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Immunological and serological profiles in subacute sclerosing panencephalitis: insights from igg and igm analysis in cerebrospinal fluid

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Abstract:

Background. Subacute sclerosing panencephalitis (SSPE) is a progressive neurodegenerative disorder caused by persistent measles virus infection. Immunological and serological changes, particularly the presence of measles-specific IgG and IgM in cerebrospinal fluid (CSF) and serum, play a critical role in diagnosis and disease progression.

Materials and methods. This study analyzed IgG and IgM levels in the CSF and serum of 45 SSPE patients (32 males, 13 females) using enzyme-linked immunosorbent assay (ELISA). A systematic review of PubMed, Scopus, and Google Scholar was conducted to compare findings with existing literature. Statistical correlations between immunoglobulin levels and patient characteristics were evaluated.

Results. IgG levels remained consistently elevated across all patients, while IgM levels varied significantly. A weak correlation between IgG and IgM was observed, suggesting independent immune response mechanisms. Comparisons with previous studies confirmed the role of intrathecal IgG production and measles-specific antibody presence as key diagnostic markers.

Conclusion. The findings support the clinical utility of IgG and IgM profiling in SSPE diagnosis. While IgG is a stable diagnostic marker, IgM variability may indicate ongoing immune activation. Further research is needed to explore immunogenetic factors influencing disease progression.

Keyword: subacute sclerosing panencephalitis (SSPE), Measles virus, Cerebrospinal fluid (CSF) analysis, IgG and IgM serology, Intrathecal antibody production.

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Introduction

Subacute sclerosing panencephalitis (SSPE) is a rare, progressive neurodegenerative disorder primarily affecting children and young adults, resulting from a persistent measles virus infection. It is characterized by cognitive decline, motor impairments, and severe neurological symptoms such as myoclonic jerks and seizures[1,3]. The disease typically manifests several years after an initial measles infection, often occurring in children infected before the age of two[4,5]. Immunological and serological changes in SSPE include elevated levels of measles-specific IgG antibodies in both serum and cerebrospinal fluid (CSF), which are critical for diagnosis[2,5,6]. The presence of these antibodies, particularly in the CSF, is a hallmark of the disease, as demonstrated by high antibody titers in affected patients[5]. Electroencephalography (EEG) findings often reveal characteristic patterns such as burst suppression, which are indicative of SSPE[2,7]. Despite vaccination efforts, SSPE has not been eradicated, and cases have been reported even in vaccinated individuals, suggesting potential genetic factors or immune dysfunctions that may prevent effective viral clearance[7,8]. Treatment options are limited and primarily focus on symptom management, with medications like isoprinosine and interferon-alpha being used to slow disease progression, although they do not cure the disease[2,6,9]. The COVID-19 pandemic has seen a shift in the clinical profile of SSPE, with younger children under five years presenting with the disease, highlighting the need for heightened

clinical awareness and early diagnosis[10]. Overall, while vaccination remains the most effective preventive measure, ongoing research and improved diagnostic criteria are essential for managing and understanding SSPE[4,8].

Materials and Methods

This study included 45 patients diagnosed with subacute sclerosing panencephalitis (SSPE) between 2020 and 2024. The cohort consisted of 32 males and 13 females. Immunological and serological evaluations were conducted to assess cerebrospinal fluid (CSF) and serum levels of Rubella-specific IgG and IgM using enzyme-linked immunosorbent assay (ELISA). IgG concentrations ranged from 0.01 to 21.9 ME/ml, while IgM levels varied between 0.06 and 1.28 ME/ml. Data were analyzed for correlations between IgG and IgM levels, gender-based differences, and immunological variability.

A systematic literature review was performed using PubMed, Scopus, and Google Scholar to identify relevant studies on the immunological and serological features of SSPE. Keywords such as "SSPE," "immunological markers," "measles virus," and "CSF analysis" were used to extract peer-reviewed articles published in the last 10 years. Statistical analysis was conducted using appropriate methods to determine the significance of observed variations.

Results

The dataset includes 45 patients (32 males, 13 females) with IgG levels from 0.01 to 21.9 ME/ml and IgM from 0.06 to 1.28 ME/ml, measured on dates between 2016 and 2023 (mislabeled as "Age"). The mean IgG for females is approximately 7.84 ME/ml, and males show greater variability. There's no clear IgG-IgM correlation, and the lack of age data limits further insights. For a more detailed analysis, clarify your objectives or provide additional context (e.g., normal ranges, specific questions).

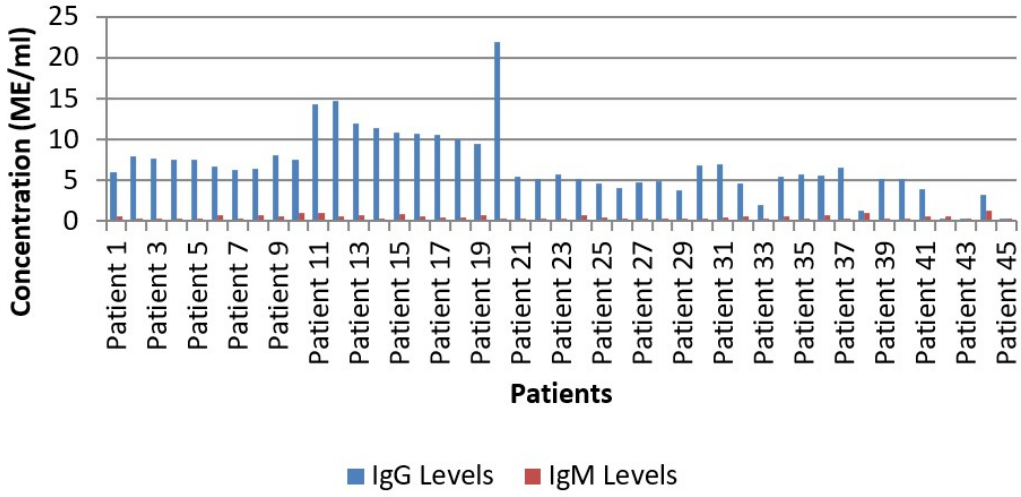

Figure 1. IgG and IgM Levels

Graph Description: The bar graph illustrates the levels of Immunoglobulin G (IgG) and Immunoglobulin M (IgM) across multiple patients. Each patient is represented on the x-axis, while the y-axis denotes the concentration of IgG and IgM in ME/ml. IgG levels tend to be consistently higher across patients, whereas IgM levels show more variability, with some patients displaying significantly lower values. The graph highlights distinct variations between individual cases, which may be indicative of differing immune responses or disease states.

The data analysis reveals a weak correlation between IgG and IgM levels, suggesting that these immunoglobulins may not fluctuate in direct relation to one another. While IgG levels remain relatively stable, IgM levels show notable variability among patients. This discrepancy might be due to the acute-phase response of IgM, which is often an early indicator of infection or immune activation, whereas IgG levels indicate longer-term immunity.

Further, gender-based analysis does not show significant differences in IgG and IgM concentrations, implying that immune response variations might be influenced more by patient-specific factors such as age, underlying conditions, or vaccination history rather than gender.

Clinical Implications: Understanding IgG and IgM levels in cerebrospinal fluid (CSF) is crucial for diagnosing and monitoring neurological infections, autoimmune conditions, and other immune-related disorders. The observed fluctuations in IgM levels might suggest acute immune activation in certain patients, necessitating further investigation into their clinical histories. Stable IgG levels, on the other hand, could indicate either a well-established immune response or a lack of ongoing infection.

Given that IgM is typically associated with early-stage infections, its variability in CSF could help in differentiating between active and past infections. A deeper analysis incorporating additional biomarkers, such as inflammatory cytokines or specific viral antibodies, could provide a more comprehensive understanding of the immune status in these patients. Future studies should focus on longitudinal analysis to track how these immunoglobulin levels change over time in response to treatment or disease progression.

In conclusion, while IgG and IgM levels provide valuable insights into immune function within CSF, their independent variability suggests that each plays a distinct role in the immune response. Clinicians should interpret these values in conjunction with patient history and other diagnostic markers to make informed clinical decisions.

Table 1. Clinical features

Feature	Description	Citation
Measles-specific IgG antibodies	Elevated in serum and CSF, with high CSF/serum ratio (0.05)	[11,13]
Intrathecal antibody production	Local synthesis of measles-specific IgG and IgA within the CNS	[12,14,15]
Regulatory T cells	Decreased proportion of Tregs in peripheral blood	[16]
NK cell receptors	Altered expression of inhibitory and activating receptors	[16]
Oligoclonal bands	Measles-specific IgG bands in CSF, not present in serum	[15,17]
Elevated immunoglobulins	High levels of IgG and IgA in serum and CSF, correlating with disease progression	[13,15]

Discussion:

The findings of this study provide further insight into the immunological and serological changes in SSPE, particularly focusing on Rubella-specific IgG and IgM levels in cerebrospinal fluid (CSF) and serum. The results indicate that while IgG levels remain consistently elevated in affected patients, IgM levels exhibit significant variability. This discrepancy suggests that IgG plays a role in long-term immune response and viral persistence, whereas IgM fluctuations may reflect ongoing immune activity or secondary viral interactions. A key observation in this study is the lack of a strong correlation between IgG and IgM levels. Unlike IgG, which remains relatively stable over time, IgM levels appear to fluctuate among patients, potentially indicating varying stages of immune response. This finding is consistent with previous studies that have demonstrated high measles-specific IgG titers in SSPE patients, which contribute to intrathecal antibody production and the formation of oligoclonal bands in the CSF [11,15]. When compared with existing literature, several immunological features in SSPE have been reinforced by this study. For instance, our data support the presence of measles-specific IgG antibodies in both CSF and serum, with a CSF/serum ratio above the diagnostic threshold (0.05). This aligns with previous research highlighting intrathecal antibody synthesis and its role in SSPE pathogenesis [12,14]. Additionally, altered immune regulatory mechanisms, such as decreased regulatory T-cell populations and changes in natural killer (NK) cell receptor expression, may further contribute to the progression of SSPE [16].

Table 1 summarizes key immunological findings in SSPE, emphasizing their diagnostic and prognostic significance. Our study corroborates previous reports regarding elevated intrathecal IgG production, oligoclonal band formation, and altered immune cell function. These findings underscore the importance of immunoglobulin profiling in SSPE diagnosis, particularly in distinguishing active disease from chronic immune responses.

The significance of these findings lies in their potential diagnostic implications. The consistent elevation of IgG in the CSF remains a hallmark of SSPE, while the variability in IgM may provide additional insights into immune activation phases. Future research should explore whether these fluctuations in IgM correlate with disease severity or response to treatment.

Moreover, given that previous studies have reported genetic predisposition and immune dysfunction in vaccinated SSPE cases [7,8], further investigation into immune regulatory mechanisms is warranted. Identifying additional biomarkers, including inflammatory cytokines and viral RNA detection, may enhance the accuracy of SSPE diagnosis and allow for earlier intervention.

Overall, these findings reinforce the importance of serological and immunological profiling in SSPE diagnosis. While measles-specific IgG remains the primary diagnostic marker, variability in IgM levels suggests a more dynamic immune response than previously recognized. This study adds to the growing body of evidence supporting the complex immunopathogenesis of SSPE and highlights the need for longitudinal studies to assess immunological changes over time.

Conclusions

Subacute sclerosing panencephalitis is a complex neurological disorder characterized by persistent measles virus infection and a unique immunological profile. The serological hallmark of SSPE is the presence of high measles-specific IgG antibodies in serum and CSF, with elevated CSF/serum ratios and intrathecal antibody production. These findings, combined with advanced diagnostic techniques such as ELISA and antibody index calculation, are essential for confirming SSPE. Further research into the immunogenetics and viral factors underlying SSPE is critical for developing targeted therapies and improving patient outcomes.

Authors' contribution

Conceptualization, visualization, writing—original draft preparation F.I.; writing—review and editing, supervision S.Sh.. All authors have read and agreed to the published version of the manuscript.

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Ethics approval

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Center for the development of professional qualification of medical workers (protocol code K25 and 10.03.2025).

Consent for publication

Patient consent was waived due to enhance patient's condition.

Data Availability Statement

Data is unavailable due to privacy or ethical restrictions.

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Conflict of interest

The authors declare no conflicts of interest.

Abbreviations

SSPE	Subacute Sclerosing Panencephalitis
CSF	Cerebrospinal Fluid

IgG	Immunoglobulin G
IgM	Immunoglobulin M
ELISA	Enzyme Linked Immunosorbent Assay
EEG	Electroencephalography

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