Mitotic chromosomes acquire mechanical independence through assembly of a non-adhesive surface

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Abstract

The faithful transmission of genetic information during mitosis requires extensive chromosome reorganization. Upon mitotic entry chromosomes are transiently reorganized from a single mass of chromatin into compacted, spatially separate bodies, which move individually along the mitotic spindle. During mitotic exit, each set of segregated sister chromatids merges to form one nucleus in each of the emerging daughter cells. How the morphological reorganization of mitotic chromosomes relates to biophysical changes enabling independent motility is poorly understood. We identified a cell-cycle dependent regulation of chromosome surface adhesion. We show that adhesion between chromosomes is low during mitosis, but increases during mitotic exit to cluster chromosomes prior to nuclear envelope reformation. By an image-based RNAi screen, we identified Ki-67, a prominent cancer prognostic marker, as a chromosome surface adhesion regulator. 3D-confocal time-lapse microscopy revealed that Ki-67 is required to keep mitotic chromosomes spatially separated after nuclear envelope breakdown, which is important for timely mitotic progression. In conclusion, our study elucidates how biophysical changes at the chromosome surface establishes mitotic chromosomes as independent mechanical bodies.