MICROFLUIDIC STR-TYPING SYSTEM FOR SAMPLE-TO-PROFILE OF SEXUAL ASSAULT SAMPLES

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Analysis of sexual assault case samples using the STR-typing process is broadly used in molecular forensic analyses. Due to the necessary separation of sperm and epithelial cells this lengthy process requires experienced laboratory technicians to carry out the protocol. To simplify the implementation of this process, it is desirable to use advances in microfluidics technology and system engineering to build a platform that involves fully integrated disposable cartridges which can be used by minimally trained operators and increase throughput capabilities with greater reproducibility of the test.

A fully automated microfluidic system for rapid sample preparation and STR typing of sexual assault samples has been developed, and validation data obtained from mixtures of different ratios of sperm and epithelial cells will be reported. Using commercially available reagent kits for magnetic bead DNA capture, DNA quantification, and STR-typing, an instrument platform was assembled that uses disposable cartridges performing the entire work-flow starting with the differential extraction of DNA from sperm and epithelial cells to the chip-based 5-color capillary electrophoresis (CE) detection. The entire process from sample elution to obtaining the STR-profile takes approximately four hours. The extraction and sperm/epithelial cell separation efficiency results compare favorably to the conventional phenol/chloroform DNA extraction method. A commercially available 16-plex PCR assay (Identifiler™ from Applied Biosystems) was successfully used for the system. The challenges of efficient chip-based integration of the STR-typing processes will be discussed as well as the advantages and limitations of the eventual implementation of such technology for casework.

To allow large volume and cost effective fabrication of the disposable STR-typing plastic cartridges, scalable manufacturing processing using injection molding and cold bonding were developed for the full assembly of the microfluidic devices. The feasibility of performing an automated STR-typing process on such integrated all-polymer microfluidic system was demonstrated, establishing the possibility of building a reliable low to medium throughput, sample-to-profile system.

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