Reliability of ultra long-term **subcutaneous EEG**: a demonstration of temporal **impedance** consistency

Line S. Remvig[1], Pedro F. Viana[2,3], Jonas Duun-Henriksen[1], Mark P. Richardson[2] ,Troels W. Kjaer[4,5]

[1]UNEEG medical A/S, Lynge, Denmark, [2]Institute of Psychiatry, Psychology and Neuroscience, King's College London, [3]Faculty of Medicine, University of Lisbon, Lisbon, Portugal, [4]Department of Neurology, Zealand University Hospital, Roskilde, Denmark, [5]Department of Clinical Medicine, University of Copenhagen, Copenhagen, Denmark

Key Points

- Subcutaneous EEG (sqEEG) impedance measurements are low and remain stable throughout 29 everyday life monitoring periods of up to 230 days
- The demonstrated temporal impedance consistency adds confidence to the reliability of ultra long-term sqEEG recordings

Introduction

- Ultra long-term subcutaneous EEG (sqEEG) recording is a relatively new modality that enables continuous real-life monitoring of brain activity throughout extended periods of time.

- The minimally invasive sqEEG could provide a proper balance between recorded data of good quality and user acceptance.

- Reliable and consistent sqEEG signal quality is a prerequisite for the modality to succeed e.g. in the development of automatic electrographic seizure detection algorithms to work during everyday life activities. This starts with a reliable and stable electrode-to-body-tissue contact.

Methods

- Multicenter cohort of ultra long-term sqEEG impedance measurements, including 16 people with epilepsy* and 12 healthy people**.

- Median number of recording days was 70 (range 23-230) and a total of 2231 days.

- All data was recorded with the 24/7 EEG™ SubQ solution (UNEEG medical A/S, Denmark)(Figure 1).

- Ultra long-term temporal trends in recorded signal impedance were investigated with subject-specific linear regression models.

Results

- All electrode impedance measurements remained low (all below 4 kΩ) and were highly stable within-subjects (Figure 2).

- The subject-specific linear regression models showed long-term trends close to zero with a median absolute trendline gradient of 0.06 kΩ/month (range 0.002-0.25) (Figure 2).
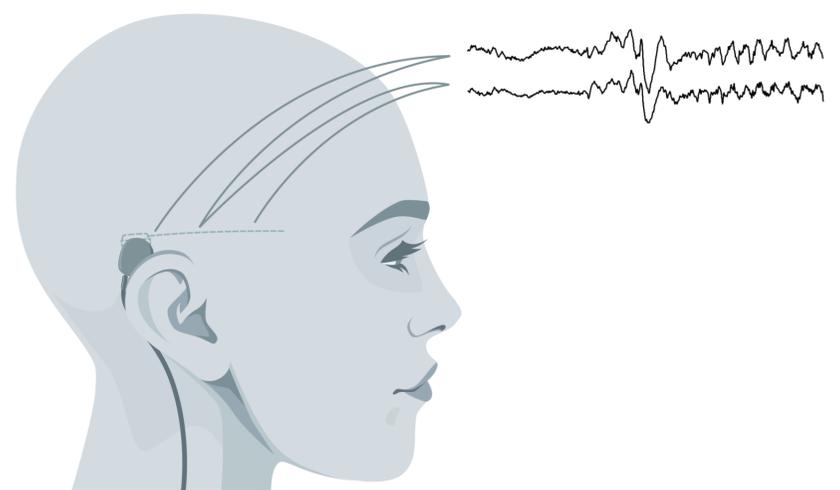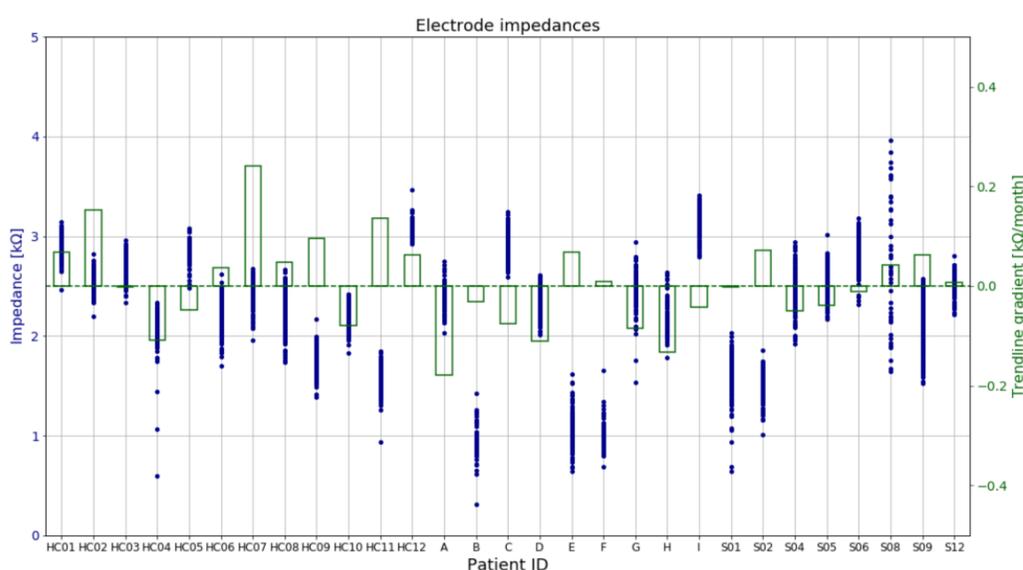

Figure 1 Illustration of the subcutaneous implant lead placement of the 24/7 EEG™ SubQ system (UNEEG medical A/S, Denmark) used by the people with epilepsy. The lead pointed towards vertex for the healthy people. Three measurement points are available with an inter-electrode distance of 3.5 cm, recording two bipolar sqEEG signals. The implant is powered by an external device through an inductive link, which also stores the recorded EEG. This means that the implant can stay implanted for more than a year without being serviced.

Figure 2 All estimated electrode impedances (blue dots; left y-axis) for every subject. The barplots (green; right y-axis) represent the corresponding gradients of the subject-specific linear regression models, fitting impedance changes with time. It is evident that all impedances take values below 4 kΩ and that the absolute value of the trendline gradients stays below 0.25 kΩ/month. The number of recording days was smallest (<45 days) for subjects HC01-HC12 and subject A.