

The Role of Diffusion Weighted Imaging and Magnetic Resonance Imaging Scoring System in Assessing the Effectiveness of Treatment with Hypothermia in Neonates with Hypoxic-ischemic Encephalopathy

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In the study of Twomey, et al. all neonates had MRI within 10 days of birth, however none of them was treated with hypothermia. All neonates with an ADC value in the PLIC of $<860 \times 10^6 \text{ mm}^2/\text{s}$ had an unfavorable outcome at 2 years of age. Neonates with an ADC value of $>860 \times 10^6 \text{ mm}^2/\text{s}$ in the PLIC combined with an ADC value of $>1070 \times 10^6 \text{ mm}^2/\text{s}$ in the BG had a favorable outcome. ADC values in the

The inclusion criteria were a gestational age of 36 weeks or more,

of $1290 \times 10^6 \text{ mm}^2/\text{s}$, even though infants in the study by Twomey had not been treated with hypothermia [13].

Twomey, et al. has quoted the threshold ADC value above which all neonates have a good outcome and not the threshold ADC value with the highest sensitivity and specificity for predicting clinical outcome. If we had decided to represent the ADC value above which all neonates had a good clinical outcome, the value would be $1436 \times 10^6 \text{ mm}^2/\text{s}$. As can be seen, threshold ADC values that are quoted in studies also depend on the presentation of the results.

Based on comparison between ADC values of the present and ADC values of the previous studies measured in the PLIC/T and WM, it can be concluded that the ADC values of the present study were among the highest. Neonates in the present study were treated with hypothermia whereas neonates of the previous studies mentioned in this paper have not been. Therapeutic hypothermia causes a reduction in cerebral lesions seen on MRI and has a neuroprotective effect [5-10]. It can therefore be concluded that threshold ADC values represented in the present study were among the highest because neonates had been treated with hypothermia.

We evaluated and scored the level of injury seen on T1 and T2 weighted sequences, for each of the 25 neonates. Table 3 shows the most frequently given scores in the group with a good and that with a poor clinical outcome. Considering all of the evaluated areas together, it can be seen that the most frequently given score in the group with a good clinical outcome was 0, only in the BG/T was the most frequently given score 2. In the group with a poor clinical outcome, the most frequently given score overall was 3, only in the PLIC was the most frequently given score 1.

We found that scores given by the morphological MRI scoring system in the area of BG/T ($p=0.006$) and cortex ($p=0.001$) were significantly associated with clinical outcome at 1 month of age but scores given in the PLIC and WM were not ($p>0.01$). It can be seen that there are some differences in association between clinical outcome and the results obtained by ADC values and the MRI scoring system. We showed that ADC values measured in the PLIC/T and in the WM were most associated with clinical outcome, but scores given by the morphological MRI scoring system in these areas were not. Instead we have shown association between clinical outcome and MRI scores given in the area of BG/T and cortex. Differences may be present due to the fact that the morphological MRI scoring system is fairly subjective and depends on the person evaluating the image. At this point we would like to emphasize that evaluation of hypoxic-ischemic lesions in the BG/T by the morphological MRI scoring system is more difficult compared to cortex. Therefore ADC values have a greater role and are more objective in evaluation of lesions of the deep brain areas.

The first limitation of our study was the number of enrolled neonates. Low number of neonates with HIE treated with hypothermia at the national level was the main reason for that. Our second limitation was that we correlated our results with Amiel-Tison neurologic assessment at 1 month of age. We did so because we had a complete neurologic assessment for all treated neonates at this early age. Comparison of our results with clinical outcome at 2 years of age will be evaluated in our future studies. Our third limitation was that we did not have a control group. Because hypothermia is currently the best known treatment for neonates with HIE, it would have been unethical to have a control group of untreated neonates with HIE for comparison.

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The present study has shown statistically significant association between DWI with ADC mapping and clinical outcome and between morphological MRI scoring system and clinical outcome in neonates with HIE at 1 month of age. ADC values measured in the PLIC/T and in the WM were shown to have the best association with clinical outcome. In comparison to threshold ADC values from literature

univariate analysis

15. Paro-Panjan D, Neubauer D, Kodric J, Bratanic B (2005) Amiel-Tison Neurological Assessment at term age: clinical application, correlation with other methods, and outcome at 12 to 15 months. *Dev Med Child Neurol* 47: 19-26