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Letter to the Editor

Advances in medical polymer technology towards the panacea of complex 3D tissue and organ manufacture

Dear Sir,

The intricacy of different organs and tissues, along with confounding factors linked with disease or trauma fundamentally requiring repair, is a challenge for medicine. Biomaterials, cells and growth factors are used to produce a construct for tissue replacement but not all tissues are the same architecturally or functionally.[1] New manufacturing techniques that fall under the banner of 3D printing enables design and manufacture of constructs that are architecturally closer to native tissue.[2] These techniques allow for the biofabrication of tubular tissues (the heart, urethra, blood vessel), viscus organs (pancreas) and solid systems (bones).[3,4] In its simplest form, these techniques print the scaffold upon which cells could be seeded. They can later be implanted into the body, however, the most exciting part of this technique is the ability to replicate the intrinsic detailing of any tissue or organ. Subsequentially generating a structure analogous to scanned tissue.

This technique known as 3D bioprinting opens the possibility to move from organ harvesting to organ manufacturing. This could potentially save millions of lives that are on the waiting list for organ transplantation. Furthermore, from a research point of view these printed tissues could be used as a platform to understand and explore different pathways that leads to diseases. This could include - cancer and testing drugs on real-time tissue systems instead of animal models. This more often than not results in failed clinical trials. Most drugs that have shown groundbreaking results in the animal usually under perform in humans. This is due to the species variation and the bioprinted organs can bridge this gap.

One of the exciting techniques that could be crucial in determining the functionality of printed organs or tissue is the precision of the cells than are printed. The capacity to deposit bioink filled with living cells at desired locations layer after layer to generate a 3D construct that architecturally resembles native tissue is going to be game changer. To successfully generate artificial tissues or organs, different factors can play a role such as temperature, humidity or viscosity of the material, printability and shape fidelity. However, techniques to place cells at exact positions as are in native tissues is critical. 3D printing is currently the only technology that can allow single cell deposition control which is excellent for multicellular organs in which each cell type has special or distinct functionality.

Like in case of the retina, in which retinal pigmented epithelium cells transport nutrients, water and ions along with phagocytosis of shed photoreceptor membrane along with absorbing lights and protecting the retina from photo-oxidation. Photoreceptors are specialized cells that respond to the light and pass information to the retinal ganglion cells (RGC)'s. These RGCs are the type of neurons that are located in the retina which collect information or signal for photoreceptor and transmits to the brain. The hierarchy of the cells is utmost important here and if cells are misplaces the newly formed tissue would be nonfunctioning. In such multicellular tissue, 3D bioprinting could provide the control that other tissue engineering techniques lack, that is the ability to spatially arrange the cells within the 3D construct to mimic the native tissue in its totality and not just in the physical and chemical form[5] as shown in Fig. 1.

References

1. Deepti Singh, et al. A biodegradable scaffold enhances differentiation of embryonic stem cells into a thick sheet of retinal cells. *Biomaterials*. Feb 2018;154: 158–168.
2. Kang Hyun-Wook, Lee Sang Jin, Ko In Kap, Kengla Carlos, Yoo James J, Atala Anthony. A 3D bioprinting system to produce human-scale tissue constructs with structural integrity. *Nat Biotechnol*. 2016;34:312–320.
3. Ferry PW, et al. Additive manufacturing of tissues and organs. *Prog Polym Sci*. 2012;37:1079–1104.
4. Mironov Vladimir, et al. Organ printing: tissue spheroids as building blocks. *Biomaterials*. 2009;30:2164–2174.
5. Lorber, et al. Adult rat retinal ganglion cells and glial can be printed by piezoelectric inkjet printing. *BioFabrication*. Dec 2013;6(1).

https://doi.org/10.1016/j.amjsurg.2018.05.012

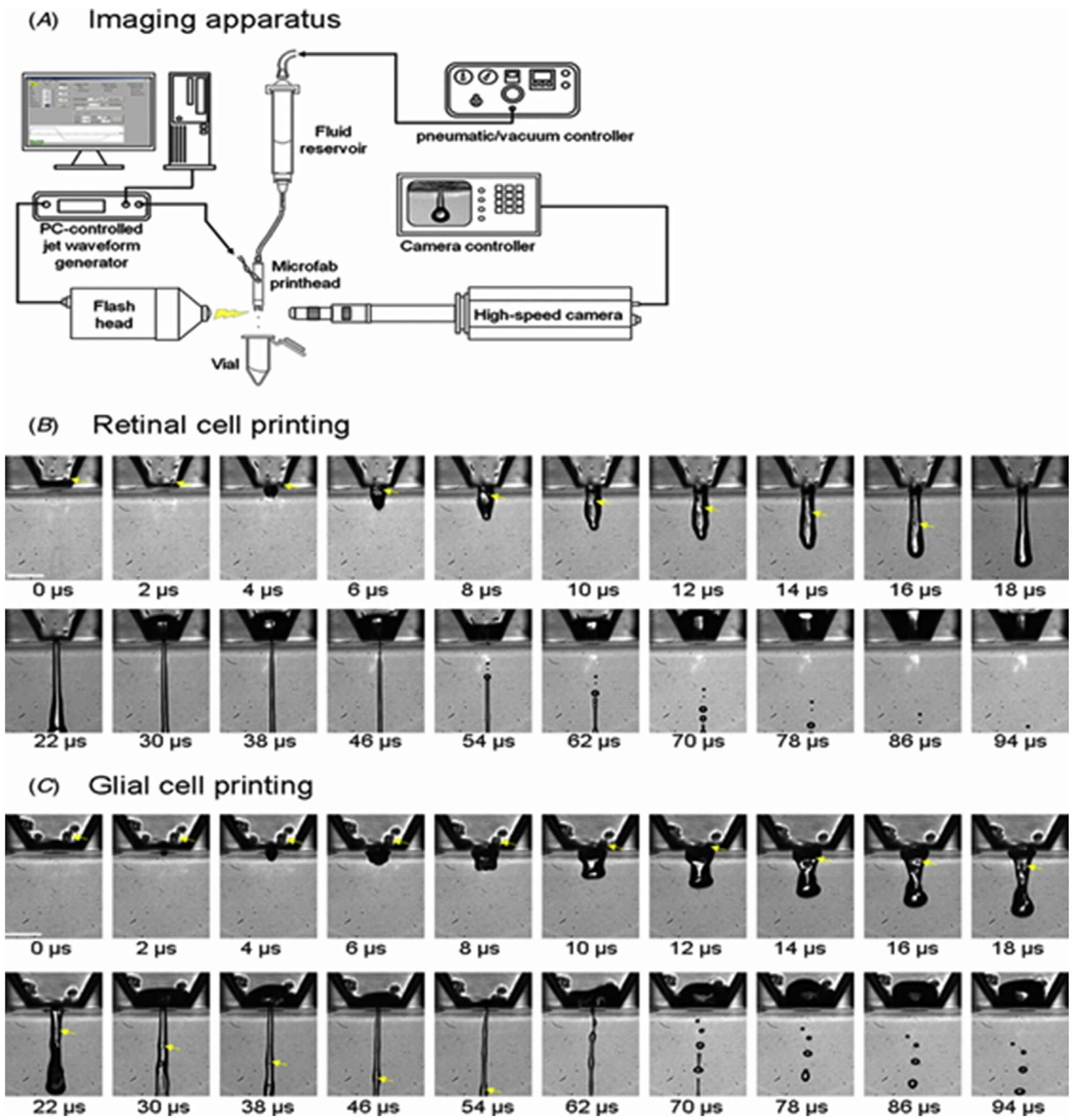

Fig. 1. Schematic representation of the inkjet 3D bioprinting and imaging that was used to study printing retinal glial (B) and other dissociated retinal cells (C). (Reprinted under creative commons attribution 3.0 licenses from ref [5].

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