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Caffeine Toxicity: An Overview

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Abstract- Caffeine is a widely consumed stimulant substance known for its stimulating effects on the central nervous system. It is found in various food and beverage products, with coffee and tea being the most common sources. While caffeine has short-term benefits, such as increased alertness and reduced fatigue, its long-term effects on health and cognition are still under investigation. This overview aims to provide a comprehensive understanding of caffeine toxicity, including its potential adverse effects and risk factors. Caffeine toxicity can occur when consumed in excessive amounts, leading to symptoms such as restlessness, insomnia, rapid heartbeat, and gastrointestinal disturbances. It can also have more severe effects, including anxiety, tremors, and even cardiac arrhythmias in extreme cases. Certain populations, such as pregnant women, children, and individuals with certain medical conditions, may be more susceptible to caffeine toxicity. Understanding the potential risks associated with excessive caffeine consumption is crucial for promoting safe and responsible use. Further research is needed to establish clear guidelines on safe caffeine intake levels and to determine the long-term consequences of excessive caffeine consumption on human health.

Keywords: Caffeine Toxicity, Human Health, Central Nervous System, Cardiovascular effects, Gastrointestinal Disturbances

Introduction

Caffeine, a commonly consumed stimulant, holds a prominent place in the lives of millions of people worldwide. It is present in various food and drink items, including coffee, tea, energy drinks, sodas, and chocolate.^[1] With its ability to enhance alertness and combat fatigue, caffeine has become a pervasive substance in our society. However, understanding the potential toxicity associated with caffeine consumption is crucial for its safe and responsible use. Caffeine, a natural stimulant belonging to the xanthine alkaloid class, affects the central nervous system.^[2] It is well-known for its capacity to increase mental alertness and alleviate physical fatigue, making it a preferred choice for many individuals.^[3] By blocking adenosine receptors in the brain, caffeine prevents the neurotransmitter adenosine from exerting its calming and sedative effects.^[4] Consequently, caffeine promotes wakefulness, improves focus, and temporarily enhances cognitive performance.^[5, 6]

The consumption of caffeine-rich beverages, such as coffee and tea, is deeply ingrained in various cultures and daily routines. Globally, caffeine consumption is widespread and continues to be popular. It is estimated that over 90% of adults consume caffeine regularly in some form. The primary sources of caffeine include coffee, tea, energy drinks, soft drinks, and chocolate.^[7] Its widespread availability and accessibility have contributed to its popularity as a go-to stimulant. While caffeine is generally considered safe when consumed in moderation, it is important to explore the potential toxicity associated with its excessive use. Caffeine toxicity refers to the adverse effects that can occur when an individual surpasses their tolerance level or exceeds the safe limits of caffeine consumption.^[8]

Excessive caffeine intake can lead to a range of adverse health effects, including increased heart rate, palpitations, elevated blood

pressure, gastrointestinal disturbances, restlessness, anxiety, sleep disruptions, and in severe cases, seizures.^[9] Additionally, certain individuals, such as those with underlying health conditions, pregnant women, children, and the elderly, may be more vulnerable to the toxic effects of caffeine.^[10] Understanding caffeine toxicity is important for several reasons. Firstly, it enables healthcare professionals and researchers to comprehend the potential risks and complications associated with excessive caffeine consumption. This knowledge empowers them to educate the public and provide evidence-based recommendations for responsible caffeine use. Moreover, exploring caffeine toxicity facilitates the identification of vulnerable populations, such as individuals with preexisting cardiac conditions or those taking specific medications. This information aids in developing guidelines and precautions to safeguard these individuals from potential harm.

Caffeine, a widely consumed stimulant, can be obtained from both natural and synthetic sources. Understanding the various sources of caffeine and its metabolism in the body provides insights into its effects and how it is processed. Caffeine occurs naturally in certain plants and their products. The most common natural sources of caffeine include coffee beans, tea leaves, cocoa beans, and kola nuts.^[11] Coffee is particularly notable for its high caffeine content and is a major source of caffeine consumption worldwide. Tea, both black and green varieties, also contain caffeine, although generally in lower amounts.^[12] Additionally, caffeine is present in cocoa-based products, such as chocolate, and kola nuts, which are used in some soft drinks.

In addition to natural sources, caffeine can also be synthetically produced and added to various products. Energy drinks, supplements, and certain medications may contain synthetic caffeine.^[13] Energy drinks are popular among individuals seeking a quick boost of energy and often

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Biomarkers of Alcohol Metabolism and Its Relevance in Forensic Investigations

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Abstract- The consumption of alcohol by human beings are monitored by the recognition of direct and indirect biomarkers. Liver enzymes such as Gamma Glutamyl Transferase (GGT), Alanine Aminotransferase (ALT), and Aspartate Aminotransferase (AST) are elevated in the blood and can be used in forensic for determination of amount of alcohol consumption and the pattern of drinking. Carbohydrate Deficient Transferrin (CDT) as indirect biomarker having exception as it can be elevated in cases other than alcohol related diseases. Non-oxidative biomarkers such as Ethyl Glucuronide (EtG) and Fatty Acid Ethyl Esters (FAEE) have longer half-life and a tendency to incorporate into hairs gives better time frame and drinking pattern in the determination of alcohol abuse. Direct markers having higher specificity giving better opportunity to analyse and compare alcohol consumption. Precaution has to be taken regarding pre-analytical impact of indirect markers on direct ethanol metabolites in forensic science. The aim of this review is to investigate sensitivity and specificity of EtG, FAEE, PEth, in hair to analyse heavy alcohol intake pattern and different biomarkers with comparison to CDT, AST, ALT, GGT. Analysis of hair is a powerful method for retrospective drug analysis. Determination of direct non-oxidative metabolites EtG and FAEE in hair can detect the time of alcohol consumption even after abstinence.

Keywords- Alcohol Biomarker, Gamma Glutamyl Transferase, Ethyl Glucuronide, Aldehyde Dehydrogenase, Alcohol Abuse

1. Introduction

Alcoholism is one of the biggest threats to people's health and safety worldwide. [1] According to the World Health Organization (WHO), 38.3% of people worldwide regularly use alcohol in 2010. Each year, alcohol misuse results in 3.3 million fatalities globally. [2] Over 30% of Indians, or over 11%, binge drink, and over 30% of Indians drink frequently, according to the WHO's 2010 Global Status Report. [2] The comprehensive data report released by the National Crime Records Bureau (abbreviated NCRB) of the Ministry of Home Affairs is the supreme of formal studies on the relationship between alcohol and crime. The incidence volume of crimes connected to "Liquor and Narcotic Drugs" came out at 8,63,696 in its most recent incarnation, which was issued at the beginning of this momentous year "2020," accounting for 65.3% of the crime rate. [3]

Alcohol is an inebriant poison (Inebriants are substances that induce intoxication or inebriation). Alcohol (ethyl alcohol or ethanol) is an organic compound containing -OH functional group having a general formula of R-OH (where R is an alkyl or aryl group). It is produced via the fermentation of sugar (carbohydrate) using yeast. Different percentage of alcohol is present in different alcohol-containing beverages, most common amongst them are beer (4-8%), wine (14-16%); whiskey, rum, and gin (36-50%), vodka (40-45%), etc. Alcohol is widely consumed by human beings differently. Alcohol abuse is linked with socio-cultural practices across the world. Alcohol use disorders (AUD) are the major problem across the world as it includes the regular consumption of alcohol and problems in controlling drinking, consuming alcohol even of persisting ill effects and withdrawal symptoms of it after sudden decreasing the amount of alcohol or total abstinence. The mass media transmitting the false propaganda of alcohol consumption puts a negative effect on the society by showing consumption of alcohol to represent the higher-class society and their high-status values. Global death caused by alcohol is due to various reasons some of which are mentioned below, liver cirrhosis, oral and pharyngeal cancer, inter-personal violence, self-harm, traffic injuries, tuberculosis, and liver cancer related to consumption of alcohol. [4]

2. Metabolism of Alcohol

2.1. Absorption of alcohol in the human body

Alcohol is readily absorbed via simple diffusion and does not require digestion due to its small molecular size. 20% of ethanol is absorbed in the stomach and 80% in the small intestine. Consuming alcohol with carbonated drinks fastens the absorption due to increased surface area. It has also been observed in the empty stomach has more absorption because food slows down the absorption of alcohol as it contains fats and proteins. Some drugs like atropine and benzene may also decrease absorption. [5] Alcohol intoxication by the respiratory tract via inhalation is low as it is rapidly eliminated from the body if absorbed by this route. However, alcohol does not absorb much through intact skin contact. Females have higher Blood Alcohol Concentration (BAC) than males because females eliminate alcohol faster than males resulting in shorter but higher BAC peaks.

2.2 Oxidative Metabolism of alcohol

95% of ethanol is metabolized in human beings via an oxidative pathway in the liver; and 0-5% of remaining ethanol is metabolized via a non-oxidative pathway that is by sweat glands, and can be excreted out in various bi-products via urine, sebum, and in-breath (ethanol vapors). Oxidative metabolism of alcohol takes place in the liver. Ethanol (C₂H₅OH) is converted into acetaldehyde in the presence of the enzyme Alcohol Dehydrogenase (ADH) with its co-enzyme nicotinamide adenine dinucleotide (NAD⁺). This reaction is reversible in the formation of an NADH⁺ in the cytosol. Here, the Class I ADH enzyme works mostly but in case of excessive ethanol Class II and III of ADH enzyme also work to convert ethanol to acetaldehyde. [6] Acetaldehyde formed here is responsible for hangover and if it enters the blood increases toxicity. This acetaldehyde is further converted into acetate in the presence of mitochondrial Aldehyde Dehydrogenase (ALDH) again with coenzyme NAD⁺ which liberates another NADH⁺ molecule, and this step is irreversible. Acetate in the presence of Acetyl-CoA Synthetase or Acyl-CoA Synthase converts to Acetyl CoA. Some of the Acetyl CoA enters the Krebs cycle and forms CO₂ and H₂O. 90% of ethanol is oxidatively metabolized in this pathway. [7]

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Touch DNA And Its Application in Criminal Justice System in Current Scenario

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Abstract- Touch DNA can be isolated from shredded skin cells and other biological sources of a contributor which comes in contact with the matrices or a person. The crime investigation laboratories demonstrated that Touch DNA technology is a boon especially in the absence of visible DNA sources like hair, saliva, blood, semen, etc. Isolation of sufficient touch DNA to create genetic profile for individual identification has been achieved from sources like door knob, TV remote, glass, switch board, table and chair etc. Successful and efficient touch DNA isolation is achieved by using various commercial kits (QIAGEN® QI AMP, Preonic evidence collection kit, COPAN 4N6 FLOQSwabs™, Puritan FAB- MINI- AP). Quantity and quality of the touch DNA depends upon availability of epithelial cells. Availability of numerous software helps in overcoming the problem of mixed profile. Mixed profile generally originated from background contamination and or left-over DNA present over crime scene. Evaluation of sensitive DNA isolation methods for touch DNA, strengthen the criminal justice system. However, at present no benchmark methods are available to extract and quantify DNA from sample containing low quantity or quality of DNA. In present review paper we have discussed the current scenario of techniques available for touch DNA and its significance in criminal justice system.

Keywords: Touch DNA; Technology; Investigations; Cells; Sources

1. INTRODUCTION

Although touching is supposed to be how they have been deposited, the precise mechanism and origin of biological samples with low quantities of DNA that are often not identified with a specific bodily fluid are frequently referred to as "trace DNA" or "touch DNA". It is obtained from skin cells shredded and from other biological sources of a contributor which comes in contact with the substrate or a person. Touch DNA is a very specific type of evidence that plays necessary role in crime laboratories and appraised crucial aid in criminal investigations. It also includes obtaining tiny live entities from crime scenes or isolating small quantities of material from forensic evidence in forensic laboratories.

A very popular law in forensic science is law of exchange known as Locard's Principle of Exchange is very well fit in the context of Touch DNA. Touch DNA analysis is currently a juvenile branch of forensic science and is progressing to obtain important profiles from such trace DNA with respect to various surfaces (Burrill et al., 2019; Hanson & Ballantyne, 2013; Sessa et al., 2019). A healthy human skin sheds many skin cells everywhere which get in contact with the other surfaces or matrices closer to the skin. This phenomenon gives advantage of extracting and using DNA from such shredded cells in the form of Touch DNA. The culprit while committing the crime definitely comes in contact with scene of crime and victim. This led to the deposition of Touch DNA on probable items at crime scene and on victim. Carefully collected items carry many sources of Touch DNA in the form of skin cells, sweat, saliva, etc. These can be successfully sampling for further analysis. Advancements in the field of commercial kits for touch DNA analysis, increases the popularity of Touch DNA analysis in forensic cases (Williamson, 2012). Although only few findings were reported on use of Touch DNA in forensic science so far because recovering information from touch DNA analysis is a complex task for forensic scientists especially from weapons, explosives and degraded remains carrying

sources of Touch DNA. The crime laboratories claim Touch DNA technology a boon especially in the absence of visible DNA sources like hair, saliva, blood, semen, etc. Also, many of the unsolved incidents with too small or degraded samples to verify valuable information are nowadays again putting forward such evidences to laboratories for analysis of "Touch DNA" or "Trace DNA". In this review article, the available literatures on Touch DNA analysis will be discussed and reported with respect to Global and National Scenario.

2. METHODS INVOLVED IN TOUCH DNA ANALYSIS:

Touch DNA Analysis methods comprises swabbing, taping or scraping for minute quantity of epithelial cells from the items that commonly comes in human contact like computer keyboards, window panes, knobs, door knobs, TV remotes, Table, Chairs, Switch Boards, etc.

2.1. Analysis of Touch DNA

Earlier times the analysis of touch DNA required at least 1 ng of DNA to create a genetic profile of an individual. With the advent of trace and touch DNA, these problems resolved but the success rate of these methods are depending upon the capacity of commercial kits available because the successful analysis of Touch DNA requires appropriate number of epithelial cells deposition on the surfaces in contact. The Analysis of Touch DNA involves following steps (Table-1).

3. DESTRUCTIVE METHODS OF COLLECTION

(i) Cutting out the area of interest for direct extraction or amplification:

Soft items like clothes or any other fabrics containing potential sources of Touch DNA. Edges cut out from fabric sources are easy to be processed in case of direct amplification and extraction, only flaw with this method is its destructive nature hence less preferred.

(ii) Scraping:

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Current Knowledge in Post-Mortem Interval Estimation from Synovial Fluid

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Abstract- The series of complex, extensive and irreversible physical, chemical and physicochemical changes occurring in the body after death has been a topic of interest among scientists for a long time. Post-mortem changes have been studied extensively in an attempt to develop a model that can successfully assist in predicting the post-mortem interval (PMI) with better accuracy than previously existing methods. Synovial fluid, compared to other body fluids, is an ideal specimen for investigating post-mortem biochemical changes due to its stable chemical composition, isolated location and higher resistance to microbial contamination. The determination of PMI from synovial fluid has been researched at length since the late 1950s. In the present review paper, the numerous studies done in the last 60 years on PMI estimation from the synovial fluid are examined, summarized and discussed regarding the analyte(s) studied, the analytical methods, sample size, the statistical evaluation, the practical relevance and the precision of death time estimation.

Keywords- Post-mortem interval, Time since death estimation, Post-mortem chemistry, Post-mortem changes, Synovial fluid

INTRODUCTION

Post-mortem interval (PMI) or time since death (TSD), in the simplest of words, is defined as the time elapsed since death. Precise assessment of this period often plays a crucial role in many medico-legal investigations by limiting the number of suspects and authenticating the legitimacy of witness statements and alibis.

Determination of time passed since death requires the calculation of quantifiable data as a function of time [1] i.e., the premise behind calculating the time since death is the computation of data that can be measured back to the starting point along a time-dependent curve, with numerous factors influencing the slope.

Over the years, various methods of estimating the time since death have been developed. To get a more accurate time frame, a combination of the physical (conventional), physicochemical, biochemical, microbiological, entomological, and botanical parameters is used [2, 3]. Despite the considerable number of research conducted on the determination of PMI till now, it remains one of the most challenging questions in the field of forensic science [4, 5].

DIFFERENT METHODS OF PMI ESTIMATION

Existing methods for estimating time since death include the following processes.

- Physical processes, i.e., radiocarbon dating, cadaveric cooling [6-13], post-mortem hypostasis, and, the opacity of eyes;
- Physico-chemical processes, i.e., rigor mortis, supravital reactivity of skeletal muscle, immunological reactivity;
- Chemical methods, based on metabolic processes (i.e., metabolites concentration-substrates, enzymatic activities), autolysis (i.e., loss of selective permeability of the membrane, diffusion, and morphological changes);
- Bacterial processes, i.e., putrefaction;
- entomological approaches, i.e., either a carrion insect development or a succession model
- Botanical i.e., palynological studies, examination of growth rings in plants

The three mortis - *algor* [6-13], *rigor* [14-27], and, to a lesser extent *livor* [28-33], regardless of the drawbacks, remain the most commonly utilized methods in PMI

determination due to their simplicity and convenience.

Algor mortis is a forensic science method that estimates the time since death by measuring the cooling of the body. However, *algor mortis* alone is not considered precise or reliable due to various influencing factors such as ambient temperature, clothing, body size, and circumstances surrounding death. It is typically used in conjunction with other forensic techniques like *rigor mortis*, *livor mortis*, and forensic entomology for a more accurate estimation.

Rigor mortis is the stiffening of muscles after death due to chemical changes. It can provide valuable information for estimating the time since death, but it is influenced by factors such as temperature, physical activity before death, muscle groups involved, and underlying medical conditions. *Rigor mortis* typically starts within hours after death, peaks at 12 to 24 hours, and disappears within 24 to 48 hours. While it can offer an approximate estimation, *rigor mortis* alone is not precise or reliable and is used alongside other indicators.

Livor mortis, or *lividity*, is the settling of blood in the lower parts of the body after death, resulting in purplish skin discoloration. Estimating the time since death based on *livor mortis* involves examining the color, distribution, and fixation of the lividity. The color changes from red to purple and eventually darkens to maroon. The distribution pattern indicates the position of the body after death and helps estimate the duration since death. Factors like body temperature, ambient temperature, and medical conditions can affect the accuracy of *livor mortis* estimation.

Changes in the eyes, such as corneal clouding and potassium levels in the vitreous humor, can also provide insight into the time since death. Corneal clouding occurs shortly after death and is due to drying and dehydration of the cornea. Potassium levels in the vitreous humor increase over time, and measuring them can aid in determining the post-mortem interval.

Supravital reactions are biochemical changes that occur shortly after death but while cells are still viable. Examples include the Kastle-Meyer test, which detects the presence of haemoglobin, and the diaphorase test, which detects NADH. Supravital reactions can estimate the time since death in certain circumstances, but their accuracy and applicability are influenced by temperature, oxygen availability, and tissue conditions.

Original Article / Research Article

Assessment of Particulate Matter (PM) exposure and its associated health hazards among the selected population of Bilaspur: A survey-based study

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Abstract- In today's modern world due to industrial, automobile exhaust and other causes the Particulate Matter (PM) exposure is the topic of discussion among academicians and researchers which is significantly linked to various diseases that have been causing a decrease in life expectancy around the globe. Industries, power plants, coal mines, vehicular exhausts, road traffic emissions etc. are the major concern to cause emission. In the present study two sites (RTS colony & Mangla chowk) were selected to measure PM concentration via monitoring air quality index with the help of reliable mobile application, "AQI version 3.6". The objectives of the present survey based study were to assess the PM concentration in some densely populated areas of Bilaspur and to determine the health issues related with manifestations caused due to PM_{2.5} and PM₁₀ emissions. The findings of the study revealed that the concentration of PM₁₀ and PM_{2.5} were under the permissible exposure limit (PEL). AQI for Mangla chowk region was higher compared to the other area. The effect on the nervous system was obtained to be the highest compared to the impact on other systems. Males were adversely affected as compared to females in significant aspects of clinical manifestations. This study is particularly based on Bilaspur city. Furthermore, these studies conducted in central India are significantly lower than other regions of India. Therefore, this study tried to bring out the health-related effects observed in the studied population of central India.

Keywords: Particulate Matter, PM₁₀, PM_{2.5}, Air Pollution, Health Hazards etc,

Introduction

Air pollution refers to the contamination of chemical, physical, and biological factors that alter the natural characteristics of our environment, which is a significant threat to our environment and human health. Toxic chemicals from industries, agricultural waste, automobile emissions, and natural resources are notable sources of air pollution. Particulate matter (PM) or atmospheric particulate matter is a combination of liquid droplets and solid particles in the air. These particles can come from natural sources such as dust storms, volcanic eruptions, and sea sprays, or human activities such as burning fossil fuels, agricultural waste, and emissions from industrial processes. PM can cause health concerns as it can penetrate the lungs and bloodstream, leading to respiratory problems, allergies, and cardiovascular diseases. The article also talks about other harmful gases, including sulfur dioxide (SO₂), nitrogen dioxide (NO₂), ozone (O₃), and carbon monoxide (CO), which can lead to respiratory infections, lung diseases, and other health issues.

The National Air Quality Index (NAQI) was established in 2014 in New Delhi as a part of the Swachh Bharat Abhiyan to measure air quality. It was developed by a technical group formed by the Central Pollution Control Board (CPCB) and IIT Kanpur. The AQI is a quantifiable tool that government agencies use to report air quality daily for public awareness about air pollution. The system converts the measured concentrations into a single number or set of numbers. Real-time data monitoring is available in five Indian cities: New Delhi, Mumbai, Pune, Ahmedabad, and Kolkata. The NAQI has issued a set of 6 AQI categories for differentiating air quality.

Research studies conducted across various regions in India, including metropolitan cities and states with heavy industries, have shown high

levels of pollution, leading to significant health issues among the exposed population. But the Chhattisgarh State which is dominated by various industries, coal mines, thermal plants, factories, mills etc. is left almost untouched. Although some epidemiological studies have measured the concentration of PM in some cities but those studies are limited to environmental measurements only. Hence, the present study is conducted to address the existing gap by assessing the concentration of PM₁₀ and PM_{2.5} of the two selected areas of Bilaspur along with their impact on health on the exposed population.

METHODOLOGY

This proposed study targets two selected areas of Bilaspur (RTS Colony & Mangla Chowk), Chhattisgarh, India, which is the central part of the country. The city is preoccupied with diverse thermal and steel plants, rice mills, cement factories, paper mills, etc.

PM concentration data were collected from a reliable digital application every 6 hours for a 24-hour clock cycle. Data on air quality for the month of June, 2022 from selected two locations in the study area were recorded. The measured concentrations were noted down. Data from digital boards installed by the government at the selected locations were also collected. The Average PM concentration (daily, weekly, and monthly) was calculated. For conducting the survey on the exposed population, first the participants were briefed about the objectives and purpose of the study. They were given assurance about the confidentiality of their personal information as well as the responses given by them. Then a questionnaire-based survey was conducted on the study population to record the related health hazards.

RESULT & DISCUSSION

After the collection of all the data, data analysis was done on the basis of

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Comparative Analysis of Manual Docking and Computer-Assisted Overlay Technique for Bite Mark Analysis

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Abstract: The bite mark is important physical evidence that plays a significant role in forensic investigation. Through, proper scientific analysis of bite marks found at the scene of the crime and comparing it with the suspect's bite impressions may help in the exclusion and inclusion of an individual. Teeth leave their mark on the surfaces which are unique to an individual. And this is the scientific basis for using bite marks as evidence to prove individuality. Various direct and indirect techniques have been developed to analyze and compare the bite marks. Keeping this in view, the current study aims to perform the comparative analysis of bite marks on three different edible materials i.e., chocolate, apple, and cheese via manual docking as well as through computer-assisted overlay generation techniques. Apart from that, the current study also evaluated the accuracy of the two above-mentioned used techniques.

Keywords: Bite marks, Hand docking, Computer-assisted overlay technique, Dental imprints, Dental cast

INTRODUCTION

Bite marks on inanimate materials like wooden cabinets and flesh have both been probed in the criminal justice system but bite traces on foodstuffs left are the most common of all bite marks found at crime scene. In forensic investigations, investigating bite marks is essential. By contrasting a sample with one that was collected from the defendant and comparing the specific features of each, bite mark analysis is done to ascertain whether the defendant left the original mark or not. Since the shape of the bite marks might reveal vital information about the person who inflicted them and may influence the inclusion or exclusion of a person under investigation, physical bite mark evidence will always be important in criminal investigations. No matter if they are present alone or alongside other mouth structures, teeth leave their mark. Even identical twins' bite scars differ from one another, making each individual's bite mark distinctive. The uniqueness of a person's dentition serves as the scientific foundation for bite mark identification, which links bite marks to criminal suspects.

A three-dimensional dentition of the suspect is left behind and can be drawn from bite traces left on foodstuffs during the criminal inquiry, and analysis of bite marks evidence that can be used to either implicate or exclude the subject of the investigation as the offender as a creator of bite mark⁴. Similar to this, the forensic importance of teeth marks on food substances is determined by the substrate's nature⁵. The importance of biting marks on food in forensic investigations is determined by the substrate's nature⁶ and the perishable food substance's ability at room temperature to hydrate and deform, along with the precision of the time it took to gather and preserve the bite mark evidence, as well as the suspect's teeth when it left an impression on the food. However, for teeth mark analysis and victim identification, the forensic odontologist requires life-size bite mark pictures with good quality and angulation. At the crime scene, bite marks are most commonly seen in sexual assault, homicide, and child molestation too. Evidence of bite traces could be found on a living or deceased person's body, as well as on items.

Bite marks can appear on any region of a victim's body, although the face, neck, arm, breast, legs, buttocks, waist, and female genitals are the most usually affected. In this research, bite traces have appeared in cheese, chocolate, apples, oranges, cucumber, biscuits, sandwiches, chewing

gum, roast pig, meat, and potato pie, and even a fake soap apple have all been recorded as sources of bites. While multiple cases of bitten food items found at crime scenes have happened during larceny, the Forensic Odontologist's evidence in bite traces on remains of food items found at crime scenes has been significant in many more serious offenses. Although photography is the most secure way to create a bite mark that remains on perishable goods⁷ like apples, cheese, and chewing gum must be of the best quality to be most useful in forensic investigations. Bite marks on food should be compared to a person's dentitions⁸, the size, shape, and spatial orientation of each tooth are taken into consideration. The efficiency of bite mark analysis was evaluated using three different food products. Because bitten food is typically left at crime scenes: apples, cheese, and chocolate the unique dental structure that only humans possess⁹. Bite marks have a characteristic dual loop shape pattern that shows the lower and upper jaw's anterior teeth¹⁰. These markers show unique characteristics of each dentition, such as tooth spacing or ridges. Repairs on the biting surfaces, as well as missing, damaged, chipped, or deformed teeth that make it easier to identify a specific person¹¹. The bite impressions identification on food can be critical in some circumstances¹²⁻¹³. This study's objective was to see how well bite marks could be identified in various foods.

Various techniques for recording biting traces have been devised, which can be divided into direct and indirect methods. The direct technique compares a replica from life-size images of the bite mark to the victim's teeth, whereas the indirect technique compares dental exemplars with a duplicate of the teeth's biting surface. The method for evaluating bite marks is well-established, and it involves measuring and analyzing the pattern, size, and form of teeth versus similar features seen in a skin injury or a trace left on an object¹⁷⁻¹⁸. Dental study casts used for hand tracing, wax impression technique, photography method, radiographic wax impressions technique, photocopying, and a way for creating overlays with computer assistance method are some of the ways used to create these overlays¹⁹⁻²⁰. The study's aims and objectives compared the biting mark with an investigation of Using two methods—manual docking and computer aided overlay generation—we analysed bite marks on three different food ingredients: apples, cheese, and chocolate. We compared the two methods' accuracy: docking and computer assistance overlay generation. The bite marks and dental impressions, of these suspects, were scanned using 3D surface scanning. To examine how bite marks

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Blood Stain Identification Through Presumptive Tests in Forensic Cases: A Comprehensive Review

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Abstract- Forensic investigators employ presumptive blood detection techniques for insight at suspicious stains or to identify small amounts of blood. Human bias and inhibition in the practice of forensic science give rise to significant concern. Numerous academic studies have demonstrated the bias and erroneously susceptibility in particular forensic science fields, including fingerprint and DNA matching. The assessment of presumptive tests for the detection of blood with comparison of various criteria has drawn minimal attention. The purpose of this paper is to explore feasible test interpretations and the best outcomes obtained through the chemical or technique to identify an inadequate amount of human blood. In this study, we carefully deliberate for assessing the persistence of blood stains existing on a surface, we found that dark, non-porous surfaces were particularly challenging. The individual stains might be detected with different levels of precision. The potential of the forensic luminol test to identify small amounts of blood that are completely undetectable to the naked eye has long been seen to be valuable. The forensic luminol test involves the luminol chemiluminescence (CL) that develops when haemoglobin is present. It is employed at crime scenes as a preliminary blood test. The luminol test's primary benefit is that it is highly sensitive, and competent to identify blood traces in quantities as small as one nanogram. In our opinion, the subjective assessment of the forensic police, there is no replacement for further testing using a color-change reagent, and eventually a confirmation test.

Keywords: - Blood stain, Haemoglobin, Presumptive test, Chemical enhancer

INTRODUCTION

Blood is significant evidence that helps investigator to solve the crime (Li, 2015). It is one of the common substances found at the scene of crime. To identify and boost the blood with the help of different presumptive test helps in recognizing the nature of blood and its action with its surrounding. Sometime due to adverse condition of environment blood remains hidden and undetectable with naked eyes at a scene of crime due to time, weather and often attempt by the criminal to eliminate the blood stain by washing. In such instance, it is essential to use presumptive test enhancement for the detection of latent blood stain at a scene of crime (Frégeau et al., 2000; Tontarski et al., 2009). Chemical and biological test are used through which blood can be detected. To detect the presence of blood the chemicals get enhanced by the presence of haemoglobin which will give positive results for both animals and human blood (Tobe et al., 2007). Mostly for the identification blood at the scene of crime performed by the presumptive test, while in the laboratory confirmatory test is performed for the further forensic analysis.

With the help of alternative light source, colorimetric test and the IR photography the nature of the aged and concentrated blood stain and identification of invisible blood stains on different surfaces like fabric, paint and frail blood. (Fildes, John; et al., 1998).

Hence blood is used as major evidence at the scene of crime due to the stability (Li, 2015). J. Fildes et al. (Fildes, John et al, 1998) according to his study of effects of heat on human blood stated that it is not destroyed up to the exposure up to 60°C for up to 600 milliseconds.

In this review article comparison and contradiction of the relative sensitivity, specificity of laboratory and the commercial preparation of the chemicals to boost the reagent. This complete study at the meanwhile examines the sensitivity of reagents used by considering different surfaces such as natural fibre to synthetic fibre such as cotton, tiles carpets and hard surfaces such as stone, wood, permeable and impermeable surfaces. By altering the surfaces, the effects of colour and dyes were observed by testing sensitivity.

Sensitivity radically had a great impact on the latent blood stains depending upon the surfaces. Also sensitivity shows result depending upon the preparation of different reagents (Cox, 1991; *Critical Revision of Presumptive Tests for Bloodstains by Pon...*, n.d.; Tontarski et al., 2009). Hence the chemical enhancement method boost the stain into coloured one which can be visualized and analysed.

BLOOD: COMPOSITION

In the animal kingdom, various categories possess distinct blood cellular compositions. Blood among individuals is a constantly circulating, opaque bright red fluid which is denser and more sluggish than water. Haemoglobin, a unique iron-containing protein, provides fluid their distinctive colour. Oxyhemoglobin (oxyhemoglobin) and deoxyhemoglobin (deoxyhemoglobin) are two different colours of haemoglobin that change when oxygen is involved. Centrifugal force can separate blood components (erythrocytes, leukocytes, and platelets) from the blood plasma, and blood and the circulatory system helped to facilitate with the development of more complex lifeforms over billions of years. The dried-out part of whole blood which originates in the form of droplets. Blood classified on the basis of their components (a) Extracellular fluid: plasma (b) Formed elements: RBCs, WBCs and (c) Platelets (Wecht & Rago, 2005). Therefore, the biochemical properties of blood and their dynamics useful in enhancing the blood through chemicals (Magalhães et al., 2015).

RED BLOOD CELLS (RBCs)

The fundamental function of red blood cells is to carry oxygen from the lungs to all the tissues in the body. These cells are highly specific and well-fitted for their role in the body. With a diameter of 7.8 μ m (1 μ m = 0.000039 inch), red blood cells have a major surface-to-volume ratio due to their biconcave disc shape and contain 97% of whole blood. Erythropoietin, a hormone mostly produced by the kidneys, regulates the production of red blood cells in the bone marrow, red blood cells originate as immature cells and

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Comparative Analysis of Manual Docking and Computer-Assisted Overlay Technique for Bite Mark Analysis

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Abstract: The bite mark is important physical evidence that plays a significant role in forensic investigation. Through, proper scientific analysis of bite marks found at the scene of the crime and comparing it with the suspect's bite impressions may help in the exclusion and inclusion of an individual. Teeth leave their mark on the surfaces which are unique to an individual. And this is the scientific basis for using bite marks as evidence to prove individuality. Various direct and indirect techniques have been developed to analyze and compare the bite marks. Keeping this in view, current study aims to perform the comparative analysis of bite marks on three different edible materials i.e., chocolate, apple, and cheese via manual docking as well as through computer-assisted overlay generation techniques. Apart from that, the current study also evaluated the accuracy of the two above-mentioned used techniques.

Keywords: Bite marks, Hand docking, Computer-assisted overlay technique, Dental imprints, Dental cast

INTRODUCTION

Bite marks on inanimate materials like wooden cabinets and flesh have both been probed in the criminal justice system but bite traces on foodstuffs left are the most common of all bite marks found at crime scene. In forensic investigations, investigating bite marks is essential. By contrasting a sample with one that was collected from the defendant and comparing the specific features of each, bite mark analysis is done to ascertain whether the defendant left the original mark or not. Since the shape of the bite marks might reveal vital information about the person who inflicted them and may influence the inclusion or exclusion of a person under investigation, physical bite mark evidence will always be important in criminal investigations. No matter if they are present alone or alongside other mouth structures, teeth leave their mark. Even identical twins' bite scars differ from one another, making each individual's bite mark distinctive. The uniqueness of a person's dentition serves as the scientific foundation for bite mark identification, which links bite marks to criminal suspects.

A three-dimensional dentition of the suspect is left behind and can be drawn from bite traces left on foodstuffs during the criminal inquiry, and analysis of bite marks evidence that can be used to either implicate or exclude the subject of the investigation as the offender as a creator of bite mark⁴. Similar to this, the forensic importance of teeth marks on food substances is determined by the substrate's nature⁵. The importance of biting marks on food in forensic investigations is determined by the substrate's nature⁶ and the perishable food substance's ability at room temperature to hydrate and deform, along with the precision of the time it took to gather and preserve the bite mark evidence, as well as the suspect's teeth when it left an impression on the food. However, for teeth mark analysis and victim identification, the forensic odontologist requires life-size bite mark pictures with good quality and angulation. At the crime scene, bite marks are most commonly seen in sexual assault, homicide, and child molestation too. Evidence of bite traces could be found on a living or deceased person's body, as well as on items.

Bite marks can appear on any region of a victim's body, although the face, neck, arm, breast, legs, buttocks, waist, and female genitals are the most usually affected. In this research, bite traces have appeared in cheese, chocolate, apples, oranges, cucumber, biscuits, sandwiches, chewing

gum, roast pig, meat, and potato pie, and even a fake soap apple have all been recorded as sources of bites. While multiple cases of bitten food items found at crime scenes have happened during larceny, the Forensic Odontologist's evidence in bite traces on remains of food items found at crime scenes has been significant in many more serious offenses. Although photography is the most secure way to create a bite mark that remains on perishable goods⁷ like apples, cheese, and chewing gum must be of the best quality to be most useful in forensic investigations. Bite marks on food should be compared to a person's dentitions⁸, the size, shape, and spatial orientation of each tooth are taken into consideration. The efficiency of bite mark analysis was evaluated using three different food products. Because bitten food is typically left at crime scenes: apples, cheese, and chocolate the unique dental structure that only humans possess⁹. Bite marks have a characteristic dual loop shape pattern that shows the lower and upper jaw's anterior teeth¹⁰. These markers show unique characteristics of each dentition, such as tooth spacing or ridges. Repairs on the biting surfaces, as well as missing, damaged, chipped, or deformed teeth that make it easier to identify a specific person¹¹. The bite impressions identification on food can be critical in some circumstances¹²⁻¹³. This study's objective was to see how well bite marks could be identified in various foods.

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Sex Determination from Frequency of Occurrence of Minutiae in Fingerprints

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Abstract- Fingerprints are one of the most reliable evidences that is accepted for personal identification. Minutiae plays an important role when comparing the two fingerprints. In this study, the distribution of minutiae is studied and the gender estimation from the frequency of minutiae is observed. For this purpose, fingerprint samples of all ten fingers are taken from 300 samples (150 males and 150 females) of the tribal population of the Jashpur districts of Chhattisgarh. The methodology used is, the core is identified and a 5mm x 5mm transparent box with a center at baseline is kept at the core position, and minutiae under the box are observed. The most common type of minutiae observed was bifurcations in both sexes followed by ridge end. Male shows high overall minutiae count when compared with females.

Keywords: Dermatoglyphics, Minutiae, Forensic fingerprinting, Gender Determination, Adermatoglyphia.

Introduction

Gender estimation is important to provide investigative leads for finding missing or unknown persons. Various methods have been used to estimate gender using different biometrics traits such as the face, gait pattern, iris, hand geometry, speech, and fingerprint [1].

Fingerprints are one of the most important contact traces left behind after the commitment of crime by the perpetrator as their uniqueness puts an individual at the scene [2,3]. Fingerprints are unique, permanent, easy to collect, and the best, most positive, and infallible clue that connects the culprit with the crime. Even in the case of identical twins who share the same genetic codes, do not share the same fingerprints [4,5,6]. Fingerprints are used as evidence for personal identification, sex determination, and valuable aid to the investigating officers in the process of detection, prosecution of crime, and identification of criminals as it is Permanent, accurate, reliable, and acceptable in the courtroom [7,27,28]. Friction ridges start to develop between the 9th and 24th week of intrauterine life. Due to the differential growth and pressure experienced by the embryo inside the womb, the pattern of development of furrows and raised skin is different in each individual, even for identical twins [8]. These visible patterns of furrows and raised ridges are known as fingerprints when located on the distal phalanges of the hand [9]. The continuous dark pattern flow in the fingerprint is called raised ridges while the light area between ridges is called furrows [10]. Adermatoglyphia is a genetic disorder occurred due to a mutation in the SMARCAD1 gene due to which an individual lacks fingerprints throughout his life [7]. The surfaces of the palms of the hands, soles of the feet, fingers, and toes all share an anatomical feature known as friction ridge skin [11]. The study of these epidermal ridges and their configurations on the fingers, palms, and soles is termed Dermatoglyphics. The word dermatoglyphics is derived from the Greek words 'Derma' meaning skin and 'glyphics' meaning carvings [12,13]. The term Dermatoglyphics was given by "Cummins & Midlo" in 1926 [14]. Sir Francis Galton, a pioneer in the field of

dermatoglyphics, published the first book on fingerprints in 1892. The individuality and uniqueness of fingerprints are identified by Galton in his study, Galton identified the unique characteristics of fingerprints, which were later known as minutiae [15,9]. It can be Plastic print, visible print, and Latent print in nature [4]. Basically, the fingerprints are categorized as (a) tented arch, (b) plain arch, (c) ulnar loop (d) radial loop, (e) whorl (f) twin loop (g) central pocket loop (h) lateral pocket loop (i) accidental. Except for the plain arch [16]. Each type has one or more cores and a delta. Fingerprints possess three basic elements which are Delta, core, and recurve. Delta is a point from which the ridges converge into three directions. It is also termed as a triradii. The core is the central area of the pattern. It contains the point of the core. Recurve (shoulder of the loop) is a point at which the recurring ridge turns inward or curves. Arches and tented arches lack free recurves [4,17]. The friction ridges have minute peculiarities (features) that are present in a sufficient number in every fingerprint. These basic features are also called ridge characteristics Or Minutiae [18]. A single fingerprint may possess as many as a hundred or more characteristic features in the form of fine minute details of the ridges in the complete print area of a finger impression [19]. Minutiae (ridge characteristics) which are commonly found in a fingerprint impression are: Bifurcation, Bridge, Point/Dot, Ending-Ridge, Short-ridge, Spur/Hook, Trifurcation, Break, Overlap, Crossbar, Opposed Bifurcation, Dock, and return [20].

Gender classification from fingerprints is helpful for anthropologists and investigating officers to minimize the range of suspects from excavated articles [1]. The features like pattern type, pattern intensity index, ridge counts, minutiae, epidermal ridge width (ridge density), and ridge thickness to valley thickness ratio are used for sex determination [21,22,1]. Statistically, it is found that ridge parameters of male and female shows variations and that dermatoglyphic features differ between the ethnic groups, sexes, and age categories. Various researchers have proved that a fingerprint can be processed for sex determination [1,23,24,25]. Various studies suggest that there are significant differences in the fingerprints of

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Psychological Autopsy as an emerging tool in forensic investigation: Application and Relevance

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Abstract- Psychological Autopsy (PA) is considered the keystone of suicide research providing detailed information. Its prime objective is to rectify full-scale information about suicide. Information is collected from key informants i.e., family members, relatives, close friends, and colleagues. Additional information about the decedent is gathered from personal documents, social media and networking history, and available healthcare and mental records. Thus, the information is synthesized from various informants and personal records. The process of PA is used in death investigation cases to come to a valid conclusion regarding the manner of death when the manner is in question; particularly considering suicide cases, the exact manner of death is in question unknown. Thus, PA is an advanced step to analyze the risk factors and mental state of the decedent before death. The main purpose of the present article is to explain the importance of psychological autopsy and its application in understanding suicide along with generating awareness and improving the perception of the layman about the psychological autopsy process.

Keywords: - Psychological autopsy, decedent, informants, suicidal death, equivocal death

Introduction

Suicide is the most distressing way of death because it puts an end to an individual's life and adversely affects the family, relatives, and friends of the individual who committed it. It is an intricate and multi-casual phenomenon and stands for a serious problem of public health (1). According to recent data from the World Health Organization (WHO), each year roughly more than 700,000 people in the world put an end to their life by committing suicide. Suicide is among the root cause of death worldwide, being the 4th among youth from 15-29 years old. In 2019, 1.3% of deaths were caused due to suicide [WHO Report 2021] (2). Thus, suicide needs to be consciously analyzed by including the events of a person's life, circumstances, family and environmental events, psychological aspects traced by subjective questions, cultural references, and the socio-economic context in, which the individual was involved. To conclude the reason behind suicide, one must scrutinize the decedent's personal and circumstantial factors thoroughly. A medico-legal autopsy finds out the origin of death by scrutinizing the physical condition of the body. From time to time, the evidence found by the physical autopsy does not disclose the way of death. In such cases where the way of death is untold and not clear, a psychological autopsy may assist the investigator in clearing up the mystery of the unsolved case. It refers to the evaluation of the mindset of the decedent before death. It involves the assessment of the sort of person they were, their personality, and their thought processes to assist the investigation (3). Thus, PA is the complete line of action for looking into a person's death by reframing the thoughts, feelings, and preceding of the person before death. The psychological autopsy reframing is based upon the information assembled from the personal document along with medical history, police records, and information gathered from close one of the suicidal victims (4). The PA is known as the main investigating procedure for better perception of suicide and reconstruction of situations surrounding death.

2. Structure of Psychological Autopsy

Two psychologists employed in a hospital in the USA developed psychological

autopsy in the late 1950s. The two found a bag in the underground room of the hospital containing more than 200 suicide notes. Later, they studied the notes and other suicidal aspects. The term 'Psychological Autopsy' was devised by the Director of the Los Angeles Suicide Prevention Centre (LASPC), Edwin Shneidman, in the year 1958. The conditions under which a behavioral scientist should conduct a psychological autopsy were formalized by Ebert, in the year 1987. (5-7).

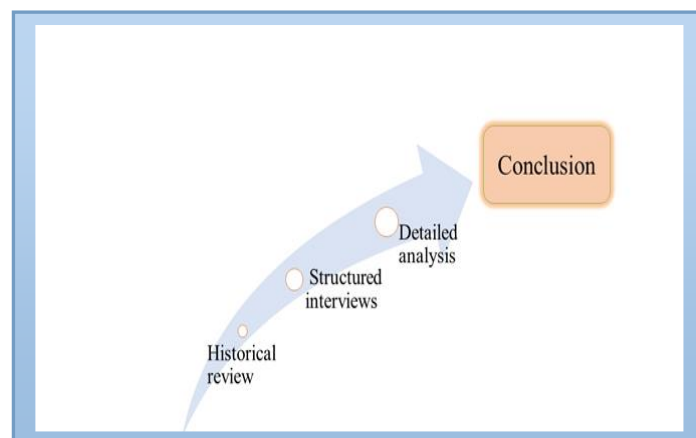


Fig.1. Basic steps of psychological Autopsy.

The basic structure of how the PA is conducted is the same among Psychological Autopsy Investigators, but the method of how they do their study may be different (Fig.1) (8). The sub-structure of the PA may change accordingly. To conclude any PA, information has been collected from various sources based upon conceptual as well as theoretical basis. It seems that the professionals involved drew upon their own experience to relate the facts of symptoms and syndromes that they would come across in everyday practices (4). The PA is compound/multiplex and needs several hours of work using and applying multiple and different disciplines. The deepness and extent to which an

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Reliability of Mandibular Canines as Indicators for gender estimation in Bilaspur population, Chhattisgarh, India

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Abstract- Determination of gender is important in forensic investigation although DNA analysis is the most precise technique to determine the gender but sometimes lack of facilities and the cost factor may be a hindrance, in such cases the teeth especially the canines from an important material as they are hardest and chemically most stable tissues and sexual dimorphism in canines can be determined by using various dimensions like the buccolingual, mesiodistal and the inter canine diameters. The aim of the present study was to check the reliability of mandibular canine index (MCI) in the determination of gender in an individual. This study was conducted in the Department of Forensic Science at Guru Ghasidas University in Bilaspur Koni, Chhattisgarh. Dental casts from the vicinity of Bilaspur's dental clinics were used for the investigation. This study signifies the possible role of morphometric study of canine teeth in estimation of gender and it can be used in forensic investigations where gender determination of skeletal remains is difficult. Our study conclusively establishes the existence of a definite statistically significant sexual dimorphism in mandibular canines and that MCI is of limited value and can only be used as an adjunct with other parameters for the determination of gender in cases of highly mutilated and damaged bodies

Keywords- sexual dimorphism, mandibular canine index, forensic investigation, inter canine diameter.

Introduction

The dentition considered as a useful adjunct in skeletal gender estimation particularly since teeth are resistant to postmortem destruction and fragmentation. teeth are the first-rate material for genetic and forensic investigations an important initial step in identification of the dismembered remains of mass disaster victims is the separation of sexes¹⁸. Sex assessment of skeletal remains is part of the archaeological and many medico-legal Examinations.

Identification of sex in damaged dead bodies (non-living population) is an essential step for medico-legal purposes. Teeth are an excellent material in living and non-living population for anthropological, genetic, deontological and forensic investigations⁵. Their extreme durability in the face of fire and bacterial decomposition makes them invaluable for identification. Being the hardest and chemically the most stable tissues in the body, they are selectively preserved.

Determination of gender is important in forensic investigation although DNA analysis is the most precise technique to determine the gender but sometimes lack of facilities and the cost factor may be a hindrance. in such cases the teeth especially the canines from an important material as they are hardest and chemically most stable tissues. Teeth are known to be unique being made of the most enduring mineralized tissues in the human body. teeth are extremely durable even at high temperatures and may be identified even when the rest of the body has undergone decomposition. canines are better likely to survive severe trauma among all the teeth including air disaster, hurricanes, or conflagration. these findings indicate that mandibular canines can be considered the "key teeth" for personal identification.^{4,16}

"Sexual Dimorphism" refers refer to those differences in size, stature and appearance between male and female that can be applied to

dental identification because dentitions of two person are different^{3,8}. Gender determination of skeletal remains a part of many medico-legal as well as anthropological examinations. the teeth and their measurement seem to be most reliable method since teeth represents the most durable and resilient part of the skeleton⁷. sexual dimorphism in canines can be determined by using linear dimensions like the buccolingual, mesiodistal and the intercanine diameters.^{3,7}

The aim of the present study was to check the reliability of mandibular canine index (MCI) in the determination of sex in an individual¹¹ and it can be of immense medico legal use in identification. The measure of permanent mandibular canines suggests that males have heavier teeth and more dentin than their female counterpart. The mesiodistal measure of mandibular canine⁶ and the mandibular intercanine distance are a simple inexpensive method that could be useful in forensic odontology establishing sex identity²¹, and is of particular interest in adults aged 18-25years.¹⁷

ANATOMY OF TEETH-

Original Article / Research Article

Role of mitochondrial cytochrome b (cyt b) DNA in animal species identification and its forensic applications

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Abstract-Wildlife crime involves the trading of endangered and protected species protected under the Wildlife Protection Act of India 1972 and monitored by Convention on International Trade in Endangered Species of Wildlife, Flora and Fauna [CITES]. The most commonly found evidence of wildlife crimes are bones, hairs, ivory, antlers, claws, and highly processed animal products. Some of the evidences like hair, skin, antlers, etc. can be identified using morphometric techniques and microscopy. Degraded animals' sample like urine, saliva, and formalin preserved samples can't be analyzed. Hence, its need of hours for better techniques over morphology and microscopy to identify species. Species identification in wildlife forensics is one of the major concerns for law enforcing agency and curbing of illegal wildlife trade. Among all the available techniques, DNA-based species identification is the most robust and acceptable evidence in a court of law. Species identification can be performed efficiently with the help of mitochondrial DNA [mtDNA] by using short fragments of cytochrome b gene (cyt b), especially in samples that are degraded and of low quality. This review covers the various aspects of species identification in forensic, wildlife, taxonomic, and phylogenetic studies and it highlights the role of the mtDNA cyt b gene in the identification of different animal species.

Keywords: - Species Identification, Mitochondrial DNA, Wildlife, Cytochrome b and Phylogenetic studies.

INTRODUCTION

Wildlife trading is considered the third largest illegal trade in the world. It includes the smuggling of numerous reptiles, mammals, and amphibians' species all across the globe [1]. The powdered samples were commonly encountered by forensic laboratories which frequently lacked the morphological features. A simple test can determine the sample's species are listed on CITES or as endangered and illegal to trade [2]. In the last ten years, according to CITES [Convention on International Trade in Endangered Species of Wildlife, Flora and Fauna], IUCN [International Union for Conservation of Nature] and TRAFFIC [Trade Records Analysis of Flora and Fauna in Commerce], Pangolian scales, ivory, tiger skins, Asian bears, and African Rhino horn have entered the illegal trade markets and are purposely used for making ornaments, traditional medicines, and are used as decorative items [1]. Wildlife crime generally includes offences like smuggling of internationally protected species, their possession, illegal poaching, etc. Analysis of wildlife trade requires the identification of species involved in the trade and assessment of whether they are from legal or illegal trade. [3]. Although various legal agencies are working continuously for wildlife protection, prosecutions of more than 70% of the cases of wildlife crimes are not possible due to improper identification of species. [4,5,6,7 and 8] Species identification gives a taxon name to a particular living being. Forensic identification of species and individualization of samples can serve many purposes, such as in the investigation of illegal trading, animal attacks, robbery of livestock etc. [10, 11 and 12]. There are multiple ways of species identification. Morphological feature can be evaluated by microscopy. However, some of the features are intentionally removed [13], which makes identification of morphological features very difficult. [14]; some of the morphological characteristics have been used as a marker but are not suitable for highly degraded samples. Therefore, other methods [15], like molecular analysis are usually done through DNA.

DNA markers have been used extensively for species identification due to easy processing and even degraded DNA can also give the valuable information. DNA can be extracted from highly processed products of wildlife trade markets like dried sharp fins [16], egg shells [17], rhinoceros [18], etc. DNA typing is frequently used in taxonomy, forensic science, and archeology and phylogenetic for the purpose of species identification. [18,19,20,21 and 22]. The genetic variation is unique for every species and serves as a potential technique for species identification. [23]. Species identification can be done via various samples [faces, bones, internal organs, skin, meat, hair, ivory, animal products, etc.] for estimation of animal distribution and investigation through morphological characteristics and molecular analysis. [24]. However, low quality and insufficient sample amount results in degradation and can lead to unsatisfactory results, thereby making it difficult to identify the species. By using universal primer, amplification and sequencing of a particular region and comparing it with the database in Gen bank can help in the determination of sequence of an unknown sample as well. [25, 26]. Gen bank reportedly has around 108 million gene sequences, increasing the probability of an unknown sample matching a sequence from a reference sample deposited on the database. [27]. A recent development in DNA testing led to the identification of not only individual species within a mixture as well as multiple species. It requires targeting the gene sequences that are specific to particular species. [28]. The loci generally used for species identification are present in mitochondria.

THE MITOCHONDRIAL GENOME

All eukaryotic cells have a cell organelle called mitochondria except non-nuclear cells which is capable of generating cellular energy through oxidative phosphorylation process [29]. Mitochondria are the powerhouse of the cell and provide energy to the cells for its functioning. The cells with high energy requirement contain high number of mitochondria and are

Original Article / Research Article

Wildlife Crime: Reason and Consequences and Preventive Measures

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Abstract- The term wildlife originally referred to undomesticated species, but it has now expanded to apply to any organism that grows or lives in the wild without human introduction. The extinction of specific species is threatened by wildlife crimes like poaching and illegal wildlife trading. IWT has gained prominence as a worldwide policy concern in recent years, largely because of its link to losses in well-known species that are trafficked internationally. The constant depletion of wild flora and fauna in India due to uncontrolled human activities, natural habitat destruction, illegal trading, and clandestine poaching activities is threatening the ecological balance. In the current scenario, the IWT system shifted from traditional to e-platforms to control that different types of governmental and non-governmental organizations are working together at national and international levels. Advanced tools and technologies are being used to detect and stop wildlife crimes. This review deals with the illegal trading of wildlife and its products, along with the techniques, causes, and effects. In addition, the measures and techniques were also considered to combat this serious and major wildlife crime.

Keywords: Wildlife, Wildlife crimes, Wildlife trading, Ecosystem, Conservation, Prevention.

Introduction

"Wildlife" includes any animals, bees, butterflies, crustaceans, fish and moths, and aquatic or land vegetation which form part of any habitat.[1]. Wildlife includes all non-domesticated animal species of land and water, uncultivated plants, and insects that live in an area without humans. These plants, animals, and insects live in their natural habitat, such as forests, grassland, ocean, river, desert, etc. Wildlife is conserved due to following reasons: a) to Maintain the balance of the ecosystem, b) for Pollination purposes, c) for Medicinal purposes, d) Regulate the food chain, e) for Cultural meaning associated with wildlife, f) for Agriculture and farming purposes g) Natural Evolution [2]. To enhance the soil's fertility and health. Wildlife crime is the illegal taking, trading, exploiting, possessing, or killing of animals or plants in contravention of national or international laws. There are the following common types of wildlife crime:[3]

- **Hunting-** It includes capturing, killing, poisoning, snaring, and trapping of any wildlife.
- **Poaching** – It is the illegal hunting or capturing of wild animals.
- **Possessing-** Illegal taking over of wildlife.
- **Trading, shipping, or moving** – Selling or exchanging of wild animals or plant resources, trade of which is prohibited under the law.[4]

The wildlife protection Act 1972 is an act of the parliament of India passed on August 21, 1972, and implemented on 9 September 1972 enacted for the protection of plant and animal species. Before the establishment of this law, India had five designated national parks. Now there are 106 national parks present in India. The Act consists of 60 sections and VI

Schedules – divided into eight Chapters. The Act provides powers to the central and state governments to declare any area a wildlife sanctuary or national park. The Act regulates the hunting and trading of wild animals. Chapter V deals with the trade or commerce of wild animals, animal articles, and trophies. Chapter V- A deals with the prohibition of trade or commerce in trophies, animal articles, etc.[1][6] The trade includes living and dead wildlife of different species that are captured, poached, and sold for various purposes, such as food, medicine, pets, artifacts, and various products. Illegal trade routes range in scale from local to international levels and are often conducted through informal networks. Illegal wildlife trade [IWT] is a global problem. This includes the deliberate and illegal transport of wildlife across international borders. Illegal wildlife trade is among the largest illegitimate businesses. Different types of species of both plants and animals are subjected to illegal wildlife trade, known as the illegal buying and selling of harvested species or their derivatives.[5] Illegal wildlife trade is gaining prominence as a threat to biodiversity. The rising demand for illegal wildlife products results in the decline of threatened species, as well as it also creates an international security threat and is responsible for economic losses. The world is losing wildlife at an alarming rate. The illegal trading of wild animal parts such as ivory, tiger skin, bones, bear bile, rhino horn, the skin of various reptiles, and other wildlife material this kind of trade creates a serious threat to the global as well as local diversity either directly or indirectly. A large variety of plant species are also being threatened by illegal wildlife trading. Plant species like orchids, cycads, cacti, and timber are traded for the production of food supplements, for example, oils, medicines, and perfumes. There are many international organizations present, such as CITES [Convention Union for Conservation of Nature], IUCN [International Union for Conservation of Nature], and WWF [World Wildlife Fund], that control and monitor wildlife trafficking.[6] Illegal wildlife trade is a transnational crime that is the illegal acquisition, movement, and distribution of wildlife species or their items across international borders. Illegal wildlife trade follows a chain and