Cellular Dewetting: Opening of Macro Apertures

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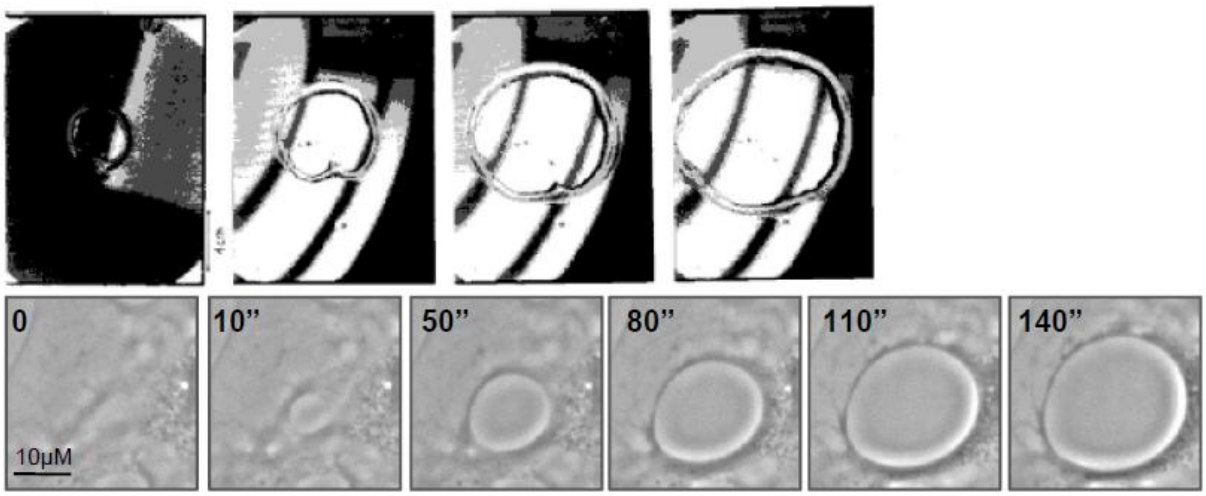
Abstract

Pathogenic bacteria migrate from blood and lymphatic vessels to host tissues by opening transient macro apertures, MAs, in endothelium cells. To accomplish this, Staphylococcus aureus infects cells with EDIN, which produces a sudden disruption of the contractile cytoskeleton network. Cell membrane tension is no longer resisted by contractile fibers, leading to the opening of MAs. The opening is opposed by the line tension at the rim of the hole, which is induced by specific lipid sorting in the curved membrane. This induced line tension limits MA maximal size and eventually closes the hole, limiting endothelium permeability and preventing cell death. We model here the opening and closure of MAs by analogy with the dewetting of a liquid drop. We calculate the minimum radius for hole nucleation, as well as the maximal MA size as a function of the initial membrane tension, assuming a constant line tension, T. We show that the radius $R(t)$ of a transient MA obeys simple scaling laws if T is small, leading to large MAs.



Top: Dewetting of a liquid film of PDMS on a fluorinated wafer. Bottom: Opening of a macro aperture in an endothelial cell.