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Profound alterations in brain tissue linked to hypoxic episode after device implantation

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Abstract:

To enable authentic interfacing with neuronal structures in the brain, preventing alterations of tissue during implantation of devices is critical. By transiently implanting oxygen microsensors into rat cortex cerebri for 2 h, substantial and long lasting (>1 h) hypoxia is routinely generated in surrounding tissues; this hypoxia is linked to implantation generated compressive forces. Preferential loss of larger neurons and reduced metabolic components in surviving neurons indicates decreased viability one week after such hypoxic, compressive implantations. By devising an implantation method that relaxes compressive forces; magnitude and duration of hypoxia generated following such an implantation are ameliorated and neurons appear similar to naïve tissues. In line with these observations, astrocyte proliferation was significantly more pronounced for more hypoxic, compressive implantations. Surprisingly, astrocyte processes were frequently found to traverse cellular boundaries into nearby neuronal nuclei, indicating injury induction of a previously not described astrocyte-neuron interaction. Found more frequently in less hypoxic, force-relaxed insertions and thus correlating to a more beneficial outcome, this finding may suggest a novel protective mechanism. In conclusion, substantial and long lasting insertion induced hypoxia around brain implants, a previously overlooked factor, is linked to significant adverse alterations in nervous tissue.

Keywords: Implantation generated hypoxia, neural implant, insertion forces, neuronal viability and loss, neuron-astrocyte interactions