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Utility of Diffusion Tensor Imaging in Evaluating Spinal Cord Repair Following Stem Cell Transplantation in Spinal Cord Injury

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ABSTRACT

Introduction: Spinal cord injury (SCI) is a devastating condition that can lead to permanent neurological deficits. Stem cell transplantation is a promising therapeutic approach for promoting spinal cord repair and functional recovery. However, assessing the extent of repair and regeneration remains a challenge. Diffusion tensor imaging (DTI) has been proposed as a non-invasive imaging technique to evaluate the microstructural integrity of the spinal cord following stem cell transplantation. This systematic review aimed to evaluate the utility of DTI in assessing spinal cord repair following stem cell transplantation in SCI.

Search Strategy: We conducted a comprehensive literature search in multiple electronic databases (PubMed, Embase, Web of Science, and Cochrane Library) to identify relevant studies that utilized DTI to evaluate spinal cord repair after stem cell transplantation in animal models or clinical trials of SCI. The search was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Seven relevant articles were identified and included in the review.

Results: Of the seven studies, five were preclinical animal studies, and two were clinical trials. Across the studies, 142 subjects (112 animals and 30 human patients) underwent DTI evaluation after stem cell transplantation. Meta-analysis revealed a significant increase in fractional anisotropy(FA; mean difference = 0.12; 95% CI: 0.08-0.16; p = 0.001) and a significant decrease in mean diffusivity (MD) (mean difference = -0.15×10^{-3} mm^2/s; 95% CI: -0.21 to -0.09; p= 0.001) in the transplanted regions compared to control groups. These DTI changes correlated with improved functional outcomes and histological evidence of axonal regeneration and remyelination.

Conclusion and Discussion: DTI is a valuable non-invasive imaging technique for evaluating spinal cord microstructural changes following stem cell transplantation in SCI. Increased FA and decreased MD suggest improved axonal integrity and myelination, corresponding with functional recovery and histological repair. DTI can provide insights into stem cell-mediated repair mechanisms and guide therapeutic decision-making.

Keywords: Diffusion tensor imaging, Spinal cord injuries, Stem cell transplantation