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Original Research Article

Assessment of Cerebral Perfusion Parameters in Post-Stroke Seizure Patients Using Magnetic Resonance Imaging

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Abstract
Stroke is a significant neurological event that often leads to various complications, including post-stroke seizures (PSS), which can further exacerbate the prognosis and functional recovery. One of the mechanisms underlying post-stroke seizures is cerebral perfusion changes that occur in the affected regions. Cerebral perfusion refers to the blood flow to brain tissue, which is critical for maintaining neuronal function. This study aims to assess cerebral perfusion parameters in patients with post-stroke seizures using magnetic resonance imaging (MRI). A total of 60 patients who suffered a stroke and developed seizures were included. These patients underwent MRI with perfusion-weighted imaging (PWI) to measure cerebral blood flow (CBF), cerebral blood volume (CBV), and mean transit time (MTT) in both the infarcted and contralateral brain regions. The results showed that patients with post-stroke seizures exhibited significant alterations in cerebral perfusion, particularly in the areas adjacent to the infarcted tissue, with decreased CBF and increased MTT. The study found a correlation between these perfusion abnormalities and the frequency and severity of seizures, suggesting that changes in cerebral perfusion may contribute to the pathophysiology of PSS. These findings highlight the potential of MRI-based perfusion imaging as a non-invasive tool to understand the cerebral hemodynamic changes associated with post-stroke seizures and provide insight into possible therapeutic targets for managing these patients.
Keywords: post-stroke seizures, cerebral perfusion, magnetic resonance imaging, cerebral blood flow, perfusion-weighted imaging, stroke complications.

Introduction

Stroke, a leading cause of disability worldwide, frequently leads to both short-term and long-term neurological complications. One of the most concerning sequelae of stroke is the development of post-stroke seizures (PSS), which can significantly impair a patient's functional recovery and quality of life. Post-stroke seizures can be categorized as either early (within 24 hours) or late (after 24 hours), with late seizures being more commonly observed (1). The pathophysiology of PSS is complex, with various mechanisms including neuronal excitability, cortical damage, and altered cerebral hemodynamics.

Cerebral perfusion, which refers to the blood flow through the brain's vasculature, is a key parameter that influences neuronal function. It is crucial for maintaining the brain's metabolic demands and preventing ischemic damage (2). After a stroke, cerebral perfusion can be disrupted in both the infarcted region and the surrounding tissue, which may lead to areas of ischemia or hypoperfusion. Altered perfusion in these regions is thought to contribute to the development of secondary complications, such as PSS, by affecting the excitability of neurons and facilitating epileptogenic activity (3).

Magnetic resonance imaging (MRI) has emerged as an important tool for assessing cerebral perfusion in patients with stroke. Perfusion-weighted imaging (PWI) is a specific MRI technique that allows the visualization and quantification of cerebral blood flow (CBF), cerebral blood volume (CBV), and mean transit time (MTT) (4). These parameters provide detailed insights into the hemodynamic status of the brain, particularly in regions affected by stroke. Recent studies have suggested that alterations in these perfusion parameters could be related to the development of post-stroke seizures, although the exact relationship between cerebral perfusion and PSS remains poorly understood (5).

This study aims to assess the cerebral perfusion parameters in patients with post-stroke seizures using MRI-based perfusion imaging and explore the potential relationship between these perfusion changes and the occurrence of seizures.

Aim:

To assess cerebral perfusion parameters (CBF, CBV, and MTT) in patients with post-stroke seizures using magnetic resonance imaging and examine their correlation with the frequency and severity of seizures.

Objectives:

1. To evaluate the cerebral perfusion parameters (CBF, CBV, and MTT) in infarcted and contralateral brain regions of patients with post-stroke seizures.
2. To investigate the relationship between altered cerebral perfusion and the incidence of post-stroke seizures in terms of frequency and severity.

Materials and Methods:

This observational study was conducted with 60 patients diagnosed with ischemic or hemorrhagic stroke who subsequently developed post-stroke seizures. The patients were recruited from a neurology clinic and underwent clinical evaluation, including a detailed seizure history, neurological examination, and laboratory investigations. All participants provided informed consent, and the study was approved by the institutional ethics committee.

Inclusion Criteria:

- Patients aged 18-75 years.
- Diagnosis of ischemic or hemorrhagic stroke confirmed by CT or MRI.
- Development of post-stroke seizures, defined as at least one seizure occurring after 24 hours of the stroke event.
- Ability to undergo MRI and consent for the procedure.

Exclusion Criteria:

- History of epilepsy prior to the stroke.
- Pregnancy.
- Contraindications to MRI (e.g., pacemaker, metal implants).
- Severe comorbidities that would interfere with the study (e.g., severe cardiovascular disease).

MRI studies were performed on a 3T MRI scanner (Philips Achieva). Perfusion-weighted imaging was performed using a dynamic contrast-enhanced technique. The following perfusion parameters were measured:

- **Cerebral Blood Flow (CBF):** The volume of blood passing through a given amount of brain tissue per unit of time (mL/100g/min).
- **Cerebral Blood Volume (CBV):** The total volume of blood in a given amount of brain tissue (mL/100g).
- **Mean Transit Time (MTT):** The average time taken by blood to pass through the brain tissue (seconds).

Regions of interest (ROI) were drawn on the infarcted and contralateral hemispheres to quantify the perfusion parameters. Statistical analysis was conducted using SPSS version 23.0, with p-values <0.05 considered statistically significant. Correlation analysis was performed to evaluate the relationship between altered perfusion parameters and the frequency/severity of post-stroke seizures.

Results:

Table 1: Comparison of Cerebral Perfusion Parameters in Infarcted vs. Contralateral Brain Regions

Parameter	Infarcted Region (Mean ± SD)	Contralateral Region (Mean ± SD)	p-value
Cerebral Blood Flow (CBF)	32.5 ± 6.4	54.3 ± 7.2	0.001
Cerebral Blood Volume (CBV)	4.8 ± 1.1	7.2 ± 1.5	0.001
Mean Transit Time (MTT)	8.2 ± 2.3	5.4 ± 1.7	0.004

There were significant differences in cerebral perfusion parameters between the infarcted and contralateral brain regions, with decreased CBF and CBV, and increased MTT in the infarcted regions.

Table 2: Correlation Between Cerebral Perfusion Parameters and Seizure Frequency

Perfusion Parameter	Correlation with Seizure Frequency (r)	p-value
Cerebral Blood Flow (CBF)	-0.43	0.005
Cerebral Blood Volume (CBV)	-0.37	0.012
Mean Transit Time (MTT)	0.41	0.008

There was a significant negative correlation between CBF and CBV with seizure frequency, and a positive correlation between MTT and seizure frequency.

Discussion:

The results of this study suggest that post-stroke seizures are associated with significant alterations in cerebral perfusion, particularly in the infarcted brain regions. The decreased cerebral blood flow (CBF) and cerebral blood volume (CBV) in the infarcted tissue, along with the increased mean transit time (MTT), indicate a disruption in the normal cerebral hemodynamics following stroke. These perfusion abnormalities are thought to contribute to the pathophysiology of post-stroke seizures by creating an environment conducive to neuronal excitability and epileptic activity (3, 6).

Previous studies have also reported that ischemic brain tissue can exhibit hypoperfusion, which may lead to an imbalance in excitatory and inhibitory neurotransmission, ultimately increasing the likelihood of seizure development (7, 8). The positive correlation between MTT and seizure frequency further supports the hypothesis that delayed blood flow in the brain may facilitate epileptogenic activity by prolonging the time it takes for blood to clear metabolic byproducts and provide oxygen and nutrients to neurons.

The findings from this study are consistent with previous research, which has shown that perfusion abnormalities in post-stroke patients may serve as a biomarker for predicting seizure risk (2, 9). Moreover, the study emphasizes the potential of MRI-based perfusion imaging as a non-invasive tool for assessing cerebral hemodynamics in post-stroke patients and providing insights into the mechanisms underlying post-stroke seizures.

Conclusion:

This study highlights the significant alterations in cerebral perfusion parameters in post-stroke seizure patients, particularly in the infarcted regions. These changes in cerebral blood flow, blood volume, and transit time may contribute to the development of post-stroke seizures. MRI-based perfusion imaging proves to be a valuable tool in understanding the hemodynamic changes associated with post-stroke seizures, potentially aiding in the development of targeted therapeutic strategies for these patients.

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