MULTIPLEX-MULTILAYER NETWORK ANALYSIS AFTER INTRAVENOUS THROMBOLYSIS PREDICTS FUNCTIONAL OUTCOME AND TREATMENT-RELATED COMPLICATIONS IN ACUTE ISCHEMIC STROKE

C. Casella, A. Naro, V. Tudisco, G. Giacobbe, A. Toscano
UOSD Stroke Unit, AOU Policlinico G. Martino – Messina, Italy

INTRODUCTION

The use of biomarkers for early prognostic assessment of acute stroke remains challenging due to high inter-individual variability. While the relationship between quantitative EEG parameters in the pre-thrombolysis hyperacute phase and clinical outcome is under investigation,data regarding the immediate post-thrombolysis phase are still limited. We therefore aimed to evaluate possible correlations between EEG-derived markers obtained immediately after intravenous thrombolysis (IVT)and short-/long-term clinical outcomes and neuroimaging data.

PATIENTS AND METHODS

EEG was recorded in:

- 65 patients with anterior-circulation,hyperacute ischemic stroke immediately after reperfusion therapy (IVT group)
- 65 patients who did not receive reperfusion therapy (no-IVT group).

Brain network core-periphery architecture was estimated using frequency-band intervals through a multiplex-multilayer network analysis (MMNA)approach.

EEG measures were correlated with specific stroke outcome parameters:

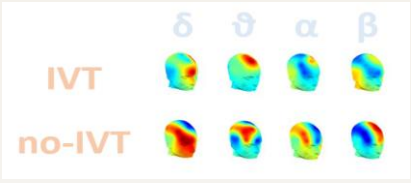
- National Institutes of Health Stroke Scale (NIHSS)scores at 2 and 7dd,3 and 6mm;
- Modified Rankin Scale (mRS)scores at 3 and 6mm.

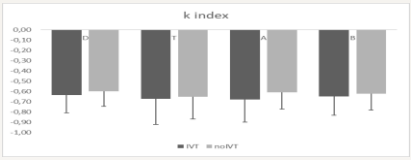
RESULTS

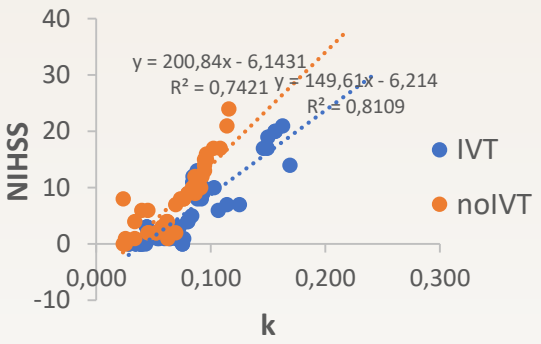
Patients in the *IVT group* showed a dynamic core-periphery network architecture (with nodes that dynamically shift behaviour across frequency intervals),characterized by enhanced *alpha-beta frequency connectivity within fronto-parietal and transcallosal loops*.

Conversely,the *no-IVT group* exhibited a rigid core-periphery configuration,with dominant *delta-theta frequency connectivity and weaker alpha-beta connectivity,limited to intra-hemispheric fronto-parietal loops* (non-transcallosal).

Notably,the deterioration index of the core-periphery architecture (k index)in the alpha band showed the strongest correlation—among other clinical and electrophysiological parameters—with favourable clinical outcome as measured by the 3m mRS score,the 7d NIHSS score,and the severity of thrombolysis-related haemorrhagic complications in the acute phase.







DISCUSSION AND CONCLUSIONS

Our findings suggest that certain MMNA-derived parameters in the post-treatment hyperacute phase may be useful in estimating short- and medium-term prognosis,as well as predicting thrombolysis-associated intracranial haemorrhage.

IVT appears to better preserve core-periphery network organization in the multiplex model compared to best medical therapy (BMT).It is plausible that early reperfusion allows for improved preservation of local neuronal networks,which in turn supports a more functional core-periphery network organization—unlike BMT.This is likely linked to neuronal survival in the ischemic penumbra,as indicated by stronger alpha/beta connectivity and reduced delta/theta activity—both associated with better prognosis following IVT relative to BMT.

Thus,neurophysiological biomarkers obtained through non-invasive techniques such as EEG in the immediate post-treatment phase may contribute to short-/medium-term outcome prediction.They may also detect changes in brain function in potentially reversible states,offering immediate insight into the effects of thrombolysis in acute stroke patients and enabling timely,targeted therapeutic strategies.

BIBLIOGRAFIA

- Ajčević M, Furlanis G, Naccarato M, Miladinović A, Buoite Stella A, Caruso P, Cillotto T, Accardo A, Manganotti P. Hyper-acute EEG alterations predict functional and morphological outcomes in thrombolysis-treated ischemic stroke: a wireless EEG study. Med Biol Eng Comput. 2021 Jan;59(1):121-129. doi: 10.1007/s11517-020-02280-z.
- de Vos CC, van Maarseveen SM, Brouwers PJ, van Putten MJ. Continuous EEG monitoring during thrombolysis in acute hemispheric stroke patients using the brain symmetry index. J Clin Neurophysiol. 2008 Apr;25(2):77-82. doi: 10.1097/WNP.0b013e31816ef725
- Naro A, Pignolo L, Calabrò RS. Brain Network Organization Following Post-Stroke Neurorehabilitation. Int J Neural Syst. 2022 Apr;32(4):2250009. doi: 10.1142/S0129065722500095.