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RESEARCH ARTICLE

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## CSF IN MOYAMOYA DISEASE: PATHOPHYSIOLOGICAL ROLE AND THERAPEUTIC PERSPECTIVES

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### ABSTRACT

Moyamoya disease is a rare cerebral vasculopathy and progressive, characterized by occlusion of the arteries at the base of the brain and formation of fragile collateral vessels. Recent evidence indicates that cerebrospinal fluid (CSF) may act in the mediation of angiogenic, inflammatory and blood-brain barrier (BBB) dysfunction mechanisms. This systematic review aimed to analyze the biomarkers present in the cerebrospinal fluid of patients with Moyamoya and their possible diagnostic and therapeutic implications. Clinical and experimental studies were reviewed in the PubMed, Scopus and Web of Science databases, published between 2004 and 2024, using specific descriptors. Our results indicate significant elevations of VEGF, FGF, IL-6 and TNF- $\alpha$  in the cerebrospinal fluid, indicating involvement in pathological angiogenesis and neuroinflammation processes. BBB dysfunction was also observed, suggesting increased permeability and worsening neurological damage. It is concluded that cerebrospinal fluid represents a promising source of biomarkers for early diagnosis and therapeutic guidance, contributing to more personalized approaches to disease management.

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## INTRODUCTION

Moyamoya disease is characterized by progressive stenosis of the internal carotid artery and its branches, culminating in ischemic events and hemorrhagic. Although its etiology remains uncertain, there is increasing evidence that CSF components actively participate in pathogenesis, modulating inflammation and angiogenesis. In this context, the analysis of the cerebrospinal fluid not only offers diagnostic insights, but also points to new therapeutic targets.

## METHODOLOGY

A systematic literature review was carried out in the PubMed databases, Scopus and Web of Science, with articles published between 2004 and 2024. The following descriptors were used: "Moyamoya disease", "cerebrospinal fluid", "biomarkers", "angiogenesis", "neuroinflammation" and "blood brain barrier". Clinical and experimental studies with analysis of cerebrospinal fluid were included. patients with Moyamoya. Narrative reviews and articles without data on the biochemical composition of the cerebrospinal fluid.

## RESULTS AND DISCUSSIONS

**Inflammatory and Angiogenic Biomarkers:** Several studies have demonstrated an increase in VEGF (vegetative factor) levels.

Vascular endothelial growth factor), FGF (fibroblast growth factor), IL-6 and TNF- $\alpha$  in the CSF of patients with Moyamoya. These factors are associated with the formation of collateral vessels, which although compensatory, are friable and at risk of hemorrhage. The presence of inflammatory cytokines reinforces the role of neuroinflammation in disease progression.

**Blood-Brain Barrier Dysfunction:** Changes in BBB integrity were observed in blood tests, neuroimaging and histopathology, suggesting an increase in its permeability in patients with Moyamoya. This dysfunction favors the entry of inflammatory mediators in the brain parenchyma, exacerbating damage neurological.

**CSF as a Diagnostic Tool:** CSF analysis using proteomics and mass spectrometry can reveal specific biochemical profiles of Moyamoya, aiding in early diagnosis and monitoring of progression. Such techniques also allow the identification of subgroups of patients with different evolutionary patterns.

**Potential Targeted Therapies:** The possibility of therapies with anti-VEGF antibodies or inhibitors of IL-6 and TNF- $\alpha$  appear as an alternative to reduce angiogenesis aberrant and neuroinflammation. Experimental studies suggest that modulation of the cerebrospinal fluid can help restore the balance of neural microenvironment.

## CONCLUSION

CSF emerges as a key element in understanding Moyamoya Disease, providing biomarkers with diagnostic and therapeutic potential. Interventions aimed at restoring BBB integrity and controlling inflammatory and angiogenic mediators represent a promising frontier. The integration of advances in molecular neuroscience and cerebrospinal fluid analytical technology could usher in a new era in Moyamoya's personalized approach.

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