B52 The Forensic Value of Electrospun Nanofiber Mesh for Sexual Assault Samples

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Learning Overview: After attending this presentation, attendees will understand the forensic value of electrospun nanofiber mesh in sexual assault casework.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by explaining the potentially groundbreaking idea that electrospun nanofiber mesh could aid in the separation of sperm cells from female epithelial cells in sexual assault samples.

According to the Bureau of Justice Statistics of the U.S. Department of Justice, approximately 323,450 rapes/sexual assaults took place in 2016.[1] The current methodology for separating the DNA of the perpetrator from that of the victim is the same methodology originally described in 1985. It is the current standard for sexual assault cases. However, that is not to say that it is without weaknesses. It is labor-intensive; some sample is lost during the washes and carryover occurs between the male and female fractions.[2]

Electrospinning is a technique that results in the production of nanofibers of different materials in various fibrous formations. The porosity of the resulting nanofiber formations is controllable. The head of a human sperm cell has a cross-section of approximately 5 µm by 3 µm. The vagina is lined with a 0.2 mm thick layer of squamous epithelial cells that is composed of four layers with the following epithelial cell diameter dimensions: superficial–50-60 µm, intermediate–30-50 µm, parabasal–approximately 20 µm, and basal–12-14 µm.[3] Based on these dimensions of both sperm and epithelial cells, electrospun nanofiber meshes could be designed with a specific porosity for discrimination between sperm cells and epithelial cells in a mixed sample based on size. It would allow the transport of sperm cells across the mesh, while simultaneously acting as a barrier to keep the epithelial cells from permeating.

The goal of this research is to accomplish the development of an electrospun nanofiber mesh with proper dimensions and adequate strength to separate sperm cells from epithelial cells based on size without lysing the cells in the process. Accomplishing a successful mechanism for doing so would result in cleaner differential extraction results, and therefore, cleaner profiles for a DNA analyst to interpret. This would eliminate the subjectivity associated with current analysis and interpretation due to the carryover between the male and female fractions. This would ultimately give electrospun nanofiber meshes relevance within the field of forensic science with the goal of assisting in determining the perpetrators in the hundreds of thousands of sexual assaults that occur annually within the United States.

Reference(s):

1. Morgan, Rachel E., and Kena, Grace. “Criminal Victimization, 2016.” December 2017. https://www.bjs.gov/content/pub/pdf/cv16.pdf.
2. Butler, John M. *Advanced Topics in Forensic DNA Typing: Methodology.* Gaithersburg: Elsevier Science, 2011.
3. Casallas, Luz H.C.. “Classification of Squamous Cell Cervical Cytology.” Thesis, Universidad Nacional de Colombia, 2012.

Nanofiber Mesh, Sexual Assault, DNA Analysis