Long term scalp EIT recordings for noise modelling to use in intracranial bleeding monitoring

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Abstract: Detection of delayed intracranial haemorrhage (ICH) following head trauma or stroke could benefit many patients worldwide [1]. The purpose of this study was to determine the feasibility of monitoring with time difference EIT. This was assessed by addition of noise from actual scalp recording to simulated data for ICH. Reasonably faithful images were produced with realistic recorded drifts.

1 Introduction

Noise in recorded boundary voltages over time, such as drift caused by contact impedance changes during an EIT measurement, can severely degrade the resultant images [2]. As this drift is inevitable in human recordings, its quantification would be an essential part of analysing the data before image reconstruction.

2 Methods

Long term EIT recordings at 2 KHz were taken in one normal human subject with two industry standard EEG electrode types: conventional EEG Ag/AgCl cup electrodes (the current gold standard) and an Easycap EEG recording cap for rapid application. Changes in signal across 3 time bands were calculated: fast (up to 10 seconds, system attributed), medium (up to 10 minutes, subject movement attributed), and slow (over hours, electrodes-skin contact attributed. Samples from recorded noise were added to computer simulated boundary voltages (BV) of intracranial bleeding with volumes of 9-43 ml, to simulate bleeding occurring over different time frames from 10 minutes to 3 hours [3]. Simulated BV with realistic noise component were then used for image reconstruction with Tikhonov regularization algorithm. Resulting images were compared to simulations without noise.

3 Results

3.1 Drifts quantification

Variance was 0.7±1.8, 1.6±3.6 and 15±85.7% (mean ±1SD) across channels of the initial standing BV for the 10 sec, 10 min and 3.5 hour time bands respectively.

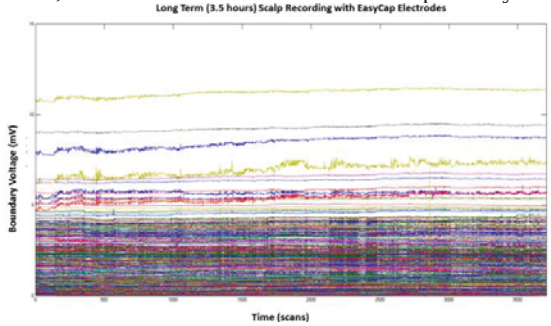

Figure 1: Boundary voltages recorded at 2 KHz over 3.5 hours with EasyCap applied on a healthy subject scalp.

3.2 Imaging

Images were reconstructed for a large extra-dural haematoma (~40ml in volume) located in the right tempo-parietal area for the cases of development over 10, 45, 75, 120 and 190 mins. Images reconstructed with noise were very similar in size, location and shape to the simulated perturbation and to the one reconstructed without noise.

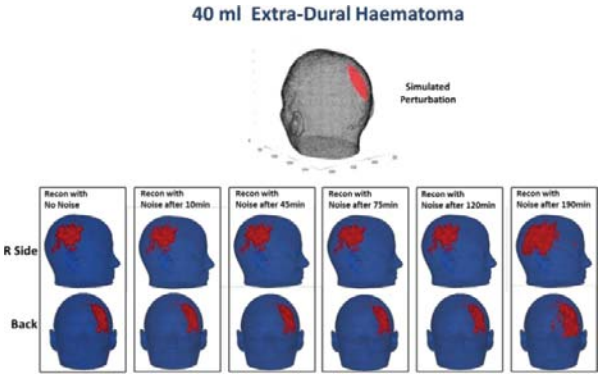

Figure 2: Upper side of demonstrate the original perturbation mesh. Lower part demonstrates reconstructed images of the original perturbation without nose and with realistic noise recorded at 10, 45, 75, 120 and 190 minutes.

4 Conclusions

These initial results suggest that EIT could indeed be used to image intracranial bleeding in head trauma and stroke. Image quality would benefit from more advanced data processing and EIT protocols. This could be a first step toward using EIT as a reliable, accessible, portable and affordable bedside or field monitoring tool in brain trauma and stroke. Work is in progress to collect additional data on multiple subjects to build a more representative sample, determine the drift threshold to enable imaging, and improve the protocol and signal processing.

5 References

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