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Nodal cilia-driven flow: development of a computational model of the nodal cilia axoneme

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Abstract

Cilia-driven nodal flow is important in the determination of left-right asymmetry in the body. Several theoretical and computational models have been proposed to explain the mechanics of ciliary motion, although the full mechanism remains unknown. Here, we developed a three-dimensional nodal cilia axoneme model using a finite element-boundary element coupling method, and investigated the mechanics of nodal ciliary motion. We found that the rotational orbit was strongly dependent on the dynein activation frequency. We also investigated flow field generated by the ciliary rotation, and the flow strength decayed as r^{-3} at the far field from the cilium. Our numerical results also suggest that experimentally observed tilt angle $\theta = 2\pi/9$ is sufficiently large to make a leftward flow. These findings are helpful in better understanding ciliary motion and nodal flow.

Keywords: Nodal flow, Nodal cilia axoneme, Boundary element method

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