New Bioactive Spatially-Embedded Growth Factor (SEGF) Scaffold Promotes Bone-to-Tendon Interface Healing after Chronic Rotator Cuff Repair

Jian Han, Hyeon Jang Jeong[1], Joo Han Oh
[1]Seoul National University Bundang Hospital

INTRODUCTION:

Background: Restoration of the original anatomical bone-to-tendon interface (BTI) after rotator cuff repair (RCR) remains a significant challenge, therefore a multitude of biocompatible biomaterials has been investigated to promote rotator cuff healing after repair.

Purpose: To investigate the efficacy of 3D-printed scaffolds incorporated with spatiotemporal delivery of growth factors (GF) to accelerate BTI healing after RCR.

METHODS:

Advanced 3D printing was used to fabricate the multilayered scaffolds, spatially embedded with different GFs to guide regional differentiation of endogenous stem/progenitor cells. A sustained, spatially controlled release of GFs was confirmed. The multi-lineage differentiation potential of mesenchymal stem cells (MSCs) in the scaffold was assayed. In vivo, a total of 50 rabbits, with induced chronic rotator cuff injuries, were divided into 4 groups: Normal (N, n = 2), saline control (A, n = 16), scaffold without GF (B, n = 16), and scaffold with GF (C, n = 16). At 6 weeks after the creation of rotator cuff tears, surgical repairs were performed when scaffolds were implanted between the bony footprint and supraspinatus tendon. RT-qPCR analysis was performed at 4 weeks after the repair, and biomechanical and micro-CT analyses were performed at 12 weeks after repair.

RESULTS:

In vitro, the scaffolds successfully guided regional differentiation of MSCs, forming multiphase tissues with tendon, cartilage and bone-like regions. In vivo, group C showed higher collagen type Iα1, collagen type IIIα1, and aggrecan expressions than the other groups ($P < 0.001$, $= 0.005$ and $=0.006$, respectively) at 4 weeks after repair. For the biomechanical evaluation, group C showed a significantly higher load-to-failure rate than the other groups ($P = 0.003$) at 12 weeks after repair. For the micro-CT analysis, group C showed higher bone mineral density and bone volume/total volume rate than the other groups ($P = 0.001$ and < 0.001, respectively) at 12 weeks after repair.

DISCUSSION AND CONCLUSION:

This new bioactive spatially-embedded growth factor (SEGF) Scaffold effectively accelerated BTI healing in chronic rotator cuff tear model of rabbits.