

Hepatocyte Cell Membrane Permeability Measurement in Perfused Rat Liver

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Purpose: An understanding of the membrane permeability for water is important to evaluate MR images of complex tissues, such as liver, and to interpret the effects of contrast agents. To obtain data essential for such an understanding we measured water exchange across the isolated rat hepatocyte membranes by proton MR relaxation with Gd-EOB-DTPA as a relaxation agent.

Materials and Method: MR relaxation data were obtained on MR spectrometer (Proton Larmor frequency=50 MHz). The perfused rat hepatocytes were doped with Gd-DTPA and Gd-EOB-DTPA separately. The concentration of the agents was 1mM. Typical relaxation data consist of more than 30 points and ranged up to 5T1. The raw T1 MR relaxation data were then analyzed using a continuous distribution method which provides continuous T1 relaxation time distribution. First, water exchange time across the membrane was calculated using bi-exponential T1 relaxation model. The membrane permeability was then estimated from the water exchange time.

Results: Based on two site chemical exchange model between intra- and extracellular space, the calculated water exchange time was 250 msec. The permeability coefficient of the cell membrane was estimated from $P=V/(A\tau)$. For simplicity, the hepatocyte was assumed spherical shape ($V/A = r/3$). Using mean radius (r) of rat hepatocyte and the exchange time τ , the estimated permeability coefficient (P) was $(1.3 \pm 0.1) \times 10^{-3}$ cm/sec. For human RBC, the reported permeability was approximately 4.7×10^{-3} cm/sec. Even through the hepatocyte is larger than RBC in size, the hepatocyte membrane appears to be more restrictive of water exchange than the RBC membrane.

Conclusion: The tissue-specific contrast agents can be used as an important tool to study compartmental water exchange and so the membrane permeability. Water exchange in hepatocytes is much slower than that in red blood cells. This indicate that water exchange across the hepatocyte membrane is more restrictive.