Drug Evaluation on a Biomimetic Microfluidic Device

Wentao Shi, Yuyuan Zhou, Yaling Liu
Department of Bioengineering, Lehigh University
wes214@lehigh.edu, yuz917@lehigh.edu, yal310@Lehigh.edu

LEHIGH UNIVERSITY

Background

Traditional 2D tumor model for drug screening has several issues:

- **No drug concentration gradient**
- **Not accurately mimic an *in vivo* drug delivery environment**

Microfluidic devices serves as a platform for testing drug delivery on 3D tumor spheroid model:

- **Vessel-tumor interface can be mimicked**
- **Drug and nutrition gradients can be achieved**

Objective

This study attempts to utilize microfluidic devices to mimic vessel-tumor interface of a 3D tumor model, and test the effect of cancer drugs on the platform:

- **Build vessel-tumor interface model on a bilayer device**
- **Administrate anti-cancer drugs to the built 3D tumor model**
- **Analyze drug efficacy on tumor spheroid volume change in with Optical Coherence Tomography (OCT) and fluorescent images**

Methods and Materials

This study uses microfluidic devices constructed from glass and PDMS (Fig 1)

- **HCT-116 tumor spheroids were seeded into the devices basal channel in a 2:1 ratio of Matrigel and spheroid-media solution**
- **Two types of anti-cancer drugs were applied to HCT-116 spheroids under various concentrations**
- **OCT and fluorescent dye was used to evaluate the volume and cell death of the treated tumor spheroids in the channel (Fig 2 and Fig 4).**

Figure 1. Microfluidic Device Schematic

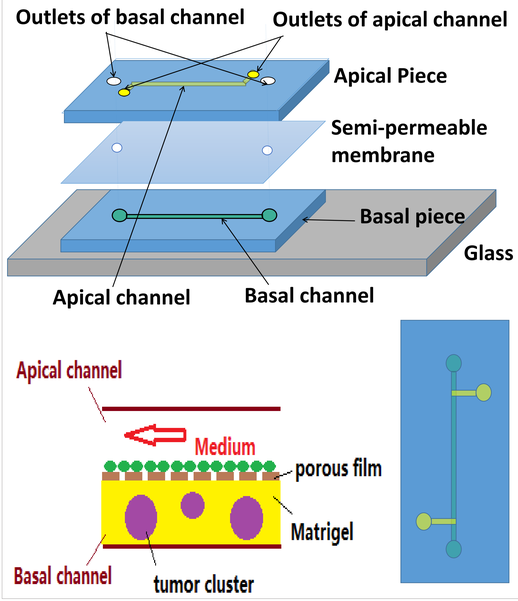


Figure 2. OCT Spheroid Scan

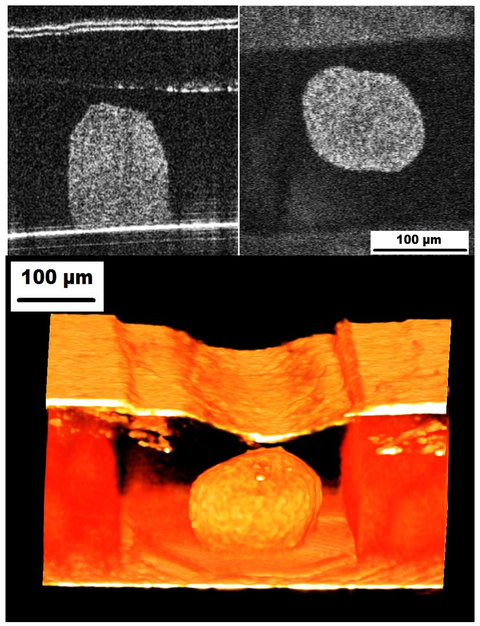


Figure 3. Drug Effect on HCT116 tumor spheroids

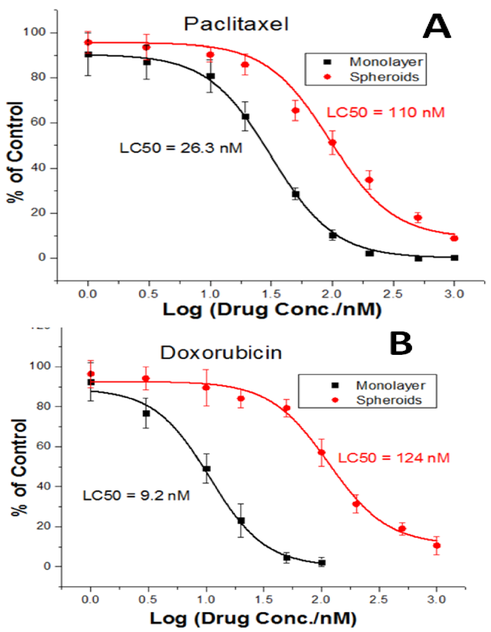
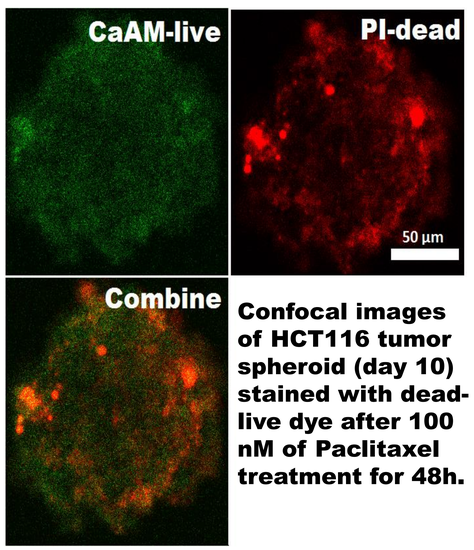


Figure 4. Dead-Live Staining of Treated Spheroids



Confocal images of HCT116 tumor spheroid (day 10) stained with dead-live dye after 100 nM of Paclitaxel treatment for 48h.

Results

- **OCT scanning shows a volume decrease of tumor spheroid with increased drug concentration**
- **3D tumor model shows an increase drug resistance comparing to the 2D tumor model**
- **Dead-live staining demonstrates an increase in dead cells on drug-treated spheroid surface (Fig 4).**
  - **Control spheroids exhibit higher quantity of live cells in the spheroid core.**

Conclusions & Discussion

- **Microfluidic devices proved to be a successful method for constructing biomimetic 3D tumor model**
- **This research serves as an initial step toward anti-cancer drug evaluation on chip**
- **Further studies using this model include:**
  - **The development of a more complex microfluidic system which more closely mimics the 3D tumor microenvironment**
  - **Implementing a drug auto-delivery procedure.**

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