**Translational Regenerative Therapies for Chronic Spinal Cord Injury**

Created by: Alexander Seifalian

Kyriakos Dalamagkas¹,²*, Magdalini Tsintou²,³*, Amelia Seifalian⁴, Alexander M Seifalian⁵

¹The Institute for Rehabilitation and Research, Memorial Hermann Texas Medical Centre, Houston, TX, U.S.A.

²Centre for Nanotechnology & Regenerative Medicine, Division of Surgery and Interventional Science, University College of London (UCL), London, U.K.

³Center for Neural Systems Investigations, Massachusetts General Hospital /HST Athinoula A. Martinos Centre for Biomedical Imaging, Harvard Medical School, Boston, MA, U.S.A.

⁴UCL Medical School, Faculty of Medical Sciences, London, U.K.


Spinal cord injury is a chronic and debilitating neurological condition that is currently being managed symptomatically with no real therapeutic strategies available. Even though there is no consensus on the best time to start interventions, the chronic phase is definitely the most stable target in order to determine whether a therapy can effectively restore neurological function. The advancements of nanoscience and stem cells technology, combined with the powerful, novel neuroimaging modalities that have arisen can now accelerate the path of promising novel therapeutic strategies from bench to bedside. Several types of stem cells have reached up to clinical trials phase II, including adult neural stem cells, human spinal cord stem cells, olfactory ensheathing cells, autologous Schwann cells, umbilical cord blood-derived mononuclear cells, adult mesenchymal cells and autologous bone-marrow-derived stem cells. There also have been combinations of different molecular therapies; these have been either alone or combined with supportive scaffolds with nanostructures to facilitate favorable cell-material interactions. The results already show promise but it will take some coordinated actions in order to develop a proper step-by-step approach to solve impactful problems with neural repair.

It is evident that more promising therapies will come up in the future regarding chronic SCI. We anticipate that the management of chronic SCI will change during the next few decades due to the fast pace of advances in the field of nanotechnology/smart materials and regenerative medicine. A combinatorial approach using cells and/or growth factors or other molecules along with biocompatible nanostructured scaffolds, that would allow fine-tuning of the release of the incorporated factors and would guide nerve growth in the CNS environment, would most probably be the key for success in such a complex tissue.

One significant component seems to be the ability to catalyze the translation of all the promising new therapies into clinical practice. This refers to imaging technology, and more specifically, Magnetic Resonance Imaging (MRI) sequences that can help assess and objectively quantify the biological response of the CNS to the tested intervention, solving a known issue of reproducibility and quantification in the application of all the new therapies. MRI could assess the biological significance, detecting tissue-related changes, while techniques like surface electromyography could assess the functional outcomes in a more objective way, leading together to the development of the much needed objective clinical scales that
would take into consideration the statistical, biological and clinical significance associated with the tested therapeutic strategy or management plan. In addition, the combination of imaging technology along with the implementation of new, clinically relevant models, like the non-human primate model of SCI developed for evaluating pharmacologic treatments, could open the pathway to safer and more efficient clinical application to patients in the future. Nevertheless, we do anticipate that the use of bioengineered models on-a-chip and further advancements in nanomedicine might revolutionize the field and change the translational pathway in the future, accelerating the drug approval process and the implementation of new treatments in the clinic.

From the practical standpoint, there are several obstacles that need to be tackled, like the lack of published data from companies that have done significant work on SCI regeneration and repair through clinical trials. The inclusion of controls is crucial for obtaining reliable outcomes and yet certain clinical trials either fail to implement controls in their study plan or they avoid reporting the outcomes in a timely manner, hindering the progress in the field. In addition to that, researchers mainly use less clinically relevant SCI models like hemisections/transection models. There is a significant need for inclusion of contusion SCI models that are more similar to the lesions usually managed in the clinic. Last but not least, it should be stressed that acute SCI models are mainly used for research purposes aiming to address the problem soon after the injury in the clinic and to avoid complications (e.g., formation of glial scar that would hinder neuroregeneration). The inclusion of more chronic SCI models in research might seem to be a challenging task, but it is very important for the reliable assessment of the therapeutic interventions in order to solve significant questions on CNS regeneration, ensuring the safe application of future treatments to any SCI patient.

**Keywords**

Spinal cord injury; stem cells; biomaterial

Retrieved from https://encyclopedia.pub/14