# Characterization of early somatosensory evoked potentials (SEPs) to electrical stimulation of the median nerve in adult macaque monkeys: intact and spinal cord lesioned animals.

S. Bashir[1], M.-L. Beaud[1], P. Freund[1], M. Kaeser[1], A. Wyss[1], A. Belhaj-Saif[1], J. Bloch[3], D. Debatisse[3], A. Mir[4], E. Pralong[3], E.M. Rouiller[1], M.E. Schwab[2] and T. Wannier[1,2]

(1) Dept. Med., Univ. Fribourg, 1700 Fribourg, (2) Dept. Neuromorphol., Univ. Zurich, 8057 Zurich, (3) Dept. Neurosurg., Univ. Lausanne, 1011 Lausanne, (4) Inst. Biomed. Res., Novartis, 4002 Basel

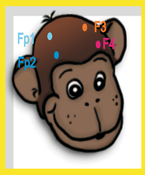
## Introduction

In adult macaques subjected to unilateral cervical spinal cord lesion, neutralizing the neurite growth inhibitor Nogo-A with a specific antibody leads to corticospinal fibers sprouting and behavioural improvements. The effects of this treatment on ascending system is unknown. The present study aimed to establish whether SEPs to median nerve stimulation can provide indices regarding the time course of recovery and the participation of ascending systems.

## Material and methods

Animals: six adult macaque monkeys
Stimulation sites: median nerve at the wrist or posterior tibial nerve
Reference: extracephalic (wrist)
Stimulation: 0.2ms, 0.6mA, 5Hz
Lesion: unilateral partial section, C7/C8 border
Anaesthesia: ketamine/medetomidine

Position of the 4 cortical electrodes =>




## Conclusions

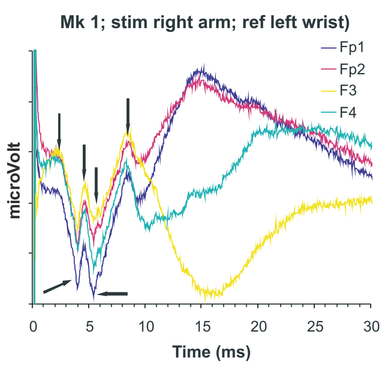
1) Three early components reflecting the passage of volleys at spinal and brainstem levels are detectable. They are followed by waves of cortical origin with larger amplitude.
2) The latency and amplitude of the early components are moderately influenced by the level of anaesthesia.
3) After a spinal lesion, two components of the early potentials exhibited a reduced amplitude.

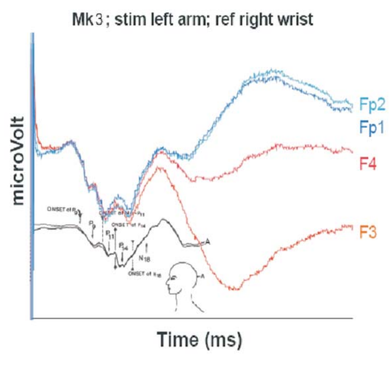
SEPs can thus be used to investigate mechanisms of recovery after a spinal cord lesion

## Results

### Results from intact monkeys

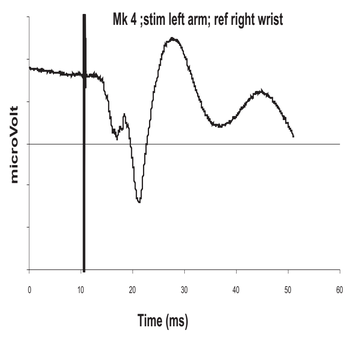
#### *Characteristics of the SEPs to median nerve stimulation (scalp electrodes)*

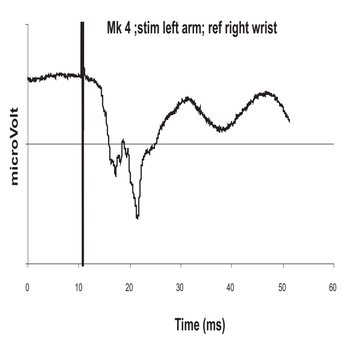



SEPs observed with cranial electrodes using a non-cephalic reference. A first modulation was observed 3 ms after the stimulation, followed by three early peaks at 3.8, 4.8 and 6.2 ms latency. Because these early peaks do not depend on the position of the electrodes on the skull and because of their short latency, they reflect activity of non cortical sources. These peaks appear comparable to the P9, P11 and P14 waves in human, which respectively reflect the arrival of the volleys in the brachial plexus, the transmission inside the spinal cord and then at the level of the medial lemniscus. The shape of the later components (>8ms) depend on the position of the recording electrode on the skalp. These components reflect activity at cortical levels.
Inset: For comparison, response to median nerve stimulation in human after Desmedt (1987)

#### *Characteristics of the SEPs to median nerve stimulation (cortex surface electrodes)*

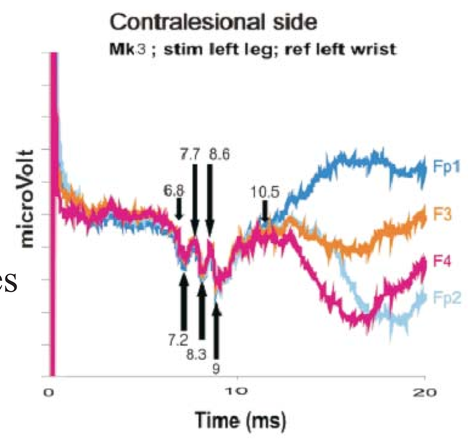



SEPs obtained with two electrodes placed on the cortex surface (in contact to the dura) in an intact monkey. Note that the SEP wave form and latencies correspond to those observed with electrodes placed on the skull.

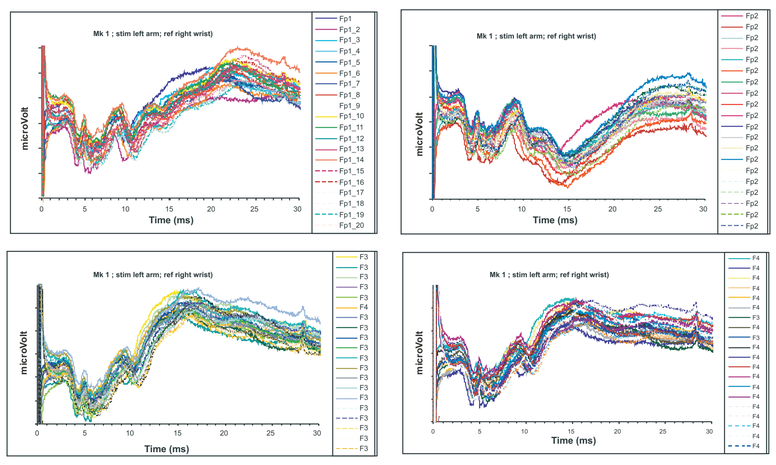
#### *Characteristics of the SEPs to tibial nerve stimulation*

SEPs following tibial nerve stimulation for 4 cortical electrodes

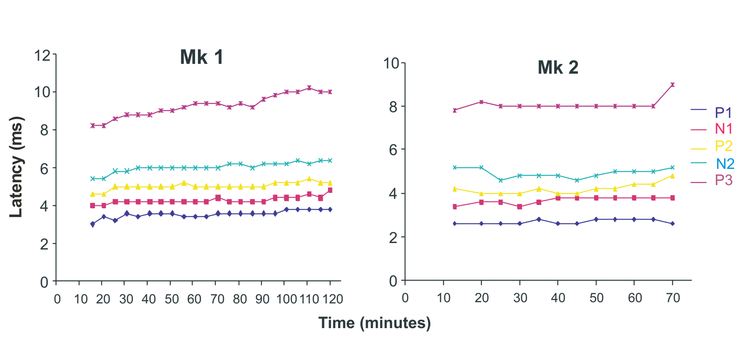



Note that the similitude of the shape with that observed to median nerve stimulation, and the longer latencies.

#### *The level of anaesthesia influences the late SEP components, but has a moderate effect on early components*




Each panel shows the SEPs obtained with one recording electrode after stimulation of the median nerve at different time points following the injection of the anesthetics.
Note that the wave form of the SEPs remain globally stable with amplitude and latency variability mostly for late components.




Latency of five SEPs components as a function of the time after the injection of the anaesthetics. Note the limited variability of the earliest components.

### Results from lesioned monkeys

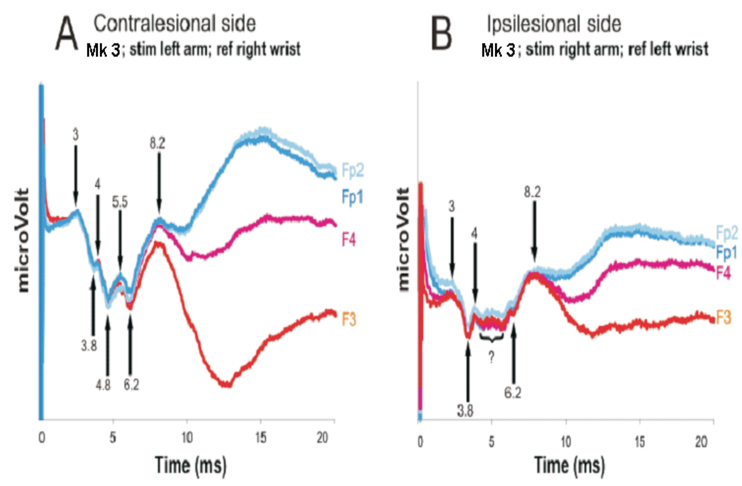
#### *MRI of the fixed spinal cord and histological reconstruction of the lesion*


Histological MRI MRI & histological

Note that the lesion sectioned part of the cuneate fasciculus, but left the gracialis fasciculus intact.

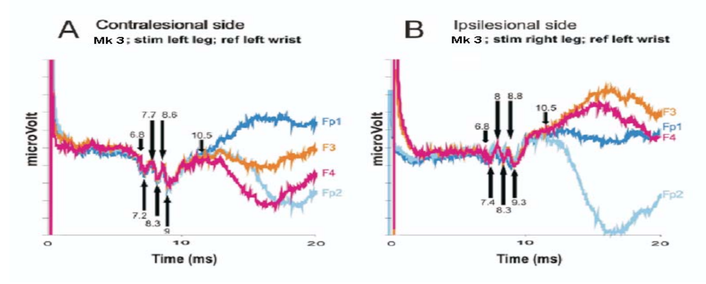
#### *Effects of the cervical spinal cord lesion: median nerve stimulation*

*Intact vs. lesioned side*




SEPs components obtained following the stimulation of the median nerve of both sides of the body on a monkey subjected to a cervical cord lesion. Note the absence of peaks on the ipsilesional side for P4.8, P5.2. These peaks reflect the transmission of the EP response at spinal and brainstem levels.

#### *Effects of the cervical spinal cord lesion: tibial nerve stimulation*




SEPs components obtained following the stimulation of the tibial nerve on both sides of the body of a monkey subjected to a cervical cord lesion. Note the presence of the same components on both sides.

*Supported by NCCR-Neuro and SNF 3100-110005 (EMR) 3100A0-104061(TW)*