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SpineRepair RTD 2013

FNSNF

Spinal neural interface and neuromodulation strategies to achieve precise control of leg movements in rats and primates

Jérôme Gandar[1], Marco Capogrosso[2], Nikolaus Wenger[1], Frédéric Michoud[3], Andrea Mortera[2], Natalia Pavelova[1], Stéphanie Lacour[3], Silvestro Micera[2] and Grégoire Courtine[1]

1. Chair in spinal cord repair, Center for Neuroprosthetics, School of Life Sciences, Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland.
2. Translational Neural Engineering Lab, Center for Neuroprosthetics, School of Bioengineering, Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland.
3. Laboratory for soft bioelectric interfaces, Center for Neuroprosthetics, School of Bioengineering, Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland.

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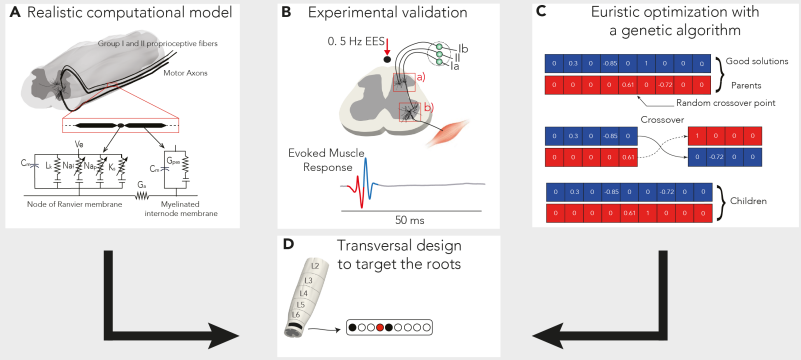
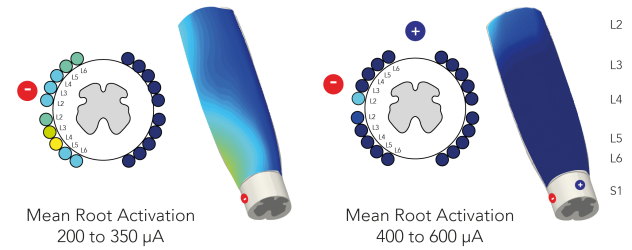
- Mechanisms underlying site-specific facilitation of movement are poorly understood. Consequently, there is limited information available on the optimal strategy for the design and use of modern interfaces like Multi-Electrode Arrays.
- We developed a realistic computational model of the rat lumbosacral spinal cord [1].
- We identified the spinal roots as the main target of Epidural Electrical Stimulation (EES).
- We used computerized simulations to find optimal stimulation strategies.
- Innovative multipolar stimulation protocols enhance the specificity of Epidural Spinal Cord Stimulation.
- Results are translatable to non human primates.
- A new generation of spinal interfaces is proposed on the basis of the results on rodents and non human primates.

A realistic computational model validated experimentaly and an optimization algorithm lead to transversal multipolar strategies



Acute experimental results of multipolar neuromodulation on spinal sacral segments in rodents

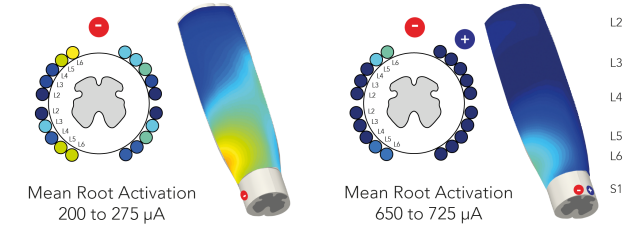
Flexion: Stimulating the L2 from the S1 Level



Mean Root Activation 200 to 350 µA

Mean Root Activation 400 to 600 µA

Extention: stimulation of lower segments

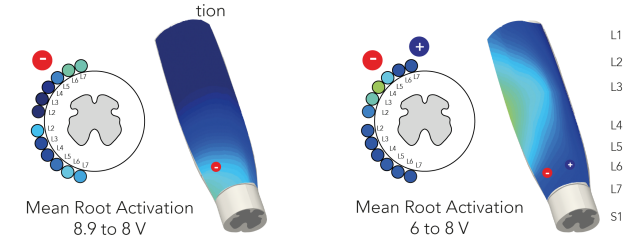


Mean Root Activation 200 to 275 µA

Mean Root Activation 650 to 725 µA

A similar organization of the spinal roots in primates ensures the translatability

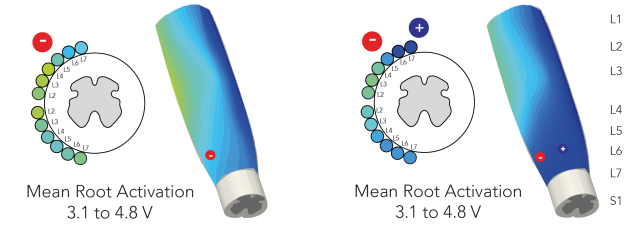
Monkey Q4 Monopolar vs Bipolar Epidural Stimulation



Mean Root Activation 8.9 to 8 V

Mean Root Activation 6 to 8 V

Monkey Q21 Monopolar vs Bipolar Epidural Stimulation

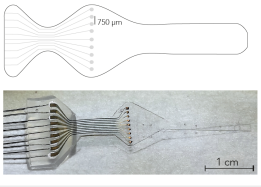


Mean Root Activation 3.1 to 4.8 V

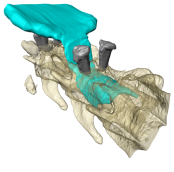
Mean Root Activation 3.1 to 4.8 V

An innovative design for chronic spinal electrode array

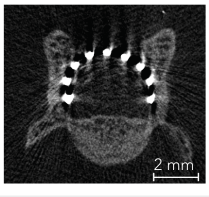
Layout of PDMS-based implant [2]



µCT view



Transversal view



We proved in acute experiments in rodents and non human primates, that model-driven multipolar stimulation protocols can enhance spinal cord stimulation specificity.

We then developed a new concept of epidural array for locomotion with a transversal design to target specific roots at the lower lumbar or sacral levels.

Finaly, we implanted chronically in rats more than 2 months.

[1] Capogrosso M., et al. (2013) A computational model for epidural electrical stimulation of spinal sensorimotor circuits, The Journal of Neuroscience, in press.
[2] I.R. Minev, et al. (2015) Electronic dura mater for long-term multimodal neural implant. Science, vol347, num 6218 p. 159-163, 2015

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