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Cheiloscopy (Lip Prints) – An Advanced Boon for Forensic Odontology: A Review

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Cheiloscopy, deals with the identification of Lip traces, based on the fact that the pattern of lines. It plays a major role as a forensic tool of identification in addition to Bite marks, Tooth Morphology, Restorations and Palatal rugae patterns. Research indicates the existence of heredity in the Lip prints. This article presents a recent advances in Cheiloscopy.
Keywords: Dental, Cheiloscopy, Forensic, Lips, Oral.

1. Introduction

Identification of a person has always been a challenging task for scientists. It is necessary for all legal, personal and social reasons. Dental data, DNA, fingerprints are the most popularly used identification methods. The emerging technology or tool for human identification is Cheiloscopy- study of lip prints. Lip pints are normal lines and fissures in the form of wrinkles and grooves present in the zone of transition of human lip, between the inner labial mucosa and outer skin. Similar to finger prints, lip prints are considered unique to an individual.Traces of can be looked on cutlery and crockery items, on the window or door glass, on photographs or letters, food products1,2,3.

History

In 1902 Fischer was first to describe lip prints. In 1960 Dr.Martin Santos proposed a classification system for lip prints. In 1966- criminal identified by lip print on window. In early 1970's, two Japanese scientists named T. Suzuki and Y.Tsuchihashianalysed the lip-prints of 1364 individuals and inferred that lip-prints are unique for an individual. They also established

a possibility of utilizing lip-prints in personal identification. In 1972- McDonell identified that identical twins had different lip prints. In 1981- Cottone reported cheiloscopy as a special technique for personal identification4,5.

Classification

Martin and Santos Classification(1966)

Divided the nature of wrinkles and grooves into simple and compound types.

Simple types was subdivided into four groups - a straight line, a curved line, an angled line and a sine shaped curve. Compound type was further subdivided into bifurcated, trifurcated and anomalous groups.

Based on it thickness, thin lips are generally seen amongst the European people, medium lips are 8–10 mm in thickness, in which the pink zone is found to be more rounded. It is found in the Asian population whereas thick or very thick lips are very big in which the labial string appears inverted. These are the characteristics of Negros. Mixed type of lips was very commonly seen in Oriental people

Suzuki and Tsuchihashi (1970):

According to the shape and course of the grooves, type I includes vertical furrows over the entire lip, type Ia of partial vertical furrows, type II of branched furrows, type III of crossed furrows, type IV: net-drawing and type V: other patterns. Sex of an individual indentified by predominance of pattern is of type I, I′ pattern: female, type I and II patterns: female, type III pattern dominant: male, type IV patterns: male and type V varied patterns: male6,7,8

LIP PRINTS- ANALYSIS

FORMS OF LIP PRINTS FOUND ON CRIME SCENE

These 3 types of lip prints can be found at the scene of crime. Lip prints are available particularly in the following forms of visible lip prints which are visible to the unaided eye and it do not need any further development for its visualization. Latent or Hidden Lip prints which are not visible to human eye. It requires further development processes for its visualization. 3-D or Plastic Lip Prints which are found on soft, gel like surface (wax or butter). They are visible to unaided eye but sometimes need develop processing for photography9,10,11.

SEARCH LIP PRINTS ON CRIME SCENE

The search for possible Lip Prints needs a systematic and narrowly approach to the suspected areas. A magnifying lens is useful to locate and judge the quality of the lip prints.

Traces of lips should be looked for on cutlery and crockery items, on the window or door glass and on photograph or letters. Lip print may also appear on side by side with tooth marks on food products. In practice, lip prints have also seen in the windows, painting, doors, plastic bags and cigarette ends. Observation under white light may reveal latent Lip Prints that can be photographed without any further treatment. Lip Prints can frequently be seen by holding the flashlight at low angles so that the surface is observed under oblique lighting12,13. In some cases, latent print can often be detected using episcope coaxial illumination. The print is,

therefore, visible as dark ridges against a light background.

DEVELOPMENT OF LIP PRINTS

Powder Method:

Powder method in which a powder technique is usually used to identify latent prints on nonporous surfaces such as glass, marble, metal, plastic, and finished wood.When powder is distributed on the surface, it adheres to the residue deposited from the finger's touch, allowing investigators to find the print.Following powder method can be used to develop lip print - aluminum powder method, magnetic powder method and plumb carbonate powder (white powder)

Chemical Methods

Crime Scene Investigators often use chemical methods to locate the print such as iodine fuming [must be photographed quickly because print fades quickly after the fuming takes place], silver nitrate (Agno3) [works well on impressions left in cardboard and paper-like surfaces], ninhydrin, [reacts with the oils in the print's residue to create a bluish print], lysochrome Dyes (Sudan 3 Dye And Oil Red 'O' Dye/ Red 'O' Dye), small particle reagent (SPR). When one of these chemicals comes into contact with the chemicals present in the lip prints residue (natural oils, fats), the print become visual14,15,16.

Lead powder distributed on suspected area with the help of brush. Dusted area should X-Rayed and then photographic film of X-Ray should treat with required chemicals. Development of lip prints on multi colored surface. Following 3 methods can be used to develop lip prints on multicolored surface - Sudan Black Reagent it can applied directly to the print, Yellow Fluorescent Powder (Illumination through UV light) and Nile Red Reagent17,18,19

LIFTING OF LIP PRINTS

There Are 2 Methods Are Applied For Lifting Of Lip Prints- Photographic Method – The developed prints should always be photographed by using a fixed focus camera or variable zoom photographic camera with the help of measuring. Transparent Tape Method – Powder dusted lip prints can be lifted with the help of transparent tape from a liquid and hard surface

Collection of lip print from suspect

Lip prints can be recorded in a number of ways such as photographing the suspect's lips, applying lipstick, lip rouge, or other suitable transfer mediums to the lips and then having the individual press his or her lips to a piece of paper or cellophane tape or similar surface. By having the subject impress his or her lips (without lipstick or other recording medium) against a suitable surface and then processing these prints with either conventional finger print developing powder or with a magna brush and magnetic powder. On a non-porous flat surface such as a mirror they can be photographed, enlarged and overlay tracings made of the grooves20,21.

Examination and Comparison

Generally two prints are required for comparison: a lip print recorded from the Scene Of Crime (SoC) and a lip print which has been taken from suspect. Both compared on the basis of individual characteristics of Lip Prints. Manual methods are prone to human errors. Automated

methods use various image processing techniques, machine learning algorithms and statistical approaches that may not adapt to anything beyond the algorithm's scope. They involve pre-processing of acquired digital images to enhance the quality and remove noise. Patterns are then extracted and classified using various machine learning algorithms. Automated methods yield better results when compared to the manual methods

The extracted features are classified using various classifiers like - Support Vector Machine (SVM), K-Nearest Neighbours (KNN), Ensemble classifiers and Neural Networks. Performance of each and every classifier is analyzed

SUPPORT-VECTOR MACHINES

They are unsupervised learning models with associated learning algorithms that analyze data for classification and regression analysis. Given a set of training examples, each marked as belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier. SVM maps training examples to points in space so as to maximise the width of the gap between the two categories. New examples are then mapped into that same space and predicted to belong to a category based on which side of the gap they fall.. In addition to performing linear classification, SVMs can efficiently perform a non-linear classification using what is called the kernel trick, implicitly mapping their inputs into high-dimensional feature spaces.When data are unlabelled, supervised learning is not possible, and an unsupervised learning approach is required, which attempts to find natural clustering of the data to groups, and then map new data to these formed groups22,23,24.

K-NEAREST NEIGHBOURS

k-nearest neighbors algorithm (k-NN) is a non-parametric classification method first developed by Evelyn Fix and Joseph Hodges in 1951, and later expanded by Thomas Cover. It is used for classification and regression. In both cases, the input consists of the k closest training examples in data set. k-NN is a type of classification where the function is only approximated locally and all computation is deferred until function evaluation. Since this algorithm relies on distance for classification, if the features represent different physical units or come in vastly different scales then normalizing the training data can improve its accuracy dramatically25,26

ENSEMBLE CLASSIFIERS

The word ensemble is a Latin-derived word which means ‘union of parts’. The regular classifiers that are used often are prone to make errors. As much as these errors are inevitable they can be reduced with the proper construction of a learning classifier. Ensemble learning is a way of generating various base classifiers from which a new classifier is derived which performs better than any constituent classifier. These base classifiers may differ in the algorithm used, hyperparameters, representation or the training set. The key objective of the ensemble methods is to reduce bias and variance27.

NEURAL NETWORKS

Neural networks, also known as artificial neural networks (ANNs) or simulated neural networks (SNNs), are a subset of machine learning and are at the heart of deep learning

algorithms. Artificial neural networks (ANNs), usually simply called neural networks (NNs), are computing systems inspired by the biological neural networks that constitute animal brains. An ANN is based on a collection of connected units or nodes called artificial neurons, which loosely model the neurons in a biological brain28.

Uses of lip prints

Lip prints have the same value as Dactyloscopy traces. Just like finger print and teeth, lip print can be used as tool for identification. Lip prints are unique and do not change during life of a person. They can be most frequently seen during murders, rapes and burglaries. Traces with clear lines and individual elements enable individual identification of human beings.Gender identification29

Limitations

Lip prints have to be obtained within 24 hours. Lip print pattern depends on whether the mouth is opened or closed. Any pathology of the lip or any post surgical alteration can change the pattern30

2. Conclusion

Lip print analysis is a very simple and inexpensive procedure. The use of lip prints exist as evidence in personal identification and criminal investigation in forensic dentistry.

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