Mechanical deformation induced modulation of biochemical functions of microtubules

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【Introduction】 Microtubule (MT), the most rigid component of cytoskeleton, plays important roles in many cellular processes such as cell shape regulation, cell division, intracellular transportation, etc.[1] The mechanical properties of MTs, which are inevitably important for maintaining MT's functions in cells, have widely been studied in order to understand the involvement of MTs in the cellular events. Recently MTs have been drawing much attention for their responsiveness to mechanical stress. It is suspected that mechanical stress modulates the biochemical functions of MTs although any solid evidence is lacking yet. In this work we systemetically investigate the mechanoresponsiveness of MTs and functionality of the mechanically deformed MTs in an *in vitro* condition. We found that despite their superior mechanical integrity, MTs undergo mechanical deformation when subjected to mechanical stress.[2] The mechanical deformation of MTs is found to significantly modulate their biochemical functions. This work may offers a new insight in the mechanoregulation of cellular activities related to the cytoskeletal component.

【Results and Discussion】 To investigate the mechano-responsiveness of MTs in an *in vitro* condition we recently developed an experimental set up named mechanical chamber. By using this device we investigated the effect of tensile and compression stress on the MTs. Under compression or tensile stress MTs underwent buckling and fragmentation respectively. Next we addressed how the response of MTs to mechanical stress consequently enables the MTs to modulate their functions for which we focused on the motor protein based transportation along MTs, which is one of the important physiological functions of MTs. By monitoring kinesin driven transportation of Quantum dot (Q-dot) as cargo along buckled MTs (Figure 1) we unveil the effect of compression stress on the dynamics of transportation by a motor protein. The cargo transportation was hindered due to the MT buckling which was found tightly correlated to the extent of MT deformation. More importantly, the affinity between kinesins and MTs was found to increase due to the buckling of the MTs, which clearly figures out how the responsiveness of MTs to mechanical stress allows them to work as mechanosensors. This work would help understand the role of MTs as mechanosensor in regulating the cellular mechanotransduction process.

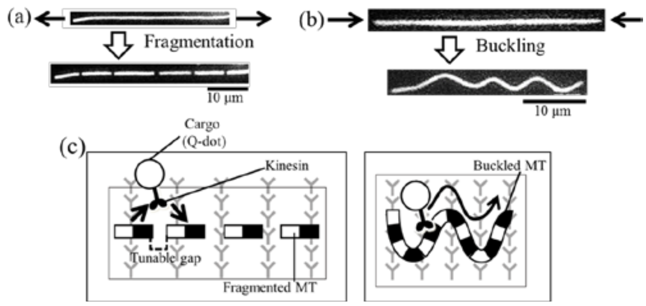

Figure 1: Mechanical deformation of microtubules under tensile (a), and compression stress (b). Schematic illustration showing experimental design for investigating the motor protein driven cargo transportation along mechanically deformed MTs.

【References】

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