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#### 4.4. *In vivo tumor study data in comparison to phantom study results*

In the tumor study, measured  $\mu_a$  and  $\mu_s'$  show large variations between subjects (see Figs. 7a and 7b). The range of variations,  $\mu_a$  (830 nm) from 0.07 to 0.16  $\text{cm}^{-1}$  and  $\mu_s'$  (830 nm) from 5.35 to 13.1  $\text{cm}^{-1}$ , is within the range studied using liquid phantoms. The influence of the  $\mu_s'$  variations on flow indices was found to be greater than that of  $\mu_a$ , supporting the phantom study results. This is exemplified by the trends shown in Fig. 7c. The overestimation of optical properties (using maximum  $\mu_a$  and  $\mu_s'$ ) leads to underestimation of DCS flow index ( $\alpha D_{B-\text{max}}$ ) and underestimation (using minimum  $\mu_a$  and  $\mu_s'$ ) leads to overestimation of DCS flow index ( $\alpha D_{B-\text{min}}$ ). These are in agreement with the trends of  $D_B$  estimation errors using inaccurate  $\mu_s'$  in liquid phantoms (see Figs. 5c, 5f and 6). Percentage  $\alpha D_B$  errors range greatly, from  $\sim-70\%$  up to  $\sim+280\%$ , depending on optical properties assumed. Errors in flow indices (see Fig. 7d) produce an incorrect observation of trends in the  $\alpha D_B$  magnitudes among patients (see Fig. 7c). It is evident that lack of consideration for optical property influences can lead to invalid results in similar studies.

#### 4.5. *Conclusions*

The advent of DCS technology as a safe and quick alternative for measurement of blood flow in deep tissues has brought the need to further investigate potential errors, notably by the assumption of constant optical properties,  $\mu_a$  and  $\mu_s'$ . The flow index produced by DCS measurement is based on a solution to the correlation diffusion equation which includes parameters of  $\mu_a$  and  $\mu_s'$ . Utilizing a novel hybrid optical equipment setup, capable of measuring all three parameters of interest (i.e., flow index,  $\mu_a$ , and  $\mu_s'$ ), with liquid phantom experimental protocols has made it possible to perform this investigation. The present study evaluates the influences of tissue optical properties on DCS flow indices through isolated variations of  $\mu_a$  and  $\mu_s'$  in liquid phantoms. It is found that the particle motions in liquid phantoms are not influenced by the variations in optical properties, and the usage of Einstein particle Brownian motion coefficient ( $D_{B-\text{Einstein}}$ ) as true flow index is reasonable for comparison with DCS flow indices. During  $\mu_a$  and  $\mu_s'$  variations,  $\mu_s'$  has a much greater influence on DCS flow indices than  $\mu_a$ , regardless of the wavelengths used. Studies involving significant  $\mu_a$  and  $\mu_s'$  changes should concurrently measure flow index and optical properties for accurate extraction of blood flow information in tissue. The flow index errors resulted from the optical property assumptions in the tumor study elicit such need for concurrent monitoring of optical properties. Incorporation of laser sources at wavelengths beyond those tested in this study may be the subject of future investigation. The range of optical properties tested in the phantoms may also be extended to encompass a wider variety of tissues.

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