Assessing the Feasibility of Ureter Engineering using Rotational Internal Flow Layer Engineering (RIFLE)

A Novel Biofabrication Method for Tissue Engineering

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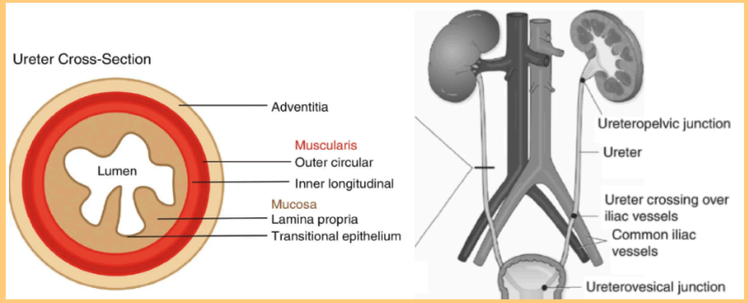
1) INTRODUCTION

- Ureters can be damaged by diseases or injuries. Current treatment techniques, including artificial, non-living tubes lead to inflammation
- Bioengineering living tubes with the properties of natural tissue would be a potential way to reconstruct the ureter which is composed of three distinct layers (adventitia, muscularis, mucosa)



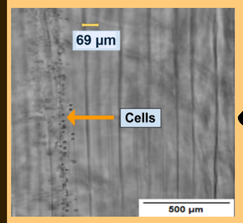
- Existing 3D printing with low resolution cannot effectively generate a finely layered structure of ureter that is 1.5-6 mm in diameter.
- RIFLE can create layered tubes with each layer tuneable from one cell thick to hundreds at high density cell layers

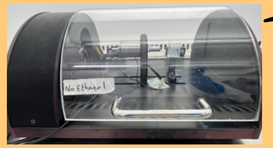
2) MAIN OBJECTIVE

Using RIFLE to generate tubes with MDCK cells (representative of urinary tissue) encapsulated in alginate layers.

3) METHODOLOGY

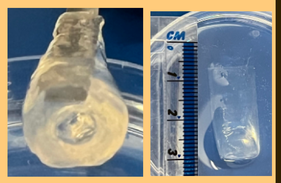
Microscale layers of RIFLE tubes



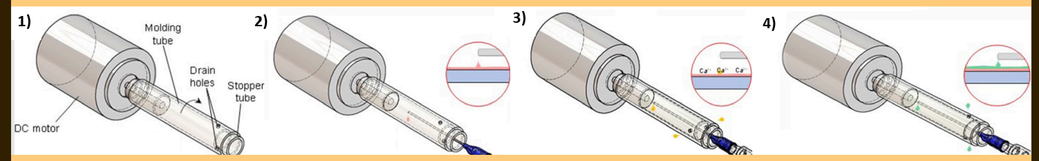


RIFLE

Macroscale of RIFLE Tubes



4) RIFLE PROCESS



Molding tube mounted onto motor shaft and rotated at high speed (8000 rpm)

A small volume of 1% alginate is added to the inner rotating surface

Addition of a gelation process, such as calcium chloride gels the alginate

Repeated operations builds up a multilayer thin film tube

5) RESULTS

a) MDCK Cells' Viability in Alginate Layers

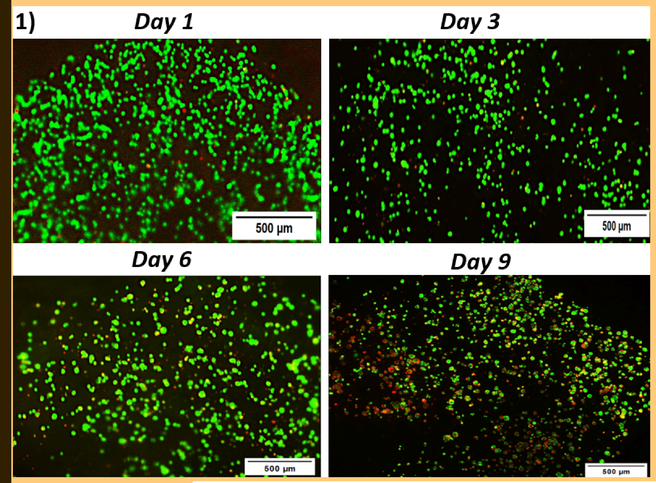
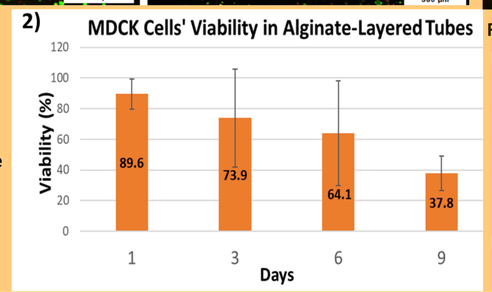


Figure 1- MDCK cells encapsulated within alginate layers using RIFLE. Sections of the tube were stained with live/dead staining



b) Cell Positioning

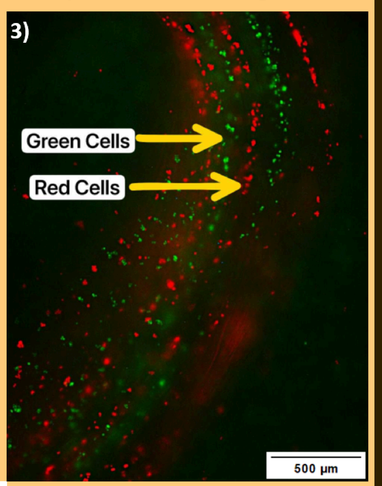


Figure 3 - Patterned layers made using prelabelled red and green MDCK cells (10^6 cells per ml)

Figure 2 - Plot of MDCK cells' viability data, n=3

6) CONCLUSION

- MDCK cells survived in alginate until day 9. The decline in their viability suggests that alginate is not a suitable material for ureter tissue engineering
- The cell layer remains distinct from the surrounding adjacent layers, suggesting the ability to form heterogeneous composite layered structures

7) FUTURE DIRECTIONS

Using RIFLE to fabricate ureter-like tissues by co-culturing different cell types within collagen layers such as fibroblasts (adventitia), smooth muscle cells (muscularis), and MDCK (urothelium)

8) REFERENCES

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9) ACKNOWLEDGEMENTS

Biomedical Teaching Organisation (BMTO), Sneha Ravi, Natalia Penar, Orla McArthur, Rhiannon Beadman, Louise Goossens,