CCEP Symposium

Symposium	CCEP - The Past, Present and Future for Intraoperative Monitoring
Date	Wednesday, November 26, 2025
Time	15:30 – 17:30 (Japan Standard Time)
Venue	Kyoto International Conference Center, Room D
Chairs	Riki Matsumoto, MD, PhD (Department of Neurology, Kyoto University Graduate School of Medicine) Takayuki Kikuchi, MD, PhD (Department of Neurosurgery, Kyoto University Graduate School of Medicine)

15:30～17:30 CCEP –The Past, Present and Future for Intraoperative Monitoring

15:30～15:40 (TFP.10m)
Introductory Remarks
Speaker：Riki Matsumoto (Department of Neurology, Kyoto University Graduate School of Medicine)

15:40～16:05 (TFP.20m + 5m)
Intraoperative CCEP Monitoring for Language Pathways: Japanese Experience
Speaker：Yukihiro Yamao (Department of Neurosurgery, National Hospital Organization Kyoto Medical Center)

16:05～16:30 (TFP.20m + 5m)
Intraoperative CCEP Monitoring for Language Pathways: Swiss Experience
Speaker：Kathleen Siedel (Affiliation: Department of Neurosurgery, Inselspital, Bern University Hospital, Switzerland)

16:30～16:55 (TFP.20m + 5m)
Intraoperative ACEP Measurement: Real-World Clinical Application and Kobe Experience
Speaker：Yosuke Fujimoto (Department of Neurosurgery, Kobe University Graduate School of Medicine)

16:55～17:20 (TFP.20m + 5m)
1) Victor Horsley Department of Neurosurgery, Unit of Functional Neurosurgery, National Hospital for Neurology and Neurosurgery, London, UK
2) Department of Epilepsy, UCL Queen Square Institute of Neurology, London, UK
Speaker：Davide Giampiccolo (Combined Single and High Frequency White Matter Stimulation to Explore Subcortico-Cortical Networks: UK Experience with SEEG)

17:20～17:30 (TFP.10m)
Closing Remarks
Speaker：Riki Matsumoto (Department of Neurology, Kyoto University Graduate School of Medicine)
Takayuki Kikuchi (Department of Neurosurgery, Kyoto University Graduate School of Medicine)

Total Duration: 120 minutes (4 presentations × 25 min = 100 min + 10 min opening + 10 min closing)

Intraoperative CCEP monitoring for language pathways: Japanese Experience

Yukihiro Yamao

Department of Neurosurgery, National Hospital Organization Kyoto Medical Center

In the surgery for the lesion around the eloquent areas, the preservation of brain functions still poses a challenge for neurosurgeons. In the awake craniotomy, high-frequency electrical stimulation has been established in order to map intraoperative brain function and preserve eloquent areas. However, awake craniotomy cannot be performed in the patients with preoperative language dysfunction or cognitive dysfunction. Therefore, intraoperative electrophysiological is needed to preserve the integrity of functional network, such as language.

We have recently developed the *in vivo* electrical tract tracing method using cortico-cortical evoked potentials (CCEPs). Even in the intraoperative setting, by using CCEP connectivity pattern, we can map the language pathways such as the dorsal language pathway (arcuate fascicles) and frontal aslant tract. From our experiences, CCEPs potentially enable monitoring of the language pathway during surgery, even only under general anesthesia.

To establish intraoperative electrophysiological monitoring even under general anesthesia is clinically useful for preservation for the brain function in patients who are not suitable for the awake surgery.

CURRICULUM VITAE

NAME: Yukihiro Yamao

NATIONALITY: Japanese

EDUCATION:

MD: Kyoto University, Medical school, March 2004

PhD in Medicine: Department of Neurosurgery, Kyoto University Graduate School of Medicine, March 2014

WORK EXPERIENCE:

April 2006 – March 2010

Resident, Department of Neurosurgery, National Cardiovascular Center

September 2014 – August 2015

Postdoctoral Researcher, Natbrainlab, King’s college London, UK

January 2017–December 2023

Assistant professor, Department of Neurosurgery, Kyoto University

January 2024–

Department of Neurosurgery, National Hospital Organization Kyoto Medical Center

Intraoperative CCEP monitoring for language pathways: Swiss Experience

Kathleen Seidel

Jonathan Wermelinger, Pablo Alvarez Abut, Switzerland

Despite major advancements in neurophysiology, it remains challenging to visualize language function in in the operating room. Understanding and measuring these networks in real time is essential not only for scientific insight but – more importantly – for preserving healthy brain tissue during invasive procedures in patients with neurological **pathologies affecting the language area**. For example, in epilepsy and brain tumor surgery, the primary objective is to remove the lesion while sparing essential functional areas. Intraoperative neurophysiological techniques have been developed to support this goal, with established success in mapping the motor system. However, the current gold standard for language mapping – awake intraoperative testing – relies heavily on patient cooperation. This is often stressful, complex, and not always feasible, especially in children. In cases where awake surgery is not an option, no reliable alternative exists. This underscores the critical need for **techniques that can monitor and protect language function without requiring active patient participation**.

A valuable alternative could be provided through **Cortico-Cortical Evoked Potentials (CCEPs)**, introduced in 2004 by Riki Matsumoto and colleagues. By electrically stimulating one brain region and recording responses in others, CCEPs allow mapping of functional language networks without patient participation. Over the past two decades, this technique has proven valuable in identifying key language pathways such as the arcuate fasciculus.

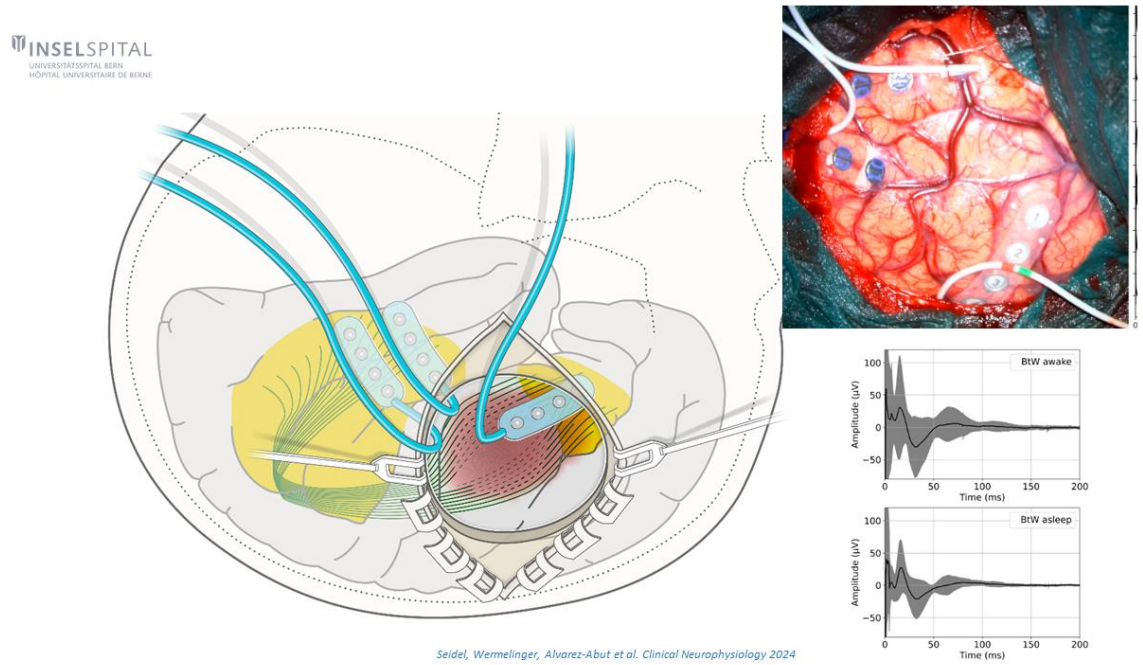

Figure X Left side image: Illustration of the intraoperative setting. Note the craniotomy is placed around the tumor and strip electrodes are placed on speech eloquent cortical areas. Right upper image: Intraoperative microscope view with marked positive speech hubs detected by Penfield stimulation and placed strip electrodes for stimulation and recording of CCEP signals. Right lower image: Examples of CCEP signals recorded from Wernicke's area while stimulating Broca's area in an awake and an asleep condition of the patient during open brain tumor surgery (Ref Seidel, Wermelinger, Alvarez-Abut et al. Clinical Neurophysiology 2024)

Since the introduction of CCEPs by Matsumoto and colleagues at the Cleveland Clinic (Matsumoto et al., 2004), early foundational work was carried out in Japan, particularly under the leadership of Matsumoto. CCEPs were applied to map the motor system (Matsumoto et al., 2007), the supplementary motor area (Kikuchi et al., 2012), visual and parieto-frontal networks (Matsumoto et al., 2012; Matsuzaki et al., 2013), and language-related structures including the basal temporal cortices and frontal aslant tract (Koubeissi et al., 2012; Ookawa et al., 2017). The extension of CCEPs into tumor surgery began in 2014 with pioneering studies by Saito et al. and Yamao et al., who demonstrated that language monitoring could be achieved intraoperatively in patients under general anesthesia. Internationally, interest in CCEPs has grown significantly in recent years. Early conceptual work was continued by (Keller et al., 2014), and recently, (Miller et al., 2023) proposed algorithms to classify canonical CCEP waveforms. CCEPs have also gained traction for intraoperative language mapping in tumor surgery

(Giampiccolo et al., 2021; Vega-Zelaya et al., 2023) and biophysical modeling and dynamic connectomics (Seguin et al., 2023). Most recently, (Seidel et al., 2024) correlated CCEP features of the arcuate fascicle with tumor parameters and patient outcomes.

Professor and Senior Attending Physician,
Department of Neurosurgery, Inselspital, Bern
University Hospital, Bern, Switzerland.

Prof. Dr. med. Kathleen Seidel, is board certified neurosurgeon, staff physician specialized in neurooncological surgery and professor of the Department of neurosurgery at the Inselspital, University Hospital Bern, Switzerland. Since 2008 at the Inselspital, she has established the unit of intraoperative neurophysiology (IONM). After a fellowship in IONM with Vedran Deletis and Sedat Ulkatan in New York, she is providing training to other professionals, hosting international observers and focusing on advance of IONM modalities to improve patient safety in technical high-risk surgeries. Providing expertise in neurosurgery and intraoperative neurophysiology, she is a routinely invited speaker at international courses and congresses. She has published numerous IONM papers and key papers concerning subcortical brain mapping and mapping of the spinal cord. She is contributed to many book chapters and is co-editor of an IONM book. Recently, she was awarded with the prestigious Theodor Kocher Prize of Bern University, which honors its best academics across its faculties for their exceptional and innovative scientific achievements. Currently, she serves as the president of the society of intraoperative neurophysiology (ISIN).

Intraoperative ACEP measurement: Real-world clinical application and Kobe experience

Yosuke Fujimoto

Department of Neurosurgery, Kobe University Graduate School of Medicine

Epilepsy Center, Kobe University Hospital

Abstract

Axono-cortical evoked potentials (ACEPs) extend the concept of cortico-cortical evoked potentials (CCEPs) by stimulating subcortical fibers and recording cortical responses, and reports have increased with the rise of SEEG in epilepsy surgery. In the intraoperative setting, *Mandonnet l*/Bonnetblanc et al. demonstrated that stimulating the resection cavity can identify functionally relevant subcortical–cortical networks ("*surface ACEP*"). The RAABE ultrasonic aspirator probe also allows dynamic subcortical stimulation **during** tumor resection, but no established intraoperative method enables continuous monitoring of deep-seated fibers ***before and throughout resection***, when the risk of pathway injury is greatest.

The fence-post technique is used to define tumor margins and optimize the extent of resection. Recently, depth electrodes have been adopted for both fence-post guidance and neurophysiological recordings. At Kobe University, we extended this strategy by placing depth electrodes at the tumor boundary to serve simultaneously as fence-post markers and electrodes for low-frequency stimulation, enabling "*deep ACEP*" or "***Depth Electrode derived Evoked Potentials (DEEP)"*** acquisition from the beginning of surgery—**the DeFENSE technique** (Depth Electrodes as Fence-post Guidance and Stimulating Electrodes).

In early cases involving the inferior fronto-occipital fasciculus (IFOF), we recorded reproducible ACEPs from subdural and scalp electrodes, demonstrating the feasibility of ACEP-based monitoring for identifying and protecting deep critical fibers. A decreasing trend in ACEP amplitude during surgery likely reflected brain shift, indicating the need for improved recording stability and physiologically meaningful thresholds.

This presentation summarizes global ACEP developments and introduces initial experience with **the DeFENSE technique** as a novel intraoperative neurophysiological approach for deep-seated fibers.

CV

Yosuke Fujimoto, MD
Assistant Professor & Chief of Epilepsy and Functional Neurosurgery, Department of Neurosurgery, Kobe University Graduate School of Medicine / Epilepsy Center, Kobe University Hospital, Japan. Council Member, Japan Epilepsy Society

Dr. Yosuke Fujimoto is a neurosurgeon whose clinical and scientific work spans neurophysiology-grounded epilepsy surgery and stereotactic and functional neurosurgery. After completing his neurosurgical training at Kobe University, he spent a period in the BCI/BMI research field in Osaka University, fostering a cross-disciplinary perspective that seeks the physiological principle behind intracranial electrophysiology and their translation into clinical application. Since the establishment of the Kobe University Epilepsy Center in 2022, he has played a central role in shaping its surgical program.

His scientific vision centers on advancing explainable and intelligible analyses of neural dynamics grounded in core principles of theoretical neuroscience—such as phase synchrony and slow–fast interactions across hierarchical and heterarchical scales—and on developing “theoretical neurosurgery,” a framework in which empirical neurophysiology, combined with theory-driven modeling and mechanism-grounded interpretation, contributes to a mechanistic understanding of brain dynamics and guides principled and precise decision-making in neurosurgical practice.

Combined Single and High Frequency White Matter Stimulation to Explore Subcortico-Cortical Networks: UK Experience with SEEG

Davide Giampiccolo

1) Victor Horsley Department of Neurosurgery, Unit of Functional Neurosurgery, National Hospital for Neurology and Neurosurgery, London, UK2) Department of Epilepsy, UCL Queen Square Institute of Neurology, London, UK

Brain function and dysfunction are increasingly understood as a circuits supported by specific white matter connections. In this talk I will first show how SEEG are the ideal methodology to interrogate white matter tract's function with direct electrical stimulation by showing casual, tract-specific response to stimulation from 0.5 mA. Then I will discuss the promise of tract-specific axono-cortical evoked and axono-axonal evoked potentials under the lens of SEEG.

Brief CV：Davide Giampiccolo is a Senior Neurosurgical Fellow in Functional Neurosurgery at the National Hospital for Neurology and Neurosurgery in London and a Principal Investigator in the Department of Epilepsy at the UCL Institute of Neurology. He qualified in Medicine and Surgery between the Charité – Universitätsmedizin Berlin, Germany and the University of Verona, Italy in 2015. He completed his training in Neurosurgery in Verona, Italy under Prof. Francesco Sala and Montpellier, France under Prof. Hugues Duffau in 2021. He previously studied white matter anatomy under Prof. Marco Catani at King's College London in 2016. He has completed his PhD fellowship in complex surgical epilepsy at the UCL Queen Square Institute of Neurology in 2025 under Prof. John Duncan/Ms Anna Miserocchi.

His research focused on brain circuits combining white matter anatomy and direct white matter stimulation. Together with Prof. Duffau, he has proposed revision to language models by rediscussing functional anatomy for the arcuate fasciculus (Giampiccolo and Duffau 2022 Brain) and the inferior fronto-occipital fasciculus (Giampiccolo, Herbet and Duffau 2025 Brain). He researches also specific white matter tracts involvement in seizure networks, and showed that discrete white matter pathways disconnection (i.e. anterior thalamic radiation) directly impacts long-term seizure freedom in frontal lobe epilepsy (Giampiccolo et al 2023 Brain). Within the field of intraoperative neurophysiology, he has pioneered cerebello-cortical stimulation and white matter stimulation with SEEG.

Davide has received a number of awards from scientific and clinical communities including the Organisation for Human Brain Mapping (2016), the International Society for Intraoperative Neurophysiology (2018), the European Association of Neurosurgical Societies (2020), the British branch of the International League against Epilepsy (2025) and the American Epilepsy Society (twice, in 2024 and 2025). In 2019 he was the first non-North American to receive the Academy Award from the American Academy of Neurological Surgery. In 2024 he was awarded the prestigious Emerging Leaders fellowship by the Epilepsy Research Institute UK. He is the scientific co-Chair of the International Society for Intraoperative Neurophysiology and an investigator for

Neuralink in the GB Prime trial. He is the editor together with Prof. John Duncan of *MRI Neuroanatomy: Cortex, Nuclei and Connections* (2025), a white matter atlas published by Springer Nature as a Major Reference work.