Supplemental Document

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Choosing a model for laser speckle contrast imaging: supplement

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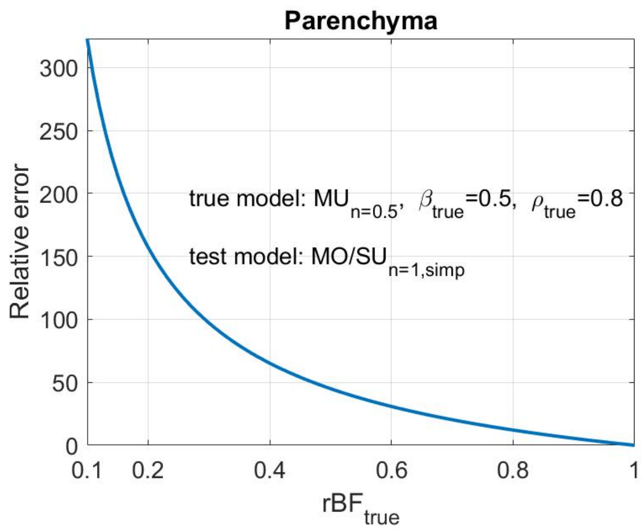

Fig. S1. Relative error caused by a typical combination of wrong assumptions when measuring blood flow in the parenchyma. Ground truth model was set to $MU_{n=0.5}$ with $\tau_c = 1ms$, $T = 5ms$, $\beta = 0.5$, $\rho = 0.8$, while the conventionally used $MO/SU_{n=1,simp}$ was tested.

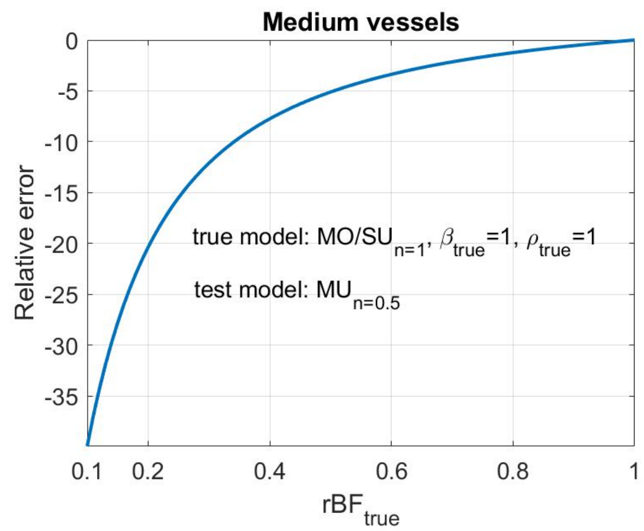

Fig. S2. Relative error caused by using $MU_{n=0.5}$ model in medium-sized vessels. Ground truth model was set to $MO/SU_{n=1}$, with $T = 5ms$, $\tau_c = 0.2ms$, $\beta = 1$, $\rho = 1$.

Derivation of Eq. 12

Field autocorrelation function for multiple scattering unordered motion regime is given by:

$$g_1(\tau) = exp\Big(-\sqrt{\tau/\tau_c}\Big) \tag{S1}$$

With Eq. 10, g_2 becomes:

$$g_2 = 1 + \beta\Big[\rho^2 exp(-\sqrt{\tau/\tau_c}) + 2\rho(1-\rho)|exp(-\sqrt{\tau/\tau_c})| + (1-\rho^2)\Big] \tag{S2}$$

Substitute the new g_2 into Eq. 3 to compute the autocovariance $C_t(\tau)$:

$$C_t(\tau) = \beta\Big[\rho^2 exp(-\sqrt{\tau/\tau_c})^2 + 2\rho(1-\rho)exp(-\sqrt{\tau/\tau_c}) + (1-\rho)^2\Big] < I >_t^2 \tag{S3}$$

From Eq. 1 the contrast is derived as:

$$K_s^2 = \frac{2\beta}{T}\int_0^T (1-\frac{\tau}{T})\Big\{\rho^2 exp(-\sqrt{\tau/\tau_c})^2 + 2\rho(1-\rho)exp(-\sqrt{\tau/\tau_c}) + (1-\rho)^2\Big\}d\tau \tag{S4}$$

Compute the definite integral to obtain Eq.12 .

Derivation of Eq. 13

For single scattering and ordered motion regime, the proper model of autocorrelation function is

$$g_1(\tau) = exp\Big(-(\tau/\tau_c)^2\Big) \tag{S5}$$

Substitute Eq. S5 in Eq. 10, g_2 becomes:

$$g_2 = 1 + \beta\Big\{\rho^2 exp\Big(-(\tau/\tau_c)^2\Big)^2 + 2\rho(1-\rho)exp\Big(-(\tau/\tau_c)^2\Big) + (1-\rho)^2\Big\} \tag{S6}$$

The autocovariance function $C_t(\tau)$ in this case becomes:

$$C_t(\tau) = \beta\Big\{\rho^2 exp\Big(-(\tau/\tau_c)^2\Big)^2 + 2\rho(1-\rho)exp\Big(-(\tau/\tau_c)^2\Big) + (1-\rho)^2\Big\} < I_t >^2 \tag{S7}$$

Substitute Eq. S7 into Eq. 1, the contrast equation is:

$$K_s^2 = \frac{2\beta}{T}\int_0^T (1-\frac{\tau}{T})\Big\{\rho^2 exp\Big(-(\tau/\tau_c)^2\Big)^2 + 2\rho(1-\rho)exp\Big(-(\tau/\tau_c)^2\Big) + (1-\rho)^2\Big\}d\tau \tag{S8}$$

Compute the definite integral to obtain Eq.13.