

IMMUNOLOGICAL DYSREGULATION AND CYTOKINE SIGNATURES IN SYSTEMIC SCLEROSIS: ASSOCIATION WITH DISEASE PROGRESSION

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Abstract

Systemic scleroderma (systemic sclerosis, SSc) is a chronic autoimmune disease characterized by fibrosis, vascular damage, and immune dysregulation. The study aimed to evaluate the role of immune status and cytokine profiles in the early stages of the disease and their potential significance in primary prevention. Twenty patients diagnosed with systemic scleroderma were included. Immunological parameters and cytokine levels were analyzed and correlated with clinical manifestations and disease severity. The findings demonstrate that immune imbalance and cytokine dysregulation play a critical role in disease onset and progression, highlighting their importance in early detection and preventive strategies.

Keywords

systemic sclerosis; cytokine profile; immune status; IL-6; TNF- α ; TGF- β ; immune imbalance; fibrosis; clinical correlation; biomarkers

Introduction. Systemic scleroderma is a complex autoimmune connective tissue disease characterized by excessive collagen deposition, microvascular dysfunction, and immune system abnormalities. Despite advances in understanding its pathogenesis, early diagnosis and primary prevention remain challenging. Recent studies emphasize the pivotal role of immune system disturbances, particularly alterations in cytokine production and immune cell function, in initiating and driving the disease. Identifying these changes at early stages may provide opportunities for preventive interventions and improved clinical outcomes.

Materials and Methods. Study Population. The study included 20 patients diagnosed with systemic scleroderma according to established clinical and immunological criteria. Patients were recruited from a clinical setting and provided informed consent. **Immunological Assessment-**The following parameters were evaluated: Cellular immunity markers (T-lymphocytes, CD4+, CD8+ subsets) , Humoral immunity indicators (immunoglobulins: IgG, IgM, IgA) , Autoantibodies

(ANA, anti-centromere, anti-Scl-70). **Cytokine Analysis**-Serum levels of key cytokines were measured: Pro-inflammatory cytokines: IL-6, TNF- α , IL-1 β ; Anti-inflammatory cytokines: IL-10 ; Fibrogenic cytokines: TGF- β . **Clinical Evaluation** Clinical parameters included: Skin involvement (modified Rodnan skin score); Presence of Raynaud's phenomenon ; Internal organ involvement (lungs, heart, gastrointestinal tract) ; Disease duration and activity. **Statistical Analysis.** Data were analyzed using standard statistical methods. Correlation analysis was performed to assess relationships between immunological markers, cytokine levels, and clinical manifestations.

Results. Immune Status Alterations -A significant imbalance in cellular immunity was observed, with decreased CD4+/CD8+ ratio in most patients; Elevated levels of immunoglobulins (particularly IgG) were noted, indicating activation of humoral immunity; High prevalence of autoantibodies (ANA and anti-Scl-70) was detected. **Cytokine Profile Changes**- Increased levels of pro-inflammatory cytokines (IL-6, TNF- α) were found in the majority of patients; Elevated TGF- β levels correlated with the degree of skin fibrosis; Reduced IL-10 levels suggested insufficient anti-inflammatory regulation. **Correlation with Clinical Course** - Higher IL-6 and TNF- α levels were associated with more severe disease activity and organ involvement; TGF- β levels showed a strong positive correlation with skin thickness scores. Patients with pronounced immune dysregulation exhibited more aggressive disease progression.

Discussion. The results confirm that systemic scleroderma is strongly associated with immune system dysregulation and cytokine imbalance. The observed increase in pro-inflammatory and fibrogenic cytokines suggests their involvement in both initiation and progression of fibrosis. The correlation between immune markers and clinical severity highlights the importance of immune status assessment in early stages. These findings support the concept that immunological abnormalities precede overt clinical manifestations, making them valuable targets for primary prevention.

Conclusion. Immune system imbalance plays a ключевую роль (key role) in the development of systemic scleroderma. Cytokine dysregulation, particularly increased IL-6, TNF- α , and TGF- β , is closely associated with disease severity and progression. Early assessment of immune status can serve as an important tool for identifying high-risk individuals. Monitoring immunological and cytokine parameters may contribute to the development of effective primary preventive strategies.

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