Small-Scale Model of Liquid Plugs Rupture in Human Lungs

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Lung airways are coated with a liquid film made of mucus and serous layers. Owing to capillary instability, surface tension forces can form liquid plugs (especially under pathological conditions) that occlude the distal respiratory tract [1]. Thereafter, within a breathing cycle, such liquid plugs can be broken by propagation [2,3] and splitting in the airways [4]. Upon their breakup, a pressure wave forms and can be acoustically detected in form of crackling sounds (Fig. 1, [5]). The dynamics of the liquid plug is here studied in detail by deriving and solving an asymptotic small-scale model of the mucus plug right prior to its rupture.

Before the rupture of the liquid plug, the front and back air fingers gradually approach each other. Our study will therefore be employed in future investigations that will focus on the coupling between the large-scale liquid plug propagation and the small-scale dynamics of its rupture.

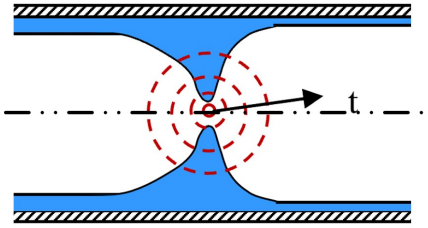

Figure 1. Schematic diagram of a liquid plug breaking. The red circles represents the propagation of a pressure wave.

References

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