Résumé

Pulling membrane nanotubes from liposomes presents a powerful method to gain access to membrane mechanics. Here we extend classical optical tweezers studies to infer membrane nanotube dynamics with high spatial and temporal resolution. We first validate our force measurement setup by accurately measuring the bending modulus of EPC membrane in tube pulling experiments. Then we record the position signal of a trapped bead when it is connected, or not, to a tube. We derive the fluctuation spectrum of these signals and find that the presence of a membrane nanotube induces higher fluctuations, especially at low frequencies (10-1000 Hz). We analyse these spectra by taking into account the peristaltic modes of nanotube fluctuations. This analysis provides a new experimental framework for a quantitative study of the fluctuations of nanotubular membrane structures that are present in living cells, and now classically used for in vitro biomimetic approaches.

Le résumé de l'article de Camillo Campillo contient des informations sur l'effet des propriétés de la membrane cellulaire sur le cytosquelette actine.

Résumé

Lipid membranes define the boundaries of living cells and intracellular compartments. The dynamic remodelling of these membranes by the cytoskeleton, a very dynamic structure made of active biopolymers, is crucial in many biological processes such as motility or division. In this review, we present some aspects of cellular membranes and how they are affected by the presence of the actin cytoskeleton. We show that, in parallel with the direct study of membranes and cytoskeleton in vivo, biomimetic in vitro systems allow reconstitution of biological processes in a controlled environment. In particular, we show that liposomes, or giant unilamellar vesicles, encapsulating a reconstituted actin network polymerizing at their membrane are suitable models of living cells and can be used to decipher the relative contributions of membrane and actin on the mechanical properties of the cellular interface.

Résumé

Cells modulate their shape to fulfill specific functions, mediated by the cell cortex, a thin actin shell bound to the plasma membrane. Myosin motor activity, together with actin dynamics, contributes to cortical tension. Here, we examine the individual contributions of actin polymerization and myosin activity to tension increase with a non-invasive method. Cell-sized liposome doublets are covered with either a stabilized actin cortex of preformed actin filaments, or a dynamic branched actin network polymerizing at the membrane. The addition of myosin II minifilaments in both cases triggers a change in doublet shape that is unambiguously related to a tension increase. Preformed actin filaments allow us to evaluate the effect of myosin alone while, with dynamic actin cortices, we examine the synergy of actin polymerization and myosin motors in driving shape changes. Our assay paves the way for a quantification of tension changes triggered by various actin-associated proteins in a cell-sized system.

F-actin mechanics control spindle centring in the mouse zygote
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Résumé

Mitotic spindle position relies on interactions between astral microtubules nucleated by centrosomes and a rigid cortex. Some cells, such as mouse oocytes, do not possess centrosomes and astral microtubules. These cells rely only on actin and on a soft cortex to position their spindle off-centre and undergo asymmetric divisions. While the first mouse embryonic division also occurs in the absence of centrosomes, it is symmetric and not much is known on how the spindle is positioned at the exact cell centre. Using interdisciplinary approaches, we demonstrate that zygotic spindle positioning follows a three-step process: (1) coarse centring of pronuclei relying on the dynamics of an F-actin/Myosin-Vb meshwork; (2) fine centring of the metaphase plate depending on a high cortical tension; (3) passive maintenance at the cell centre. Altogether, we show that F-actin-dependent mechanics operate the switch between asymmetric to symmetric division required at the oocyte to embryo transition.