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Original Research Article

.Latent lip print: A comparative study of developers

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ABSTRACT

Introduction: Identification of a person is of paramount importance in a medico-legal investigation. At present more and more people use protecting lipsticks and permanent lipsticks. With these lipsticks a latent lip print is generated by contact with a surface and, like with the latent fingerprints occur, this latent lip print can be developed.

Aims: This study aims to retrieve latent lip prints from various inanimate surfaces like thermocol plate, bone china, and glass to compare the efficacy of developers i.e., fingerprint powder, Sudan III, Vermilion, and its comparison with standard lipstick prints. Current research assesses the effectiveness of particular surfaces in the retrieval of lip print in personnel identification.

Materials and Methods: This study included a total of 30 subjects. Latent lip print was developed on the different inanimate surfaces by pressing the lips against the different vehicles. After collecting samples, a camel hair brush was used to retrieve all three chemicals individually by simply tapping on all three surfaces. Application of chemicals was continued until the print became clearly visible for the study. Developed latent lip print was then compared with the visible lip print. Subsequently, a standard lipstick print was developed from the same subject. All the samples were coded and graded according to the patterns suggested in the literature.

Statistical Analysis used: Discrete (categorical) data were summarized in number and percentage and compared by chi-square (χ^2) test. Analyses were performed on SPSS software (Windows version 17.0).

Results: The overall (i.e., total of all three surfaces) favourable outcome was found highest in Fingerprint powder (58.9%) followed by Sudan III (28.9%) and Vermilion (10.0%) the least (Vermilion < Sudan III < Fingerprint powder). Comparing the overall outcomes of three developers, χ^2 test showed significantly different and higher favourable outcome in Fingerprint powder as compared to both Sudan III and Vermilion ($\chi^2=92.09$, $p<0.001$)

Conclusions: The study found Fingerprint powder the best developer and Thermocol plate the best surface. The findings of this study may be beneficial for investigators.

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1. Introduction

The identity of an individual is a distinctive tool that is unique to every individual. It is an important aspect in cases of theft, criminal investigations, and mass

disasters. Fingerprints, DNA, and Retina patterns have been using for a long time in the identification of a person.^{1,2} With the advancement in technology many innovations have come across in the field of forensic science. However, there are many well-known implanted methods like DNA comparisons and Dental fingerprints of human identification, one of the most remarkable emerging

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methods of human identification is human lips recognition. The peripheral surface of the lip has many elevations and depressions forming a characteristic pattern called lip prints, which are unique to an individual.^{2,3}

Lip prints affect the characteristics found on one's lips. Identifying a selected person to those characteristics (lip prints) is mentioned as Cheiloscopy. Cheiloscopy is a forensic investigation tool that deals with the identification of humans with the help of lip traces which can be found on any inanimate surfaces. The various patterns present of wrinkles or furrows or grooves present on the lips have distinct characteristics to every single individual like fingerprints. At this time more and more people (women) use protecting lipsticks and permanent lipsticks. Through these lipsticks, a latent lip print can be generated by contact with a surface.^{3,4}

Based upon the research done by Suzuki and Tsuchihashi (1968 – 71), it was established that the arrangement of lines on the red part of human lips is individual and unique for each human being. This statement led to the conclusion that there is a possibility of using the arrangement of furrows on lips for the identification of a person.⁴

The Lip Prints being uniform and do not change during the life of a person so; these characteristics and unique patterns of an individual can be used as an identification marker at the crime scene. Lip Prints obtained from non-lipstick coated lips are considered latent prints. The latent lip prints are considered as an important tool in criminal identification. These latent lip prints could be developed successfully for study purposes using various dyes.⁵

For the study of the characteristic lines and for the possibility of extracting DNA to obtain genetic profile different types of reagents make it possible to develop invisible or latent prints. It can provide information of an unquestionable value, both for the study of the characteristic lines and for the possibility of extracting DNA to obtain a genetic profile.^{6,7}

The objective of the study was to compare the development of lip prints on the various inanimate surfaces (transparent glass, thermocol cups, and bone china) after different dwell times from the time of taking of impressions. Furthermore, the study aimed to investigate that which developing powder, namely fingerprint black powder, Sudan III-lysochrome dye, and vermilion produced the best results to enable to see fine wrinkles and grooves under the magnifying lens.

2. Materials and Methods

A total of 30 subjects were included in the study in the Department of Oral Pathology and Microbiology after ethical clearance. Participants having any known allergy to cosmetic products or any lesion or scar on the lips were excluded from the study.

2.1. Materials

1. Traditional lipstick
2. Vaseline body lotion
3. Bone china cup
4. Thermocol plates
5. Glass
6. Camel hairbrush
7. Magnifying lens

2.2. Reagents

1. Sudan III
2. Vermilion (sindoor)
3. Fingerprint powder (black)

2.3. Method

The lips of the subject were first cleaned thoroughly using wet cotton with a cleanser and then with sterile cotton. The Vaseline body lotion was applied on the vermilion zone of 30 volunteers and after one-minute fixation, lip prints were taken on a bone china cup, glass, and thermocol plate. All the 30 volunteers applied traditional lipstick which leaves visible print and lip prints were taken on a plain white sheet for comparison of latent lip prints.

2.4. Development with Sudan III, fingerprint powder, vermilion

After collecting all the samples, a camel hair brush was used for the application of all three chemicals individually by simple tapping on all three surfaces. Application of dye was continued until the print became clearly visible for the study and then the excess powder was removed. Developed latent lip print was then compared with the visible lip print for clarity of lip outline and lip grooves. Two observers examined the latent lip print separately and compared it with the patent lip print for grooves and lip outline using a parameter of Good (++), Fair (+), and Poor (-) as per analysis done by Singh et al.⁸ All the parameters were statistically evaluated using chi-square test.

3. Results

Two observers examined the latent lip print separately and compared it with the patent lip print for grooves and lip outline using a parameter of Good (++), Fair (+), and Poor (-) and statistically evaluated the data using chi-square.

GOOD (++): Lip outline and lip grooves that can easily be studied.

FAIR (+): Lip outline visible but with less clarity of lip grooves.

POOR (-): Lip outline can still be noticed but lip grooves cannot be appreciated

3.1. Comparison Between developers

The latent lip print outcome (fair/good/poor) of three developers at different surfaces is summarized in Table 1. In the Thermocol plate, the favorable outcome (good) was highest with Fingerprint powder (73.3%) followed by Sudan III (43.3%) and Vermilion (16.7%) the least (Vermilion < Sudan III < Fingerprint powder) (Figure 1). Comparing the outcomes of three developers on the Thermocol plate, χ^2 test showed significantly different and higher favorable outcomes in Fingerprint powder as compared to both Sudan III and Vermilion ($\chi^2=42.35$, $p<0.001$).



Fig. 1: (a): Visible lip print on plane sheet, (b): Lip print on thermacol by all three chemicals

Similarly, in the Bone china cup, the favorable outcome was highest in Fingerprint powder (56.7%) followed by Sudan III (26.7%) and Vermilion (10.0%) the least (Vermilion < Sudan III < Fingerprint powder) (Figure 2). Comparing the outcomes of three developers on Bone china cup, χ^2 test showed significantly different and higher favorable outcome in Fingerprint powder as compared to both Sudan III and Vermilion ($\chi^2=34.26$, $p<0.001$) Table 1.



Fig. 2: (a): Lip print developed by fingerprint powder on bone china; (b): Lip print developed by vermilion on bone china; (c): Lip print developed by Sudan III on bone china

Further, in Glass, the favourable outcome was also highest in Fingerprint powder (46.7%) followed by Sudan III (16.7%) and Vermilion (3.3%) the least (Vermilion < Sudan III < Fingerprint powder) (Figure 3). Comparing the outcomes of three developers on Glass, χ^2 test showed

significantly different and higher favourable outcomes in Fingerprint powder as compared to both Sudan III and Vermilion ($\chi^2=29.77$, $p<0.001$) Table 1.

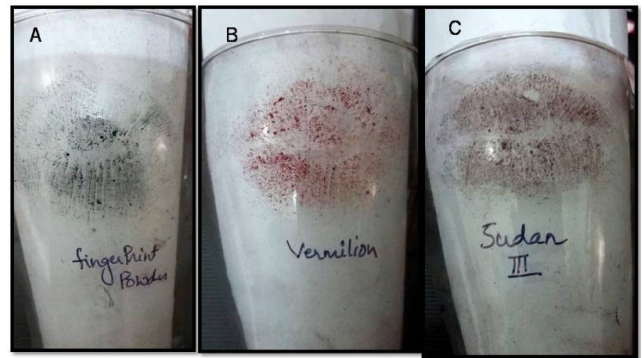
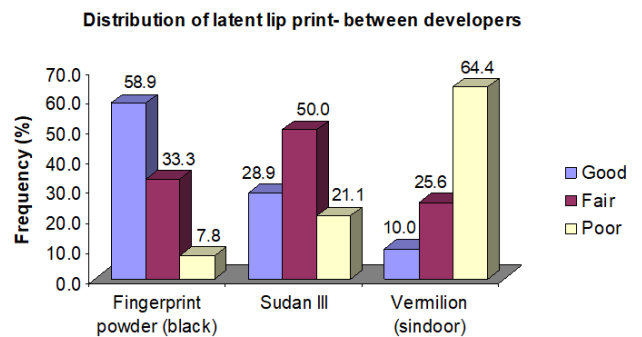


Fig. 3: (a): Lip print developed by fingerprint powder on glass, (b): Lip print developed by vermilion on glass, (c): Lip print developed by Sudan III on glass

Moreover, the overall (i.e. total of all three surfaces) favourable outcome was found highest in Fingerprint powder (58.9%) followed by Sudan III (28.9%) and Vermilion (10.0%) the least (Vermilion < Sudan III < Fingerprint powder). Comparing the overall outcomes of three developers, χ^2 test showed significantly different and higher favourable outcome in Fingerprint powder as compared to both Sudan III and Vermilion ($\chi^2=92.09$, $p<0.001$) (Table 1, Graph 1)



Graph 1: Distribution of latent lip print outcomes between developers

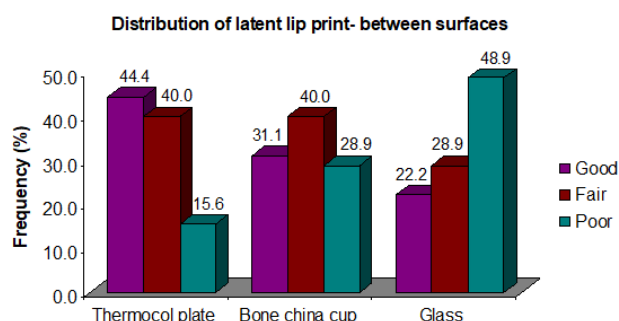
4. Between surfaces

The latent lip print outcome (fair/good/poor) of three surfaces at different developers is summarized in Table 2. In Fingerprint powder, the favourable outcome (good) was highest in Thermocol plate (73.3%) followed by Bone china cup (46.7%) and Glass (46.7%) the least (Glass < Bone china cup < Thermocol plate) (Figure 1). Comparing the outcome of Fingerprint powder between surfaces, χ^2

Table 1: Distribution and comparison of latent lip print outcomes between developers

Surface	Outcome	Developers			χ^2 value	p value
		Fingerprint powder (black) (n=30) (%)	Sudan III (n=30) (%)	Vermilion (sindoor) (n=30) (%)		
Thermocol plate	Good	22 (73.3)	13 (43.3)	5 (16.7)	42.35	<0.001
	Fair	8 (26.7)	17 (56.7)	11 (36.7)		
	Poor	0 (0.0)	0 (0.0)	14 (46.7)		
Bone china cup	Good	17 (56.7)	8 (26.7)	3 (10.0)	34.26	<0.001
	Fair	13 (43.3)	15 (50.0)	8 (26.7)		
	Poor	0 (0.0)	7 (23.3)	19 (63.3)		
Glass	Good	14 (46.7)	5 (16.7)	1 (3.3)	29.77	<0.001
	Fair	9 (30.0)	13 (43.3)	4 (13.3)		
	Poor	7 (23.3)	12 (40.0)	25 (83.3)		
Total	Good	53 (58.9)	26 (28.9)	9 (10.0)	92.09	<0.001
	Fair	30 (33.3)	45 (50.0)	23 (25.6)		
	Poor	7 (7.8)	19 (21.1)	58 (64.4)		

test showed significantly different and higher favourable outcome in Thermocol plate as compared to both Bone china cup and Glass ($\chi^2=17.25$, $p=0.002$) Table 2.



Graph 2: Distribution of latent lip print outcomes between surface

Similarly, in Sudan III, the favourable outcome was highest in the Thermocol plate (43.3%) followed by the Bone china cup (26.7%) and Glass (16.7%) the least (Glass < Bone china cup < Thermocol plate) Figure 1. Comparing the outcome of Sudan III between surfaces, χ^2 test showed significantly different and higher favourable outcome in Thermocol plate as compared to both Bone china cup and Glass ($\chi^2=15.78$, $p=0.003$) Table 2.

Further, in Vermilion, the favorable outcome was also highest in Thermocol plate (16.7%) followed by Bone china cup (10.0%) and Glass (3.3%) the least (Glass < Bone china cup < Thermocol plate) Fig 1. Comparing the outcome of Vermilion between surfaces, χ^2 test showed similar outcomes among the surfaces ($\chi^2=9.02$, $p=0.061$) i.e. did not differ significantly Table 2.

Moreover, the overall (i.e. total of all three developers) favorable outcome was found highest in Thermocol plate

(44.4%) followed by Bone china cup (31.1%) and Glass (22.2%) the least (Glass < Bone china cup < Thermocol plate). Comparing the overall outcome between surfaces, χ^2 test showed significantly different and higher favorable outcomes in the Thermocol plate as compared to both the Bone china cup and Glass ($\chi^2=25.24$, $p<0.001$) Table 2, Graph 2.

5. Discussion

Lip prints at crime scenes are rarely mentioned simply due to the fact most investigators and/or crime scene examiners do not look for them. It is important to note though, lip prints left at scenes of a crime are more prevalent than one thinks.

Lip prints can be traced from various surfaces like glass, plates, clothes, cutlery, cigarette butts, etc. Similarly, the invisible or latent lip prints can also map out using aluminum and magnetic powder. The efficacy of developing lip prints by different chemical developers depends on the surface of the object on which lip print was made and the composition of the chemical compound used.^{5,8,9}

This study aims to compare the efficacy of different chemicals or developers when used on various inanimate surfaces or vehicles. Current research also tests the effectiveness of particular surfaces in the retrieval of lip print in personnel identification.

It has been found that lysochrome dyes, such as Sudan III, aluminum powder, indigo dye, fingerprint powder can be developed successfully for latent lip print purposes.^{9–11}

In this study, fingerprint powder was found to be the best developer followed by Sudan III and vermilion. In the past literature also fingerprint powder was found to be of prime importance due to its composition and mechanical properties. Alvarez Segui et al. in 2000 found in a study that fingerprint black and silver metallic powders be the most effective for the development of latent lip print.^{12,13}

Table 2: Distribution and comparison of latent lip print outcomes between surfaces

Developers	Outcome	Surfaces			χ^2 value	p value
		Thermocol plate (n=30) (%)	Bone china cup (n=30) (%)	Glass (n=30) (%)		
Fingerprint powder (black)	Good	22 (73.3)	17 (56.7)	14 (46.7)	17.25	0.002
	Fair	8 (26.7)	13 (43.3)	9 (30.0)		
	Poor	0 (0.0)	0 (0.0)	7 (23.3)		
Sudan III	Good	13 (43.3)	8 (26.7)	5 (16.7)	15.78	0.003
	Fair	17 (56.7)	15 (50.0)	13 (43.3)		
	Poor	0 (0.0)	7 (23.3)	12 (40.0)		
Vermilion (sindoor)	Good	5 (16.7)	3 (10.0)	1 (3.3)	9.02	0.061
	Fair	11 (36.7)	8 (26.7)	4 (13.3)		
	Poor	14 (46.7)	19 (63.3)	25 (83.3)		
Total	Good	40 (44.4)	28 (31.1)	20 (22.2)	25.24	<0.001
	Fair	36 (40.0)	36 (40.0)	26 (28.9)		
	Poor	14 (15.6)	26 (28.9)	44 (48.9)		

On the other hand Trozzi et al. 2001 stated that Sudan black is the best developing agent for lip prints contaminated with foodstuff, oils, and other fatty substances while Alvarez and Castello in 2002 were found lysochrome dyes as a better lip print developer than fingerprint powder.¹⁴

It has also been stated that black fingerprint powder can be used on a wide range of surfaces as it has fine particle size and mechanical attraction property towards latent print residue. While the Sudan III powder can be used only for smooth and glossy surfaces. Vermilion powder was found dense in consistency and uneven dispersion and thus didn't trace the minor details of the latent lip print.¹⁵

On assessing the three inanimate surfaces it was found that the thermocol plate gives the best results followed by bone china and glass. Various investigators divided the surfaces into three categories. Accordingly, they are of three types: POROUS TYPE - it readily absorbs the chemical substance and the print is more durable. eg- paper, thermocol, cardboard. NON-POROUS TYPE - it repels the substance thus not absorb the chemicals so the print is not clear. Eg- glass, bone china. SEMIPOROUS TYPE - intermediate between porous and nonporous. Eg- polished wood, smooth surfaces. They have found thermocol medium as the best surface compared to any other vehicle. Thermocol plates gave the best result due to their porous nature in comparison to bone china and glass.^{9,13}

6. Conclusion

The conclusion most noted during this research is that the Fingerprint powders the best developer and the Thermocol plate the best surface. The findings of this study may be beneficial for investigators in developing visible and latent lip prints. Also, the fact that lip prints are hereditary yet considered to be individualistic, each possessing its unique characteristics. For this reason, it is safe to suggest lip prints can and should be included in the forensic sciences arena

as a legitimate means of identifying persons of interest connected with criminal activity. However, further studies with a larger sample size are needed to validate the findings.

7. Source of Funding

None.

8. Conflict of Interest

The authors declare no conflict of interest.

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