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Membrane tension regulates clathrin-coated pit dynamics

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Intracellular organization depends on close communication between the extracellular environment and a network of cytoskeleton filaments. The interactions between cytoskeletal filaments and the plasma membrane lead to changes in membrane tension that in turns help regulate biological processes. Endocytosis is thought to be stimulated by low membrane tension and the removal of membrane increases membrane tension. While it is appreciated that the opposing effects of exocytosis and endocytosis have on keeping plasma membrane tension to a set point, it is not clear how membrane tension affects the dynamics of clathrin-coated pits (CCPs), the individual functional units of clathrin-mediated endocytosis. Furthermore, although it was recently shown that actin dynamics counteracts membrane tension during CCP formation, it is not clear what roles plasma membrane tension plays during CCP initiation. Based on the notion that plasma membrane tension is increased when the membrane area increases during cell spreading, we designed micro-patterned surfaces of different sizes to control the cell spreading sizes. Total internal reflection fluorescence microscopy of living cells and high content image analysis were used to quantify the dynamics of CCPs. We found that there is an increased proportion of CCPs with short ($<$20s) lifetime for cells on larger patterns. Interestingly, cells on larger patterns have higher CCP initiation density, an effect unexpected based on the conventional view of decreasing endocytosis with increasing membrane tension. Furthermore, by analyzing the intensity profiles of CCPs that were longer-lived, we found CCP intensity decreases with increasing cell size, indicating that the CCPs are smaller with increasing membrane tension. Finally, disruption of actin dynamics significantly increased the number of short-lived CCPs, but also decreased CCP initiation rate. Together, our study reveals new mechanistic insights into how plasma membrane tension regulates the dynamics of CCPs.