IJAE
Vol. 117, n. 2 (Supplement): 153, 2012
ITALIAN JOURNAL OF ANATOMY AND EMBRYOLOGY

In vivo morphological evaluation of the efficacy of an hydrogel conduit as scaffold for peripheral nerve regeneration

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Autologous nerve grafting is considered the gold standard for bridging nerve lesion, although in several cases the use of artificial tubular guides is needed. Nowadays, the research is addressed to identify the ideal treatment able to support complete nerve regeneration and functional recovery. Therefore, the use of artificial synthetic or natural guides is required but, despite numerous studies on several kinds of conduits, the clinicians are still waiting for an alternative scaffolds giving the best regenerative properties. In this light, we evaluated in vivo the efficacy of a polyamidoamine-based hydrogel, shaped as small tubing for nerve regeneration.

Studies were done on 3 experimental groups consisting of injured guide-implanted, sham operated and autograft rats (in which sciatic nerve was excised, inverted and re-implanted). In the implanted rats the sciatic nerve was transected and 5 mm gap between proximal and distal stumps was left in the middle of the conduit. Animals were then analyzed at 1, 3, 6, months post-surgery.

The gait analysis and the thermal sensitivity analysis demonstrated movement improvement and sensitive recovery.

The repaired, control and autograft nerves from all groups analyzed (implanted, sham and autograft) were processed for light microscopy and morphometric analysis. The axon size, myelin thickness and fiber density showed a complete nerve regeneration covering the gap in the central part of the conduit. In particular, the medial segment of the nerve tended to turn similar to sham operated (control) animals, while the autograft rats showed a less extensive regenerative process.

Moreover, immunofluorescence analysis of longitudinal sections of the conduits were performed by labeling the axonal neurofilaments. The immunopositivity observed further confirmed that the regenerative process was complete, being the fibres present through the entire conduit between the proximal and the distal stumps.

Overall, our data demonstrate that polyamidoamine-based hydrogel conduits are an implantable material providing a good support for the peripheral nerve regeneration. These conduits are biocompatible and biodegradable over the time to non toxic product metabolites. Finally our findings are promising for the achievement of implantable poliamidoamine-based hydrogel conduits functionalized for drug delivery with growth factors.

This work has been supported by Fondazione CARIPLO under the Project "Functional Polymeric Hydrogels for Tissue Regeneration" (no. 2010-0501), call for the Scientific Research on Advanced Materials, 2010.

Keywords: Nerve guide, sciatic nerve.