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Ronald R Riso, Adv Robot Autom, 6:3 (Suppl)
DOI: 10.4172/2168-9695-C1-011

4th World Congress on

Robotics and Artificial Intelligence

October 23-24, 2017 Osaka, Japan

The promise of direct neural control of powered prosthetic limbs via peripheral nerve interfacing: Techniques, successes and current issues

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The full potential of advanced anthropomorphic powered prostheses depends on the effectiveness of the user control system. With a peripheral nerve based controller, the user commands the actuators of the prosthesis in the same manner that motor nerves in an intact limb elicit muscle activity. Ideally, each actuator is controlled by the specific motor nerve that performs the same joint movement in an intact limb. The simultaneous movements of multiple joints to complete complex limb motions is then able to be coordinated by the user's brain, as aptly demonstrated by amputees treated with targeted muscle re-innervation (TMR). Despite the increases in prosthesis performance with TMR, several drawbacks exist such as the need for pattern recognition to correct for signal crosstalk when a host muscle becomes re-innervated by a mix of motor nerves that originally sub-served different joint motions. Moreover, researchers still struggle with how to provide tactile and proprioceptive sensibilities from artificial limbs. Microchannel nerve interfaces are being developed in diverse laboratories, to mitigate these issues and to expand the clinical applicability of naturally controlled prostheses. Microchannel rational and development: Microchannel nerve interfaces are based on the ability of severed peripheral nerves to regenerate and sort themselves into individually addressable channels that contain electrodes for recording and/or stimulation. Thus, efferent motor nerve activity can be recorded for prosthesis commands and sensory nerve fibers can be electrically stimulated to input tactile sensations and information regarding joint motion and position. Developmental studies of micro-channel nerve interface technology substantially concern discovering ways to control the sorting of different nerve fiber modalities into specific channels of the array. This presentation describes strategies used to fabricate microchannel devices, clinical applications and the present status of their deployment in animal studies. Key design factors are discussed such as channel cross sectional area and length, physical topography of channel walls, presence of appropriate extracellular matrix proteins, inclusion of nerve outgrowth scaffold materials, inclusion of specific neuro-trophic molecules and the importance of providing target tissues.

Recent Publications

1.Maimon B, Zorzos A, Song K, Bendell R, Riso R and Herr H (2016) Evaluation of a New Regenerative Microchannel. *Electrode Int J Phys Med Rehabil;* 4: 332-40.

Biography

Ronald R Riso has his research activities centered on developing implantable neural interface technology for controlling powered artificial limbs and techniques to provide tactile and position sensibilities from prostheses. Previously, he was Senior Research Scientist with Inner Sea Technology Inc., a research company for developing neuro-prostheses.

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