



# MODERN SCIENTIFIC METHODS FOR IDENTIFICATION

*JV'n Dr. Gaurav Gupta*

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**MODERN SCIENTIFIC  
METHODS  
FOR IDENTIFICATION**

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## **PREFACE**

Forensic Medicine is an essential knowledge that should be possessed by every medical practitioner. Identification is one of the subject, that is important in the field of forensic science which helps in determining the race, age, sex, stature, etc. for identification of Living persons, recently dead persons, Decomposed bodies, Mutilated and burnt bodies, and skeleton. It is also used in criminal investigation in identifying the victim and accused. Now as the science and technology is advancing, more modern methods are developed for this like finger printing, retina scan, DNA fingerprinting etc.

The aim of writing this book is too concise all essential information in an easily comprehensible arrangement that can easily be understood by students without missing any essential information. It is tried to keep chapter arrangement in a uniform format so that it can become easy to learn.

JV'n Dr. Gaurav Gupta

Author

## **ABOUT AUTHOR**

Dr Gaurav Gupta is a Homoeopathic academician and consultant having B.H.M.S. M.D. from Jaipur. Currently, he is working as Assistant Professor in the Department of Forensic Medicine and Toxicology at Faculty of Homoeopathic Science under Jayoti Vidyapeeth Women's University, Jaipur. He has a vast clinical experience of more than 5 years. He has written and published 5 research papers in SCOPUS indexed international Journal, 3 in UGC Care listed Journals and 4 research papers in peer reviewed journals. He has published a book on Toxicology and another on forensic medicine. He has written multiple book chapters in many edited volumes. He has also published 6 patent applications. He has knowledge of the subject and has a unique style of teaching.

## **ACKNOWLEDGEMENT**

Writing a book is harder than I thought and more rewarding than I could have ever imagined. My inspirations in writing this book are my students, whose need always pushed me to do a work that is easily comprehensible and can be read and revise even before the examination.

I would like to thank the publisher, who gave me the opportunity to publish this book

I would like to thank my parents and family for their immense support, without which this work was not possible. I would also like to thank my colleagues who encouraged and supported me in writing this book.

I wish that this book will help students to understand the topic and will also guide them in preparation for the PG examination.

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# DACTYLOGRAPHY

**DACTYLOGRAPHY**, also known as fingerprint system, dermatoglyphics, Galton-Henry system. It is the scientific study of ridge patterns in the skin and is widely accepted as most reliable and scientific evidence of identification. This method was first time used by Sir William Herschel in 1858 and systematized by Sir Francis Galton in 1892. It was used in India in 1858 for the first time by Sir William Herschel in Bengal. In India, first Fingerprint Bureau was established in Kolkata.

## **PRINCIPLE:**

- Fingerprints are impressions of patterns that are formed by the papillary or epidermal friction ridges of the fingertips. The fingers, palms of the hands and soles of the feet of humans have this friction ridge skin and on the tip of the fingers, and this friction ridge skin makes number of basic patterns and each basic pattern have numerous possible variations and helps in distinguishing one person to other.
- These dermal ridges appear first time from the 12th–16th week of IUL and their formation gets completed by 24th week. A fine pattern of ridges is seen on the skin of the bulbs of the fingers and thumbs, parts of the palms and the soles of the feet at the time of birth. These patterns remain constant throughout embryonic life, birth and the life of the individual until damage has occurred to the dermal skin layer.
- The arrangement and distribution of the ridges makes unique patterns in an individual, and pattern of no two hands resembles each other.
- Multiple factors plays important role in determining the basic shapes of the patterns and ridges. Genetic makeup is one of the important factors.

- Identical twins have identical genetic makeup, but distinguishably different fingerprints. The probability of two individuals having same conventional fingerprint is about one in 1 billion.
- Fingerprints can get damaged temporarily or permanently. Temporary loss of fingerprints may be seen in case of swelling of the fingers, e.g. when stung by bee, but returns when the swelling recedes or due to weather. Permanent impairment of fingerprint pattern also occurs in leprosy, electric injury and after exposure to radiation. Fingerprints can also be erased permanently and deliberately by criminals to reduce their chance of conviction. Erasure can be achieved in a variety of ways including burns, acids and plastic surgery.

#### **CLASSIFICATION-**

1. Loops (about 60 to 70 percent)
  - (a) radial
  - (b) ulnar
2. Whorls (about 25 to 35 percent)
  - (a) concentric
  - (b) spiral
  - (c) double spiral
  - (d) almond-shaped
3. Arches (about 6 to 7 percent)
  - (a) plain
  - (b) tented
  - (c) exceptional

4. Composite (about one to two percent)

- (a) central pocket loops
- (b) lateral pocket loops
- (c) twinned loops
- (d) accidentals.

### **MODE OF PRODUCTION OF FINGERPRINT-**

A constant stream of sweat covers the skin. Sweat contains about 99% water and 1% solids, which include salt, sulphates, carbamates, lactic acid, urea, fatty acids, formic acid, acetic acid, butyric acid, little albumin etc. The fingerprint also contains oil secreted by the sebaceous glands, If any part of finger is applied to a smooth surface, a greasy impression of its pattern is made on it.

### **RECORDING OF FINGERPRINTING-**

- The hands are washed, cleaned and dried to avoid blurring of print. Now printer's ink is applied on finger tip and the fingerprints are recorded on unglazed white paper.

Two methods are used to obtained impression:

1. A plain print is taken by applying ink to the tips of the fingers and placing the fingers directly on paper.

2. The rolled fingerprint is taken by rolling the fingers on paper from outward to inward in such a way as to obtain an impression of the whole tip.

- Impressions of all the ten digits of both hands are taken in case of criminals.
- Usually, left thumb impression of male and right thumb impression of female in lieu of signature for illiterate person and on legal and other documents is taken.
- Prints can be obtained from the dermis if epidermis is lost.
- If rigor mortis is well developed, incision into the palmar surface of the fingers at the proximal inter-phalangeal joint will enable the fingers to be straightened, and printing can be carried out. If even after this, a clear print is not obtained then the palmer skin of the terminal phalanx of each finger may be removed from both the hands and placed in a labelled bottle containing 10% formalin. If the post-mortem changes advances resulting in putrefaction or in case of drowning, the skin may come out like a glove which can be preserved in formalin for the development of fingerprints.

#### **TYPES OF FINGERPRINTS-**

1. **Latent print (chance print)** - It is an invisible or barely visible impression left on a smooth surface. It requires additional processing to be rendered visible and suitable for comparison.
2. **Visible prints-** These are formed by fingers stained with blood or ink or other medium. It requires no processing to recognize it as a fingerprint.
3. **Plastic print-** It is an impression made on a soft surface, such as soap, cheese, mud, pitch, candles, thick dried blood, adhesives, etc.

## **DEVELOPMENT OF LATENT PRINTS-**

Latent prints are the most prominent example of Locard's Principle of Exchange which states that 'when two objects come into contact with each other, there is always some transfer of material from one to the other.' Fingerprints may be taken from almost any surface with which the fingers come in contact, including certain fabrics and human skin.

**COMPOSITION OF LATENT PRINT RESIDUE:** Palmer and planter surface is completely free from hair and sebaceous glands, and is rich of sweat glands, the composition of which forms the basis for latent fingerprint residue. The salts predominant in perspiration are sodium and potassium chlorides, with the organic fraction containing amino acids, urea and lactic acid. Free fatty acids, triglycerides and wax esters prevail in sebaceous secretions. Fingerprints are stable compounds and may remain indefinitely if not exposed to extremes of heat or humidity or friction,

## **LIFTING OF FINGERPRINTS-**

- Fingerprints on a hard surface are developed, photographed and then adhesive surface of cellophane tape is pressed on the print, taken out gently and pasted against a cardboard sheet for permanent preservation.
- **Fingerprints on Human body:** The fingerprints of a person remain on the body of other only after death because pre-death struggle causes sweat and one's sweat removes the print of other's. After death, the body doesn't sweat, due to which the fingerprints remains on the body. Electronographic method is used to develop latent fingerprints on skin of living persons or dead bodies.

## FINGERPRINT DEVELOPMENT-

A. For non-porous surfaces- e.g. glass, gloss-painted surfaces, metal and plastic.

### a) Examination

- **Visual examination:** Oblique illumination is used to show latent fingerprints.
- **Fluorescence examination:** High intensity light source or argon-ion laser or UV light may show latent fingerprints.

### b) Development techniques

- **Vacuum metal deposition (VMD):** It is most sensitive method and can develop fingerprints on surfaces that have previously been wet or even submerged in water for extended periods of time. It detects monolayer of fat by sequential deposition of a thin coating of thermally evaporated gold followed by zinc.
- **Fingerprint powders:** It is one of the oldest techniques and is widely used but it is insensitive. Many powders like milled aluminum or brass, or molybdenum disulfide, black (chalk and mercury) or white powders (lead carbonate or French chalk), iron, cobalt or nickel-based powders, fluorescent powders are used. Milled aluminum or brass, or molybdenum disulfide are more sensitive and effective than the more traditional black or white powders in developing fingerprints on smooth, clean surfaces. In case of contaminated surfaces, granular black (chalk and mercury) or white powders (lead carbonate or French chalk) are more suitable. Rough or grained surfaces may be treated

with iron, cobalt or nickel-based powders along with a magnetic applicator.

- **Superglue fuming-** It can be used on any nonporous surfaces and is composed of methyl or ethyl cyanoacrylate, which polymerize with latent prints. It is particularly useful on surfaces such as rough or grained plastic surfaces.
- **Small particle reagent (SPR):** It consists of a suspension of molybdenum disulfide suspended in aqueous detergent solution and is applied by spraying or immersion. The molybdenum disulfide particles adhere to fats deposited in the fingerprints, producing a gray-black image.
- **Iodine fuming:** It is one of the oldest and cheapest methods to develop recent prints on porous and non-porous surfaces. Iodine fumes are absorbed by fingerprints to form a brown image which is photographed immediately.

B. For porous surfaces, e.g. paper, wallpaper, cardboard and matt emulsion painted surfaces.

a) **Examination**

- **Visual examination-** It shows fingerprints on porous surfaces.
- **Fluorescence examination-** It may sometimes detect fingerprints either by the fluorescence of naturally occurring components or fluorescence of some contaminants.

b) **Development techniques**

- **DFO (1,8-diaza-9-fluorenone):** It is the most sensitive reagent and reacts with amino acids deposited in the fingerprints to produce

a faintly colored but intensely fluorescent compound which can be easily photographed.

- **Ninhydrin-** It is a widely used chemical which reacts with amino acids and produces a deep blue or purple color known as Ruhemann's purple.
- **Powders:** Smooth papers may be treated with black or magnetic powder, although these will usually detect recent fingerprints.
- **Superglue fuming-** It may be used on some smooth surfaces such as cigarette packets.
- **Physical developer:** It is the only available technique for detecting fingerprints on a wet porous surface. This reagent is an aqueous solution of silver nitrate containing Fe II/III redox couple and two detergents. The developed fingerprints are gray-black in color, and recorded using conventional photography.

### **MEDICO-LEGAL APPLICATION-**

1. Identification of criminals whose fingerprints were found at scene.
2. Identification of fugitive through fingerprint comparison.
3. Exchange of criminal identifying information with identification bureau of foreign countries in cases of mutual interest
4. Identification of unknown deceased person, persons suffering from amnesia, missing persons and unconscious patient.
5. Identification in disaster work.
6. Identification in case of accidental exchange of newborn infants.

7. Identification of licensing procedure for automobile, firearm, aircrafts, etc.
8. Problems of mistaken identity and detection of bank forgeries.
9. Electronic fingerprint readers have been introduced for security applications such as log-in authentication for the identification of computer users. Fingerprint sensors gained popularity in the notebook PC market.
10. Electronic registration and library access: Fingerprints can be used to validate electronic registration, cashless catering and library access. This 'conventional biometrics' is routinely practiced in some schools in the UK, US, Belgium, France and Italy replacing library cards. However, privacy issues are of concern since children are fingerprinted by schools, often without the knowledge or consent of their parents.

## **POROSCOPY**

Poroscopy is the term applied to a specialized study of pore structure found on the papillary ridges of the fingers as a means of identification. It is the further study of fingerprints, discovered and developed by Edmond Locard in 1912.

Ridges on fingers and hands are studded with microscopic pores formed by mouths of ducts of subepidermal sweat glands. Each millimeter of ridge contains 9–18 pores.

There are about 550–950 sweat pores per square centimeter in finger ridges, and less (400) in the palms and soles.

He observed that like the ridge characteristics, the pores are also permanent, immutable and individual, and these are useful to establish the identity of individuals when available ridges do not provide sufficient ridge characteristics.

# **PALATOPRINTS**

Anterior part of the palate has a structural details similar to rugae which is individual specific and permanent.

## **MEDICO-LEGAL APPLICATION-**

1. It can be used in the similar way as fingerprints.

## **FOOTPRINTS (Podogram)**

The skin patterns of toes and heels are also distinct and permanent similar to the fingers. Any peculiarities in the foot, such as a flat foot, supernumerary toes, scars or callosities may be found in the footprint. In case of bootmark the pattern and arrangement of nails or holes in the sole may be useful.

A footprint produced by walking is usually larger than one produced by standing. The imprint on soft and loose material like sand is smaller than the foot, and the imprint produced on mud or clay is larger.

### **RECORDING OF FOOTPRINTS**

Footmarks are recorded by photography, casts or lifting or by a combination. Casts can only be taken when there is a footmark in depth. As they are three dimensional, they can be easily compared with the suspect's shoes even by lay persons. Crime scene footprints are compared with the comparison prints made on similar surface by the suspect. Prints are taken in normal standing position, standing position with pressure on inner side and outer side, when walking and when jumping. It may be possible to know whether the track marks are that of a young or old person.

## **MEDICO-LEGAL APPLICATION-**

1. Footprints of newborn infants are used in some maternity hospitals to prevent exchange or substitution of infants.
2. A fresh footprint of suspected person is taken and compared with the original. A footmark expert may identify a shoe with a mark made at the scene of crime, and by general examination may find out the number of persons involved, their actual movements at the scene and their point of entry.
3. Individual impressions, especially in yielding soil, will indicate the shoe size and approximate weight of the person and any peculiarity of gait.
4. A partial footmark may be quite sufficient to positively identify a shoe.

## **LIPPRINTS (Cheiloscopy)**

The study of lip prints is called cheiloscopy. The fissures and grooves on the lips are said to be characteristic of the individual.

Lip prints are divided into six patterns which are specific to the individual; vertical, branched, intersected, reticular patterns, etc. 24 characteristic details have been identified and identification is established if 7 to 9 characteristics tally. Minor differences can be noted between the right and the left and upper and lower lips.

### **TYPES OF LIPPRINTS-**

Suzuki has divided lip prints into five main types:

1. **Type I** – It represents grooves running vertically over the lips.
2. **Type II-** It has partial length grooves of Type I variety and do not cover the entire breadth of the lips. Type II represents the branched grooves.
3. **Type III-** It represents the intersected grooves.
4. **Type IV-** It represents the reticular pattern, much like a wire mesh.
5. **Type V-** It represents all other patterns. These are irregular non-classified patterns.

### **RECORDING OF LIPPRINTS-**

- Simplest method to makes lip print are similar to that of fingerprints by using powders and fixing on foil.
- Aquaprint and cyanoacrylamide may be also applied.

- For classification, the middle part of the lower lip, 10 mm wide is taken which is almost always visible in the trace.

### **MEDICO-LEGAL APPLICATION-**

- It is useful for personal identification.
- Lip prints are transferred at the point of direct, physical contact of the individual's lips with an object at the scene of crime, e.g. cutlery and crockery items.
- The use of lip prints in criminal cases is limited because the credibility of lip prints has not been firmly established in our courts.

# TRICOLOGY

Study of hair is known as trichology. Examination of hair can provide important clues as apart from burning, hair is virtually indestructible.

## **MEDICO-LEGAL APPLICATION-**

1. It remains identifiable even on bodies in an advanced state of decomposition, or attached to the weapon of offence after a crime has been committed.
2. Whether it is a hair or fibre and if it is hair, is it a human hair or animal hair.
3. It helps in identifying the race.
4. It helps in identifying the age as well as sex.
5. Whether the hair fall
6. was natural or pulled.

# **EAR PRINTS**

Ears have four basic shapes; (1) oval; (2) round; (3) rectangular and (4) triangular. \Most of the ear prints are found on doors or windows.

## **RECORDING OF EARPRINTS-**

- From the suspect three prints are taken (1) functional pressure, (2) gentle pressure, (3) more pressure, on a glass pane.
- The print is made visible as in the case of fingerprints and a photograph of the print is taken.
- The same process is applied to the ear prints from the scene.

## **MEDICO-LEGAL APPLICATION-**

- Photocopies of both known and unknown ear prints are produced on plain and transparency overlays. The transparency overlay is put on the top of the unknown print and taped to the top of a light box. If the tragus point, crus of the helix points and antitragus point fit, lower and upper crura of the antihelix and the helix rim are seen.
- If all details coincide the prints are from the same source. The opinion can be positive, highly probable, probable, possible or no basis for comparison.

## **RETINA/IRIS IDENTIFICATION**

Every person's retina has an unique pattern which is not changed from birth until death. The pattern is different even in identical twins. It is the most precise and reliable biometric.

### **RECORDING OF EARPRINTS-**

- A retinal scan is performed by casting an undetectable ray of low-energy infrared light into a person's eye as he looks through the scanner's eyepiece, which outlines a circular path on the retina.
- Retinal blood vessels absorb light more readily than the surrounding tissue, but the amount of reflection fluctuates.
- The results of the scan are converted to computer code and stored in a data base. Using suitable cameras and infrared illumination, image of cornea is copied and converted into digital templates.

### **MEDICO-LEGAL APPLICATION-**

- It can help in the identification and recognition of individuals for security purposes.
- Retinal patterns may be altered in cataracts, glaucoma, retinal degeneration and diabetes
- It can help in identification of missing, dead persons.

## **SKULL-PHOTO SUPERIMPOSITION**

This technique was applied by Glaister and Brash in 1935. It is the technique used to determine whether the skull of the person resembles to the person in the photograph.

### **TECHNIQUE OF PHOTO SUPERIMPOSITION-**

- The photograph can be used with front view, lateral view and even semi-lateral view of face.
- Recent photograph is better and if the negative of photograph is not available, negative is prepared from photograph. Using this negative, photograph is enlarged to natural size from the presence of some standard thing in the photograph of the missing person to indicate the scale. In the absence of a standard for the measurement of face in the photograph, photographs of the skull and face are superimposed by adjusting the magnifications until the interpupillary distances correspond.
- The negative is placed under the ground-glass of camera and salient features of the face are marked out carefully on the glass. The soft parts are removed from the skull.
- A comparison can be made even in the absence of the lower jaw. The skull is mounted on an appropriate skull rest, so as to align as accurately as possible with the outline of the head on the ground-glass in the corresponding portrait. making due allowance for the soft tissues covering the bone.
- The distance of the camera is adjusted so that the one inch scale on the ground-glass of the camera is exactly equal to the scale on the skull. Thus, when photographed, gives a life-sized negative of the skull. The negatives of the photographs and the skull are superimposed by aligning the characteristic points in the negatives.

- The two superimposed negatives are then photographed on bromide paper and the resulting superimposed photograph brings out the points of similarity or dissimilarity between the photograph and the skull.
- The superimposition is correct, if the outlines and the size of the skull accurately correspond to the face in the photograph. For this, positive portrait and negative of the skull are rephotographed on X-ray film, thus producing a transparent positive of the skull. Finally, the two films are bound together in register and thus superimposed; they are then re-photographed on X-ray film by transmitted light.

**POINTS FOR COMPARISON-** The following points are compared.

- The eyes within the orbital plates, with the two pairs of canthuses properly aligned.
- The nasion.
- The prosthion in the central line.
- The nasal spine in the centre which is a little above the tip of the nose.
- The lower border of the nose.
- The lower border of the upper jaw, i.e., below the tip of the nose.
- The zygomas below the eyes.
- Supraorbital ridges.
- Angle of the jaw.
- External auditory meatus.
- Angle of the jaw.
- Teeth.

## **MEDICO-LEGAL APPLICATION-**

- The data from an unknown skull are electronically 'clothed' with standard soft tissues and modified on screen to produce various images to recognise a missing person by a viewer, a variety of stored eyes, ears and noses can be added, and any feature altered instantaneously.

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