

Examining the Significance of Saliva and Sweat in Forensic Science



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Abstract

Forensic science plays a very crucial role in establishing the links between the series of evidences and body of facts. This article argues that personal identification is that important concept of forensic science which is responsible for the identification of victim as well as the culprit. After the concept of blood examination as an important body fluid, saliva is emerging as an attention gaining fluid for the forensic scientist. This article aims to study that saliva is a source of wider scope in the medico-legal field and having a vast role in serological testing, crime detection, drug and alcohol abuse, hormone analysis, poisoning cases, unknown animal bites. Sweat has its own unique identification feature as an average square of skin has 650 sweat glands, which is itself a unique identification just like the fingerprints and this number varies from person to person. Saliva and sweat are easy to handle and analysis. Sweat is very hard to find and collect, that is why, it has a limited scope. These two body fluids are alternative and very useful body fluids in the study of forensic science.

Keywords: *crime detection, medico-legal field, personal identification, serological testing*



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Public Interest Statement

Over the years, forensic science and research revolves around blood as the most important body fluid for criminal investigations because of its easy access and easy sampling. In this emerging and developing era of new scientific innovations and technology, it is very important to research over other important body fluids which can be proven to play a very crucial role in personal identification, crime detection, diagnosis of various diseases and many more aspects. This study suggests an overview of the importance of saliva and sweat in the forensic investigations apart from blood and semen. They can be proven as crucial piece of evidence at the scene of crime.

1.0 Introduction

Identification of body fluids is an important aspect of forensic science, as it is based on the most important principle of forensic science, i.e., Principle of Individuality and Principle of Comparison. Body fluids are proved to be the key tool in criminal investigation very often, and an evidence on which the court has given its judgements. The most important body fluid in the criminal investigation is Blood. Due to all the important and valuable information it contains, easy to trace and detect, again it becomes the most valuable biological trace. The other very important fluid is Semen or vaginal fluid. These fluids play very important role in determining the individuality in the criminal offences like rape, sexual assault etc. If we talk about the saliva, it is being considered as new body fluid gaining popularity in forensic research as it is having a very close relationship with plasma, it is easy to collect and safe to handle. It can easily be collected from scene of crime from the bite marks, lip marks, or any place which include oral cavity. Samples of saliva are very much of use for the identification of the accused in serological and cellular analysis like in crime detention, drug and alcohol abuse, unknown animal bites, gender identification, hormonal analysis, case of poisoning etc. The other important fluid, i.e., sweat, is having the unique identification feature like fingerprints, as an average square of skin has 650 sweat glands which differ from person to person and skin to skin [1]. Each of our skin secretion is different and therefore unique to us. The most important advantage of sweat analysis is that, normally without any DNA sample, which takes days and weeks, it is very difficult to analyse how many persons were present on the crime scene, but sweat, because of having unique feature can help in distinguishing them easily because metabolites are known to fluctuate over time due to change lifestyles. Sweat contains a large number of metabolites and amino acids that can be detected on the surface. The research of Professor Halemek's team stated that the sweat secretion contains three major metabolites, urea, glutamate and lactate. These three metabolites are present in high concentration and the chances of two people having same level of secretion is virtually zero.

2.0 Composition of Saliva and Sweat

The composition of Saliva is very important in forensic science because it is composed of various electrolytes like Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Bicarbonates (HCO₃⁻), Phosphate (PO₄³⁻). Saliva also contains proteins, enzymes, nitrogenous products, mucins, immunoglobulins etc. Sweat has minerals as well as metals present in its composition. Minerals like Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg) and metals like Zinc (Zn), Copper (Cu), Iron (Fe), Chromium (Cr), Nickel (Ni), Lead (Pb). It also contains lactate and urea. It has low tonicity. It has pH value of 6.3 and is more acidic in nature than blood. It possesses the feature of non-invasive sampling through iontophoresis and hence it is easier and more effective for analysis. It hosts a large range of bio-makers like drug metabolites and disease specific makers. It provides information about metabolic state of person.

3.0 Methods of collection and detection of dried saliva

Saliva can easily be detected from ay bite mark found in many cases of assault, homicides, and many other criminal cases. Since saliva cannot be collected from skin, clothes or paper because of its invisible nature and the substrate on which saliva is deposited, cannot be directed to extraction procedures. In case of bite marks, the very first problem is the distortable nature of skin and lack of good impression, saliva which is then found on the bite marks receive an important alternative focus because it can be the gulf of information. Saliva being a very new identification fluid, inheriting the properties like invisibility, it is difficult to detect it from the objects, especially when it is in dried form. Certain methods to detect dried saliva can be:

- a) Ultraviolet rays or laser
- b) Chemicals include special kind of enzymes which gives an insoluble precipitate of red colour by acting upon the reducing sugars like starch, amylase, and alkaline phosphate.
- c) Fluorescent spectroscopy

4.0 Sampling and analysis of sweat

The simplest technique to take the sweat sample is an occlusive patch contain 2-3 layers of gauze. But this is time consuming. There may be chances of pH variation. To avoid this error a device was introduced using Whatman paper which was fixed on a surgical

dressing film lined with an adhesive layer for adjusting to arm skin. These patches allow the evaporation of the water from the sweat concentration leaving behind the sweat patch [2]. For effective analysis, certain analytical instruments like Macroduct and Megaduct are used as sweat sampler [3]. They are used for smaller and larger volume of sweat respectively. The analysis quality will depend upon the quality of sampling. Most of the times the analysis of sweat depends on the principles of conductivity, potentiometry, osmolarity or colorimetery [4].

5.0 Gender determination and role of saliva

Our tooth enamel is comprised of 90% of Amylogenin enamel matrix protein, which regulates the initiation, growth and maturation of hydroxyapatite crystals. When we take a single amylogenin gene, the X and Y chromosome give a 106 bp amplification and 112 bp amplification respectively. Here saliva sample of XY chromosomes exhibit two bands whereas XX chromosome exhibit only one. This is one of the basic and easy tests for gender determination.

6.0 Unknown bite marks and role of saliva

Wherever there is a bite mark, it is considered as a vital source of salivary transfer. Around 80% of human beings are the secretors of ABO blood group antigens in saliva. Through genetic fingerprinting we can obtained 90% of ABO DNA profiles from saliva present in epithelial cells. But the only hindrance faced by the forensic experts is, degradation of genetic material, during the DNA extraction from bite marks residue. In case of unknown animal bite marks, the specific-specific genetic profile helps in the identification of the animal. Fletcher described an enzyme-linked immunoassay technique using monoclonal antibody based on the presence of salivary immunoglobulin A for species identification in stains up to 6 months old [5]. Electrophoreses and double gel diffusion techniques are used for the comparison and bitemarks examination in case of non-human bites.

7.0 Diagnosis of disease

7.1 Sweat

Sweat analysis is playing a vital role in disease diagnosis and one of the most important disease diagnosed by sweat is cystic fibrosis. This disease is being originated from genetic transformation of CFTR proteins in sweat gland [6]. Other important diseases are diabetes, lung cancer. Genomics and proteomics have played a key role for searching sweat biomarkers such as dermcidin (DCD). Sweat contains DCD, a peptide containing 47-amino acids, which possesses antimicrobial activity against different

pathogens in high salt concentrations and over an extensive pH range resembling to the human sweat. For this reason, sweat is considered to be crucial for human skin microflora [7]. Moreover, DCD and the receptors for DCD are present and overexpressed on the cell surface of invasive breast carcinomas and their lymph node metastases and neurons of the brain. These findings reveal that DCD is involved in tumorigenesis by promoting cell growth and survival in breast carcinomas [8]. Another prognostic biomarker is prolactin inducible protein (PIP) which is expressed in many exocrine tissues including sweat glands and is overexpressed in metastatic breast and prostate cancer [9]. In addition, prognostic biomarkers have also been investigated in a study performed on eccrine sweat in healthy and schizophrenic patients. The eccrine sweat contains plenty of various proteins and peptides unlikely to that of serum showing that eccrine sweat may produce distinctive disease-linked biomolecules [10]. The most common disease like diabetes can be diagnosed by sweat as recently the correlation between glucose level and sweat has been confirmed [11]. Change in concentration of electrolytes in the body can be diagnosed through sweat in the patients of chronic kidney failure [12].

7.2. Saliva

The importance of saliva increases in the cases of diagnosis of many critical diseases like Cardiovascular disease, a disease related to circulatory system, cancers of oral cavity and other sites, pancreatic cancer, lung cancer prostate cancer, breast cancer, Sjögren's syndrome, diabetes mellitus, viral infections which are relied upon the salivary biomarkers etc. It has the potential to diagnose the disease at early stage also.

7.2.1 Hormonal analysis through saliva

Analysis is gaining importance in hormonal analysis because of having non-invasive and stress-free collection of plasma, serum, endocrine parameters like steroids, peptides and amines. The most important and accepted application of saliva hormonal analysis is use of salivary cortisol for the diagnosis of Cushing Syndrome [13]. One of the hallmarks of Cushing syndrome of any origin is the abrogation of circadian rhythmicity in adrenal cortical secretion. In contrast to healthy individuals, who show a decrease in cortisol levels from high morning to low evening values [14], patients with Cushing syndrome do not display any reduced cortisol secretion even in late evening [15]. Consequently, the measurement of increased late evening or midnight cortisol is considered a very simple and useful way to screen for Cushing syndrome [16]. The diagnosis of endogenous hypercortisolism can be made without the disturbing experience of stressful

hospitalization, by obtaining a saliva sample from patients at bedtime, even at home under accustomed conditions.

7.3 Analysis in case of drug and alcohol abuse and role of sweat and saliva7.3.1 Sweat

Sweat is a biofluid which is transparent having low tonicity and low acidic nature [17] that is why the basic drugs accumulate more in sweat in comparison to blood due to its pH value [18]. Due to the presence of very less impurities, less prone to adulterations, sample of sweat can be preserved for longer period of time. There are two type of testing for sweat analysis, early and late testing. Early testing is used for the detection of the drug within 24 hr of consuming the drug, whereas, the late testing, within 168 hrs, involved patch testing. [19] A sample of dried sweat patch is useful in detecting the drug patches in the body, where the dried sweat patch is the result of the sweat patch that sticks to the skin and absorbs perspiration over days. An adhesive is also used over that dries sweat patch to prevent the tampering. These patches can contain the samples of heroin, marijuana, methamphetamine, phencyclidine, methadone, cannabinoids, gamma hydroxybutyrates and morphine. Although this method of detection of drugs through sweat analysis is having very less scope comparatively to urine analysis because a whole patch is being used and it precludes the repeat testing and testing for multiple drugs, yet, sweat is also an ideal sample for the doping control like urine.

7.3.2 Saliva

Most commonly used technique for the examination of the presence of the drugs is urine analysis since it is acceptable of routine check-up. Now with the improved analytical techniques it is possible for the determination of large number of drugs in the samples of oral fluids. The easy, rapid and nonintrusive sampling procedure are the major advantage of this over urine analysis. The commonly found drugs in the saliva samples are barbiturates, opioids, phencyclidine, amphetamines, cocaine and benzodiazepines. Through radioimmunoassay, saliva can be used to detect marijuana. Even after 4 hours of smoking the marijuana, the psychoactive component of it can be detected through saliva. Generally, the drugs concentration in saliva reflects drug's free fraction in the blood. Saliva is also used in measurement of the steroids hormones like cortisone, cortisol, testosterone etc because of the same reason that these steroids reflect the free fraction.

8.0 Conclusion

Saliva, an important body fluid which contains a good quality as well as quantity DNA information, easy to collect and handle, can be very useful in the investigation, either criminal or forensic. It can be obtained by non-invasive methods. It can help in diagnosis of several fatal diseases, can identify the drug and alcohol abuse, can help in the gender determination, hormonal analysis etc. it can be perfect substitute of the blood analysis. On the same side, sweat can also be used as a biomarker just as blood and urine to diagnose the diseases. It can also be considered as a promising body fluid. It also can be obtained by non-invasive sampling.

9.0 Suggestions

In spite of having so many advantages of using the techniques for sweat and saliva analysis in forensic as well as criminal investigation, India is a way back in using these methods. There is a very limited scope in India for these methods of analysis, even many a times these samples are being neglected on the crime scene. Investigating officers are having very least knowledge regarding this concept. Saliva and sweat are having a gulf of information which can help in the establishing the identity and link between victim, culprit and the scene of crime. These techniques must be adopted by the investigating officer and these samples must be handled carefully without any negligence. These are the new areas of research which can definitely improve the investigation process in every aspect. There must be some kind of routine testing techniques for saliva and sweat just like blood and urine.

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