High-density scalp somatosensory evoked potentials as follow-up of functional recovery from motor cortex lesion in macaque monkeys

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EEG and evoked potentials are known to have a great temporal resolution and high-density scalp recordings contribute to improve the normally poor spatial resolution of these techniques. Here we present a method for long-term investigation of the brain activity in anaesthetized macaque monkeys (*Macaca fascicularis*) using somatosensory evoked potentials (SSEPs) recorded at the whole scalp with a high-density EEG cap, allowing repeated assessment of the cortical activity in the context of a central nervous system lesion. It is expected that SSEPs will allow assessing post-lesion cortical reorganisation of neuronal networks and relate it to functional recovery, following a motor cortex lesion.

Experiments were conducted on four adult macaque monkeys, using a customised EEG cap containing 33 electrodes regularly distributed over the scalp while the animal was anaesthetised (sevoflurane). Electrical stimulations were delivered separately either to the median nerve or to the tibial nerve, successively on each side.
When the animals reached a behavioural plateau in manual dexterity tests, they were subjected to a cortical lesion, performed unilaterally in the hand representation of the primary motor cortex (M1), requiring a craniotomy. Consequently, to distinguish the possible modulations generated by the craniotomy from the consequences of the lesion itself on SSEP responses, a “sham lesion” consisting in the craniotomy alone was first performed, with the bone flap put back in place.
Data analysis was performed using the Cartool software. SSEP voltage maps were identified by cluster analysis (K-Means clustering) and fitted back to the individual data. The LAURA (Local Autoregressive Average) inverse solution algorithm with LSMAC (Locally Spherical Model with Anatomical Constraints) head model was applied to estimate the intracortical sources of the scalp potentials.

We show that pre-lesional SSEPs obtained after median or tibial nerve electrical stimulation in macaque monkeys are characterised by a progression of quasi-stable brain component maps. They are in accordance with the somatotopical organisation of the sensorimotor cortex. Moreover, SSEP recordings appear to be stable over multiple recording sessions in the same animal and across different animals. Furthermore we demonstrate that a unilateral craniotomy of 300 mm^2 over the sensorimotor cortex followed by bone flap repositioning, suture and gap plugging with calcium phosphate cement, did not induce major artefacts in our signals.

To sum up, the present data show that SSEPs can be successfully and reproducibly recorded from a high-density EEG cap in macaque monkeys. This method opens new possibilities for the long-term follow-up of cortical reorganisation in macaque monkeys after a cortical lesion. The next step is to perform a permanent unilateral lesion of the hand representation of the motor cortex.

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