Effects of single-walled carbon nanotubes on primary mixed neuro-glial cultures from chicken spinal cord and dorsal root ganglia


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Introduction

The unique physical and chemical properties of carbon nanotubes (CNTs) suggest enormous potential for many areas of research and application. The increasing use of CNTs in consumer products and medical applications lays emphasis on the importance of understanding their potential toxic effects on human health and the environment. Even though it has been demonstrated that nanosized carbon particles can be taken up by olfactory neurons and are translocated to the brain, thus making neurotoxicity of CNTs an important issue, there is still only limited knowledge about possible neurotoxic effects of CNTs.

In this study we analyzed the effects of single-walled CNTs (SWCNTs) with different degrees of agglomeration on primary mixed neuro-glial cultures as well as on glia-enriched cultures. The cells were isolated from embryonic chicken ventral spinal cord (SPC) or dorsal root ganglia (DRG). This allowed us to differentiate between effects on cells derived from a central (CNS) or peripheral nervous system (PNS) tissue, respectively. Electrophysiological properties of neurons from both areas of the nervous system were assessed by whole-cell patch-clamp recordings.

Materials

Primary cell culture:
Mixed neuro-glial cultures from ventral SPC and DRG were grown on Poly-D-Lysin/Laminin coated coverslips or Dic cover slips in modified minimal essential medium (MMEM).

Electrophysiological properties .
Current density (pA/pF)
Inward directed currents
Outward directed currents

Conclusions & Outlook

1. SWCNTs significantly reduce the total DNA content of mixed neuro-glial cultures; this effect is independent of cell origin but more pronounced with increasing agglomeration of SWCNTs.

2. While SWCNTs primarily target glial cells in DRG as well as spinal cord derived cultures, only DRG derived MAPs positive neurons are affected by SWCNT-b.

3. SWCNTs do not influence the neurite outgrowth of spinal cord derived neurons.

4. In accordance with (2.) and (3.) electrophysiological analysis reveal no influence of SWCNTs on SPC derived neurons, but a change in the resting membrane potential and the tonic conductance of DRG neurons.

In summary, our findings suggest that SWCNTs can have acute adverse effects on glial cells and - depending on the tissue type they originate from - also on neuronal cells, even though we cannot rule out that neurons might be affected secondarily.

These results necessitate further investigations to address the detailed mechanisms of nanoparticle induced toxicity in glial cells and neurons.

References:
Wick et al., 2007, Toxicol Lett. 168 (2): 121-31
Osterwalder et al., 2008, Biomaterials, submitted

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