# Drag force as a tool to test the active mechanical response of PC12 neurites.

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## Abstract

**We investigate the mechanical response of PC12 neurites subjected to a drag force imposed by a controlled laminar flow perpendicular to the neurite axis. The curvature of the catenary shape acquired by an initially straight neurite under the action of this force provides information on both elongation and tension. The sensitivity of this method allows us to assess viscoelastic and active response of neurites when serum concentration is decreased or cytoskeleton drugs are added. Furthermore, measurements of oscillations in the strain rate of neurites at constant flow rate provides insight on the response of the molecular motors and additional support for the presence of a negative strain rate sensitivity region in the global mechanical response of the PC12 neurite as a model of the mechanical behavior of axons.**

## Neurite equilibrium under drag forces

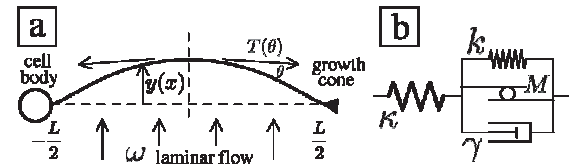



Figure 1: (a) Schematic view of the experiment
(b) Mechanical representation of a neurite.

The mechanical equilibrium is given by the equations:

$$d(T(\theta)cos(\theta)) = 0$$
$$d(T(\theta)sin(\theta)) = \omega ds$$

The neurite shape with fixed ends at x=±L/2, is then described by a catenary curve y(x) and its tension T(x).

$$y(x) = \frac{T}{\omega}\cosh\left(\frac{\omega}{T}x\right) - \frac{T}{\omega}\cosh\left(\frac{\omega L}{2T}\right)$$
$$T(x) = T\cosh\left(\frac{\omega}{T}x\right)$$

## Experimental Setup

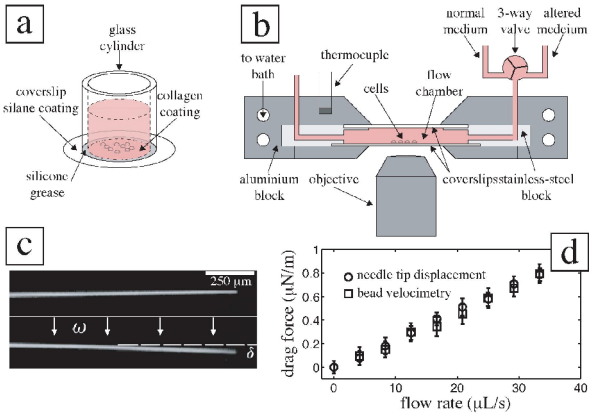
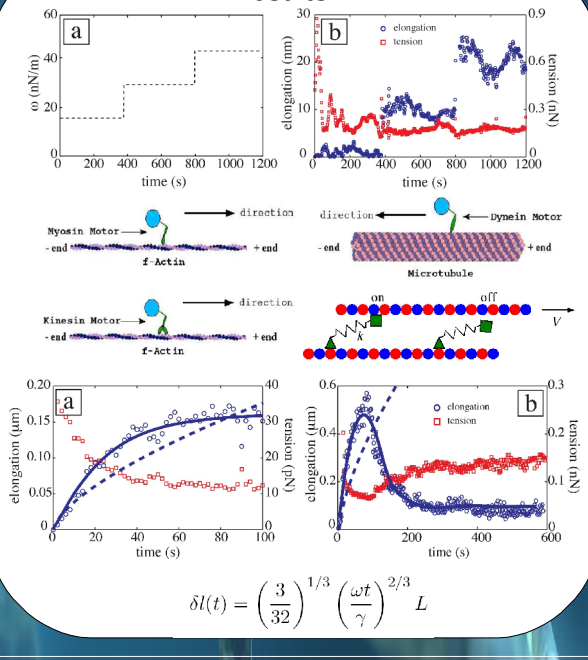
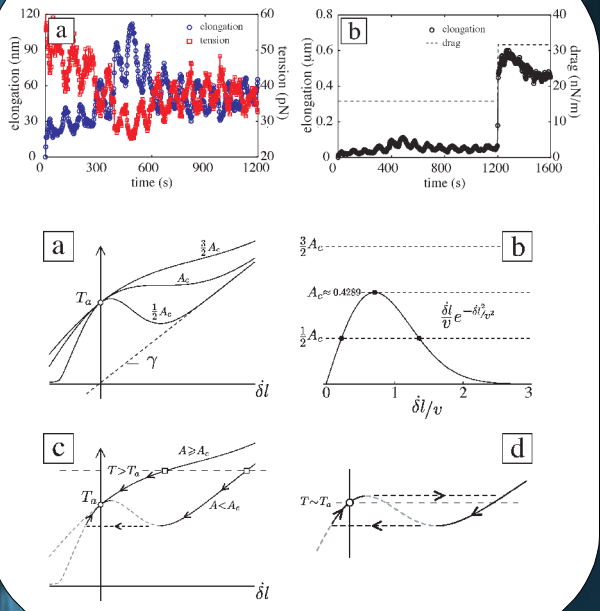



Figure 2: (a) Description of the experimental setup.
(b) Preparation of PC12 cell culture.
(c) Needle under the effect of viscous drag (L=3mm, r=16µm).
(d) Calibration of the viscous drag using beads velocimetry and microneedle tip displacement.

## Results




$$\delta l(t) = \left(\frac{3}{32}\right)^{1/3}\left(\frac{\omega t}{\gamma}\right)^{2/3} L$$

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