Biological characterization of rabbit nucleus pulposus cells on a biphasic scaffold made of policaprolactone and methacrylated gellan gum

Sebastião van Uden,[1,2] Joana Silva-Correia, [1,2] Vitor M. Correlo, [1,2] Joaquim M. Oliveira, Ph.D., [1,2] Rui L. Reis, [1,2]

1 3B's Research Group - Biomaterials, Biodegradables and Biomimetics, University of Minho, Headquarters of the European Institute of Excellence on Tissue Engineering and Regenerative Medicine,
AvePark, 4806-909 Taipas, Guimarães, Portugal

2 ICVS/3B's - PT Government Associate Laboratory, Braga/Guimarães, Portugal

Abstract

Intervertebral disc (IVD) degeneration (IDD) is nowadays considered as the main physiological cause for low back pain (LBP). LBP is known to affect people of any age, having a world socioeconomic burden of 70 billion euros per year[1]. Current LBP treatments only treat the symptoms without solving the problem. So, finding new ways of treating IDD is finding new ways of reducing socioeconomic impact created by LBP.

Tissue Engineering (TE) is an exponentially growing area due to its potential of finding patient-specific treatments in terms of immunological compatibility by using patient's own cells. Though, it is time for TE to take a step towards an even more patient-specific way of treating diseases. Reverse Engineering (RE) appeared as a way to find how a system works without having its blueprints. RE combined with 3D printing can help researchers reproduce any kind of anatomical structure. So, by combining both TE and RE it is possible to develop not only a patient-specific treatment strategy in terms of immunological-compatibility but also in terms of structure.

The IVDs, which are located on the spine, are composed by a hydrogel-like nucleus pulposus (NP) core that is contained vertically by cartilaginous end-plates, and horizontally by a fibrocartilage ring called annulus fibrosus (AF). The purpose of this study is to use Reverse and Tissue Engineering to develop custom-made implants for IVD regeneration. Rabbit spines were analyzed by micro-computerized tomography and were RE into a virtual 3D model which was then 3D printed with polycaprolactone, that has already shown, in the literature, a great potential as a material to develop AF scaffolds[2]. The solid scaffold was then filled with rabbit NP cell-laden methacrylated gellan gum (GG-MA) hydrogel. The GG-MA hydrogel has been shown great promise for NP regeneration, in vitro and in vivo[3]. This way, a fully patient-specific biphasic scaffold was produced which mimics the native IVD's structure and biomechanics.

Keywords:

Tissue Engineering; Reverse Engineering; Intervertebral Disc Regeneration; Total Disc Implant

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