Letter to the editor: Tissue Engineering - A Revolution in Medical Science

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Abstract: Tissue engineering is an interdisciplinary field in which engineering and life sciences concepts are applied to the generation of biological replacements aimed at the development, preservation, or restoration of the function of the missing organ. Genetic modification can serve to alter the fate of cells and the existence of cells is crucial especially their capacity for proliferation, cell-to-cell signaling, development of bio-molecules, and extracellular matrix formation. Basic fibroblast growth factor (bFGF), TGF-b, growth, and differentiation factor (GDF), and insulin-like growth factor (IGF)-1 are the key growth factors that affect tendon tissue growth and differentiation. The opposite approach of a changed large collaboration of the material with biological tissue is used by tissue engineering techniques and has provided a new emphasis to biomaterials research. More research in this area will provide knowledge of cell growth and separation control tools and help to explain the expected role of manufactured and organic substrates in cell function regulation.

Keywords: Tissue engineering, Medical science, Growth factors, Organ transplantation.

Introduction

Tissue engineering has now emerged as a potential alternative to tissue or organ transplantation. With this technology, tissue loss or organ failure can be treated by implantation of a tissue-engineered graft composed of either two or all of the three major components:- cells, biomaterials/scaffold, and bio-molecules [1]. So far, tissue-engineered products such as bioartificial skin (Apligraf from Organogenesis) and autologous cultured chondrocytes (Carticel from Genzyme Tissue Repairs) have reached the market.

A key factor in the tissue engineering approach to repair and regeneration is the availability of appropriate cells. The presence of cells is crucial, especially their proliferation potential, cell-to-cell signaling, bio-molecule production, and formation of the extracellular matrix. Multiple cell types have been seeded within scaffolds for tissue engineering. They can be classified into fibroblasts, mesenchymal stem cells (MSCs), and embryonic stem cells (ESCs) according to the cell potential. A variety of growth factors, angiogenic factors, chemotactic agents, and other molecules may also be released from the scaffold to facilitate tissue regeneration. The main growth factors that affect the growth and differentiation of tendon tissue include basic fibroblast growth factor (bFGF), TGF-b, growth and differentiation factor (GDF), and insulin-like growth factor (IGF)-1. TGF-b1 improves cell proliferation, migration, and the synthesis of both collagen and proteoglycan [2]. bFGF is a mitogen for a variety of cells of mesenchymal or neuroectodermal origin in vitro [3, 4]. It increases proliferation and extracellular matrix formation of tendon and ligament cells, and BMSCs, both in vitro and in vivo [5]. Other studies have shown that it promotes angiogenesis and regulates cell migration [6].

Wolfman et al. [7] first reported that GDFs 5, 6, and 7 can induce the ectopic formation of tendon/ligament-like tissue in rats. Several studies showed that GDFs 5, 6, and 7 have a similar ability to improve tissue repair [8]. Recent studies support the concept that genetic manipulation can serve to alter cell fate. Specifically, the strategy of transferring transcription factors into stem cells leads to reprogramming and phenotype transition [9]. Introduction of the pancreatic b-cell-specific transcription factor pancreatic duodenal homeobox-1 (PDX-1) into hMSCs efficiently induces them to differentiate into functional insulin-producing cells and this provides a possible source for cell replacement therapy [10].

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Until now, research in the field of biomaterials has focused on limiting biological liquid tissue connections with an end goal to forestall stringy epitome of counterfeit gadgets, that is, making the material "invisible" to the body. Tissue engineering techniques utilize the opposite methodology of a modified broad collaboration of the material with biological tissue and have given biomaterials research a new focus. We hope that research in this interesting new field will give knowledge into the control instruments of cell development and separation, and help clarify the expected function of manufactured and organic substrates in the regulation of cell function, just as the impacts of mass transfer, mechanical and biochemical conditions on tissue remodeling and repair.

Synthesis of new cell adhesion-specific materials and the development of fabrication methods to process reproducibly three-dimensional synthetic or natural biodegradable polymer scaffolds with customized chemical and physical properties, for example, porosity, pore size distribution, and connectivity, mechanical properties for load-bearing applications, and rate of degradation all present a challenge to the tissue engineer. Future objectives include the large-scale production of functional cells, and ultimately intact organs as therapy or total organ replacement.

References

1. Goh JC, Ouyang HW, Teoh SH, et al. Tissue-engineering approach to the repair and regeneration of tendons and ligaments. Tissue Engineering 2003;9:S31-31S44.
2. Mendias CL, Bakhurin KI, Faulkner JA. Tendons of myostatin-deficient mice are small, brittle, and hypocellular. Proc Natl Acad Sci USA 2008;105:388-93.
3. Hankemeier S, Keus M, Zeichen J, et al. Modulation of proliferation and differentiation of human bone marrow stromal cells by fibroblast growth factor 2: potential implications for tissue engineering of tendons and ligaments. Tissue Eng 2005;11:41-9.
4. Chan BP, Chan KM, Maffulli N, et al. Effect of basic fibroblast growth factor. An in vitro study of tendon healing. Clin Orthop Relat Res 1997;342:9-47.
5. Costa MA, Wu C, Pham BV, et al. Tissue engineering of flexor tendons: optimization of tenocyte proliferation using growth factor supplementation. Tissue Eng 2006;12:1937-43.
6. Folkman J, Klagsbrun M. Angiogenic factors. Science 1987;235:442-7.
7. Wolfman NM, Hattersley G, Cox K, et al. Ectopic induction of tendon and ligament in rats by growth and differentiation factors 5, 6, and 7, members of the TGF-beta gene family. J Clin Invest 1997;100:321-30.
8. Forslund C, Aspenberg P. CDMP-2 induces bone or tendon-like tissue depending on mechanical stimulation. J Orthop Res 2002;20:1170-4.
9. Takeuchi JK, Bruneau BG. Directed transdifferentiation of mouse mesoderm to heart tissue by defined factors. Nature 2009;459:708-11.
10. Li Y, Zhang R, Qiao H, et al. Generation of insulin-producing cells from PDX-1 gene-modified human mesenchymal stem cells. J Cell Physiol 2007;211:36-44.