The Brain Activity Changes during Acute Stroke using Electrocorticographic (ECoG) Signals on the Sensorimotor Cortex

J. Sun, K. Y. Tong, Senior Member, IEEE, Z. Ke, X. L. Hu, Member, IEEE, S. J. Zhang, X. X. Zheng

Abstract—ECoG provides a way for real time monitoring of brain activity. However, it is still a challenge to characterize the features of ECoG after the onset of stroke. In this study, ECoG signals were collected through implanted electrodes at different sites on the sensorimotor cortex during middle cerebral artery (MCA) occlusion. It was found that within 3 minutes after MCA occlusion, amplitudes of ECoG signal at the four electrodes decreased; while α and β power increased in both the affected brain region and the unaffected side. Results demonstrated that those changes correlated with stroke severity, and provided essential information for future study to validate the feasibility of a stroke severity monitoring.

I. INTRODUCTION

Focal ischemic rodent models were routinely used in experimental studies [1], especially the intraluminal suture model. However, the success rate of this model was low and infarction volume varied [2]. Thus, it is necessary to find out a better way to reduce the mortality and improve the success rate of this model. ECoG has been studied on stroke rats to explore the neural status for many years. It is possible to use ECoG to monitor the level of impairment in this model. Thus, this study aimed to investigate the correlation between stroke severity and the features of ECoG during MCA occlusion period.

II. METHODOLOGY

Seventeen male Sprague-Dawley (SD) rats with body weight of 280-320g were used in this study. At first, four stainless steel nails with 1mm diameter were used as electrodes (E1, E2, E3, and E4) and implanted on the rats’ sensorimotor cortex. After 3-day rest, all rats were randomly assigned into Stroke group (n=10) and Sham group (n=7). ECoG signal during MCA occlusion was collected through a pre-amplifier (Model 3600, A-M System, USA) with 100 times amplification and filtering between 0.3 Hz and 3 kHz, followed by digital sampling via a data acquisition system (RM6240B, Chengdu Instrument, China) at the sampling frequency of 1kHz.

ECoG signal between 0.5Hz and 30Hz was obtained using a digital Butterworth filter. The filtered 60-min ECoG data were then cut into 1-min segments. For each segment, the mean amplitude and the power spectrum density (PSD) were calculated. The percentage of α (8-13Hz) and β (13-30 Hz) band were then calculated. Two-way repeated measures analysis of variance (ANOVA) with baseline as covariate was employed to compare the two parameters among electrodes and between groups.

III. RESULTS AND CONCLUSIONS

Fig.1 showed the patterns of ECoG amplitude in both Stroke group (left) and Sham group (right). When MCA was occluded, neural activities significantly decreased within 3 minutes (p<0.05) compared to Sham group. Neuronal activities closer to the proximal end (E1) of MCA decreased more significantly. However, α and β percentage significantly increased compared to Sham group (p<0.05, shown in Fig.2).

In Stroke group, rats’ neurological deficit score assessed at 24 hours post MCAo/r surgery were between 1 and 3. Among them, six rats got moderate stroke with level 1 or 2 and kept alive throughout the experiment, while four rats had relatively severe stroke at level 3 and died within 48 hours post MCAo/r surgery. By comparing their amplitudes patterns, it was found that severer stroke rats had smaller amplitudes through MCA occlusion.

These ECoG features during MCA occlusion correlated with stroke severity. In future, further investigation on machine learning procedure might validate the feasibility of a severity predictor based on this correlate.

REFERENCES
