Conformal Multielectrode Arrays (MEAs) for Recording and Stimulating in Deep Structures of Nonhuman Primates

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Modeling and development of neural prosthetics requires the ability to record many neurons from defined spatial locations within the brain region on interest. In the hippocampus, for example, recording sites must be placed in CA3 and CA1 cell layers [1], and must also follow (conform) to the longitudinal contours of the anterior hippocampus. Hence model development requires conformal multielectrode arrays (MEAs) in order to provide the "spatial" aspects of spatiotemporal modeling [2-3]. While such MEAs are easily constructed from fine wires (17-25 µm dia.) when structures are only 3-4 mm deep, as in rodent brain [4], the same structure in a nonhuman primate (NHP) is more than 30 mm from top of brain [5] resulting in distortion of fine wire arrays or completely missing the target neurons.

One solution for deep-brain MEAs is use of ceramic electrodes with photolithographically-applied conformal recording sites. Ceramic MEAs have been successfully used to record within and between cortical minicolumns in prefrontal cortex (PFC) [6] as well as to demonstrate functionality of patterned microstimulation to alter behavioral performance via a nonlinear multi-input, multi-output (MIMO) model of PFC neural information processing [7]. However, even these MEAs, at 125 µm x 250-500 µm in cross-section, may displace too much tissue to allow for placement of multiple-stem MEAs for three-dimensional placement of recording and stimulation sites in deep brain structures such as hippocampus. Thus, new conformal MEAs are being designed and will be demonstrated to reduce tissue displacement while still allowing sufficient rigidity to target cell layers deep in primate brain. Effectiveness of these MEAs will be compared with alternative designs such as twisted-wire tetrodes and MEAs based on printed polymer sheets.

References

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