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Short Communication

An Overview on Skeletal Tissue Engineering by using Pluripotent Stem Cells

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DESCRIPTION

Accidents, injuries, and diseases are an inevitable part of life. It is unfortunate that humans are less capable of regenerating such injured tissues or organs than lower animals. Compared to mammals, amphibians and fish are more capable to regenerate missing or damaged limbs, tails, and fins. The majority of skeletal tissues, such as articular cartilage, instead rely on fibrosis and the production of scar tissue in lieu of their original structure, despite the fact that our bones and liver can regenerate to a considerable degree.

However, when human bodies are unable to heal on their own, new A Tissue Engineering (TE) technique has been developed to aid in accurate cell replacement and to produce real tissues and organs. The study of tissue engineering involves either using transdisciplinary technologies to grow the appropriate tissues from cells outside the body or stimulating cells' natural ability to generate lost or damaged tissue *in situ*. The tools available to us are improving rapidly in both cases. However, selecting the right cell source for TE is crucial to success. For skeletal applications, cells may be required to endure in an artificial construct placed in an inflammatory environment [1]. At the same time, they must be able to react to cues that indicate they should continue to be or change into the required cell type. To develop the shape and function of the original tissue or organ, cells must be able to respond to biomechanical stimuli. To do this, they must interact with other cells and migrate properly or not as their fate directs. Committed progenitors are more likely to be found in cells that are malleable and responsive to these signals. So from where do we get these cells? Adult Mesenchymal Stromal Cells (MSCs) have been suggested as a promising supply for skeletal tissues' cellular needs. They are able to differentiate into osteogenic, chondrogenic, or adipogenic cell types and can be removed from bone marrow or peripheral blood. However, these cells have drawbacks that may limit their widespread clinical application, including a decreased differentiation potential on expansion, a lack of long-term retention *in vivo*, the requirement for multiple operations for autologous transplantation, and difficulties using them allogeneically [2,3]. They also have immunomodulatory properties. Human Pluripotent Stem Cells (hPSCs) are another desirable cell source for TE. These are either human induced Pluripotent Stem Cells (hiPSCs), which are reprogrammed somatic cells, or human Embryonic Stem Cells (hESCs), which are obtained from the inner cell mass of the human blastocyst that is surplus to assisted reproductive initiatives. They have a special capacity to produce almost any type of cell in the body and continual replication without differentiation, both of which are important in modern medicine. Thousands of lines have already been generated and (banked globally), some of which are clinical grade and so suitable for cell treatments. hPSCs show considerable potential as biological starting materials for a variety of applications, including regenerative medicine, disease modelling, and drug development, because of the availability of more robust differentiation procedures [4].

There are three main paths used to produce skeletal tissues from hPSCs: (1) Developmentally-guided differentiation, which mimics multiple stages of embryonic development *in vitro* with the aim of producing real skeletal cell types specific to particular body regions. (2) Initially nonspecific differentiation, in which the minimal signals necessary to drive skeletogenesis are applied in a simple and economical manner. (3) Generation of MSC-like cells.

A better understanding of the temporal dynamics of stimulation and inhibition of signalling pathways that permit the production of desired cell types has sped up the field of stem cell engineering. The use of GFs, which are expensive, subject to batch-to-batch fluctuation, and have short shelf lives and half-lives *in vitro*, is still a major component of current approaches for hPSC skeletal development. Protocols are routinely tested using 2D or basic 3D models, like small cell spheroids or embryoid bodies. In contrast, sectors like biomedical engineering, nanotechnology, and synthetic biology have seen the emergence of technical advancements. Even while some of these have found use in TE, their full potential in the production of skeletal tissues from hPSCs has not yet been realized.

CONCLUSION

Large-scale 3D tissues are required to fix pertinent clinical problems. The majorities of hPSC differentiation techniques,

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however, were created in 2D monolayer cultures and have not been verified in 3D. To bring the potential of hPSC-derived cells to the clinic, the integration of bio-fabrication technologies to replicate the structural and functional organization of skeletal tissues in 3D will be essential. To that end, the quickly developing field of bio-fabrication technologies is projected to provide unheard-of advantages for producing extremely intricate, patient-specific models. They will probably make it easier to scale up the production of large batches of cells because they can be integrated with cutting-edge bioreactors that can offer dynamic culture conditions that mimic the *in vivo* micromechanical environment with appropriate stimuli like compression, tension, and shear. Together, these many developments will bring down the price of cellular therapies and hasten the development of hPSC skeletal therapeutics.

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