Constructing bioengineered cornea for restoring vision

It is our pleasure to offer the reader this special issue of the *Annals of Eye Science* that focuses on bioengineered cornea. Corneal disease is referred as one of the leading causes of blindness, only secondary to cataract in overall importance. The majority of corneal blind patients could potentially have their sight restored through corneal transplantation, whereas the barrier to the performance of corneal transplantation in many counties is the limited tissue availability. On a global level, there were an estimated 12.7 million people on the waiting lists for corneal transplants in 2012, and China had more than 3 million with its prevalence at 0.225%. What is more, the number of corneal blind patients in China is still increasing by 10% annually. In spite of large population of corneal blind patients in China, only fewer than 8,000 corneal transplantations were performed in 2012.

To solve the problems of lack of tissues, corneal substitutes have attracted a great deal of attention. Over the past few years, there have been significant developments in bioengineered corneas. The materials used to construct engineered corneal scaffold, which is designed to solely replace part thickness of diseased cornea, include natural polymer materials and synthetic polymers. In the current issue, Lin *et al.* and Zeng *et al.* comprehensively addressed the advantages and limitations of these corneal substitutes. An idea engineered corneal scaffold must meet the standards such as excellent optical characteristics, good biocompatibility and proper biomechanical strength. According to these criteria, acellular porcine corneal scaffold (APCS) would be a promising human corneal equivalent, which had already been tested both in animal experiments and clinic trials.

APCS is prepared from porcine cornea by removing nuclear and cellular materials from tissue. It is attractive as it is not limited by availability and has equivalent refractive properties and size with natural human cornea. To date, there have been only two brands of APCS (Acorna® and Youvision®) that had been approved for clinical use by China Food and Drug Administration (CFDA). However, more brands of APCS products have already being in the way of pre-clinical trials or clinical trials. Of note, the current approved indications for APCS are limited within chemotherapy-refractory infective keratitis and corneal perforation when no donor corneas are available as repair materials.

Product uniformity is of great importance if APCS has been commercialized, which necessitates the routine outgoing production quality inspection. In this issue, Cui and his associates introduced a non-invasive and non-destructive quality control methodology for either engineered corneas or even donated corneas. The microstructures of corneal scaffold influence its behaviours in rehydration and transparency after grafting. Multi-photo microscopy is capable of visualizing the microstructures of cornea scaffold so as to acquire useful data on how the processed cornea may respond to follow-up procedures, such as rehydration and regeneration. For this reason, Cui *et al.* strongly suggested selecting corneal scaffold through three-dimension structural analysis using multi-photo microscopy.

Moreover, in this issue, Liu *et al.* and his associates systematically reviewed the present and prospective of bioengineered cornea. Corneal transplantation techniques include penetrating keratoplasty (PK), anterior lamellar keratoplasty (ALK) and endothelial keratoplasty (EK). The bioengineered corneas that are currently used in clinics, including APCS and biosynthetic corneal stroma, are solely designed for ALK, but they could be tapped as scaffolds for full-thickness artificial cornea construction. Epithelial cells, stoma cells and endothelial cells could be seeded and cultivated in a wide range of scaffolds, such as APCS, collagen scaffold, amniotic membrane. In the near future, bioengineered corneas that could substitute for the full-thickness corneal graft should be expected.

Limber stem cells (LSCs) are responsible for the homeostasis and regeneration of the ocular surface epithelium. The loss of LSCs, known as limber stem cells deficiency (LSCD), is characterized by persistent corneal epithelial defects and vascularization, and even corneal melting and perforation at the late stages. The etiologies of LSCD can be genetic, acquired or idiopathic. The required surgical management for sever LSCD involves tissue or cell transplant therapies. However, similarly to other keratoplasty techniques, the major obstacle for allogeneic corneal limber transplantation is the widespread lack of donor corneas. One strategy to avoid this issue is to use feeder-free culture system to expand self-derived LSCs. You could find the latest advances regarding LSCs in the literature by Wang *et al.*

In summary, this special issue introduced the characteristics of different bioengineered corneas, and further discussed their application as corneal substitutes. It is our sincere hope that this special issue could generate excitement in those of us who are interested in the development and application of bioengineered cornea.

Acknowledgments

We thank Dr. Saiqun Li (from Zhongshan Ophthalmic Center, Sun Yat-sen University) for her many works at manuscript organization, collation and proofreading.
Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the editorial office, *Annals of Eye Science*, for the series "Bioengineering Cornea". The article did not undergo external peer review.

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/aes.2018.06.02). The series "Bioengineering Cornea" was commissioned by the editorial office without any funding or sponsorship. Both authors served as the unpaid Guest Editors of the series. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Weiyun Shi

Jin Yuan

Weiyun Shi[1,2], PhD
[1]*Chief Physician, Doctoral Supervisor; Director of Shandong Eye Institute, Qingdao 266071, China;*
[2]*President of Shandong Eye Hospital, Ji'nan 250021, China.*
(*Email: weiyunshi@163.com*)
Jin Yuan[3], MD, PhD
[3]*State Key Laboratory of Ophthalmology, Zhongshan Ophthalmic Center, Sun Yat-sen University, Guangzhou 510060, China.*
(*Email: yuanjincornea@126.com*)
Received: 20 May 2018; Accepted: 03 June 2018; Published: 23 July 2018.
doi: 10.21037/aes.2018.06.02
View this article at: http://dx.doi.org/10.21037/aes.2018.06.02

doi: 10.21037/aes.2018.06.02
Cite this article as: Shi W, Yuan J. Constructing bioengineered cornea for restoring vision. Ann Eye Sci 2018;3:42.

