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After spinal injury, one useful indicator of recovery is the frequency, shape and intersegmental distribution of spontaneous and evoked cord dorsum potentials (CDPs). These potentials are altered after acute injury and recover partially over time. A highly-flexible and thin, polyimide-substrate, 32-channel array has been developed that allows recording from a small area (3 mm x 6 mm) on the surface of the spinal cord. We demonstrate its use in preliminary experiments in the anesthetized cat. We recorded both spontaneous and sural nerve evoked CDPs using two of these arrays, and measured the changes produced after cutting other previously intact muscle and cutaneous nerves, after partial spinal lesions including the left and/or right dorsolateral fasciculi, and after the i.v. administration of 4-aminopyridine (4-AP), a potassium channel blocker that facilitates synaptic transmission. The flexible two-dimensional arrays allowed tracking of the spatial spread of CDPs rather locally. Inter-channel correlations of spontaneous and evoked activity dropped 50% at an average distance of 2-5 mm, thus demonstrating local fluctuations of neuronal activity within each level of the spinal cord. We also recorded from six Ag ball electrodes placed on the cord dorsum at each segment from L3 to S1 for comparison. Algorithms were developed to segment and classify these spatiotemporal patterns of activity which were then compared between experimental conditions. Evoked responses produced a spread of activity (1-2 segments), the leading edge of which was detected by the flat array. Spontaneous CDPs were detected at various regions within the flat array suggesting activation of diverse sets of neuronal aggregates. 4-AP increased the amplitude and rate of spontaneous CDPs that were highly synchronized and differed from the spontaneous and evoked potentials, likely activating separate pathways. We also measured changes in correlation between the various channels before and after nerve and spinal lesions. Due to the spatial resolution of the array, we were able to measure the lateral and longitudinal spread of activity around the spinal lesion site. These preliminary experiments demonstrate that flexible 2-D arrays can be used to record spontaneous and evoked neuronal ensemble activity from the cord dorsum with high spatial selectivity without damaging spinal cord tissue. These features make the flexible 2-D electrode array a potential candidate for testing functional segmental properties in humans after spinal injury.

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