3D Printed Intra-Vaginal Rings by Fused Filament Fabrication Technology for the Delivery of Nanomedicine as a Strategy to Prevent HIV Infection

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Abstract

It is estimated that over 36.9 million people are infected by the Human Immunodeficiency Virus (HIV) and almost 25% of these people are unaware of their HIV status. Although efforts are made to bring down these number, the number of new infection still continues to be on the rise. Additionally, during a heterosexual intercourse, women are more prone than men to be infected by HIV due to the increased area of . In the recent years, microbicides has emerged as promising prophylactic regimens to help control the transmission of HIV. Yet, the tedious dosing regimen and presence of vaginal inflammation greatly diminishes the efficacy of the microbicides. In our study, we hope to develop a nanomedicine formulation of tenofovir (TFV) conjugated with anti-CD4 antibody and acetylsalicylic acid (ASA) loaded on a 3D printed scaffold for an extended release.

Hypothesis

We hypothesize that our scaffold-nanoparticle system will actively target the delivery of TFV and ASA into the CD4+ T lymphocytes over an extended period, thereby reducing the activation of T cells and reducing HIV infection.

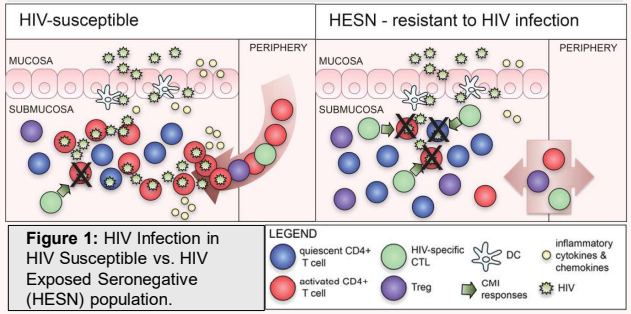
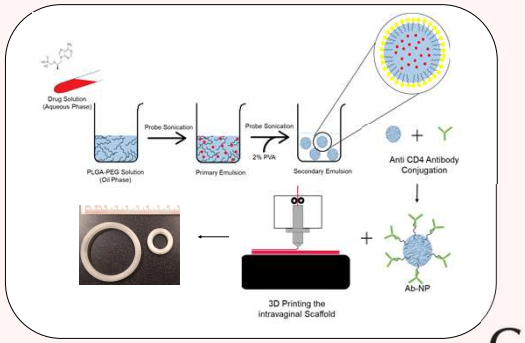


Figure 1: HIV Infection in HIV Susceptible vs. HIV Exposed Seronegative (HESN) population.

Card, C.M., Ball, T.B. & Fowke, K.R. Immune quiescence: a model of protection against HIV infection. Retrovirology 10, 141 (2013). https://doi.org/10.1186/1742-4690-10-141

Methodology



Results

	Size (nm) ± SD	Zeta Potential (mV) ± SD
Pre Antibody Conjugation	249.06±7.17	-34.08±1.13
Post Antibody Conjugation	313.91±14.48	-35.13±3.47

Figure 2: Nanoparticle Size (nm) and Zeta Potential (mV).

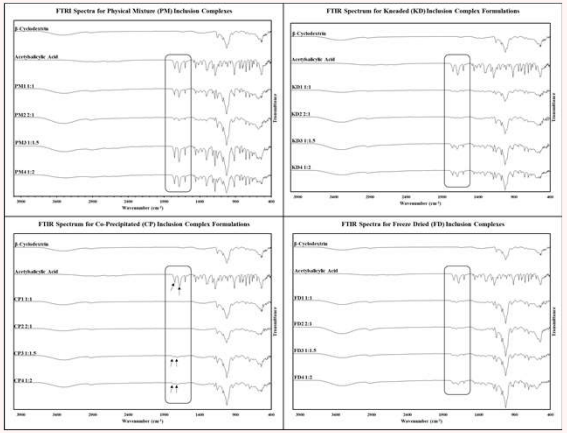


Figure 3: FTIR Spectrum of ASA-β Cyclodextrin (CD) Inclusion Complexes.

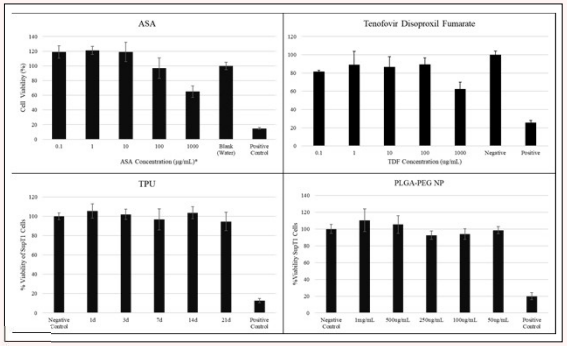


Figure 4: Cytotoxicity Data using MTS Assay on Sup-T1 Cell Line.

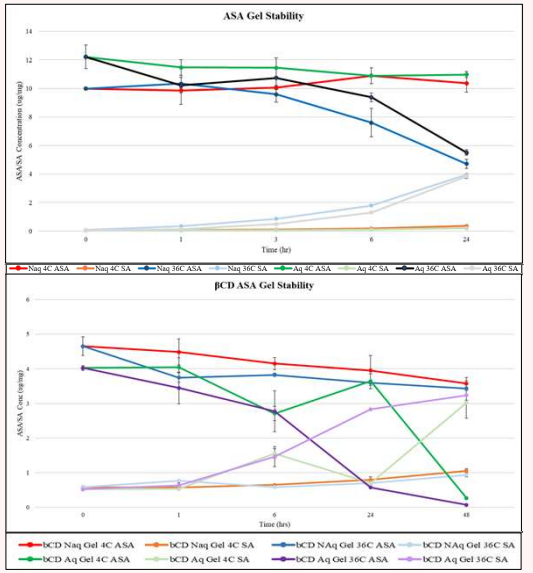


Figure 5: Stability of various ASA & ASA-Inclusion complex gel preparations at different temperatures.

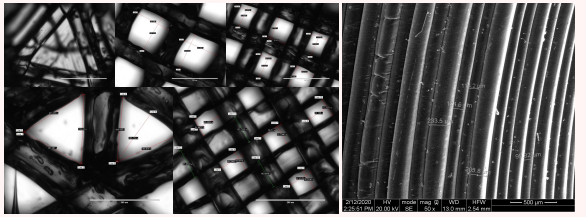


Figure 6: Left: Light microscope images of various infill patterns (20x). Right: SEM Imaging of 3D Printed IVR Wall segment (50X).

Future Directions & Conclusion

Various design parameters will be assessed to obtain optimal and extended release profile of the drug molecules. The activation and suppression of the production of the pro-inflammatory cytokines will be evaluated to determine the efficacy of the 3D Printed drug delivery system. This is the first study to evaluate the efficacy of 3D-printed scaffolds for the combination delivery of TFV and ASA-loaded nanoparticles for the prevention of HIV infection. The availability of a safe and efficacious microbicide formulation for woman can empower them and help control the spread of HIV infection drastically.