the rat model, macrophage enzymatic activity significantly increased following phototherapy ($p < 0.05$).

Conclusions: Combined pulsed phototherapy and magnetotherapy significantly improved pulmonary function, enhanced immune responses, and promoted nonspecific cellular defense in COPD patients without adverse cardiovascular effects. These findings support the integration of phototherapy modalities into COPD rehabilitation protocols.

Keywords: Chronic obstructive pulmonary disease, pulsed phototherapy, magnetotherapy, pulmonary function, immune modulation, macrophage activity, rehabilitation.

Introduction: Chronic obstructive pulmonary disease (COPD) is a progressive respiratory disorder characterized by airway obstruction and systemic inflammation. Its global prevalence and mortality have been rising, ranking COPD among the top causes of death in adults over 45. COPD is associated with significant direct and indirect healthcare burdens [1–4]. Cigarette smoke and occupational pollutants contribute substantially to disease incidence [5]. Despite modern pharmacotherapy, residual morbidity persists, highlighting the need for adjunctive

rehabilitative approaches [6–9].

METHODS

Study Population

Sixty-three adult patients (18–60 years) with COPD stages I–II were enrolled. The cohort comprised 82% males; 38% were smokers. Participants were allocated into main (n = 28) and control (n = 35) groups.

Treatment Protocol

The main group received pulsed visible-spectrum phototherapy (SLU-2 device) targeted at lung roots for 10 sessions (3–10 min daily). The control group underwent standard magnetotherapy (35 mT, 10 min/day for 10 days) without phototherapy. All patients received supportive care including mineral water intake, respiratory physiotherapy, chest massage, and detoxification procedures.

Outcome Measures

- Pulmonary function tests: FEV_1, FVC, MEF (75%, 50%, 25%).
- Immunological profiling: leukocyte subsets, T-helper/T-suppressor cells, serum IgG, IgA, IgM.
- Cytological analysis: mucosal imprint smears evaluated in four inflammatory stages.

Statistical analysis was performed using Statistica software.

Animal Model

COPD was induced in outbred rats by chronic tobacco smoke exposure for two months. Rats were divided into experimental and control subgroups, with the experimental group receiving pulsed phototherapy.

RESULTS

Clinical Outcomes in Patients

Post-treatment, the main group demonstrated statistically significant improvement in cough, dyspnea, and obstructive signs versus controls ($p < 0.05$). FEV_1 and FVC increased by 1.5 and 1.2 times, respectively. MEF parameters also improved significantly. Control group changes were minimal.

Immunological Outcomes

Phototherapy enhanced T-lymphocyte and helper cell proliferation. Secondary immunodeficiency markers decreased, indicating improved immune resilience.

Cytological Findings

Cytological smears showed increased phagocytizing leukocytes post-therapy, with progression toward later inflammatory resolution stages.

Rat Model Observations

Macrophage enzymatic activity significantly increased following phototherapy ($p < 0.05$), indicating enhanced pulmonary immune function.

DISCUSSION

The integration of pulsed phototherapy with magnetotherapy contributed to functional restoration, immune enhancement, and cytological improvement in COPD patients. These findings align with emerging evidence supporting photobiomodulation and magnetic field therapies in pulmonary rehabilitation. Enhanced macrophage activity suggests a mechanism for improved innate immune response.

CONCLUSIONS

Pulsed visible-spectrum phototherapy combined with magnetotherapy significantly improves pulmonary function and immune parameters in COPD patients. This non-invasive modality demonstrates potential as an adjunctive treatment in comprehensive COPD rehabilitation.

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