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Drug-eluting nanofibers as a dual-protection contraceptive microbicide

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OBJECTIVES

We create biodegradable nanofiber matrices uniquely suited for multipurpose prevention strategies. To demonstrate the power and flexibility of this new technology, we electrospin nanofibers that encapsulate molecules with action against HIV and sperm. This nanofiber matrix acts as a chemical and physical barrier that can protect both the cervix and vagina against sexual HIV transmission and pregnancy.

METHODS

By electrospinning blends of poly-L-lactic acid (PLLA) with modifying polymers, we fabricated biodegradable nanofibers embedded or coated with individual model compounds exhibiting action against HIV-1 or sperm. We controlled electrospinning parameters to achieve high drug loading, desired scaffold morphologies and degradation rates, and appropriate release rates for the individual agents. Image analysis of SEM micrographs provided morphological analysis of fiber size. We monitored nanofiber degradation in variable pH with SEM and mass measurements. UV-HPLC and colorimetric/fluorometric spectroscopy methods quantified drug loading and release kinetics.

RESULTS

We assembled composite nanofiber matrices and showed sustained and simultaneous release of multiple bioactive agents. We assayed the drug-loaded vaginal matrices for cytotoxicity and anti-HIV-1 activity using the TZM-bl reporter cell line, and for spermicidal activity by measuring the acrosome reaction and sperm motility. We observed that the composite vaginal matrices inhibited HIV-1 infection and sperm function in a dose-dependent manner.

CONCLUSION

This is the first report demonstrating that drug-eluting nanofibers can be effectively designed to provide chemical and physical barrier methods for dual HIV-1 prevention and contraception. This novel vaginal drug delivery platform could potentially be used to prevent other STIs or RTIs alone and in combination.