Apr 1st, 11:00 AM - 2:00 PM

Cilia Have a Significant Role in Regulating Cell Size in Response to Fluid Flow Induced Shear Stress in a Flow Chamber

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Introduction

- Cilia are hair-like protrusions on the apical surface of many different cells, and are used for relaying information from the outside world to the cell, or can be used for movement of materials moving along the surface of the cell.
- Cilia regulates cell size in response to shear stress and disorders such as Polycystic Kidney Disease (PKD) interferes with that ability.
- A custom designed parallel plate flow chamber can be used to simulate physiological flow conditions in order to study ciliary function in different cells.

Purpose

This current study finds the optimal fluid flow conditions and presents morphology data in order to build a case for studying PKD cells with the custom flow chamber.

Methods

- A fluid flow chamber and accompanying system that continually maintains steady, laminar, and temperature controlled conditions was used, and can be seen in **Figure 1**.
- Endothelial Wild Type (ETWT) and PKD Cells were grown in a controlled environment to be used in all stages of analysis.
- Both types of cells were studied before and after being exposed to phosphate-buffered saline moving at the optimal flow rate.
- After these experiments were conducted, NIS microscope software was used to study the morphology of the cells.

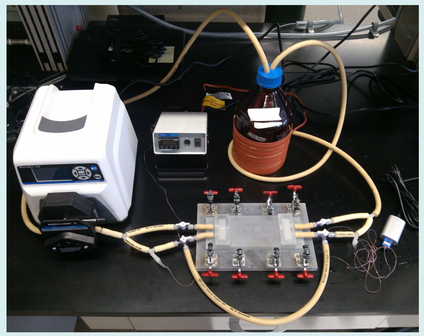

Figure 1: Flow chamber set up and accompanying system.

Results and Discussion

- The results from protein concentrations (n=12), seen **in Figure 2**, indicate that cells are still attached at normal physiological flow rate 467 mL/min (2.8 µg/µL) and did not significantly differ from 60 mL/min (4.08 µg/µL) or 600 mL/min (2.73 µg/µL).
- The results for duration of fluid flow (n=22), as seen in **Figure 3**, show that 60 minutes (0.09 ± 0.01 µg/µL) is optimal compared to 120 minutes (0.06 ± 0.01 µg/µL) or 180 minutes (0.10 ± 0.02 µg/µL).
- Under these optimal conditions, the average area of ETWT cells (n=300) measured from different slides before and after the flow is 4420.81± 67.40 µm^2 and 4678.17 ± 87.15 µm^2 (n=200) respectively. For PKD cells, the average area before and after the flow (n=300) is 5682.46 ± 105.48 µm^2 and 4173.74 ± 263.97 µm^2 (n=250). A comparison can be seen in **Figure 4**.

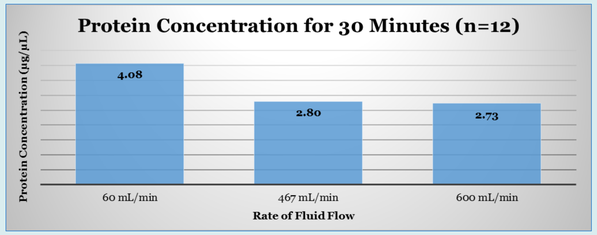

Figure 2: We found that the optimal flow rate is 467 mL/min.

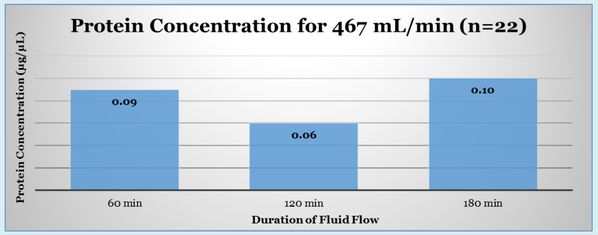

Figure 3: We found that the optimal duration is 60 min.

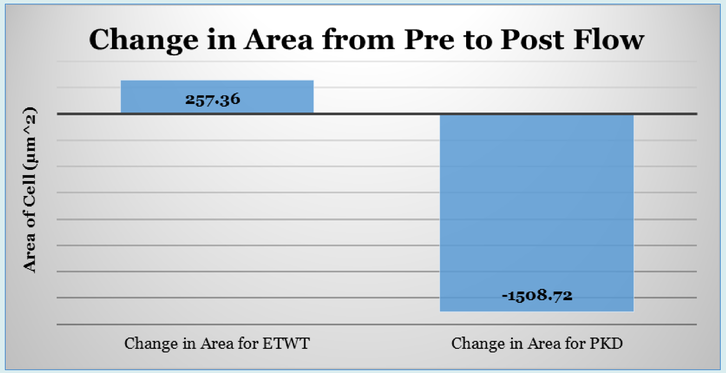

Figure 4: Shows the comparative changes in area for the ETWT cells as compared to the PKD cells. There is a much larger difference in the area of PKD cells in response to flow compared to ETWT cells.

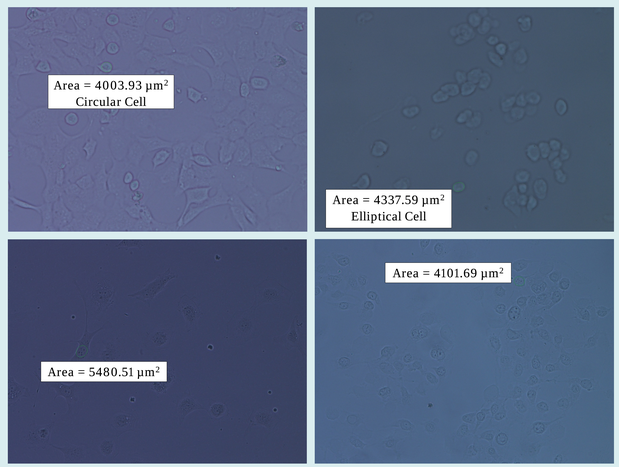

Figure 5: ETWT Cells Pre- (Top Left) and Post-Flow (Top Right), and PKD Cells Pre- (Bottom Left) and Post-Flow (Bottom Right). These are pictures of the cells' apparent change in morphology for both types.

Conclusions

- The optimal fluid flow conditions were found to be 467 mL/min for 60 minutes; using these conditions we found the ETWT cells to increase in area and change shape while the PKD cells decreased in area.
- These results provide confirmation that the custom designed parallel plate fluid flow chamber is a reliable tool to investigate the specific targets in the mechano-chemical cell signaling pathways.
- Future studies may use the conclusions we have come to in order to further understand PKD and how to best treat affected cells.