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Implantable Multimodal Probe to Obtain the Pathophysiological Signals of an Epilepsy Patient

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***Abstract*—Preoperative monitoring for a patient with epilepsy and cortical dysplasia was performed using a multimodal probe that could simultaneously identify electrocorticography (ECoG), brain temperature (BrT), and hemodynamical signals. Four seizures (s1, s3–s5) were observed during the monitoring. In s3 and s5, the change in the pathophysiological signals could be clearly observed in all modality. In s1 and s4, the change in AC or DC was not clear, although changes in the BrT or hemodynamics could be observed. Thus, the proposed probe could identify seizure-related changes by recording various pathophysiological signals even when these changes could not be clearly observed through ECoG.**

I. Introduction

Epileptic brain activity can be observed through various pathophysiological signals. Concurrent electrocorticography (ECoG) and near-infrared spectroscopy (NIRS) measurements can reflect hemodynamics changes related to epileptic activity [1]. In addition, the brain temperature (BrT) elevation caused by epileptic seizures can be identified by the simultaneous measurement of ECoG and BrT [2]. Therefore, a multimodality multichannel probe that could simultaneously record the ECoG, cortical surface temperature, and hemodynamics was developed. The probe was used to monitor the pathological neural activity for a patient with epilepsy during surgery and the postoperative state [3]. In this study, preoperative monitoring was performed for a patient with epilepsy and cortical dysplasia, and the changes in the ECoG, hemodynamics, and BrT were clarified.

II. Experimental Method and Result

The experimental procedure, which was in conformance with the Helsinki Declaration, was reviewed and approved by the Yamaguchi University Institutional Review Board. The patient was a 31-month-old female who suffered from epilepsy with cortical dysplasia in the right frontal lobe. The patient and her family agreed to participate in the study after being adequately informed of the aims, methods, and potential risks and discomfort. The patient had the right to withdraw from the study at any time.

The measurement was performed before epilepsy resection surgery. The developed probe was installed in the right temporal area to avoid any interference with the diagnosis. ECoG, BrT and hemodynamics signals were simultaneously recorded for 55 h. AC and DC potentials were extracted from ECoG.

Five seizures (s1–s5) were confirmed in the monitoring. However, s2 was excluded owing to the disconnection of equipment lines. The changes in each modality (AC potential, DC potential, BrT, and hemodynamics) during s3 are shown in Fig. 1. The green lines mark the time at which epileptic symptoms began appearing. In s3, the epileptic activity was reflected as the increase in the AC amplitude, fluctuation in DC potential, elevation of BrT, and change in hemodynamics (Fig. 1). The changes in pathophysiological signals could be clearly observed in two seizures (s3 and s5). The changes in AC and DC values were not entirely clear in certain seizures (s1 and s4), although the changes in the BrT or hemodynamics could be clearly observed. Therefore, the proposed probe could identify the seizure-related changes by recording various pathophysiological signals, even if the changes were not apparent in ECoG.

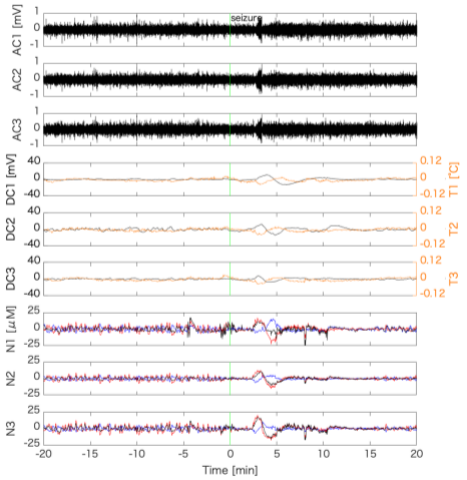

Figure 1. Change in AC, DC, BrT, and hemodynamics during s3. In terms of hemodynamics, change in the oxy-hemoglobin (red), deoxy-hemoglobin (blue), and total hemoglobin (black) are displayed.

References

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[3] T. Yamakawa et al., "Implantable multi-modality probe for subdural simultaneous measurement of electrophysiology, hemodynamics, and temperature distribution," *IEEE Trans. Biomed. Eng.,* vol. 66, no. 11, pp. 3204-3211, November 2019.

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