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Prognostic Significance of MMP-9 Level in the Clinical Course of Acute Hemorrhagic Stroke

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Abstract Acute hemorrhagic stroke stands out among neurological diseases due to its high mortality and disability rates. this study investigated the prognostic significance of matrix metalloproteinase-9 (MMP-9) levels in assessing the clinical course of stroke. a strong positive correlation between MMP-9 levels and clinical severity according to the NIHSS scale ($r \approx 0.99$; $p<0.001$) was found, showing that MMP-9 concentration significantly increases as stroke severity worsens. these results suggest that MMP-9 can be used as a biochemical biomarker in acute hemorrhagic stroke for early diagnosis, prognosis, and as an additional criterion in selecting individualized treatment strategies.

Keywords Hemorrhagic stroke, MMP-9, NIHSS

1. Introduction

Approximately 20 million stroke cases are reported worldwide each year, of which only 25–30% retain their ability to work, while the rest result in disability or death (Johnson et al., 2019) [4]. In 2019, hemorrhagic stroke accounted for 22–39% of the 12.2 million recorded stroke cases and ranked as the second leading cause of death after cardiovascular diseases (Feigin et al., 2021). Acute hemorrhagic stroke is characterized by a severe clinical course, high rates of disability, and mortality. Despite recent advances in neuroimaging and intensive therapy methods, the prognosis of hemorrhagic stroke remains unsatisfactory (van Asch et al., 2010). Therefore, identifying molecular and biochemical markers of stroke and evaluating their correlation with clinical severity is both scientifically and practically important. Matrix metalloproteinases, particularly MMP-9, play a crucial role in blood-brain barrier disruption, hematoma expansion, and secondary neuronal injury. Hence, studying MMP-9 levels is of significant value in predicting the clinical course of stroke and individualizing treatment strategies (Kelly et al., 2008; Chauhan et al., 2017 [1,3].

Purpose of study. To identify the main factors influencing the clinical course of acute hemorrhagic stroke and to determine the disease prognosis by assessing MMP-9 levels.

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2. Materials and Methods

Within the scope of the study, clinical indicators of 50 patients suffering from acute hemorrhagic stroke were evaluated. These patients were treated at the multidisciplinary clinic of Tashkent Medical Academy from 2023 to 2025 years. Clinical neurological examinations were performed using the NIHSS scale, and MMP-9 levels were measured in their blood plasma.

3. Results and Discussion

The severity of the disease was determined using the NIHSS scale. According to the NIHSS scores, patients were divided into five categories: no symptoms (0 points), mild (1–4 points), moderate (5–15 points), severe (16–20 points), and very severe (>20 points). In this study, 50 patients were analyzed. Among them, 3 patients (6%) had mild neurological deficits, while the largest group 19 patients (38%) had moderate deficits. The number of patients with severe and very severe conditions was also significant, accounting for 16 (32%) and 12 (24%) patients, respectively. (Table 1).

Table 1. Distribution of patients according to the NIHSS scale

NIHSS Score ranges	Degree	Number of patients	Percentage %
0	No symptoms	0	0%
1-4	Mild	3	6%
5-15	Moderate	19	38%
16-20	Severe	16	32%
>20	Very severe	12	24%

This distribution clearly shows that the clinical course of acute hemorrhagic stroke is often moderate to severe, requiring urgent diagnosis and treatment. Moreover, patients in the severe and very severe categories together make up 56% of the total, indicating that their health condition is not only critical but also highly complex.

The average NIHSS score among the patients was 16.24 ± 7.5, with a median score of 16, indicating that the majority of the patients exhibited moderate to severe neurological deficits. This suggests that acute hemorrhagic stroke in these patients typically presents with significant neurological impairment, requiring close clinical monitoring and urgent medical intervention.

Simultaneously, the average plasma level of MMP-9 was measured at 246.9 ± 72.7 ng/ml, with a median value of 249.45 ng/ml. These findings highlight that elevated MMP-9 levels are common in patients with acute hemorrhagic stroke.

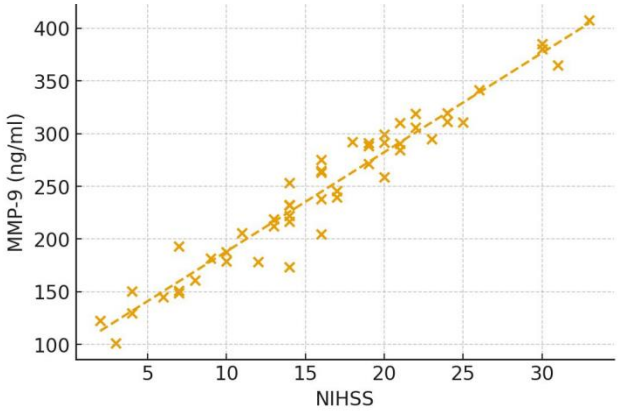

Figure 1. Correlation analysis of MMP-9 levels with the NIHSS scale

A correlation analysis revealed a strong positive relationship between NIHSS scores and MMP-9 levels ($r = 0.971$; $p < 0.001$). This statistically significant correlation implies that as the clinical severity of stroke increases—reflected by higher NIHSS scores—the plasma concentration of MMP-9 also rises markedly. In other words, patients with more severe neurological deficits tend to have substantially higher MMP-9 levels. (Figure 1).

This strong association indicates that MMP-9 not only plays a key role in the pathophysiology of acute hemorrhagic stroke but also serves as a reliable biochemical marker that reflects the extent of neurological damage. Therefore, monitoring MMP-9 levels could be instrumental in assessing stroke severity, guiding treatment decisions, and potentially predicting patient outcomes. These findings support the integration of MMP-9 measurement into clinical practice as an adjunctive tool alongside established neurological scales like the NIHSS to improve diagnostic accuracy and therapeutic strategies for patients with hemorrhagic stroke.

4. Conclusions

Thus, obtained results indicate the potential use of the MMP-9 biomarker for predicting hemorrhagic stroke and selecting individualized treatment strategies.

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