A combination of Mesenchymal stem cells and Low Intensity Ultrasound for Knee meniscus regeneration : A preliminary study

Abstract

Background

Meniscus defects critically alter knee function and lead to degenerative changes. Regenerative medicine applications including stem cell transplantation have showed a promising efficacy in finding alternatives to overcome traditional treatment limitations. However, stem cell therapy remains limited due to the substantially reduced viability and inhibitory microenvironment. Since tissue growth and repair are under the control of biochemical and mechanical signals, several approaches have recently been investigated (e.g., low intensity pulsed ultrasound [LIPUS]) to promote the regeneration process.

This study employed LIPUS to improve growth and osteogenic differentiation of mesenchymal stem cells derived from human embryonic stem cells to improve the regeneration of meniscus tissue.

Methodology: The MSCs were transplanted into the epicenter of the injured meniscus in rabbits, which were randomized into two main groups: a treatment group (n=32 New Zealand rabbits) including 4 subgroups of 8 rabbits in each subgroup (LIPUS treatment, MSC treatment, LIPUS with MSC and control), and a second group (n=9) to track implanted cells and their progeny using green fluorescence protein (GFP). GFP consists of the MSC and LIPUS-MSC combination subgroups. Rabbits were then subjected to histological, immunohistochemistry, and MRI assessment.

Results: The quantity of the newly regenerated tissue in the combination treatment group that had Ultrasound irradiation after mesenchymal stem cells were better at all end points. Likewise, Tissue quality scores were also greater in knees treated with both approaches compared with controls and single treatment at all end points, achieving significance at twelve and twenty-four weeks [$p < 0.05$], and [$p = 0.008$] at twelve weeks. Differentiation into type-I and II collagen-expressing cells were higher in the combination group at up to twenty-four weeks.

Conclusions: the combination of mesenchymal stem cells and LIPUS showed greater adhering to the sites of meniscus injury, differentiate into cells resembling meniscal fibrochondrocytes, and improve both quality and quantity of meniscal regeneration.