

Role of Intracranial Cerebrospinal Fluid and brain volume in clinical outcome of stroke patients

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Many factors govern prognosis in acute ischemic stroke. Studies have implicated the role of volumetric brain and cerebrospinal fluid (CSF) analysis in the outcome of stroke patients (1-4). There is an ongoing debate with arguments in support and against of the protective role of cerebral atrophy in stroke (1-4). Theoretically, brain volume and CSF volumes appear to play a more important role in patients with larger infarct volumes, where more brain volume reduces the space available for cerebral oedema. Also, the functional outcome is an interplay of brain volume and intracranial CSF volume as suggested in studies concerning hydrocephalus and brain tumours (5,6). Measurement of brain volume and intracranial CSF volume requires automated systems. Image-based diagnosis is prone to subjective bias and automated volumetric analysis of CSF volume and intracranial volume can detect cerebral oedema, and differentiate malignant oedema with midline shift from those without in large hemispheric infarcts (7). Brain atrophy has been attributed as a favourable prognostic indicator by many previous studies (3,7,8). However, there are studies which have suggested pre-existing brain atrophy to be a negative predictive factor (2,4). Global cerebral atrophy is associated with long term futile endovascu-

lar recanalization and poor recovery gets amplified by the age and infarct volume (4).

Kauw et al. suggested that the ratio of intracranial CSF to the intracranial volume is associated with malignant MCA infarct and when added to the prediction and imaging models, it has prognostic significance (1). Monch et al. have evaluated the role of pre-existing brain volume and intracranial cerebrospinal fluid volume and reported no significant impact in prognosticating clinical outcome in stroke patients (9). Heterogeneity in results in most of the studies is due to the variable population characteristics, for example in the study by Monch et al. (9) rarely patients included had malignant cerebral infarction. Diprose et al. reported their findings in a study of 360 patients of ischemic stroke treated with endovascular thrombectomy (10). Diprose et al. concluded that CSF volume has a strong predictive role in the functional outcome of these patients and speculated that worse outcome in patients with cerebral atrophy could be due to poor reserve (10). They found that there was 35% lower odds of functional independence and 59% higher odds of worse outcomes with a 5% increase in the CSF volume in a multivariate analysis (10). Dhar et al. have suggested that percentage change in the volume of

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CSF in follow up scans may be a more sensitive indicator for cerebral oedema, and neurological worsening as compared to the midline shift (7). On the other side, Chen et al. reported a profound correlation between the midline shift and neurological worsening (11). To this effect, Chen et al. created a normogram model comprising 24 hours CT ASPECT, cisterns effacement, hypertension and recanalization to predict patients at risk after endovascular treatment for stroke in anterior circulation (11).

Brain atrophy due to pre-existing small vessel disease has been found to be associated with 7-day stroke severity and worse mRS outcome at 3 months in patients of acute ischemic stroke treated with endovascular therapy (12). Therefore, it is possible that studies differ due to the diameter of the vessel involved in stroke or presence of additional factors which include white matter hyperintensities, leukoaraiosis etc. Another important point to consider when understanding the studies on brain and CSF volume and its impact is that most of these studies lack volumetry in the follow up scans of patients with poor functional outcome. Follow up scans and volumetric analysis will clar-

ify the occurrence of reperfusion associated cerebral oedema and will help in differentiating poor outcome from futile reperfusion (13). Dhar et al. reported in their study of 738 patients with stroke the importance of following CT scans within 24 hours (14). They suggested that change in CSF volume by 10% in 24 hours is an early significant indicator of cerebral oedema and decline in neurological outcome (14).

These studies with variable results raise an important concern about whether brain atrophy impacts patients with stroke differently in large vessel disease and small vessel disease. Since acute ischemic stroke is one of the most devastating neurological diseases, more studies to conclude the role of brain volume and intracranial CSF volume on function outcome stroke patients undergoing endovascular interventions is warranted. This ‘tau’ protein may be significantly related to brain volume (15). Thus, further investigation is required to explore the interaction between brain volume, the volume of intracranial CSF, CSF/ICV ratio, functional outcomes in patients of acute ischemic stroke treated with endovascular therapy and CSF tau concentration.

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