Touch DNA: Forensic Collection and Application to Investigations

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Abstract

Touch DNA refers to the DNA that is left behind from skin cells when a person touches or comes into contact with an item. However, since Touch DNA (also referred to as wearer or contact DNA) is invisible to the naked eye, and is usually deposited in smaller amounts than the DNA found in bloodstains or other body fluids, it is more difficult to identify areas where skin cells may be present. As such, it can be quite challenging to obtain DNA profiles from these samples. Obtaining successful Touch DNA results depends on recognizing items which may be suitable for Touch DNA analysis, proper collection/storage of these items, and the subsequent use of the optimal sampling technique that will recover the highest number of skin cells.

Keywords: Touch DNA, DNA collection, crime scene investigation, crime scene reconstruction, forensic science

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Introduction

Various Touch DNA sampling techniques have been used at the crime scene and in forensic laboratories worldwide for over a decade [1]. The recent success of using Touch DNA collection methods to obtain DNA profiles from high profile cases including the exoneration of Timothy Masters and the JonBenet Ramsey homicide investigation has created an increased interest in better understanding the science of Touch DNA and its potential evidentiary value.

Humans shed tens of thousands of skin cells each day and these cells may be transferred to surfaces our skin contacts. When a crime is committed, the perpetrator may deposit a sufficient number of skin cells on an item at the scene. If the touched item is collected as possible evidence, Touch DNA analysis may be able to link the perpetrator to the crime scene. Touch DNA has been successfully sampled from countless items including weapons, vehicles, and clothing [2]. With the advent of more sensitive DNA typing kits, such as MiniFiler, Touch DNA profiles can now sometimes be obtained from bullet casings [3], documents [4], and latent fingerprints [5].

The aim of this article is to highlight the available sampling methods, provide recommendations for the collection of potential Touch DNA items at the crime scene, and to

discuss the potential evidentiary value and limitation of Touch DNA in investigations. Case studies that demonstrate the successful application of Touch DNA will also be provided. It is important to clarify that for the purposes of this article, the term "Touch DNA" simply refers to the collection of skin cells which are subsequently typed for DNA in the exact same manner as body fluids using standard laboratory procedures. "Touch DNA" is not to be confused with "Low Copy Number" DNA, or enhanced PCR methods. All of the samples from the Touch DNA case studies described within this paper were processed using standard PCR methods.

Sampling Methods

Many crime scene investigators and laboratories test for Touch DNA using either the wet/dry swabbing or cutting methods [6,7]. When the swabbing method is utilized, the surface of the item is usually rubbed with a wet cotton swab, followed by a dry cotton swab in an effort to collect possible skin cells. The wet/dry swabbing method is recommended for hard, non-porous items such as metal, glass or plastic, and can easily be performed at the crime scene with limited risk of contamination with exogenous DNA (e.g. from the person collecting the sample, or from nearby surfaces/objects). The cutting method may be used for soft items, such as clothing, in which fabric from areas of interest is cut to collect possible cells. These two approaches can be successful on many items of evidence; however, they both have the limitation of placing unnecessary substrate (the cotton swab itself or the fabric cuttings) into the small DNA processing tube. There is a limited amount of substrate that can be placed in a tube, and the substrate itself may "trap" some cells during processing, decreasing the likelihood of obtaining results.

In addition to the commonly used swabbing and cutting methods, several laboratories also use the Scraping [6,7,8] and Tape Lift methods [1], in which the surface of soft/porous items are either scraped with a sterile scalpel blade, or sampled with a small piece of Scotch Tape, or the adhesive portion of a Post-It Note, to collect possible skin cells. The analyst utilizing the scraping or tape lift method will focus their sampling to an area of damage, or the area where the perpetrator is believed to have had the most contact. Through the use of these sampling methods, an area approximately the size of an adult's hand can be sampled. The scrapings/tape/Post-it notes are then placed directly in the extraction tube. Labs use pre-treated tape (usually exposed to a UV Cross-linker) and will also process a blank piece of tape alongside the evidence sample to ensure that no DNA has been introduced via adventitious contamination from the manufacturer. It should be noted that adhesives can be problematic during the DNA extraction procedure and as such, the investigator must ensure that their lab of choice has a validated extraction procedure that can successfully remove the adhesive without affecting the DNA yield. The scraping and tape lift methods allow a larger surface area to be sampled as opposed to the cutting method. An increase in surface area increases the chances of recovering more skin cells, which increases the chances of obtaining a DNA profile.

As mentioned, the scraping/tape lift methods are ideal in situations where the scientist can locate areas on the item which are most likely to contain the perpetrator's skin cells. If clothing was left at the crime scene by the perpetrator, pressure points on the clothing such as the interior neck of a shirt or the inside headband area of a hat are excellent candidates for these sampling methods. In a sexual assault case in which the victim's clothing had been removed by the perpetrator, areas such as the waistband may contain sufficient cells belonging to the perpetrator to produce a profile.

Recommendations for the Crime Scene

It is standard practice for crime scene personnel to wear Personal Protective Equipment (PPE) such as gloves, face masks, hair nets, and sometimes whole body suits. When collecting potential Touch DNA items at a crime scene it is extremely important that as much PPE as possible is worn so as to limit the possibility of contamination via exposed skin, shed hairs, sweat, or saliva. It is not uncommon to detect DNA profiles from Detectives, Paramedics, and Medical Examiners on evidence from cold cases and it is important that extra precautions be taken at the modern day crime scene. Crime

scene personnel should avoid speaking over evidence items (even if wearing a face mask). Touch DNA-type evidence should also be collected with disposable forceps (rather than gloved hands) and each item placed in a separate bag. It is also ideal to dust for prints with single-use brushes and small disposable aliquots of powder if available since DNA can be obtained from latent finger prints, and as such, steps to avoid cross-contamination need to be considered.

The wet/dry swabbing method is commonly used at crime scenes. It is not recommended that the scraping or tape lift methods be attempted at crime scenes due to the increased probability of contaminating the evidence/sample with exogenous DNA as well as the potential for loss of the sample in an uncontrolled environment. There is also the added risk of the crime scene examiner cutting him- or her-self on a scalpel by attempting to scrape an item in the field. It is recommended that Touch DNA items that may benefit from sampling with the scraping or tape lift method be collected and sent to the forensic laboratory where they can be sampled in a more sterile environment.

Touch DNA and Potential Evidentiary Value

When contemplating testing for Touch DNA the investigator needs to consider the potential evidentiary value of the DNA. The investigator must take into account the relationship between the victim and the suspect (if one exists), and any possibility of "innocent transfer" of DNA that may have occurred before the alleged crime. For example, if the suspect is a family member, and either lived with, or had recent contact with the victim, then finding the suspect's DNA on the evidence may be of limited probative value. Touch DNA can easily be transferred throughout the household via day-to-day interactions, contact with furniture items/bedding, or through the laundry [9,10].

However, in the case of a sexual assault by a stranger, finding the suspect's DNA anywhere on the victim's clothing may be of evidentiary value. In these situations it is important to gather as much information from the victim as possible (if living), or to attempt to recreate the events if the victim is deceased. For example, if the victim's pants were pulled down by the perpetrator, then the investigator and forensic scientist should consider sampling areas for Touch DNA where one would envision that the suspect would have grabbed during the assault. Finding the suspect's DNA on the victim's clothing, and in certain areas of the clothing, may help corroborate the victim's version of events and help address the allegations in question. It is also important that the investigator attempts to collect the clothing of deceased individuals or collect samples from the clothing prior to the deceased being removed from the scene. Collection of the clothing at the scene and optimal preservation allows for the possibility of obtaining Touch DNA at a later date, even if it's not initially indicated to be present at the crime scene.

It is critical that the investigator provide the forensic scientist with some case background information in order to receive the best advice on the potential value of DNA evidence, as well as recommendations for testing. The provision of crime scene photos can often be quite useful. In turn, it is equally important that the forensic scientist is equipped with appropriate questions for the investigator to answer or consider.

Case Studies

Case Study A

In the mid-1990s a young female was sexually assaulted on her way home from school. During the assault the suspect tore off pieces of the victim's shirt and used these to bind and gag the victim. The victim survived the assault and provided very specific details to the police. A suspect was identified but there was no physical evidence linking him to the crime. The evidence was tested several times but no semen or male DNA was detected. The case was revisited in late 2008 and the evidence was tested for Touch DNA.

The testing focused on items with which the suspect would have had the most contact during the assault, including the waistband and fly area of the victim's shorts, the damaged areas and torn pieces of the shirt, and the cloth used to gag the victim. The neckband of the victim's shirt (that had been torn off and used to bind the victim) was still in its original knotted state. The area an assailant would have touched to create the knot was sampled using the scraping

technique. This Touch DNA sample resulted in a profile consisting of two individuals and was suitable for comparison. Both the victim and the suspect could not be excluded from this sample. The Touch DNA evidence was the only physical evidence linking the suspect to the crime. The suspect was subsequently found guilty of first degree rape, first degree sexual assault and sentenced to two consecutive life sentences.

Case Study B

An adult female was sexually assaulted and strangled to death. She had been bound with multiple ligatures, including leather straps. Initial testing revealed that DNA from a semen stain on the victim's nightgown matched a convicted offender. However, this was not sufficient evidence for a conviction because the suspect had known the victim and claimed they had had a consensual sexual relationship. The scraping technique was performed on the ligatures to collect possible skin cells and the suspect's DNA was identified on one of the leather straps, providing compelling evidence that the sexual encounter was not consensual. The suspect pled guilty following the presentation of the DNA evidence at trial and is currently serving a life sentence.

Case Study C

An adult female was sexually assaulted by an unknown male. She fought with her attacker, survived, and provided investigators with a detailed description of the assault. The victim managed to grab the suspect's shirt and informed police that she had touched the front chest area. The inside neck area of the shirt was scraped for "wearer DNA" (i.e. skin cells from the person wearing the shirt), and the outside front chest area was sampled for Touch DNA using the swabbing technique. The suspect's DNA was obtained from the inside neck area, and the victim's DNA was obtained from the outside front chest area. The DNA results linked the suspect to the scene and corroborated the victim's version of events.

Limitations of Touch DNA

Touch DNA sampling methods, and the downstream DNA processing procedures, are very sensitive. Hence, there is a greater chance of detecting contamination from law enforcement personnel or even the forensic scientist sampling the item, even when the appropriate PPE has been worn. It may be necessary to obtain elimination samples from key personnel in the case where foreign DNA profiles are obtained that cannot be attributed to a suspect or the victim. There is also an increased chance of obtaining mixed DNA profiles containing DNA from individuals that may have come into contact with the victim/evidence item near the time of the crime. Contributors to these mixtures could include the victim's spouse or children, and again, elimination samples may need to be collected from these individuals.

The investigator may also be faced with the challenge of determining what it means if unexplainable DNA is obtained. For example, a foreign male profile from a Touch DNA sample may be obtained from evidence pertaining to a female victim. If the male DNA profile doesn't match the suspect in question the investigator needs to consider its relevance to the case. The foreign profile could from the true perpetrator and the original suspect could be innocent. Or perhaps the DNA profile is from adventitious transfer from crime scene personnel, first responders, laboratory analysts, or crime scene equipment such as fingerprint brushes. These are all possibilities that law enforcement may have to evaluate and address in order to move forward with the investigation.

Some evidence items are also not recommended for the collection of Touch DNA samples. Such items include those that are severely degraded (for example, moldy clothing), have been exposed to extreme environmental conditions (such as weapons left outside for months or years), have been washed, or are heavily soaked in the victim's body fluids. Also, items that are likely to have been touched by many people, such as a public pay phone or store counter are usually not good sources for probative or interpretable Touch DNA profiles. Most forensic scientists will discourage the sampling of these items.

Conclusions

The key to obtaining successful Touch DNA results depends on recognizing items which may be suitable for Touch DNA analysis, proper collection at the crime scene, and the appli-

cation of a sampling technique that will recover the highest number of skin cells. Through improvements in sampling methods coupled with increasingly sensitive DNA testing methods, and through continual education of the criminal justice community regarding the testing possibilities, Touch DNA is enabling forensic scientists to provide information in cases which were once unsolvable.

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