Platelet-Rich Plasma (PRP) Stimulates the Extracellular Matrix Metabolism of Porcine Nucleus Pulposus and Anulus Fibrosus Cells Cultured in Alginate Beads

Koji Akeda, MD,*‖ Howard S. An, MD,* Rajeswari Pichika, PhD,*
Mohamed Attawia, MD,§ Eugene J.-M. A. Thonar, PhD,*†‡
Mary Ellen Lenz, MS,† Atsumasa Uchida, MD, PhD,‖ and Koichi Masuda, MD*†

Study Design. *In vitro* assessment of the effects of platelet-rich plasma on the extracellular matrix metabolism of porcine intervertebral disc cells.

Objectives. To determine whether platelet-rich plasma is effective in stimulating cell proliferation and extracellular matrix metabolism by porcine disc cells cultured in alginate beads.

Summary of Background Data. Platelet-rich plasma is used to accelerate wound healing and tissue regeneration. Activated platelets release multiple growth factors that regulate cell proliferation, differentiation, and morphogenesis. Individual growth factors present in platelet-rich plasma have been demonstrated to affect the metabolism of intervertebral disc cells.

Methods. Platelet-poor and platelet-rich plasma was isolated from fresh porcine blood using a commercially available platelet concentration system. After preculture for 7 days and serum starvation for 24 hours, the beads containing nucleus pulposus and anulus fibrosus cells were then cultured for another 72 hours in serum-free medium, 10% fetal bovine serum, 10% platelet-poor plasma, or 10% platelet-rich plasma. The synthesis of proteoglycans and collagen, the accumulation of proteoglycans, and the DNA content were biochemically assessed.

Results. Platelet-rich plasma had a mild stimulatory effect on cell proliferation of intervertebral disc cells. Platelet-rich plasma treatment significantly upregulated proteoglycan and collagen synthesis and proteoglycan accumulation when compared with platelet-poor plasma.

Conclusions. Platelet-rich plasma was effective in stimulating cell proliferation and extracellular matrix metabolism. The response to platelet-rich plasma was greater in the case of anulus fibrosus cells than of nucleus pulposus cells. The local administration of platelet-rich plasma might stimulate intervertebral disc repair. In addition, given the risks of using animal serum for tissue engineering, autologous blood may gain favor as a source of growth factors and serum supplements needed for stimulating cells to engineer intervertebral disc tissues.

Key words: platelet-rich plasma, growth factor, intervertebral disc, extracellular matrix, proteoglycan, collagen.
Spine 2006;31:959–966

The relatively few cells that reside in the anulus fibrosus (AF) and nucleus pulposus (NP) maintain intervertebral disc (IVD) matrix metabolism homeostasis. Although the regulatory mechanisms are not well understood, nutrition to the disc, cytokines, and growth factors are thought to play a role.[1,2] Recent studies have shown that growth factors can upregulate the production of matrix molecules and also stimulate the accumulation of matrix constituents during culture.[3,4] The stimulation of cell metabolism by growth factors positively affects the perturbation of matrix maintenance even when the biochemical and biomechanical properties of disc tissues are compromised.[5] A recent study showed that the injection of a growth factor into normal IVDs[6] and the discs in a rabbit disc degeneration model induced an increase in disc height,[7] suggesting that growth factors may have a therapeutic use in the treatment of IVD degeneration. In those cases of IVD degeneration that exhibit advanced pathologic changes, apoptosis of IVD cells[8] and struc-