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# Study of differential effects of TGF-beta3/BMP2 on chondrogenesis in MSC cells by gene microarray data analysis

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**Abstract** In order to explore the differential effects of TGF-beta3 and BMP2 on chondrogenesis in mesenchymal stem cells (MSCs), the gene expression profiles of MSC treated with TGF-beta3 and BMP2 were subjected to systematic analysis on the gene and functional level. The gene expression profiles of MSCs (downloaded from Gene Expression Omnibus database) in the early and later stages, induced with TGF-beta2 and BMP2, were analyzed using packages within R software and the differentially expressed genes (DEGs) were screened. The DEGs both in the two experimental groups were subjected to Gene Ontology and pathway enrichment analysis. The protein–protein interaction (PPI) networks of the DEGs were constructed using cytoscape software. Among the DEGs, 1,194 genes were up-regulated and 580 genes were down-regulated. The up-regulated genes were mainly enriched in the TGF-beta and cell cycle signaling pathways and down-regulated genes were mainly enriched in the insulin-mediated signal pathway, metabolic pathway of fructose and mannose, and glycolysis/gluconeogenesis pathway. Based on the PPI network analysis, the genes of KIAA0101, NEDD4, and TINF2 were confirmed to be important on chondrogenesis. The analysis of DEGs both in TGF-beta3 and BMP2 treated MSCs indicates that the genes are mainly involved in the cell cycle and intracellular signaling pathways. Also the similar gene expression profile can be achieved by transcription factors or microRNAs (miR-199a-5p and miR-31-5p) based on our prediction, which can provide a new approach for the treatment of cartilage injury.

**Keywords** Chondrogenesis · TGF-beta3/BMP2 · Mesenchymal stem cells (MSCs) · Protein–protein interaction (PPI) · Differentially expressed genes (DEGs)

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## Introduction

Cartilage injuries are common especially in the middle-aged and older people due to the limited ability to heal [1]. Many factors have been demonstrated to be related to the cartilage injury including joint diseases, genetic or metabolic conditions, and trauma [2]. Considerable evidences have shown that interaction of biomechanical factors and proinflammatory mediators plays an important role in the progression of cartilage injury [3].

Many researchers have been conducted for the exploration of cartilage repair techniques considering the limited self-restorability of injured cartilage because of the avascular nature of the tissue [4]. Based on the symptoms of cartilage injury, different therapies have been developed in the treatment of cartilage injury. Resection or other surgical techniques are often used in severe cartilage injury followed by implantation of prosthesis [5]. The restore of cartilage can be made by implanting replacement tissue grafts or inducing self-healing when the cartilage injury is smaller. Considering the allogeneic and autogenic implants in the implantation from a donor tissue, a lot of efforts have been made to regenerate existing cartilage [6]. In order to enhance the regeneration ability of cartilage, a lot of methods have been developed. Penetration of subchondral