High-Performance Forensic DNA Profiling Using Fluorescence Energy Transfer Primers and a 96-Lane Microfabricated Capillary Array Electrophoresis Device

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Short tandem repeat (STR) typing is a powerful tool for forensic identification due to the unique profile it generates for an individual as a result of the highly polymorphic nature of STR markers. Polymerase chain reaction (PCR)-based STR analysis followed by electrophoretic separation of the amplified products allows simultaneously amplification and analysis of multiple loci and is the gold standard for human identification. We present a 96-channel microfabricated capillary array electrophoresis (μCAE) device for fluorescence energy-transfer (ET) dye labeled short tandem repeat (STR) genotyping. The high-throughput μCAE system produced high-speed (<30 min), highly parallel DNA separations with single-base resolution. We explore the use of the universal ET cassette labeling method for high-performance STR analyses and developed an ET 16-plex following the primer sequences and fluorescent color scheme used in the single-dye labeled commercial STR typing kit PowerPlex 16. The superior spectroscopic properties and performance of the ET 16-plex to detect low-level DNA samples, the minimum amount of DNA for obtaining a complete profile as well as the degree of heterozygote allele balance were determined and compared to those of PowerPlex 16. The practical advantages of ET 16-plex kit was demonstrated to successfully type non-probative forensic casework samples. The pairing of ET cassette technology with the μCAE system illustrates an advancement of forensics by providing rapid, high-sensitivity and high-throughput STR analysis.