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Comparative Study of Lip Color, Lead Metal and Zinc Oxide Nanoparticle for the Development of Latent Lip Prints on Non-Porous Surfaces

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Abstract

Aim: To develop and study lip prints on non-porous surfaces by using Lip color, Lead Metal and Zinc oxide nanoparticle for the development of latent lip prints on non-porous surfaces.

Materials and methods: The study was conducted on 150 subjects, who were aged between 17-54 years. Lip color, Lead metal powder and Zinc nanoparticle powder were used to develop latent lip prints on non-porous surface.

Result: On applying paired T-test between lip print impression obtained by using lip color and ZnO nanoparticles the standard deviation of lip print impression obtained using lip color is higher than ZnO nanoparticles. The significance value is <0.05 and lip print impression obtained by using lip color and lead metal powder, the standard deviation of lip print impression obtained using lip color is higher than lead metal powder. The significance value is <0.05. The number of lip print pattern obtained on using ZnO nanoparticles are significantly higher, followed by lip color.

Conclusion: The use of nanotechnology in the field of forensic, in developing latent lip prints would complement identification of individual with other identification methods. Further research including different types of nano-powders, thus facilitating the development of multiple regression models could possibly enhance human identification.

Keywords: Nano-Forensics; Lip Prints; Nanotechnology

Introduction

Forensic science refers to the areas of endeavor that can be used in a judicial setting and accepted by the court and the general scientific community to separate truth from untruth [1]. Determining the identity of a decedent is of considerable significance from the ethical, legal, and criminal perspectives; not only is it the prerequisite for officially declaring an individual dead but it is also the basis for dealing with mass disasters, crimes, and war crimes [2].

Nanotechnology is a rapidly growing field which sets new horizons in the field of science and technology. It has been applied to various fields of science including electronics, engineering, physical sciences, materials sciences, biomedical sciences and many others. Nanotechnology has great prospective to benefit the society and forensic science. An important advantage of using nanotechnology in the field of forensic science as it reveals the hidden evidences, which can prove to be helpful for the forensic scientists to give an outcome to their investigation [3]. With the ever-increasing demands placed upon law enforcement to provide sufficient physical evidence linking a perpetrator to a crime, it makes sense to utilize any type of physical characteristic to identify a suspect of an offense [4]. Establishing a person's identity can be a very difficult process. Dental, fingerprint and DNA comparisons are probably the most common techniques used in this context, allowing fast and secure identification processes [5].

Personal identification is becoming increasingly important not only in legal medicine but also in criminal investigation, identification, and Genetic research [6]. A wide range of methods are available for this purpose out of which, the best and most often used is fingerprints. Since ancient time, fingerprints have been used as unique evidence; the fingerprint powder will fix to the residues left by the finger and give rise to the distinctive patterns that help to identify an individual as a fingerprint. Latent fingerprints are commonly developed by various colored materials [7]. There are many well-known implanted methods of human identification, one of the most interesting emerging method of human identification which originates from the criminal and forensic practice, is human lips recognition [5,6]. It is the study of the grooves and furrows present on the red part of the human lips, known as cheiloscopy [1,8,9]. Lip prints have been with us since the beginning of man. Similar to the prints on a person's finger, palm and foot in that individual characteristic are used for identification, unlike fingerprints however lips also possess furrows that can be classified into various types for identification purposes, though lip prints have not been as popular [5].

Lip prints are unique and do not change during the life of a person [6]. Lip prints can be obtained at the crime scene from clothing, cups, glasses, cigarettes, windows, and doors [6]. Lip prints are suitable for the successful comparison, analysis, and identification of a person to a crime [10]. In fact, there have been convictions of perpetrators who were positively identified via the analysis of their known lip prints to those found at the crime scene [10,11].

Nano-forensics, a completely new area of forensic science associated with the development of Nano-sensors, nontechnical methods for real-time crime scene investigation and terrorist activity investigations, determining the presence of explosive gases, biological agents, and residues [12]. Nanotechnology is beginning to have an impact on the handling of evidence at crime scenes, its analysis in the laboratory and its presentation in the court room [12]. Application of nanotechnology is likely to enhance the capacity of toxic materials, forensic evidence in tissue, materials and soil [12].

Nanomaterials like CdSe, ZnO, TiO, Gold nanoparticles used to develop latent fingerprints on porous as well as non-porous surfaces [13-17].

The application of nanomaterial for the development of lip prints is likely to become a breakthrough in the world of forensic sciences. The aim of the present study is to compare the latent lip prints developed by using Lip color, Lead metal and Zinc oxide nanoparticle.

Materials and Methods

The present study included 150 subjects, who were aged between 17-54 years. The ethical committee of the institute approved the study.

Inclusion Criteria

1. Subjects who were willing to participate in the study.
2. Subjects who were ready to provide informed consent.

Exclusion Criteria

1. The subjects undergoing orthodontic treatment.
2. The subjects with any congenital and pathological lip condition.
3. Subjects having hypersensitivity to polyvinyl (cello tape material).
4. Subjects having hypersensitivity to lipstick.

Methodology

Made the subject to sit comfortably, clean the lips of the subject thoroughly and apply lipstick on the lips with lipstick applicator uniformly. Allow the lipstick to dry for 30 seconds and impression of the lips were taken with the transparent cellophane tape from the glued side.

Similarly, impressions were taken without applying lip color using transparent cellophane tape to obtain latent lip prints.

Figure A: Lip Print obtained using Lipcolor

Figure B: Lip Print obtained using lead metal particles

Figure C: Lip Print obtained using ZnO nanoparticles

Remove the cellophane tape carefully from the lips and stuck it on A4 size white bond paper. The impression obtained was divided into six sections and analyzed by using magnifying glass. Suzuki and Tsuchihashi classification were used to classify lip.

To develop latent Lip Print, lead metal powder or ZnO nanoparticle were applied on the latent lip-prints lifted with the help of cellophane tape. Using a camel hairbrush, a small quantity of powder was carefully applied on the surface where the attempt was being made to locate the latent Lip-print. Application continued and extended until the print could be seen clearly.

Results

In the past decades, lip-print studies attracted the attention of many scientists as a new tool for human identification in both civil and criminal issues. The lip crease pattern is on the vermilion border of the lip, which is quite mobile and lip prints may vary in appearance according to the pressure, direction and method used in making the print. The possibilities to use the red part of lips to identify a human being are wider than it is commonly thought [8].

The pattern of wrinkles on the lips has individual characteristics as fingerprints. The wrinkles and grooves on the labial mucosa (called sulci labiorum) form a characteristic pattern called lip prints, the study of which is referred to as Cheiloscopy. It can be defined "as a method of identification of a person based on characteristic arrangements of lines appearing on the red part of lips or as a science dealing with lines appearing on red part of the lips" [18-20]. The lip prints being uniform throughout the life and characteristics of person can be used to verify the presence or absence of a person from the crime, provided there has been consumption of beverages, drinks, usage of cloth, tissues or napkin etc, at the crime scene. However, studying and establishing further facts and truth in lip prints will certainly help as useful evidence in forensic dentistry [8,19,20].

Cheiloscopy is a relatively new field among the large number of identification tools available to the forensic expert [1].

In the present study 150 subjects were included who were free from any congenital or pathological lip abnormality. Informed consent was taken from the subjects. Lip prints of the subjects were taken from the glued part of the transparent cellophane tape and stuck on the white bond paper, which was analyzed with the magnifying glass. In the present study we used Suzuki and Tsuchihashi classification to classify lip prints.

In the studied population partial type of lip prints were significantly higher in females followed by branched and intersected pattern. Branched type of lip prints was significantly higher in males followed by complete and intersected type of lip print pattern (Table 1).

	Complete	Partial	Branched	Intersected	Reticular	Undetermined
Mann-Whitney U	291.000	1.508E3	599.000	937.000	1.071	1425.000
Wilcoxon W	1831.000	3.048E3	2139.000	2477.000	2.611	2965.000
Z	-7.348	-.030	-5.479	-3.458	-2.717	-.537
P value	.000	.976	.000	.001	.007	.591

Table 1: Correlation of lip print with gender

The measurements were statistically analyzed by using t-test. After statistical analysis, the following observations were made. Number of partial types of lip pattern visualized better on using lip color followed by unidentified lip pattern and reticular, respectively. On applying lead metal powder on latent lip print, in the resultant impression the number of partial types of lip pattern are more followed by reticular and bifurcated, respectively. In case of ZnO nanoparticles the number of partial lip print pattern is significantly more, followed by intersected and unidentified lip print pattern (Figures 1,2 and 3).

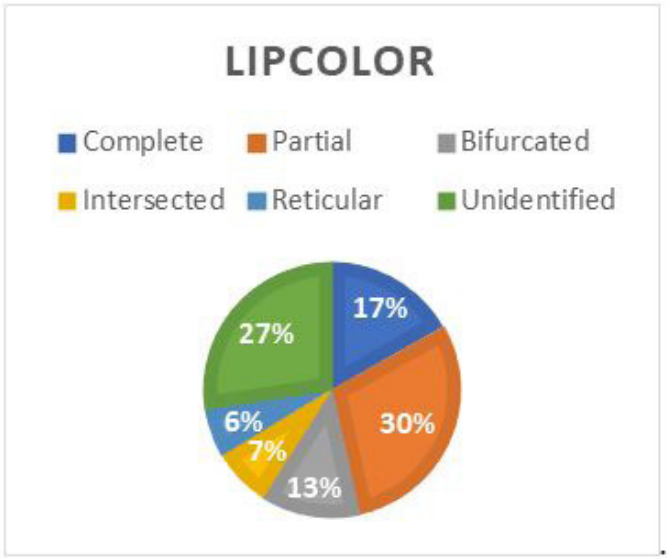

Figure 1: Lip pattern obtained by using Lip color

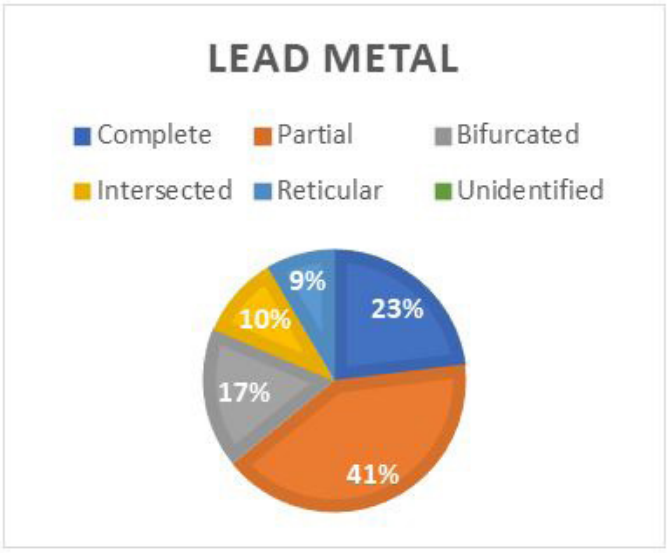

Figure 2: Lip pattern obtained by using Lead metal powder

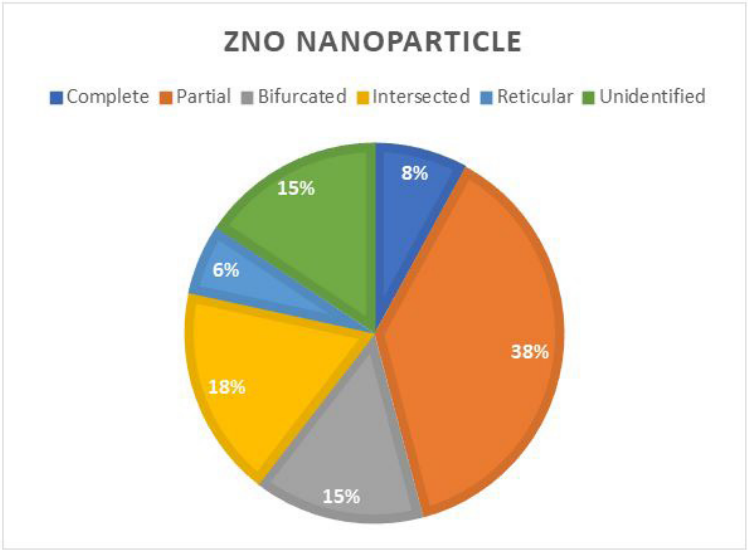

Figure 3: Lip pattern obtained by using Zinc Oxide nanoparticles

On applying paired T-test between lip print impression obtained by using lip color and ZnO nanoparticles the standard deviation of lip print impression obtained using lip color is higher than ZnO nanoparticles. The significance value is <0.05 (Table 2).

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Complete - VAR00001	1.60000	1.61031	.29400	.99870	2.20130	5.442	29	.000
Pair 2	Partial - VAR00002	-2.73333	3.43344	.62686	-4.01540	-1.45127	-4.360	29	.000
Pair 3	Bifurcated - VAR00003	-.53333	2.40306	.43874	-1.43065	.36399	-1.216	29	.234
Pair 4	Intersected - VAR00004	-1.00000	2.99425	.54667	-2.11807	.11807	-1.829	29	.078
Pair 5	Reticular - VAR00005	3.26667	2.95872	.54019	2.16186	4.37147	6.047	29	.000
Pair 6	Unidentified - VAR00006	3.46667	3.46145	.63197	2.17414	4.75919	5.485	29	.000

Table 2: Descriptive statistics lip color & ZnO nanoparticles

On applying paired T-test between lip print impression obtained by using lip color and lead metal powder, the standard deviation of lip print impression obtained using lip color is higher than lead metal powder. The significance value is <0.05 (Table 3).

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Complete - VAR00007	.80000	2.49689	.45587	-.13236	1.73236	1.755	29	.090
Pair 2	Partial - VAR00008	.60000	3.05806	.55832	-.54190	1.74190	1.075	29	.291
Pair 3	Bifurcated - VAR00009	.60000	2.54070	.46387	-.34871	1.54871	1.293	29	.206
Pair 4	Intersected - VAR00010	1.53333	2.40306	.43874	.63601	2.43065	3.495	29	.002
Pair 5	Reticular - VAR00011	3.60000	2.96648	.54160	2.49230	4.70770	6.647	29	.000
Pair 6	Unidentified - VAR00012	2.66667	3.39709	.62022	1.39817	3.93516	4.300	29	.000

Table 3: Descriptive statistics lip color and lead metal powder

On applying paired T-test between lip print impression obtained by using ZnO nanoparticles and lead metal powder, the standard deviation of lip print impression obtained using ZnO nanoparticles is higher than lead metal powder. The significance value is <0.05 (Table 4).

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	VAR00001 - VAR00007	-.80000	1.90100	.34707	-1.50984	-.09016	-2.305	29	.029
Pair 2	VAR00002 - VAR00008	3.33333	2.77095	.50590	2.29864	4.36802	6.589	29	.000
Pair 3	VAR00003 - VAR00009	1.13333	1.73669	.31707	.48484	1.78182	3.574	29	.001
Pair 4	VAR00004 - VAR00010	2.53333	1.52527	.27847	1.96379	3.10288	9.097	29	.000
Pair 5	VAR00005 - VAR00011	.33333	1.60459	.29296	-.26583	.93250	1.138	29	.265
Pair 6	VAR00006 - VAR00012	-.80000	2.75931	.50378	-1.83034	.23034	-1.588	29	.123

Table 4: Descriptive statistics of ZnO nanoparticles and lead metal powder

On comparing the impression of latent lip print obtained from lip color, lead metal powder and ZnO nanoparticles, the number of partial types of lip pattern is higher followed by unidentified lip pattern. The number of lip print pattern obtained on using ZnO nanoparticles are significantly higher, followed by lip color (Figure 4).

In the present study the impression of latent lip print obtained from lipcolor, lead metal powder and ZnO nanoparticles, the number of partial types of lip pattern is higher followed by unidentified lip pattern.

The number of lip print pattern obtained on using ZnO nanoparticles are significantly higher, followed by lip print pattern obtained on applying lipcolor.

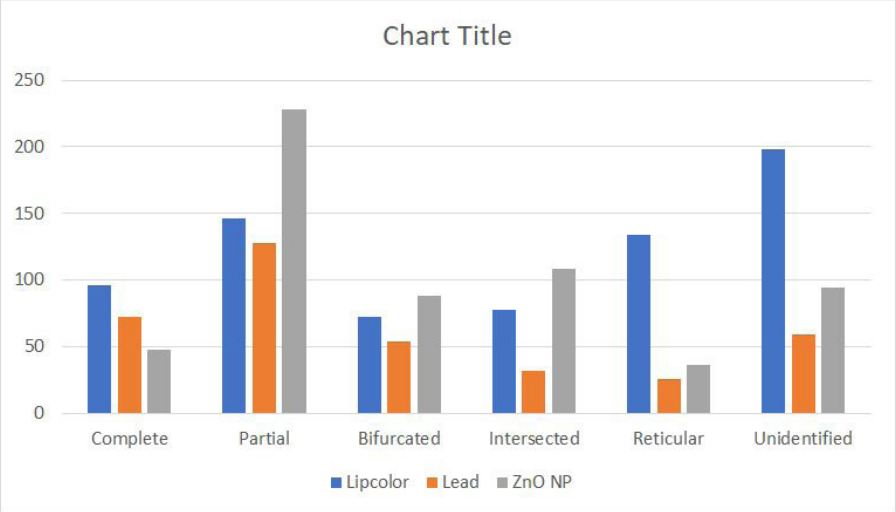

Figure 4: Graph representing Lip pattern obtained by using Lip color, Lead metal powder and Zinc Oxide nanoparticle

Discussions

In the past decades, lip-print studies attracted the attention of many scientists as a new tool for human identification in both civil and criminal issues. The lip crease pattern is on the vermilion border of the lip, which is quite mobile and lip prints may vary in appearance according to the pressure, direction and method used in making the print [8]. It concludes by enlightening the readers with the fact that the possibilities to use the red part of lips to identify a human being are wider than it is commonly thought.

The pattern of wrinkles on the lips has individual characteristics as fingerprints. The wrinkles and grooves on the labial mucosa (called sulci labiorum) form a characteristic pattern called lip prints, the study of which is referred to as Cheiloscopy. It can be defined "as a method of identification of a person based on characteristic arrangements of lines appearing on the red part of lips or as a science dealing with lines appearing on red part of the lips". The lip prints being uniform throughout the life and characteristics of person can be used to verify the presence or absence of a person from the crime, provided there has been consumption of beverages, drinks, usage of cloth, tissues or napkin etc., at the crime scene. However, studying in depth and establishing further facts and truth in lip prints will certainly help as useful evidence in forensic dentistry [8].

Cheiloscopy is a relatively new field among the large number of identification tools available to the forensic expert. In the present study 150 subjects were included who were free from any congenital or pathological lip abnormality. Informed consent was taken from the subjects. Lip prints of the subjects were taken from the glued part of the transparent cellophane tape and stuck on the white bond paper, which was analyzed with the magnifying glass. Suzuki and Tsuchihashi classification was used to classify lip prints. According to the results the type II (bisected) lip print pattern was predominant in the studied population. Partial (I') type of lip prints were significantly higher in females followed by branched (II) and intersected (III) pattern. Branched type of lip prints were significantly higher in males followed by complete and intersected type of lip print pattern. In another study by Patel et al type II pattern found to be predominant in both the sex.

In the present study the impression of latent lip print obtained from lipcolor, lead metal powder and ZnO nanoparticles, the number of partial type of lip pattern is higher followed by unidentified lip pattern [21].

The number of lip print pattern obtained on using ZnO nanoparticles are significantly higher, followed by lip print pattern obtained on applying lipcolor.

The only limitation of chelioscopy is that the same person can produce different lip prints, according to the pressure, direction and method used in taking the print. The lip print is produced by a substantially mobile portion of the lip. This fact alone explains the reason.

The application of nanomaterial for the development of lip prints is likely to become a breakthrough in the world of forensic sciences. In future different nanomaterials can be used to develop and analyze latent lip prints.

Conclusion

Our study was based on the comparison of different material in developing latent lip print. From the results of this study, it may be concluded that the use of nanotechnology in the field of forensic, in developing latent lip prints would complement identification of individual with other identification methods. Further research including different types of nanopowders, thus facilitating the development of multiple regression models could possibly enhance human identification. Consequently, this method showed promising results for development of lip print estimation by a non-invasive technique using nano powders. Lip prints have certain

limitations just like the same person can produce different lip prints, according to the direction, pressure, and method used in taking the print and Smudging of lip prints, but its features like uniqueness and stability enable it to use as evidence in court of law. The gender and geographical origin can be determined with the lip prints. Nanoparticles such as ZnO are very useful for the development of latent lip prints on non- porous and multicolored surfaces, since the normal contrast problems with dark and colored surfaces are overcome. With these nanoparticles, the appropriate light source can be selected to contrast with the color of the surface involved and the search becomes much easier. Of the two materials (lead metal powder and zinc oxide nanoparticle), ZnO nanoparticle gave the better results. The growing demand of nanotechnology today has enabled most of the scientists and analysts to go in the efficient sound skills and strategic objectives in this field.

Additionally, further studies using different nanoparticles on different population group can facilitate the development of multiple regression models that could possibly enhance human identification.

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