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Fundamental and State-of-the-Art Technologies In Retinal Studies and Disease Repair

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Editorial

Carefully sculptured by evolution, the eye comprises complex yet beautifully organized tissues that work together for light sensing. The retina, a part of the eye representing an outside extension of the brain, plays a central role in photon detection, the conversion of light to neural codes, and the transmission of encoded neural information to the brain. Due to its importance in these processes, the retina has been studied for decades as a model of physiological and disease processes of the central nervous system. However, incurable blindness is still mainly caused by retinal degeneration.

The thematic goal of this methods collection is to provide highly reproducible and consistent methods for scientists and ophthalmologists dedicated to eye research. In line with this goal, six articles on novel or improved methods have been included and discussed in this collection. These articles cover methods including the monitoring of dynamic vessel growth under pathologic conditions, the human iPS differentiation into retinal organoids, the preparation of photoreceptor cell compartments, the *in vivo* evaluation of retinal ganglion cell (RGC) functions in large animals, the optimization of *ex vivo* electroretinogram (ERG) recording, and simplified adeno-associated virus (AAV) particle titration for therapeutic and research purposes.

Briefly, as part of this collection, Ma and Li[1] provide a technique for improved imaging analysis involving monitoring retinal vessel remodeling under oxygen-induced retinopathy (OIR) conditions, which will help in the study of a range of retinal vessel-related diseases, such as proliferative diabetic retinopathy (PDR), retinopathy of prematurity (ROP), and retinal vein occlusion (RVO). Guan et al.[2] describe an optimized retinal organoid induction protocol to generate retinal tissues with high reproducibility and efficiency, which will benefit disease modeling and cell therapy. Rose et al.[3] present a relatively quick and straightforward technique to enrich photoreceptor subcellular-specific protein fractions in normal rods, which can be adapted to isolate and quantitatively investigate the protein composition of other retinal layers from both healthy and degenerating retinae. Ye et al.[4] demonstrate the *in vivo* evaluation of RGCs and optic nerve (ON) structure and function in large animals, including goats and non-human primates, by using visual evoked potential (VEP), pattern electroretinogram (PERG), and optical coherence tomography (OCT), with the aim

of increasing experimental reproducibility and facilitating the usage of large animal models of optic neuropathies. Abbas et al.[5] optimize the setup and conditions for *ex vivo* electroretinograms to improve retinal function analysis and maximize the response amplitude and stability, thus allowing the quantification of the contributions of individual cell types in the isolated retina. These improvements facilitate the investigation of light responses in retina samples from large animals and human donor eyes. Lastly, Okan et al.[6] provide a digital droplet PCR (dd-PCR) method to quantify absolute adeno-associated virus (AAV) genome copy numbers in an injected retina with high precision. This method will greatly benefit the increasing number of gene-editing/therapy studies and industries that routinely use AAV vectors to transduce the host tissues. The method could also be potentially modified for the copy number quantification of mitochondrial DNA.

All the above articles in this methods collection describe state-of-the-art technologies targeting retinal physiology and disease mechanisms, and these technologies are particularly useful in the fast-developing field of retinal gene and cell therapy. However, these methods are not entirely straightforward, as there is considerable variation in reliability between labs and setups. Nevertheless, consistent improvements, as presented in this collection, will eventually lead to innovations in developing new tools and methodologies, thus enabling future challenges to be met and moving the field forward. In conclusion, this represents a successful methods collection that is of great interest to the audience in the field.

Disclosures

The authors have nothing to disclose.

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References

1. Ma, Y., Li., T. Monitoring dynamic growth of retinal vessels in oxygen-induced retinopathy mouse model. *Journal of Visualized Experiments.* (170), e62410 (2021).
2. Guan, Y., Xie, B. Zhong, X. Retinal organoid induction system for derivation of 3D retinal tissues from human pluripotent stem cells. *Journal of Visualized Experiments.* (170), e62435 (2021).
3. Rose, K., Lokappa, S. Chen, J. Two peeling methods for the isolation of photoreceptor cell compartments in the mouse retina for protein analysis. *Journal of Visualized Experiments.* (178), e62977 (2021).
4. Ye., Q. et al. *In vivo* methods to assess retinal ganglion cell and optic nerve function and structure in large animals. *Journal of Visualized Experiments.* (180), e62879 (2022).
5. Abbas, F., Vinberg, F., Becker, S. Optimizing the setup and conditions for ex vivo electroretinogram to study retina function in small and large eyes. *Journal of Visualized Experiments.* (184), e62763 (2022).
6. Okan, I., Ahmadian, M., Tutuncu, Y., Altay, H., Agca, C. Digital droplet PCR method for the quantification of AAV transduction efficiency in murine retina. *Journal of Visualized Experiments.* (178), e63038 (2021).