Using EIT to monitor the changes of cerebral impedance during dehydration treatment for brain edema: feasibility and preliminary results

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(Abstract)

Background: Brain edema is a dangerous clinical disease, and is normally treated with dehydration. Monitoring and evaluation of the edema are crucial for fully understanding the disease progression and its severity. Due to such facts as the complexity, invasiveness, high risk, and expensive cost, the current intracranial pressure (ICP) monitor is hard to be accepted clinically. However, Electrical Impedance Tomography (EIT) may play a prominent role in this field for its sensitivity to the change of tissue composition, safety, and real-time dynamic monitoring.

Objectives: The study is to evaluate the feasibility of EIT as a new detection method to monitor cerebral impedance change during dehydration treatment for brain edema. .

Method: Seventy eight patients with edema are included (42 male cases and 36 female cases respectively, aging from 38-65). The dehydration treatment was applied by intravenous (iv) infusion of 250ml 20% mannitol within 40 mins. EIT dynamic monitoring was implemented 30 mins before and 3 hrs after the injection. The detection of mannitol content of blood was taken every 5 mins before and after the injection, and the brain images were taken by MRI before and after single dehydration treatment.

Results: No obvious brain image changes were observed before and after the dehydration treatment when MRI was employed. Impedance fluctuation was minor without dehydration treatment. The dispersion coefficients of EEG Impedance Index were 0.0031 ± 0.0012 and 0.0052 ± 0.0027 in control group and experimental group, respectively, at 30mins prior iv mannitol infusion. After dehydration treatment, brain impedance showed three phnomena: (1) the relative fluctuation coefficient (RI) reached to the peak 12.6 ± 1.3 around 89mins after iv infusion of mannitol in 57 subjects (73.1%). EIT time sequence images showed that half-area ratio index S_R was up to $74\% \pm 7\%$. This was 48mins later than the time at the maximal blood mannitol concentration. After the plateau, RI was gradually descended to the half of the peak value after 142mins; (2) RI peak value was determined at 21.2 ± 1.9 after 70.3 mins approximately in 16 subjects (20.1%). EIT time sequence images showed that half-area ratio index S_R was up to $86\% \pm 9\%$, while RI maintained at high level for a long period of time after the peak; (3) Unobvious influence was exerted for RI by mannitol (RI is less than 5) in 5 subjects (6.4%). There had no clear reflection in EIT time sequence image all along, and S_R was 0.

Conclusion: The study demonstrated that the EIT could monitor the changes of EEG impedance after the single dehydration treatment and provide guidance for edema Mannitol dehydration treatment through dynamic monitoring process. Impedance dynamic monitoring index can be used for the evaluation of the potential risk after iv infusion of manntol and thus for preventing the clinical risk effectively during the dehydration treatment.