Special Article

Tissue Engineering of Skin and Soft Tissue Augmentation, Medical View

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Tissue engineering is one application of the regenerative medicine, which aims to promote replace, repair or regeneration of tissue or organ due to congenital abnormalities, disease, trauma, or aging. This field applies the principles of physical sciences, engineering, medicine and the life sciences. To integrate knowledge of stem cell biology, tissue scaffold biocompatibility and degradation, bioreactor on cell growth and differentiation may overcome some limitation of autologous tissue grafting, allogenic tissue rejection. Tissue engineering is really a new hope for future medicine.

Keywords: *Tissue engineering, Skin, Skin graft, Soft tissue augmentation*

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Regenerative medicine is a multidisciplinary field involving biology, medicine, and engineering that is likely to revolutionize the ways improving the health and quality of life by restoring, maintaining, or enhancing tissue and organ function. Approaching of regenerative medicine can be stem cells biology, engineering biomaterial science, biochemical growth factors those effect cells growth and differentiation and tissue engineering. Tissue engineering is a subfield of biomaterials of a combination of cells, engineering materials, methods and suitable biochemical factors to remake a new tissue. This article reviews medical aspect about causes of tissue defect, stem cells, bioreactors and scaffold in tissue engineering, limitation in clinical application and future of tissue engineering.

Tissue defects

The causes of soft tissue and epithelial defect could be congenital anomalies, diseases, traumatic events or even normal aging processes. Previously, the treatment option of soft tissue and epithelial lost were autologous tissue transfer, *e.g.* flaps transfer, or allogenic soft tissue transplantation. There were some limitations of treatment in each treatment choices. The autologous tissue transfer has no rejection problem but that can be done in the small recipient area, which the donor site can cover the entire recipient site. Contrary with the allogenic tissue transfer has some difficulties to find the donor tissue to fit the quality and site of donor to the recipient site.

Moreover allogenic tissue transplantation has to control tissue rejection reaction and some problems with side effect of immunosuppressive medicine[1-4]. Tissue engineering with the autologous cells source, activating with suitable growth factor, to direct desire direction of cell growth and differentiation, on the biocompatible scaffold seems to be the solution of shortest of tissue in autologous tissue transfer and rejection problem with allogenic tissue rejection[5-9].

Cells soures

Cell source in tissue engineering or cell therapy can be autologous, allogenic, or xenogenic[10-14]. The best cell population to remake a new tissue has to remain their stem cell properties, which are remaining the capability of renewing themselves, unspecialized cell type, and can give rise to specialized cell types or differentiation[15,16]. There are two main types of stem cells, embryonic stem cells (ESCs) and adult or somatic stem cells. ESCs derive from specific site of embryonic tissue, inner cell mass (ICM) of blastocyst. Adult or somatic stem cells are cells those can be found in adult tissue and still remain all three main stem cell properties. Adult tissues those have been report success in stem cell extraction are hematopoietic tissue, adipose tissue, neural tissue and skin tissue[17-20]. By ethical issue and plenty of source, adult stem cells seem to be the perfect

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source for tissue engineering, though it has to grow in the proper culture system with right specific growth factors to stimulated growth and differentiation those adult stem cells into the desired direction.

Bioreactors

Bioreactor is a term to describe method of extraction, culture system, growth factors those can affect tissue culture into desired growth and differentiate direction[10,21]. There were several reports about growth factors those effect cell growth and differentiation. In certain types of tissue engineering, in vitro culture system is needed to create culture environments as in native conditions[22-24]. Finally in the large industrial scale, machines or method those are involved in the in tissue engineering formation are needed to be precise to obtain the same quality products from each individual product lot to obtain the same product quality[25-28].

Material scaffold

Biological scaffold is a remake tissue extracellular matrix for cells to attach and growth on. This can be divided into 2 main groups due to their origin, natural and synthetic scaffold[29-33].

A. Natural scaffold

Natural polymers are categorized in to 3 main categories, due to their natural source; polysaccharides, proteins and hydroxyalkanoates[34,35]. There were several review about scaffold, which are made from polysaccharides; chitosan, hyaluronic acid, glycosaminoglycans[33,36], protein and protein based polymers; collagen, elastin, fibrin/fibrinogen, fibronection, silk[35,37-39] and polyhydroxyalkanoated; polyhydroxybutyrate (PHB)[40,41]. The advantage of these natural scaffold is most of these natural origin scaffold are already existed in extracellular matrix of natural tissue, for example collagen and elastin are the natural dermal matrix, so they react property with cells, which are co-culture with them. The disadvantage is because its origin, this has to be extracted from natural tissue, xenogenic or allogenic source, which may cause some foreign body reaction from the contaminated xenogenic or allogenic proteins.

B. Synthetic scaffold

Synthetic biodegradable scaffold for the tissue engineering purposes are the polymers those are not originated from natural process but they are made of synthetic polymers, which can be apply for tissue scaffold. Because they are not naturally derived, all synthetic material those are designed for tissue scaffold have to be tested their biocompatible properties[30,42,43]. The advantage of synthetic material is easily reproduction and can be easily processed into desired shape and form[32,44]. There were several reports using of degradable polymers in tissue engineering such as poly (lactic) acid (PLA), poly glycolic acid (PGA) and their copolymers (PLGA)[45,46]. In the industrial scale, this synthetic scaffold may be a more favorable choice for tissue engineering.

Autologous tissue grafting

Reconstructive surgery by tissue transfer is the treatment of choice in tissue lost. There will be no grafting rejection reaction. Although there were some limitations of the donor site in order to cover the entire recipient site[1,47]. In the case of large tissue defect, such as burns patients, lost extremities, or wide spread tissue defect, tissue transfer may not able to cover the entire recipient area due to the limitation of the donor site.

Allogenic tissue grafting

Abovementioned limitation of autologous tissue transfer to treat the lost tissue, there was a report of allogenic tissue grafting in human facial soft tissue from the brain-dead donor to a victim of dog bite, which had lost her lower facial soft tissue and cannot be treated with her own tissue flap[2-4]. This allogenic tissue grafting has good cosmetic outcome with a favorable function of patient lower face portion. Like the other allogenic tissue grafting, immunosuppressive drugs have been used to suppress the tissue rejection reaction[48,49]. The disadvantages of allogenic tissue transfer are shortage of donor site and necessary to suppress tissue rejection reaction by immunosuppressive drugs, which may cause some side effect.

Future application of tissue engineering

Tissues engineering, which are made of (1) proper cell source that is not caused acute and chronic tissue reaction and has self renewal properties that can re-growth and differentiate to a new tissue, (2) proper biodegradable scaffold and (3) proper bioreactors can control the quality of tissue. With all the advantage of reproducible tissue engineering technologies, this can be the future hope for tissue repair, replacement or regeneration in regenerative medicine in the treatment of lost tissue, impair functions those are caused

congenital abnormalities, trauma, diseases or aging processes[5,7,20,50-54].

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มุมมองทางการแพทย์เกี่ยวกับวิศวกรรมเนื้อเยื่อเพื่อทดแทนผิวหนังและการเสริมมวลเนื้อเยื่อ

บริสุทธิ์ แสนมโน หาญพานิช

วิศวกรรมเนื้อเยื่อเป็นการประยุกต์ใช้อย่างหนึ่งของการแพทย์เพื่อการฟื้นฟูซึ่งการแพทย์สาขานี้ เน้นไปที่การประยุกต์ใช้เทคโนโลยีต่าง ๆ เพื่อ ทดแทน, ซ่อมแซม, หรือเสริมสร้างเนื้อเยื่อขึ้นมาใหม่ไม่ว่าสาเหตุของการเสื่อมนั้นจะมาจากสาเหตุใดก็ตาม เช่น การผิดปกติแต่กำเนิด, การเป็นโรค, อุบัติเหตุหรือแม้แต่ความแก่ชราเองก็ตาม ศาสตร์สาขานี้เป็นการประยุกต์รวมหลากหลายสาขาวิชาเข้ามาประกอบกัน เช่น วิทยาศาตร์กายภาพ, วิศวกรรมศาสตร์, แพทยศาสตร์, ความรู้ทางด้านเซลล์ต้นกำเนิด, ความรู้เกี่ยวกับโครงสร้างเนื้อเยื่อและระบบที่ใช้ควมคุมการเจริญและพัฒนาของเซลล์เพื่อนำมาพัฒนาเพื่อลดข้อจำกัดจากการใช้เนื้อเยื่อทดแทนจากตนเอง, การปฏิเสธเนื่อเยื่อจากผู้อื่นเป็นต้น องค์ความรู้ที่ได้นั้นหากสามารถนำไปประยุกต์ใช้ได้จะเป็นประโยชน์ อย่างมหาศาล