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Brain Edema After Ischaemic Stroke

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ABSTRACT

Objectives: To determine the incidence of brain edema after ischaemic stroke and its impact on the outcome of patients in the acute phase of ischaemic stroke. **Patients and Methods:** We retrospectively analyzed 114 patients. Ischaemic stroke and brain edema are verified by computed tomography. The severity of stroke was determined by National Institutes of Health Stroke Scale. Laboratory findings were made during the first four days of hospitalization, and complications were verified by clinical examination and additional tests. **Results:** In 9 (7.9%) patients developed brain edema. Pneumonia was the most common complication (12.3%). Brain edema had a higher incidence in women, patients with hypertension and elevated serum creatinine values, and patients who are suffering from diabetes. There was no significant correlation between brain edema and survival in patients after acute ischaemic stroke. Patients with brain edema had a significantly higher degree of neurological deficit as at admission, and at discharge ($p = 0.04$, $p = 0.004$). **Conclusion:** The cerebral edema is common after acute ischaemic stroke and no effect on survival in the acute phase. The existence of brain edema in acute ischaemic stroke significantly influence the degree of neurological deficit.

Key words: edema, ischaemic stroke, outcome.

1. INTRODUCTION

Large hemispheric infarction or infarction in the area of the cerebellum can give an altered state of consciousness that is progressively mostly due to massive cerebral edema. A significant number of patients with acute ischaemic stroke, but the admission to have electrolyte system disorder primarily in terms of dehydration and increased plasma osmolality which directly threatens the brain, but also the kidney functioning (1). Brain edema and increased intracranial pressure are often associated with occlusion of large intracranial arteries.

Patients with a large cerebral infarction generally have a poor prognosis. Approximately 40% of patients with total anterior cerebral infarction (TACI) syndrome deteriorate during the first week, and half of them die during the first month (2). Poor outcome is mostly explained by the volume of cerebral tissue that is damaged. Early deterioration and death is often the result of edema in the infarcted tissue (3). Edema causes mass-effect with distortion, tissue shift and increased intracranial pressure (4, 5). Such changes lead to cerebral herniation, further brain damage and death.

Conventional medical treatment aims at reducing edema and intracranial pressure in stroke patients using hyperventilation, mannitol, diuretics, corticosteroids or barbiturates (6, 7). However, once brain swelling produces clinical signs and imaging features of mass effect with tissue shift, case-fatality becomes higher, despite intensive medical treatment (3). Surgical decompression seeks to create space to accommodate the increased volume created by the swollen brain (8). This can be accomplished by opening the cranial vault and dura (7), or by removing non-viable or non-essential brain tissue (9).

2. OBJECTIVES

To determine the incidence of brain edema after ischaemic stroke and its impact on the outcome of patients in the acute phase of ischaemic stroke.

3. PATIENTS AND METHODS

We retrospectively analyzed 114 patients with acute stroke at the Department of Neurology, University Clinical Center Tuzla, in the period from August 1st to November 31st 2011. The severity of stroke was determined by National Institutes of Health Stroke Scale (NIHSS) (10). All medical complications were systematically registered during hospital stay. Abnormal laboratory values were used as criteria for the electrolyte imbalance and other metabolic complications.

Statistical analysis was performed using the SPSS ver. 17.0 (Chicago, IL, USA). To assess the statistical significance of difference between the results obtained were used: Chi-square test or Fisher's Exact Test. All statistical tests were done with the level of statistical probability of 95% ($p < 0.05$).

The study was approved by the Ethics Committee of the University Clinical Centre Tuzla.

4. RESULTS AND DISCUSSION

The study analyzed 114 patients with acute ischaemic stroke, and in 9 of them (7.9%) was formed, and brain edema. Pneumonia was the most common complication (12.3%), while there was no statistically significant difference in complication rates between patients with and without edema.

Complications and survival	With edema Without edema n % n %	Total n %	p*
With complications Without complications	2 (6.5) 29 (93.5) 7 (8.4) 76 (91.6)	31 (100.0) 83 (100.0)	p>0.05
Survivors Died	2 (12.5) 4 (87.5) 7 (7.1) 91 (92.9)	16 (100.0) 98 (100.0)	0.5

Table 1. Complications and survival of patients with and without brain edema in acute ischaemic stroke * Fisher's Exact Test;

Age and gender	With edema edema, n %	Without n %	Total n %	p*
Males Females	3 (5.5) 6 (10.2)	52 (94.5) 53 (89.8)	55 (100.0) 59 (100.0)	0.5
Average age in years	68.2 ±11.7	69.4 ±11.5	69.3 ±11.4	0.7

Table 2. The incidence of brain edema by age and sex of the patients in the acute phase of ischaemic stroke * Fisher's Exact Test;

Table 3. Biochemical parameters and hypertension in patients with and without brain edema in acute phase of ischaemic stroke. *Fisher's Exact Test; CRP – C reactive protein;

NIHSS score	With edema Without edema, n % n %	Total n %	p*
Score 1-8 Score 9-16 Score over 16	3 (4.9) 58 (95.1) 3 (7.1) 39 (92.9) 3 (27.3) 8 (72.7)	61 (100.0) 42 (100.0) 11 (100.0)	0.05
Total	9 (7.9) 105 (92.1)	114 (100.0)	

Table 4. The degree of neurological deficit on admission in patients in the acute phase of ischaemic stroke * Fisher's Exact Test;

NIHSS score	With edema Without edema, n % n %	Total n %	p*
Score 1-8 Score 9-16 Score over 16	1 (1.6) 63 (98.4) 3 (10.3) 26 (89.7) 2 (33.3) 4 (66.7)	64 (100.0) 29 (100.0) 6 (100.0)	**0.004**
Total	6 (6.1) 93 (93.9)	99 100.0	

Table 5. The degree of neurological deficit at discharge in patients in the acute phase of ischaemic stroke. * Fisher's Exact Test;

There are several limitations of our study. This was a pilot study and the small number of participants mean that a larger study is needed to assess the association between brain edema after ischaemic stroke and long-term prognosis in more detail. In our institution, we have the ability to perform a decompressive craniotomy as a therapeutic option in the treatment of ischaemic stroke, but is rarely performed due to lack of interest of our neurosurgeons for this kind of treatment. Contrast, we have no information on the outcome of patients after this kind of treatment.

Brain edema and increased intracranial pressure (ICP) are often associated with occlusion of large intracranial arteries. Edema of the brain begins to develop during the first 24-48 hours, and reaches a maximum extent of 3-5 days from the occurrence of acute ischaemic stroke. It usually is not a significant problem during the first 24 hours, except in the case of large cerebellar infarction. Less than 10-20% of patients develop clinically significant cerebral edema, which requires medical intervention. Increased ICP can also be the result of acute hydrocephalus, which occurs due to obstruction of CSF pathways large cerebral infarction. It is known that dehydration leads to a decrease in perfusion penumbra zone, and excessive intake may induce cerebral edema (1).

Intracranial hypertension syndrome, expression of cerebral edema and stroke, was objectified on CT on admission (within 24 hours) or during hospitalization in 11 patients (42%). It was present in extensive strokes (full middle cerebral artery territory or full internal carotid territory or cerebellar strokes) followed by cerebral edema with herniation, accompanied by secondary brain parenchyma and compression on the brain stem, thus resulting in death. Hypertension and hemorrhagic transformation (1/3 of the cases) contributes to the severity of prognosis. In the other 2/3 of the cases, intracranial hypertension syndrome occurred during hospitalization (2–5 days), marking the ischaemic stroke severity. Coma on admission was the main clinical predictor of early mortality. Relevant co-morbidities, like uncontrolled hypertension, atrial fibrillation, diabetes mellitus, acute coronary syndrome, were associated with early mortality. In the present study, we did not observe gender differences in early mortality after ischaemic stroke (51% in men and 49% in women) (11).

A recent study assessed the 30-day mortality in Switzerland. In this sample of 467 patients, 13% died within 30 days of their first-ever stroke, and there were more men than women (63% *vs.* 37%) (12).

Several factors are known to influence early mortality. Stroke severity on admission is a well established predictor of mortality. Several clinical variables that reflect the severity of the neurological lesion have been analyzed to predict the clinical outcome, such as motor deficits, level of consciousness. In this study coma on admission was the main clinical predictor of early mortality. In many previous studies, the level of consciousness was the main early cause of mortality after acute ischaemic stroke (13).

Dysphagia and hyperthermia have also been reported to predict 30-day mortality after stroke (14). An uncontrolled hypertension was associated with a 30-day mortality in this study. Previous studies have shown considerable variations of blood pressure in the acute phase of ischaemic stroke (15).

Variables describing the course of blood pressure over the first three days have a marked and dependent relationship with the outcome at 30 days (16). Patients with the highest and lowest levels of blood pressure in the first 24 hours after stroke were more likely to develop early neurological deterioration and a worse prognosis (17). A blood pressure within the normal or low normal values at the onset of stroke is unusual (18).

Cerebral edema is the leading cause of early deterioration and death in patients with large supratentorial infarcts. Life-threatening cerebral edema usually develops between the second and fifth day after installation of stroke, but up to one third of patients may have neurological damage in the first 24 hours after the onset of symptoms (19). Brain-blood barrier changes occur relatively rapidly in acute ischaemic stroke. For all the patients studied we found the presence of extravasated and especially perivascular edema. With the evolution of tissue necrosis and the degradation of the basal membrane, blood-brain barrier breaks down (20) and after 4–6 hours, serum proteins begin to pass from blood vessels into the brain. This disturbance initiates a type of vasogenic edema that increases the water content of the tissue. Vasogenic edema reaches its peak at 1–2 days after the onset of ischemia and causes an increase in tissue water by more than 100%. Regarding the inflammatory reaction, it seems to play a very important role in the pathogenesis of ischaemic stroke and other forms of ischaemic cerebral injuries. In this study, we noticed a variety of immune cells that were present in the stroke area as well as in the penumbra or at a distance from the ischaemic injury. According to some authors, the post-injury inflammatory reaction of the brain is characterized by a rapid activation of resident cells (mainly microglial cells), followed by infiltration with circulating inflammatory cells, including granulocytes (neutrophils), T-cells, monocytes/macrophages and other cells in the region of cerebral ischemia, as was demonstrated on animal models and in patients with stroke (21).

Results in our study is similar to the above mentioned studies. The contribution of our research is that we have demonstrated that brain edema common after acute ischaemic stroke and no effect on survival in the acute phase.

3. CONCLUSION

Brain edema is common after acute ischaemic stroke and no effect on survival in the acute phase. The existence of brain edema in acute ischaemic stroke significantly influence the degree of neurological deficit.

• Conflict of interest: none declared.

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