Proceedings of German Society for Stem Cell Research (PGSSCR)

Cell-based therapy of fatty degeneration after rotator cuff tears

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Published online on 16 May 2007

Objective:

The success of surgical reconstruction of rotator cuff tears is limited due to the lack of ability to heal spontaneously, the degree of muscular atrophy, and the fatty degeneration. Injecting autologous myogenic progenitor cells or multipotent mesenchymal stem cells (MSCs) into the area of fatty infiltration could be a crucial factor in improving the so far unsatisfactory outcome of surgical reconstruction.

Methods:

Myogenic progenitor cells and MSCs were isolated using protocols described by Blau & Webster (1981) and Noth et al. (2002), respectively. Both cell types were labelled with very small superparamagnetic iron oxide nanoparticles (VSOPs). The stability of labelling during cell expansion was determined with iron specific histochemical staining (Prussian blue). VSOP labelled, as well as non-labelled control cells were injected into a muscle specimen from a rabbit’s rotator cuff, and magnetic resonance imaging (MRI) was performed using a 7 T high-field MR spectrometer. In the MRI experiments 2D FLASH-sequences with echo times of TE = 8 ms and repetition times of TR = 689 ms were employed. A nominal spatial resolution of 137 x 137 \(\mu\)m\(^2\) was achieved with a slice thickness of 1 mm.

Results:

Intracellular uptake of iron oxide particles after incubation with VSOPs was shown with Prussian blue staining. Neither the myogenic progenitor cells nor the MSCs showed any loss of labelling within the first 6 cell divisions. Also, the proliferation capacity of both cell types was not influenced by the labelling. After the injection of VSOP labelled cells into a muscle specimen, the cells could be detected successfully with MR imaging. In a long term study, the VSOP labelled MSCs embedded in a tissue equivalent (collagen type I hydrogel) could be detected for more than 20 weeks using MRI.
Conclusion:

Both, myogenic progenitor cells and MSCs were successfully labelled with iron oxide particles and used for MR cell tracking. Running experiments with the rotator-cuff defect model will show if the labelled cells will integrate themselves into the area of fatty degeneration and contribute to the regeneration of the muscle.