254b Multipole Flows in Poroelastic Media and Neural Tissues

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Convection enhanced drug delivery (CED) uses pressure-driven flow to deliver therapeutic agents to disease-afflicted tissues. A key parameter in local drug delivery methods is the distance over which the drug penetrates in tissue, which depends, in part, on the relative rates of transport and elimination. Because the imposed pressure gradient in CED can be set arbitrarily, it may be possible to increase the penetration distance over that obtained using methods that rely solely upon diffusion. Furthermore, it may be possible in CED to achieve a nearly uniform concentration of drug over the penetration distance.

However, the anatomy of normal and neoplastic tissue may restrict the effectiveness of CED in practice, unless the anisotropy, poroelasticity, and certain heterogeneous features of the tissue are taken into account in designing CED protocols. To better control the fate of infused agents in CED, we have examined the feasibility of using multipole flows that are delivered through implantable microfluidic probes.

As a step toward analyzing multipole flows in the brain, we have conducted experimental studies of flow in a radial Hele-Shaw cell to characterize potential flows in a poroelastic medium. A low-concentration agarose gel was used as the medium because it has a similar hydraulic permeability as normal brain tissue. Dipole and quadrupole orientations were examined with characteristic lengths (source separation distance/plate separation) on the O(1-10) . The characteristic length in the Hele-Shaw cell is meant to mimic an analogous characteristic length in brain tissue (source separation distance/distance between anatomical features). The residence time of tracer solutions was analyzed to determine dispersion and transit-time distributions at different source/sink strengths. In addition, the deformation-dependent hydraulic permeability was measured as a function of source strength. The results of the Hele-Shaw studies were incorporated into models of anisotropic and heterogeneous poroelastic media to determine the utility of implementing multipole flows in brain tissue.