

# Non-Invasive Estimation of Brain Deep Grey Matter Temperature using Localised Proton Magnetic Resonance Spectroscopy in Normothermic and Hypothermic Newborn Infants

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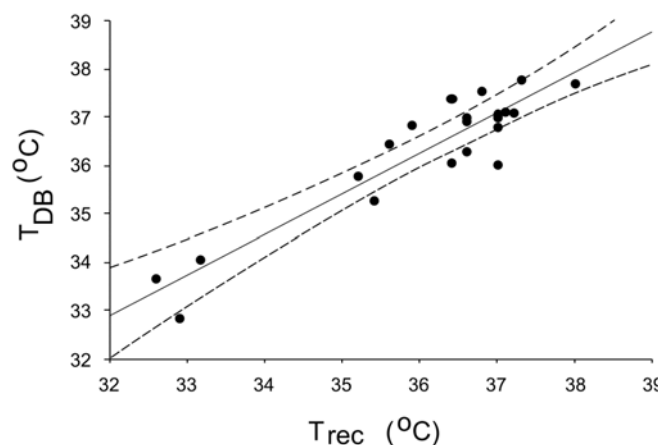
**Background:** A Cochrane review [1] concluded that therapeutic cerebral hypothermia following perinatal hypoxia-ischaemia (HI) reduced both mortality and survivor neurodevelopmental disability and reduced mortality without increasing major disability in survivors. In the acute phase following HI, precise knowledge of regional brain temperatures, at various times, in infants with differing birth weights and injury patterns, is needed in order to refine and optimise therapeutic hypothermia. Experimental studies [2] and theoretical models [3] have suggested a correlation between deep brain and rectal temperatures ( $T_{DB}$  and  $T_{rec}$  respectively). Intrinsic factors, such as body size, may influence temperature gradients in un-injured brain [4]. However, our knowledge of regional brain temperature in neonatal encephalopathy (NE) is limited despite the fact that small temperature differences can critically influence neuropathological outcome [5]. Magnetic resonance spectroscopy thermometry (MRSt) is non-invasive and has been successfully used to measure regional brain temperature in human adults and neonates [6,7].

**Aims:** To assess the relation between  $T_{DB}$  (thalamic) and  $T_{rec}$  using MRSt in normothermic and hypothermic human neonates.

**Methods:** Twenty one neonates had  $T_{rec}$  measurement and thalamic MRSt in addition to a standard clinical magnetic resonance imaging (MRI) protocol. Four of these infants were cooled as part of their clinical care: 3 of these were cooled during MRSt. Proton spectra were acquired on a Siemens 1.5 Tesla Avanto scanner using point-resolved spectroscopy (PRESS) without water-suppression with a  $1.5 \times 1.5 \times 1.5 \text{ cm}^3$  cubic voxel centred on the left thalamus (recovery time 1370 ms, echo time 288 ms, 392 summed echoes, 2048 complex datapoints). Spectra were analysed using AMARES [8] (jMRUI software [9]). The water frequency was determined by fitting a single component and then the water signal was removed using HLSVD [10] (jMRUI software [9]): the N-acetyl-aspartate (Naa) frequency was also determined using a single component.  $T_{DB}$  was estimated from the chemical-shift difference between water and Naa [7].  $T_{DB}$  was plotted against  $T_{rec}$  and linear regression was performed. Correlation between  $T_{DB}$  and  $T_{rec}$  was tested using the Pearson product moment.

**Results:**  $T_{DB}$  is plotted against  $T_{rec}$  in Fig. 1. There was a strong linear correlation between  $T_{DB}$  and  $T_{rec}$  (slope 0.84;  $P < 0.0001$ ). The slope was not significantly different from 1.

**Discussion:** The temperature of the deep brain is regulated, in part, by cerebral perfusion. Models of cerebral temperature variation [3] indicate an approximately uniform deep brain temperature. Temperature gradients in cooler peripheral brain occur in a narrow peripheral shell with width larger for lower perfusion rates.  $T_{rec}$  has been assumed to be a surrogate for deep brain temperature in NE. The strong linear correlation between  $T_{rec}$  and  $T_{DB}$  suggests that MRSt can successfully measure neonatal brain temperature over a broad temperature range. In future studies MRSt will be applied to other brain regions. Knowledge of how clinical factors such as body weight, head circumference, and cerebral perfusion affect regional brain temperature may enable patient-specific cooling protocols and optimise hypothermic cerebroprotection.



**Figure 1:**  $T_{DB}$  plotted against  $T_{rec}$ . The linear regression and 90% confidence intervals are shown

## References

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