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Distribution and Survival of Transplanted Adipose-Derived Mesenchymal Stem Cells in the Spinal Cord Injury

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Abstract Current expectations for successful treatment of post-traumatic disorders in the CNS are associated with cell-based technologies. Mesenchymal stem cells, which are under intensive study, appear to be the most promising. At the same time, mechanisms of their effect on post-traumatic regeneration of the spinal cord and their behavior and migration properties in neurodegenerative lesions are not investigated in full. In our study, we investigated the survival, migration, and phenotypic characteristics of a fibrin matrix enclosed in adipose-derived mesenchymal stem cells (AD-MSCs) by implanting them in an area of the spinal cord injury in a subacute period. We showed that adipose-derived mesenchymal stem cells retain their viability in the area of SCI for up to 60 days and migrate rostrally and caudally for more than 5 mm. Phenotyping of AD-MSCs in the spinal cord injury area performed on the seventh day post-transplantation shows that Thy-1, CD 73, and Stro-1 are expressed; however, no CD 44 expression is observed. The results obtained reveal the route of migration of AD-MSCs within an area of the spinal cord injury. However, the programed differentiation of these cells in a later post SCI period has to be studied.

Keywords Adipose-derived mesenchymal stem cells · Spinal cord injury · Migration

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1 Introduction

Spinal cord injury (SCI) is one of current medical and social problems. In spite of significant advances in surgical and conservative therapy and rehabilitation in neuropathology, there are no effective treatment modalities for spinal cord injuries. Incapacitation of such patients approaches to 100%, with high-grade disability prevail [1]. Expectations for successful treatment of post-traumatic disorders in the CNS are associated with technologies of regenerative medicine. Its main tool is cell-based technologies which are widely applied as a therapeutic strategy for the treatment of SCI.

Transplanted stem and progenitor cells support the recovery of tissue matrix for nerve fibers regeneration, and have a trophic effect on neurons and the glia and promote axonal growth and remyelination. Mesenchymal stem cells (MSCs) are the most promising for transplantation as they possess some useful properties, which promote axonal regeneration, such as: (1) the ability to secret different neurotrophic factors and cytokines, (2) the ability to differentiate into various cell types, and (3) immunomodulatory, anti-apoptotic, and anti-inflammatory effects [2, 3].

Bone marrow is the most common source of bone marrow mesenchymal stem cells (BM-MSCs). However, technical and medical difficulties, as well as their decreased number and developmental potential with age, limit their extensive and successful use in clinic. Adipose-derived mesenchymal stem cells (AD-MSCs) are a good alternative to BM-MSCs; they are inferior to the latter and their obtaining is not associated with to the above problems. AD-MSCs are intensively investigated in SCI [4–6]. At the same time, mechanisms of their effect on post-traumatic regeneration of the spinal cord, as well as peculiarities of their behavior and migration within neurodegeneration lesions are not clearly understood. Some researchers consider that within the CNS, MSCs can differentiate into neural progenitor cells, neural