# CT Perfusion and EEG assessment in Hyper-Acute Ischemic Stroke

*M. Ajcevic[1], G. Furlanis[1], L. Stragapede[1], M. Ridolfi[1], P. Caruso[1], C. Lugnan[1], M. Ukmar[2], M. Naccarato[1], P. Manganotti[1].*

[1]Clinical Unit of Neurology- University of Trieste - Department of Medical Sciences - University Hospital and Health Services of Trieste - Trieste, Italy.
[2]Radiology Unit-University of Trieste - Department of Medical Sciences - University Hospital and Health Services of Trieste - Trieste, Italy.

## Background and Aims

Neuroimaging in acute stroke is mandatory to establish the feasibility of reperfusion therapy, but cannot be used in monitoring to obtain information about the evolution of brain ischemia in the critical acute post-stroke period. Electroencephalography (EEG) in the hyperacute phase could be a feasible instrument of functional monitoring. The combined use of perfusion neuroimaging and electroencephalography (EEG) may provide a better clinical picture of neurovascular coupling of the injured area in acute ischemic stroke. The aim of this study was to assess stroke-related topographic EEG changes during the earliest phase of ischemic stroke and to compare them with hypoperfusion identified by Computed Tomography perfusion (CTP).

## Methods

This retrospective study was conducted on patients admitted to the Stroke Unit of the University medical hospital of Trieste (Italy) between October 2016 and January 2017. We studied 11 patients with ischemic stroke, who underwent both CTP and EEG recordings within 4.5 hours from symptom onset. Conditions such as hemorrhagic effusion, previous stroke, history of epileptic seizure, use of medication like benzodiazepines were exclusion criteria, because they could compromise CTP or EEG assessment. Patients with fossa posterior stroke and lacunar stroke were excluded because of the poor sensibility of CTP in such cases. The acquisition of EEG signals was performed bedside and within 1 hour after CTP scan, without delaying reperfusion treatment, using @64 channels Wi-Fi Be Plus LTM amplifier (EB NEURO, Florence, Italy) and 19 channel 10-20 Ag/AgCl electrodes wireless prewired headset (EB NEURO, Florence, Italy). Topographic representation of power for each band was calculated and compared with hypoperfusion areas estimated by CTP maps, calculated with deconvolution algorithm.

## Results

A total of 11 acute stroke patients (male N=5, 45%; female N=6, 55%) who met the above criteria were included in our study. Mean age was 79 years (range 53 to 93 years). Concerning the stroke severity, the mean NIHSS at admission was 10 (range 4-21). The mean timespan between CTP and EEG recording was 31 minutes (range 20-55).

Calculated topographic EEG maps (theta, delta, alpha, beta) together with CTP maps (MTT, CBF, CBV, core-penumbra colormap) of a patient (#3) with right ischemic lesion are reported in Figure 1.

Predominance of slow delta frequencies was found in all patients. The main finding is the agreement between slow rhythms hemispheric prevalence on EEG maps and cerebral hypoperfusion area identified using CTP. EEG e CTP imaging results are in line with presented clinical symptoms.

| | |
|---|---|
| **Age (years)** | **79 (53–93)** |
| **Gender (M:F)** | **5:6** |
| **Comorbidities** | |
| **Hypertension (%)** | **74%** |
| **Diabetes mellitus (%)** | **26%** |
| **Atrial fibrillation (%)** | **46%** |
| **Dyslipidemia (%)** | **37%** |
| **Ischemic cardiopathy (%)** | **34%** |
| **NIHSS baseline** | **10 (4–21)** |
| **mRS** | **0 (0–3)** |
| **ASPECT** | **9 (8–10)** |
| **Lesion side (R:L)** | **5:6** |
| **TOAST Classification (N)** | |
| **Large-artery atherosclerosis** | **2 (18.2%)** |
| **Cardioembolism** | **5 (45.5%)** |
| **Small-vessel occlusion** | **0** |
| **Stroke of undetermined etiology** | **4 (36.3%)** |
| **Stroke of other determined etiology** | **0** |

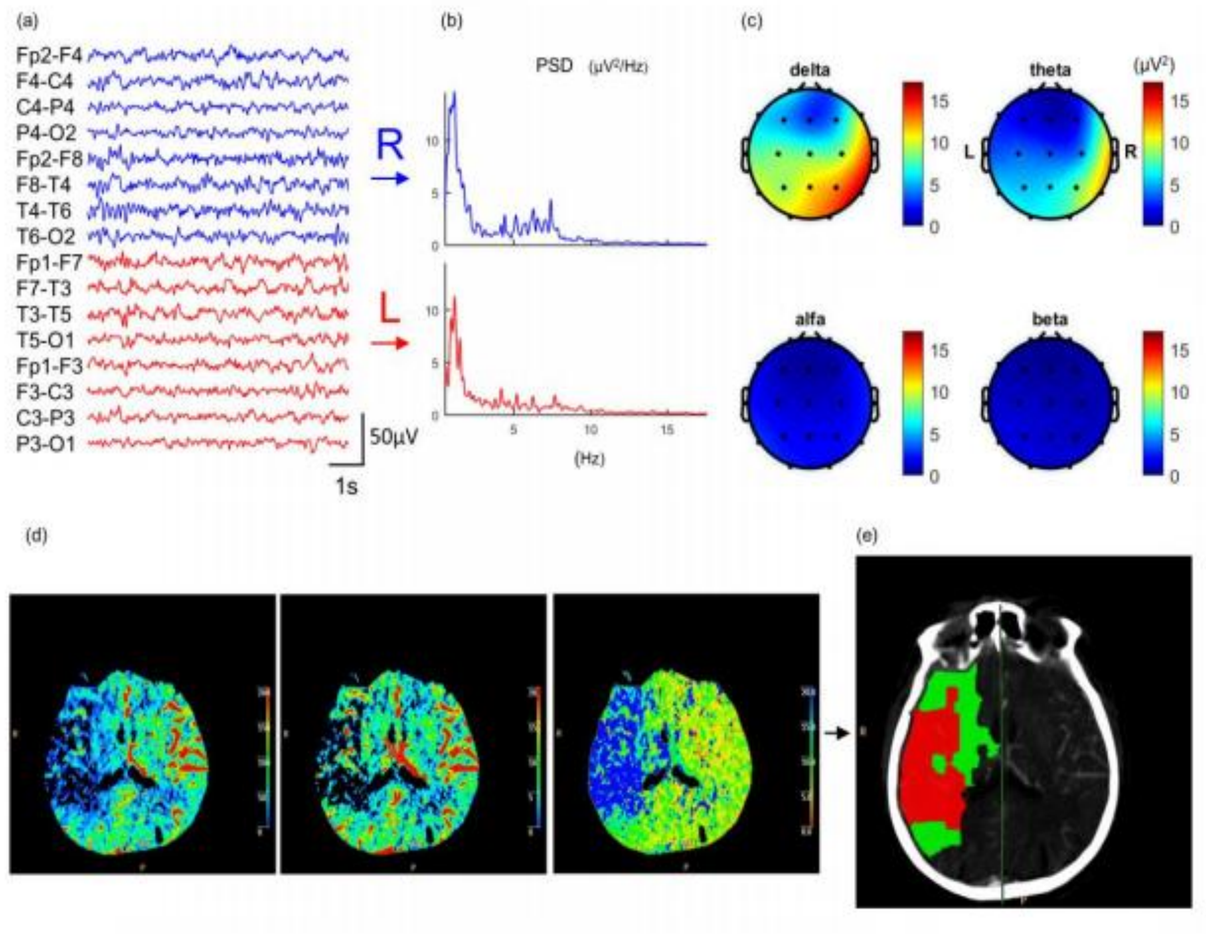


**Figure 1.** Patient (#3) with right ischemic lesion. A 79-year-old man presented sudden left hemiparesis, left hemianaesthesia and dysarthria. CT angiography showed right internal carotid artery occlusion. **(a)** EEG recording ; **(b)** Right and left side avarage Power Spectral Density (PSD) ; **(c)** EEG topographic maps show predominance of delta band on right cerebral hemisphere ; **(d)** CTP maps show high MTT, low CBF and low CBV in the whole area supplied by the right middle cerebral artery; **(e)** CTP core-penumbra colourmap with estimated core and penumbra areas, highlighted in red and green, respectively. CTP shows wide core and small penumbra.

## Conclusions

This preliminary study showed that the combined use of CTP and EEG in hyper-acute ischemic stroke may be useful in clinical practice and provide better clinical insight about functional and metabolic aspects of brain involvement. The combined use of these methodologies may give a better clinical picture of the functionality of injured area in the hyperacute phase.

## References

•*Finnigan SP, Van Putten M. EEG in ischaemic stroke: quantitative EEG can uniquely inform (sub-) acute prognoses and clinical management. Clinical Neurophysiology 2013;124.1:10-9.*
•*Campbell BC, Weir L, Desmond PM et al. CT perfusion improves diagnostic accuracy and confidence in acute ischaemic stroke. J Neurol Neurosurg Psychiatry 2016;84(6):613-8*
•*Foreman B, Claassen J. Quantitative EEG for the detection of brain ischemia. Crit Care 2012;16(2):216.*