

Supplemental Equations

Analytical expressions of S_{in} and S_{ex} acquired by OGSE and PGSE sequences

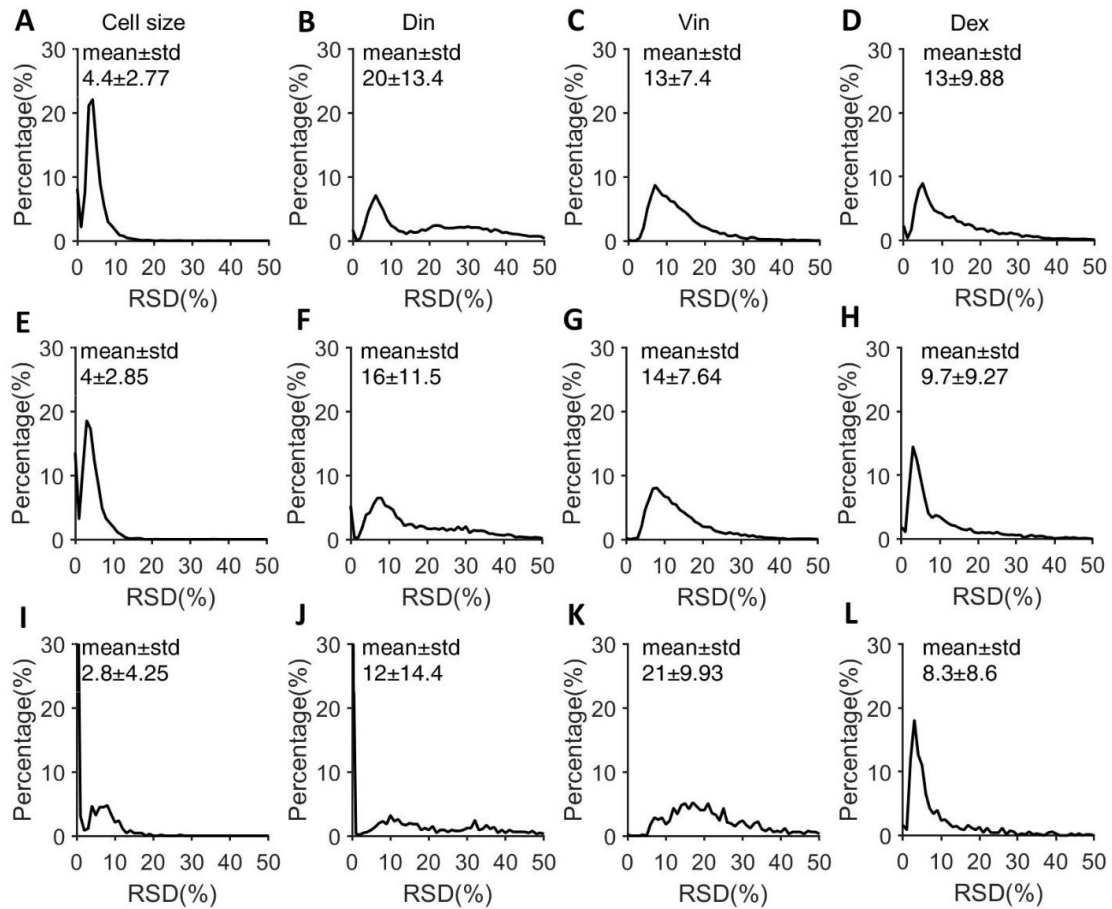
$$S_{in}(OGSE) = \exp\left(-2(\gamma g)^2 \sum_n \frac{B_n \lambda_n^2 D_{in}^2}{(\lambda_n^2 D_{in}^2 + 4\pi^2 f^2)^2} \left\{ \frac{(\lambda_n^2 D_{in}^2 + 4\pi^2 f^2)}{\lambda_n D_{in}} \left[\frac{\delta}{2} + \frac{\sin(4\pi f \delta)}{8\pi f} \right] - 1 + \exp(-\lambda_n D_{in} \delta) + \exp(-\lambda_n D_{in} \Delta) (1 - \cosh(\lambda_n D_{in} \delta)) \right\}\right)$$

$$S_{in}(PGSE) = \exp\left(-2\left(\frac{\gamma g}{D_{in}}\right)^2 \sum_n \frac{B_n}{\lambda_n^2} \{\lambda_n D_{in} \delta - 1 + \exp(-\lambda_n D_{in} \delta) + \exp(-\lambda_n D_{in} \Delta) (1 - \cosh(\lambda_n D_{in} \delta))\}\right)$$

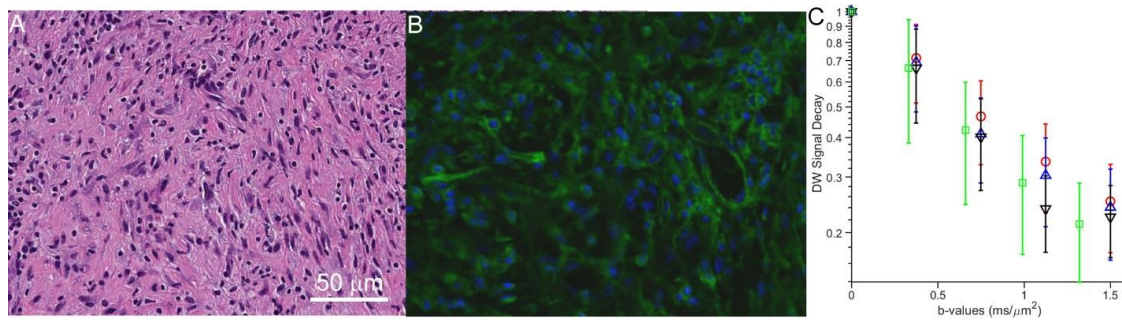
$$S_{ex}(\text{either PGSE or OGSE}) = \exp[-bD_{ex}]$$

where D_{in} is the intracellular diffusion coefficient, f is the oscillation frequency, δ is the gradient duration, Δ is the separation of two diffusion gradients, g is the gradient amplitude, and λ_n and B_n are structure dependent parameters that depend on the spherical cell diameter d , D_{ex} is the extracellular diffusion rate at frequencies close to 0. Explicit expressions for λ_n and B_n have been reported previously (15).

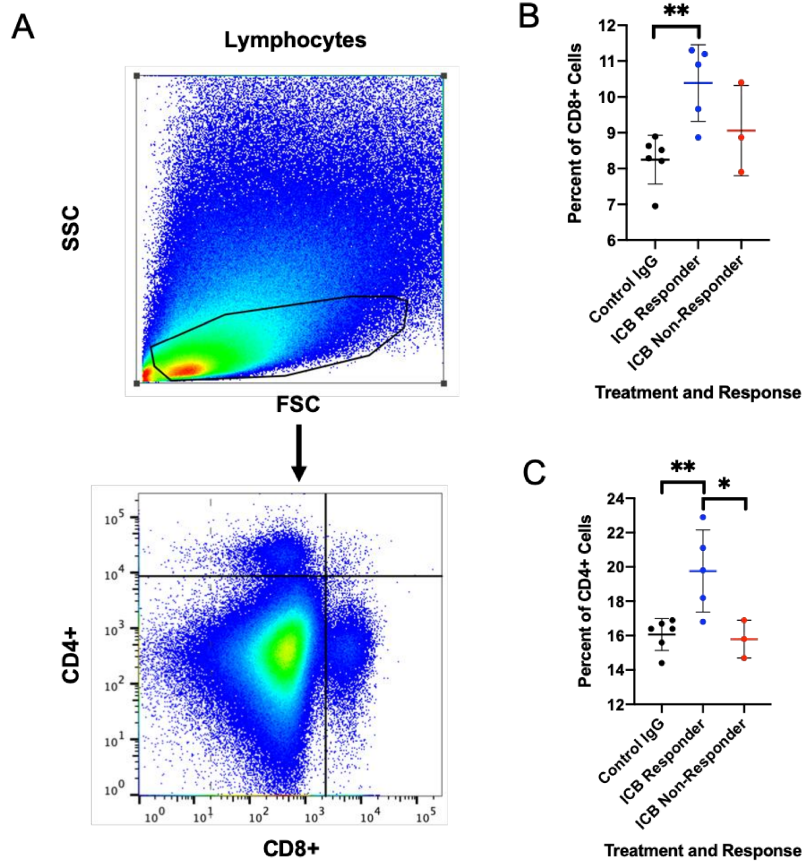
Supplemental Figures



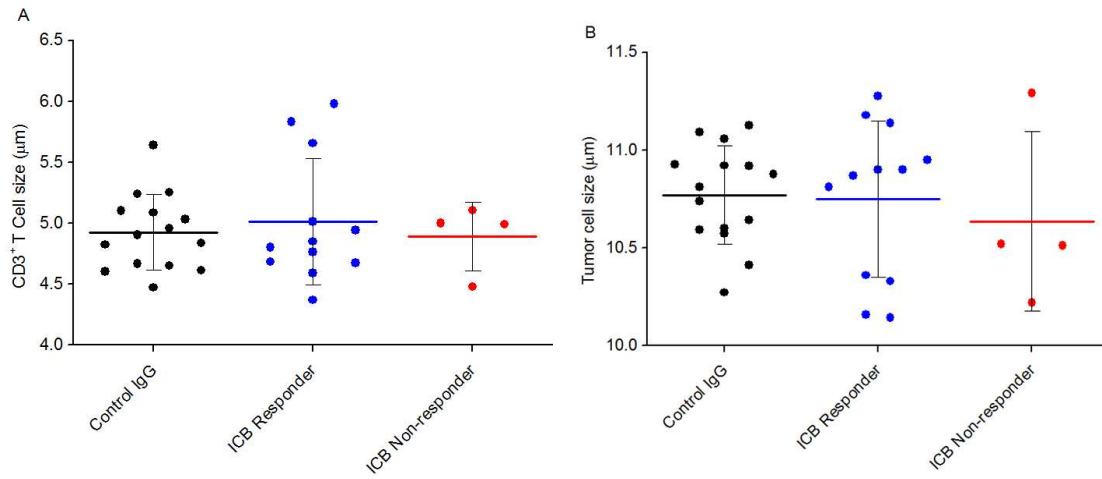
Supplemental Figure 1. Histograms of RSD of IMPULSED-derived cell size, intracellular volume fraction, and intracellular/extracellular diffusion coefficients, for representative control IgG-treated, ICB non-responder, and ICB responder tumors, respectively, at 16 DPI.



Supplemental Figure 2. Representative H&E (A) and Na⁺/K⁺-ATPase (B) stained pictures for a dual immunotherapy treated MC38 tumor which underwent significant late-stage apoptosis/necrosis. (C) Normalized diffusion-weighted signals (mean \pm std) for the same tumor.



Supplemental Figure 3. Cells were first gated by forward and side scatter for lymphocytes. Then, cells were subtyped into CD8+ and CD4+ T cells(A). ICB responders had a significantly higher percent of splenic CD8+ T cells than Control IgG treated mice (B). CD4+ splenic T cells from ICB responder also had a significantly higher percent compared to control IgG-treated and ICB non-responder spleens (C). * $P < 0.05$ and ** $P < 0.01$ as measured by ordinary one-way ANOVA for (B) and (C).



Supplemental Figure 4. Histology-derived cell sizes of CD3⁺ T cells (A) and tumor cells (B) for control IgG (black), ICB responder (blue), and ICB Non-responder (red) tumors.