Mechanotransduction of axonal growth: a journey from microtubules to local phenomena

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The effect of mechanical forces on axonal growth has been sparking great interest in the scientific community. The impact of mechanical tension on axonal outgrowth is now quite well known [1] while little or nothing is known about the molecular mechanisms evoked. To answer this biological question, we have recently developed a method for stretching axons based on magnetic nanoparticle (MNP) labeling and the application of forces via an external magnetic field [2-3]. We found that the MNP-mediated forces promoted the extension of axons, as well as sprouting and maturation. The elongation was a real mass addition as we observed an accumulation of endoplasmic reticulum cisternae and non-reduction of caliber in stretched axons. As further evidence, there was the block of the elongation by the treatment with an inhibitor of protein synthesis. We have also seen that the stretching stimulated microtubule (MT) polymerization and modulation of intracellular calcium levels [3]. We have observed an alteration of axonal transport in stretched axons, as well as an involvement of local translation. Considering that many structures involved in local translation are transported at the axonal level, we hypothesize that tension stimulates the creation of a cross-talk between local phenomena, where MTs, formerly known as tension sensors [4], could play a key role.

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