The Effects of Contrast Agents on Hyperpolarised [1-^{13}C]-Pyruvic Acid

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Introduction: It has been shown that the addition of small quantities of gadolinium based contrast agents (GBCA) to ^{13}C-enriched samples containing trityl radical significantly increases the amount of hyperpolarisation that can be obtained via DNP (1). For *in vivo* imaging, the decrease in T_1 relaxation time caused by the addition of the GBCA must be taken into consideration. **This study examines the effects of several contrast agents at varying concentrations on the T_1 relaxation time in solution and on relative amount of polarisation in the solid state obtained in [1-^{13}C]-labeled pyruvic acid.**

Methods: [1-^{13}C]-enriched pyruvic acid (CIL, Cambridge MA) samples containing 15mM OX63 trityl radical (Oxford Instruments, Abingdon UK) were doped with 0.5, 1, 2, and 3mM concentrations of Dotarem (Guebert), ProHance (Bracco), MultiHance (Bracco), Magnevist (Bayer), Omniscan (Amersham), Teslascan (GE Healthcare), or Feridex (Bayer). Volume of contrast agent added was held constant for each sample. Solutions were hyperpolarized and dissolved using a Hypersense DNP polarizer (Oxford Instruments, Abingdon UK). T_1 measurements were performed using a 0.55T bench top spectrometer (Oxford Instruments) with a small tip angle (5^o) excitation pulse and 5s repetition time. Signal decay curves were fit to a mono-exponential decay to obtain T_1. Relative hyperpolarisation enhancement as compared to no contrast agent was obtained for the equilibrium solid state signal.

Results and Discussion: T_1 relaxation times decreased with increasing contrast agent concentration for all of the contrast agents except Teslascan, which showed no change (Figure 1). Teslascan is a manganese (not gadolinium) based contrast agent. Dotarem and ProHance showed only a slight decrease in T_1. MultiHance showed the largest increase in hyperpolarisation in the solid state, which increased non-linearly with increasing concentration (Figure 2). MultiHance and Magnevist, however, also showed the largest decrease in T_1. Teslascan showed less increase in hyperpolarisation in the solid state than most of the other contrast agents, but this may be compensated by its lack of effect on T_1. Feridex showed no polarisation enhancement but strong T_1 decrease.

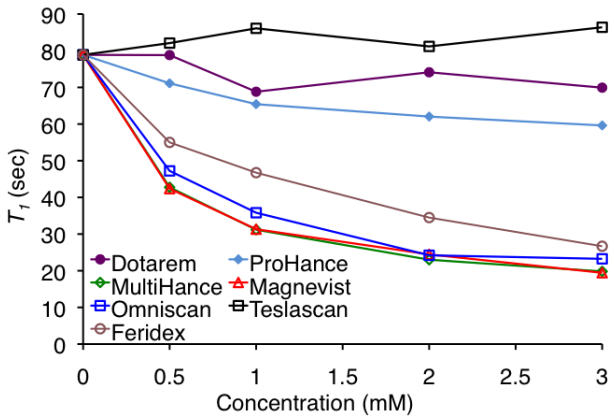

Figure 1: T_1 of hyperpolarised [1-^{13}C] pyruvic acid in liquid state vs concentration of contrast agent.

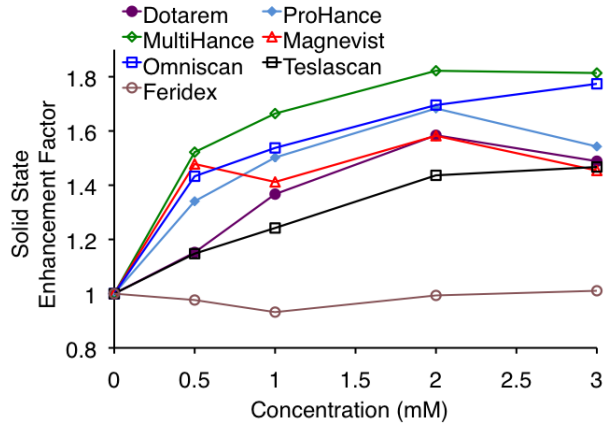

Figure 2: Polarisation enhancement of [1-^{13}C] pyruvic acid in solid state vs concentration of contrast agent.

Conclusion: Choice of contrast agent must consider the amount of hyperpolarisation required and the decrease in T_1 that can be tolerated. Thus, choice of contrast age may depend on the application. Future work includes determining the error in these measurements as well as including more contrast agents. Preliminary experiments are underway to determine the effects of contrast agent on the optimal microwave frequency.

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References

1) Ardenkjaer-Larsen *et. al.* Appl. Magn. Reson. (2008), 34:509-522.