Use of electrical impedance tomography to monitor dehydration treatment of cerebral edema: a clinical study

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Abstract: In this study EIT was used to monitor brain impedance changes due to variations in cerebral fluid content during dehydration treatment of edema patients. 30 patients with cerebral edema were continuously imaged for two hours after the initiation of dehydration treatment. Results show that overall impedance across the brain increased significantly 5 minutes after dehydration treatment started. And different brain tissues have different reactions towards dehydration

1 Introduction

Cerebral edema is a clinical condition with excess accumulation of fluid in the intracellular or extracellular space of the brain and a common emergency condition in neurology. In the past few decades mannitol dehydration treatment has been proven to be effective for brain edema and has been widely used clinically.

Some initial studies were conducted either with exposed brain or on neonatal brain where skull impedance is less. The group at UCL first demonstrated that the UCLH Mark EIT system could generate reproducible EIT images of epileptic seizures, functional activity, and the phenomenon of spreading depression in anaesthetized experimental animals with a ring of electrodes on exposed brain. We have demonstrated that subarachnoid hemorrhage and intracerebral hemorrhage could be detected by EIT.

In this study EIT is usedf or real-time and non-invasive imaging and monitoring of impedance changes due to variation of cerebral fluid content during dehydration treatment of edema patients.

2 Methods

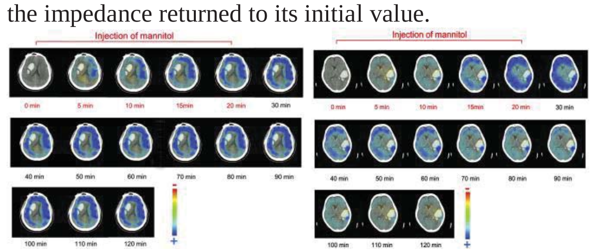
EIT data were measured in real time using an EIT monitoring system (FMMU-EIT5)developed by our group for brain imaging. The system consists of 16 electrodes. Electrodes were placed around the head. Currents were driven in turn through pairs of electrodes opposite each other and voltages on other adjacent electrode pairs were measured. The working frequency of the system ranges from 1 kHz to 190 kHz, the current from 500uA to 1250uA with a measuring accuracy at ±0.01% and the common mode rejection ratio over 80 dB. In this study 1mA-50 kHz alternating current was used.

30 patients with cerebral edema and need of dehydration treatment were included,.

For each patient 0.5g/kg of mannitol solution was administered via intravenous infusion in 20 minutes. Differential images were reconstructed with a reference measurement before mannitol administration.

3 Results

The results show that the overall impedance changes inside the brain increased significantly after mannitol injection. In Figure A, during the injection, the large areas of EIT images became increasingly blue indicating impedance increase in brain, whereas the lesion areas showed much less increase. When the impedance reached the peak after the injection, it remained at the peak for the remainder of the monitoring period. For Figure B, although the results during injection were similar, the impedance changes start to decrease after the end of injection. Two hours after the beginning of the injection, the impedance returned to its initial value.



A B

4 Conclusions

The results indicated that EIT was able to reflect the impedance variation induced by loss of brain fluid content during dehydration. The results also showed that the effect of mannitol dehydration treatment was more long-lasting in some patients than in others. Furthermore, our initial results suggest that different brain tissues have different reactions towards dehydration agents---normal brain tissues had more significant dehydration than the diseased tissues.

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Excerpted from:

Proceedings
of the
15th International Conference on
Biomedical Applications of

ELECTRICAL IMPEDANCE TOMOGRAPHY

Edited by Andy Adler and Bartłomiej Grychtol

April 24-26, 2014
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This document is the collection of papers accepted for presentation at the 15th International Conference on Biomedical Applications of Electrical Impedance Tomography.

Cover design: Bartłomiej Grychtol
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Printed in Canada

ISBN 978-0-7709-0577-4

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