Endovascular electrostimulation of rat muscles

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Abstract

Functional electrical stimulation of skeletal muscle is performed by surface electrodes, transcutaneous needle electrodes or implanted electrodes. From several months after injury, denervated muscle can only be electrostimulated by large surface electrodes or implanted electrodes. We are exploring the hypothesis that customized endovascular electrodes either via veins may be inserted in the denervated muscle up to the capillary network. In spite of the success of the endocardial electrostimulation for cardiac pacing, risks of this approach are related to the: i) lower excitability of the denervated muscle in comparison to innervated tissue or myocardium; and ii) traumatic muscle damage by the electrodes, when inducing muscle shortening. Some of these risks ask for new materials and technologies and therefore new concepts and methods. On the other hand, we will show that, standing on sound biological bases, preliminary acute studies in a rat model demonstrate the feasibility of the concept. The plasticity of the muscle tissue and of its vascular network grant further testing and development.

Key Words: denervation, electrical stimulation, endovascular electrodes, rat muscle.
Basic Appl Myol 16 (3&4): 124-126, 2006

Functional electrical stimulation of skeletal muscle is performed by surface electrodes, transcutaneous needle electrodes or implanted electrodes. From several months after injury, denervated muscle (Fig. 1) can only be electrostimulated by large surface electrodes [1, 2], or implanted perimisial electrodes [3].
We are exploring the hypothesis that customized endovascular electrodes may be inserted in the denervated muscle up to the capillary network.

Figure 1. *Gross anatomy effects of long term denervation on adult rat muscle.*

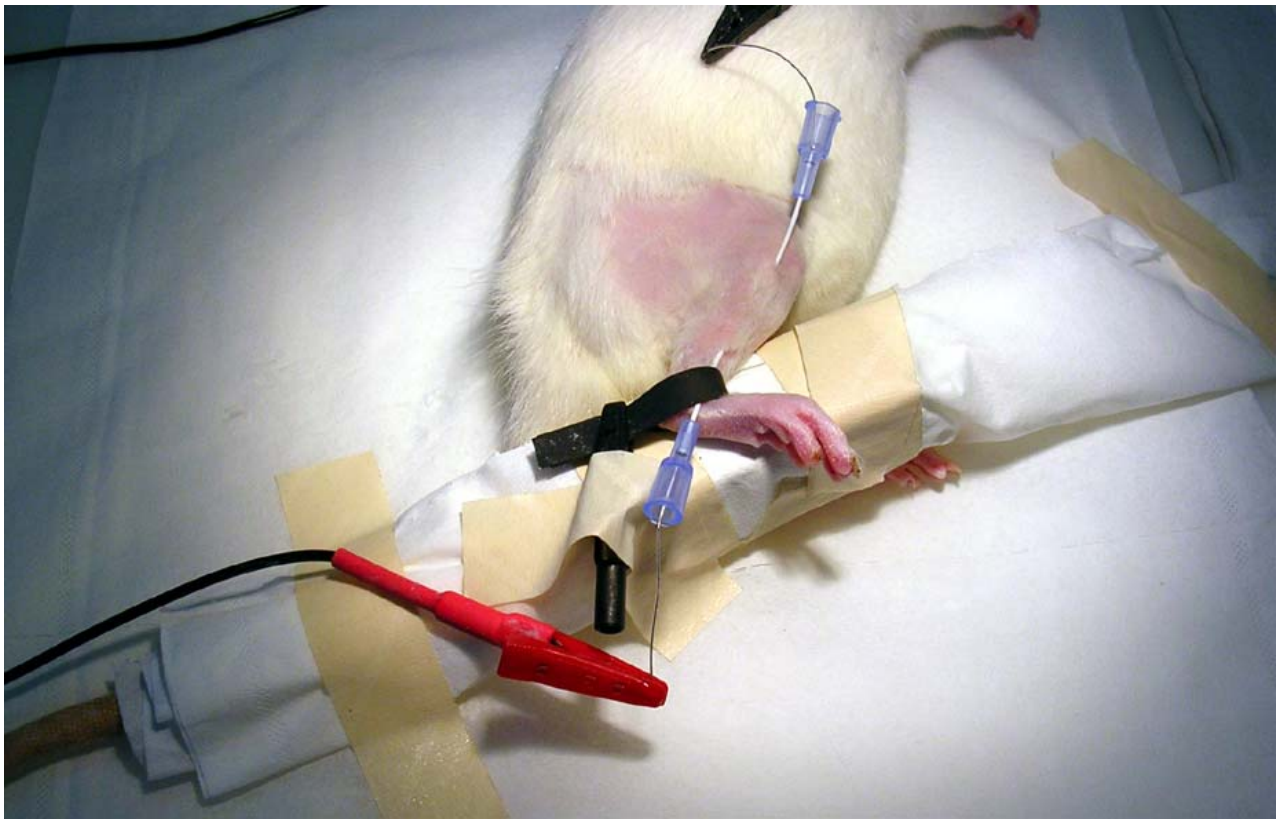

Figure 2. *Electrodes inserted in the Tibialis Anterior.*
Please, link to: *Bam-on-Line Addenda*. Movies: http://bio.unipd.it/bam/DSCN0201.MOV
http://bio.unipd.it/bam/DSCN0207.MOV
http://bio.unipd.it/bam/DSCN0375.MOV

In spite of the success of the endocardial electrostimulation for cardiac pacing, risks of this approach are related to the: i) lower excitability of the denervated muscle in comparison to innervated tissue or myocardium; and ii) traumatic muscle damage related to muscle shortening. Some of these risks ask for new materials and technologies (possibly related to nanotechnology approaches) and therefore of very new ideas and methods. On the other hand, we will show that besides standing on sound biological bases, preliminary acute studies in a rat model demonstrate the feasibility of the new concept, at least in the easier case of innervated muscles (Figure 2, and links in *Bam-on-Line Addenda*).
Plasticity of muscle tissue and of its vascular network are a sound basis to further test the concept.

Acknowledgements

This research was undertaken with the financial support of Italian Ministry of Education (MURST) under the framework of PRIN Projects (PRIN 2004 to G. Vita), and with the financial support of ex60% MURST funds to Prof. Ugo Carraro.

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