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DNA Evidence in Property Crimes: An Analysis of More than 4200 Samples Processed by the Brazilian Federal Police Forensic Genetics Laboratory

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Abstract. DNA evidence is nowadays used for the investigation of a wide range of crimes. Once reserved mostly for violent cases such as rape and murder, biological material recovery is not only restricted to such crime scenes anymore. As DNA technology is getting cheaper and its results faster, there has been a growing interest in using DNA to help solving volume crimes, mostly property crimes. In this work, an analysis of more than 4200 samples of biological material recovered from more than 1000 cases of property crime offenses processed by the Brazilian Federal Police Forensic Genetics laboratory is described. Most of the property crime offenses included: (1) Automated Teller Machine (ATM) thefts, skimming or Personal Identification Number (PIN) capturing scams, (2) post office burglaries or armed robberies, (3) Federal government buildings burglaries. Success rate at DNA recovering and STR typing showed great variability, mostly due the nature of biological

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source, but an average of 52% of samples presented usable DNA and in 44% of the cases at least one genetic profile reached the minimal criteria for insertion in CODIS. Results obtained in this work showed what types of evidence are usually collected in property crimes and which ones provide the best results for DNA typing. These results can be used to better guide crime scene evidence collection practices in property offenses, making it more efficient and cost effective.

Keywords: Property crimes; Short tandem repeat; Crime scene; Brazil; Forensic DNA.

1. Introduction

DNA fingerprinting has revolutionized the forensic sciences in the last 25 years, contributing enormously to police investigations and court proceedings[1,2]. DNA evidence analysis is now widely accepted as a standard forensic technique for the investigation and detection of a wide spectrum of crime types, from lesser to violent crimes, such as rapes and murders[3,4]. As DNA technology is getting cheaper and results faster, there has been a growing interest in using DNA to solve a broader range of crimes, including volume crimes. Property crime has a significant impact on society, as property is usually stolen or damaged. It is estimated that property crimes of motor vehicle theft, arson, household burglary, and larceny/theft generated per-offense tangible costs between $3,523 and $16,428[5]. Moreover, it may also cause great psychological and emotional damage on its victims.

Property crimes are high-volume crimes, usually committed by very prolific criminals, which have the potential to escalate their offenses to violent crimes if not stopped earlier in their criminal careers. A previous study showed that property crime cases where DNA evidence was processed had more than twice as many suspects identified, twice as many suspects arrested, and more than twice as many cases accepted for prosecution compared with traditional investigation[6]. However, cost implications and the burden that such analysis can bring to DNA laboratories and Police forces is something to consider[7]. In this sense, it is important to establish which DNA evidence usually found in property crimes provide the best results for DNA typing and use this information to better guide crime scene processing and evidence collection practices in property offenses, making it more cost effective.

Differently from violent crimes, where blood is usually found, in property crimes, DNA evidence are frequently originated from objects that have been touched by criminals. These samples can sometimes generate complex DNA profiles, due to its low DNA content, degradation or mixture.

In this work, we report an analysis of more than 4200 samples of biological material recovered from more than 1000 cases of property crime offenses processed by the Brazilian Federal Police Forensic Genetics laboratory over the period 2011-2016. Most of the property crime offenses included: (1) Automated Teller Machine thefts, skimming or Personal Identification Number capturing scams, (2) post office burglaries or armed robberies, (3) Federal government buildings burglaries.

2. Methods

2.1 Property crimes

This study is restricted to property crime cases submitted to the Forensic Genetics Laboratory for DNA analysis over the period 2011-2016. Property crime cases were included in four categories: (1) ATM thefts, skimming or PIN capturing scams, (2) post office burglaries or armed robberies, (3) Federal government buildings burglaries and (4) Miscellaneous. A total of 1072 cases were considered in this study.

2.2 Types of samples collected

Samples were recovered from 3655 evidence items sent to the lab for processing. The biological material recovered from evidence items was classified as (1) touch – material from items touched or handled by the criminal; (2) clothing – items worn by the criminal, such as clothing, gloves and masks; (3) blood, (4) oral/saliva samples – items that had contact with the criminal´s mouth, such as bottles, cups and cigarette butts; (5) hair; (6) fecal matter and (7) others.

2.3 DNA extraction

DNA was extracted from a total of 4273 evidence samples by the organic extraction method or using Prepfiler Express DNA Extraction kits on the Automate Express (Life Technologies).

2.4 DNA quantification

After DNA extraction, all samples were quantified by real-time Polymerase Chain Reaction (PCR) using Quantifiler Human DNA quantification kit (Life Technologies) or Plexor HY (Promega).

2.5 Short tandem repeat - autosomal STR amplification

Samples showing a DNA concentration higher than 0.01 ng/µL were amplified using the Short Tandem Repeats (STR) amplification kits PowerPlex 16 HS (Promega) or Identifiler Plus (Life Technologies) as recommended by manufacturers.

2.6 DNA electrophoresis

Amplification products were separated by capillary electrophoresis and detected in an ABI 3130, ABI 3100 Avant or ABI 3500 Genetic Analyzers (Life Technologies). Profile interpretation was performed using Genemapper ID 3.2 or Genemapper ID-X softwares (Life Technologies). Analytical and stochastic thresholds were determined and used for each STR kit and instruments.

2.7 Databasing

Genetic profiles presenting at least nine of the following genetic markers were uploaded into the Brazilian Federal Police CODIS database: D3S1358, D5S818, D7S820, D8S1179, D13S317, D16S539, D18S51, D21S11, CSF1PO, FGA, THO1, TPOX and vWA. Only profiles originated from a single individual were uploaded into the database. For DNA mixtures, when the major contributor´s profile could be inferred after deconvolution, it was also uploaded into the database.

3. Results

3.1 Types of crimes

DNA evidence collected in property crime offenses was sent to the DNA laboratory for analysis. ATM thefts, skimming or PIN capturing scams represented 39% of the cases, post office burglaries or armed robberies also

represented 44%. Federal government buildings burglaries represented 4% and 13% were related to miscellaneous cases.

3.2 Evidence items

Samples were recovered from 3655 evidence items sent to the lab, resulting in 4273 samples processed. An average of 3.4 evidence items per case were sent to the lab, resulting in an average of 4 samples processed per case. However, in more than sixty cases, ten or more items were sent to the lab. In one particular case, 69 evidence items were sent to the lab for processing, resulting in a standard deviation of 4.6 items and 4.7 samples.

3.3 Biological material

The most frequent biological material recovered from items was touch/contact DNA (45.8%), followed by material recovered from worn clothing (22.8 %). Blood represented 14.6% of samples and oral/saliva samples 10.8%. Hairs (4.1%), fecal matter (0.7%) and others (1.1%) were less frequently observed (Table 1).

Table 1. Biological material recovered from evidence items.

Biological evidence	n	%
Touch/handled	1957	45.79
Clothing	975	22.81
Blood	623	14.57
Saliva	464	10.85
Hair	177	4.14
Faeces	30	0.70
others	47	1.09

3.4 DNA quantification

Approximately 52% of all samples processed met the minimum threshold limit for autosomal STR amplification (0.01 ng/µL). More than 94% of blood samples and 67% of saliva samples presented DNA concentrations above the validated thresholds for STR amplification (Table 2).

Table 2. Samples that met the minimum threshold for STR amplification of 0.01 ng/µL.

Biological evidence		**DNA**
	% (total - n)	**% (DNA >0.01 ng/µL - n)**
Touch/handled	45.80 (1957)	37.14 (727)
Clothing	22.81 (975)	56.82 (554)
Blood	14.58 (623)	93.90 (585)
Saliva	10.85 (464)	67.24 (312)
Hair	4.14 (177)	13.56 (24)
Faeces	0.70 (30)	0.3 (9)
others	1.10 (47)	14.90 (7)
Total	100 (4273)	51.91 (2218)

3.5 Autosomal STR amplification

Autosomal STR amplification results of the samples that presented DNA concentrations >0.01 ng/µL showed that 82% of blood samples and 35% of saliva samples that presented yielded single source full genetic profiles (Figure 1). Almost 50% of touch DNA genetic profiles were partial or presented low quality (Figure 1). Besides, 37% of touch DNA profiles resulted in mixtures. Only 10% of touch DNA profiles were single source full STR profiles. Hair and feces were the less frequent evidence, resulting in 36% and 25% full profiles, respectively (Figure1).

When the total number of samples processed for each type was analyzed (Table 3), taking into consideration the DNA concentration obtained and the genetic profile obtained, it was observed that 93.9% of blood samples presented DNA above the established threshold and 77.4% resulted in full profiles. 67.2% of saliva samples presented DNA above the limit, however, only 26.94% resulted in full profiles. The worst results were obtained for touch/contact, hair and faeces (Table 3).

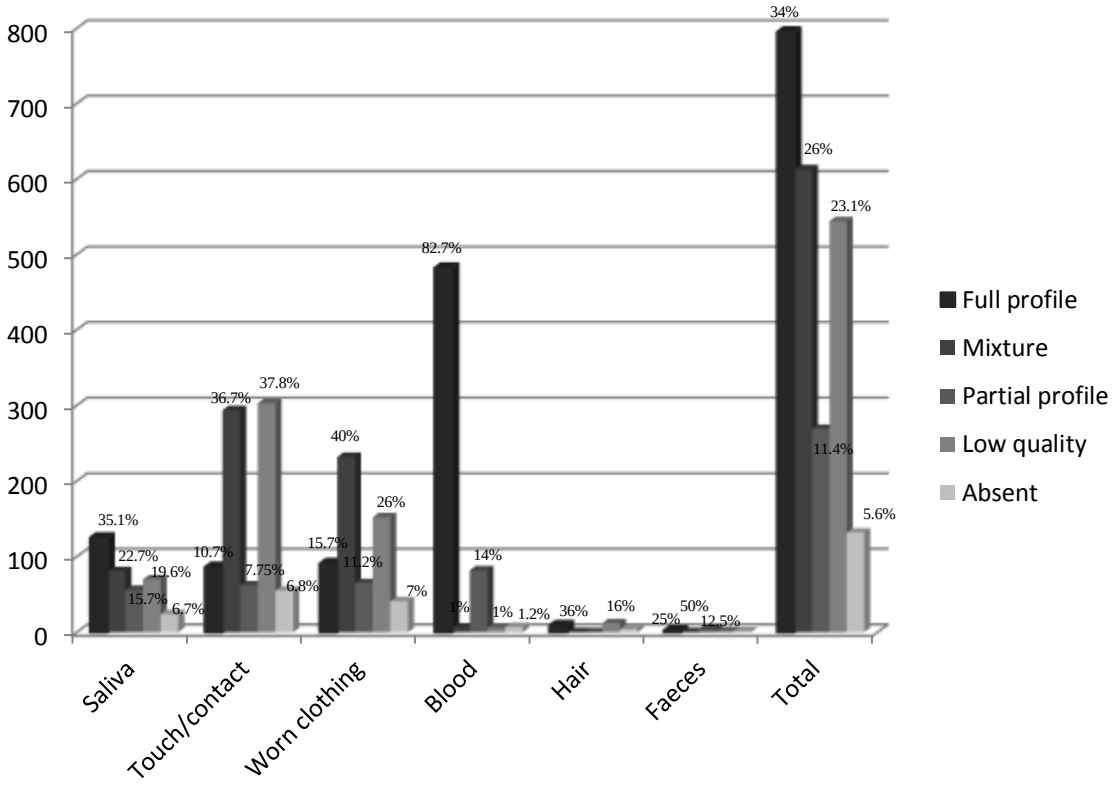

Figure 1. Genetic profiles obtained from different types of biological evidence categorized according to quality. Percentages shown are only related to samples that presented DNA concentrations >0.01 ng/µL and were then PCR amplified.

Table 3. Results obtained for all samples processed.

Sample type	**Total**	**DNA [>0.01ng/µl)**		**Full profile**	
	(n)	(n)	(%)	(n)	(%)
Saliva	464	312	67,24	125	26,94
Touch/contact	1957	727	37,15	86	4,40
Worn clothing	975	554	56,822	91	9,33
Blood	623	585	93,90	482	77,40
Hair	177	24	13,56	9	5,08
Faeces	30	9	0.30	2	6,7
Others	47	7	14,9	0	0
Total	4273	2218	51,91	795	18,6052

3.6 Suspect identification

In 134 cases, a suspect was identified and reference samples were sent to the laboratory for testing. In 53 of these cases, at least one match was observed between the suspect and the forensic samples.

DNA databasing

At least one genetic profile was entered into the DNA database (CODIS) in 44% of the cases. Most of the genetic profiles entered into the database were from blood samples (Table 4). So far, 32 matches between profiles obtained from evidence items collected from different crime scenes were observed (forensic hits). Samples that resulted in hits were cigarette butts, blood samples, touch DNA samples, drinking vessels, clothing and gloves left at the crime scenes.

Table 4. Genetic profiles uploaded into the DNA database according to its biological origin.

Biological evidence	Genetic profiles uploaded
Blood	223
Worn clothing	145
Saliva	124
Touch/contact	107
Hair	7
Faeces	4
Total	610

4. Conclusions

DNA testing of biological evidence collected from property crimes can be an important tool for the identification of perpetrators. A previous study has shown that with the use of DNA testing in these types of crimes, more than twice as many suspects were identified, twice as many suspects were arrested and more than twice as many cases were accepted for prosecution[6].

In this work, we have analyzed results obtained for more than 4200 property crime samples processed in our laboratory. An average of 3.4 items per case were sent to the lab for analysis, with a standard deviation of 4.6 items. However, in some cases, dozens of items were sent for processing. In

one particular case, 69 items were sent to the laboratory, indicating the need for better evidence item selection for DNA testing by the crime scene examiners (CSE). Results have shown that CSEs must be trained to better identify and collect biological evidence from property crimes. As many DNA laboratories already have backlogs of biological evidence to process from violent crimes, the analysis of biological evidence from property crimes will increase the burden if not properly done, creating even greater backlogs.

Results obtained in this work showed what types of evidence are usually collected in property crimes and which ones provided the best results for DNA typing. Touch/contact DNA (45.8%), followed by material recovered from worn clothing (22.8%), were the most frequent biological material recovered form items. Differently from violent crimes, where blood is usually found, criminals only left blood on the crime scenes in 14.6% of the cases, mostly due to injuries during the breaking in process.

After DNA extraction, all samples had their human DNA content estimated by Real time PCR. 94% of blood samples presented DNA above the minimum established threshold (0.01 ng/µL) (Table 2). Hair (4.14%) and faeces (0.70%) were the less collected evidence (Table 1), and presented the worst results concerning its DNA content, only 13.6% and 0.3% of samples (Table 2), respectively, contained DNA above the established threshold. As previously shown, blood and saliva samples were much more likely to yield usable DNA profiles[7]. Blood (77.4%) and saliva (27%) samples were much more likely to yield usable DNA profiles than samples taken from touched/handled items (4.4%) or clothing (9.33%) (Table 3). Touch and clothing together represented more than 63% of the samples analyzed. However, they represented only 22% of the single source full profiles obtained. Due to the nature of the evidence, a great deal of mixture profiles were obtained for touch (37%) and clothing (40%) (Figure 1). Only 1% of mixture profiles were observed for blood.

In 44% of the cases, at least one profile was uploaded into our DNA database. Even with profiles generated from blood samples being the majority of the profiles uploaded into the database (36%), they represented only 31% of the samples with forensic hits, showing the importance of collecting other types of evidence in these types of crimes.

Results obtained in this work can be used to better guide crime scene evidence collection practices in property offenses, helping to establish guidelines for the training of crime scene officers. Moreover, it shows the outcomes of every type of evidence in the DNA analysis, which can be very important to improve collection practices in order to prevent huge backlogs in the laboratories and also to make the analysis more cost effective.

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