Quantification and Biodistribution of Iron Oxide Nanoparticles in the Primary Clearance Organs of Mice using T_1 Contrast for Heating – Supporting Information

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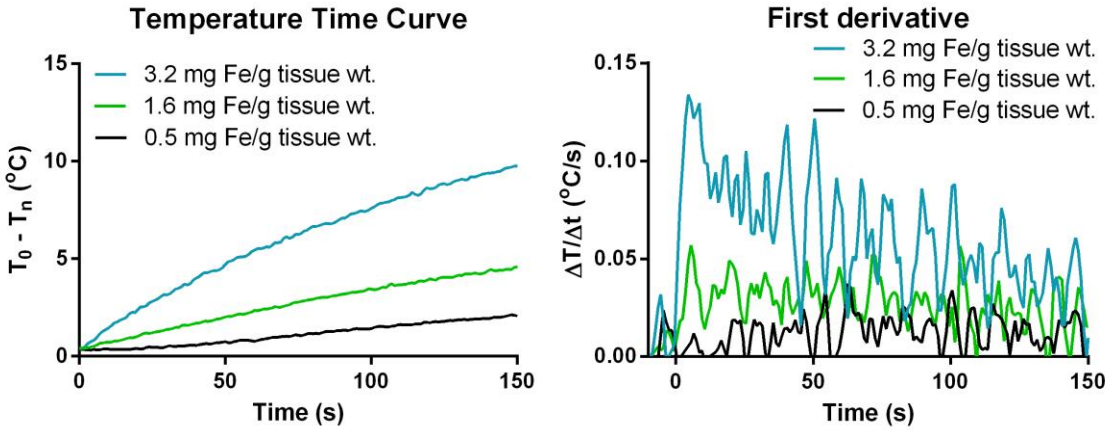
Specific Absorption Rate Calculations

Conventionally, the specific absorption rate (SAR_v) is determined from the linear temperature rise once heating is applied (Supporting Figure1). An underestimate of SAR_v can be performed if this fitting is over a time period where the change in temperature is not linear. The first derivative of the data can be used to define the stable region of temperature change, which appears as a plateau (Supporting Figure S1) (1). The first derivatives of our data were assessed with smoothing of n = 4 to remove the amplified first derivative noise. Based on the first derivatives, a time range of 10 – 60 s after heating began was used to assess this linear fit.



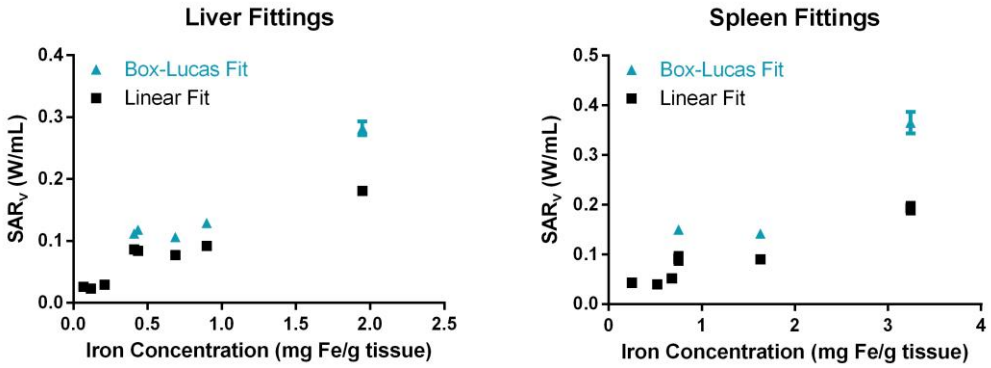
Supporting Figure S1: A normalized temperature vs. time curve from spleen tissue with msIONP uptake demonstrates the exponential curve observed as a thermal steady state is achieved within the system (left). The first derivatives demonstrate a plateau characteristic, however, for high concentrations (3.2 mg Fe/g tissue wt.) an immediate decrease is observed after the initial heating (right).

For samples with high concentrations of iron (> 0.4 and > 0.7 mg Fe/ g tissue wt. in the liver and spleen, respectively) a stable region could not be defined from the first derivative. Therefore, the linear fit SAR_v is an underestimate of the actual SAR_v. For these samples an exponential fit, known as the Box-Lucas fitting, was performed over the first 150 s of heating. It is already known that the amplitude and rate constant of this fitting is equal to the linear temperature rise (2).

$$A * B = \frac{\Delta T}{\Delta t} \qquad \text{[Eq. SI.1]}$$

As has been already described, the Box-Lucas fitting is only well suited for samples with high concentrations of iron or when high frequencies are applied (1). Therefore, this fit was not performed on tissue samples with low iron concentrations.

A comparison of the data obtained using only the linear and Box-Lucas fitting methods are shown in Supporting Figure S2. It demonstrates that the linear fit does underestimate the SAR_v compared to Box-Lucas fitting.



Supporting Figure S2: SAR_v as a function of iron concentration for the liver (left) and the spleen (right). For high concentrations of iron within both tissues, the linear fit obtains an underestimate of the SAR_v.

The table below gives SAR_{Fe} and SAR_v:R_1 values for both the Linear and Box-Lucas Fit. The Box-Lucas fit is reported in the main manuscript.

Supporting Table S1: SAR_{Fe} & SAR_v:R_1 Fitting Comparison

		SAR_{Fe} (W/g Fe)	SAR_v:R_1 (W*s/mL)
Liver	Linear Fit	80 ± 10 (n = 8)	0.069 ± 0.007 (n = 7)
	Box-Lucas Fit	134 ± 15 (n = 8)	0.114 ± 0.010 (n = 7)
Spleen	Linear Fit	49 ± 7 (n = 6)	0.146 ± 0.023 (n = 5)
	Box-Lucas Fit	107 ± 17 (n = 6)	0.314 ± 0.053 (n = 5)

1. Bordelon DE, Cornejo C, Grüttner C, Westphal F, DeWeese TL, Ivkov R. Magnetic nanoparticle heating efficiency reveals magneto-structural differences when characterized with wide ranging and high amplitude alternating magnetic fields. Journal of Applied Physics 2011;109(12):124904.
2. Kallumadil M, Tada M, Nakagawa T, Abe M, Southern P, Pankhurst QA. Suitability of commercial colloids for magnetic hyperthermia. Journal of Magnetism and Magnetic Materials 2009;321(10):1509-1513.