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Latent Fingerprint on Human Skin: A Silent Diagnosis

Upadhyay S* and Yadav B

Department of Chemistry, Biochemistry & Forensic Sciences, Amity School of Applied Science, Amity University, Gurugram, Haryana, India

***Corresponding author:** Upadhyay S, Department of Chemistry, Biochemistry & Forensic Sciences, Amity School of Applied Science, Amity University, Gurugram, Haryana, India, E-mail: shikhasivi@gmail.com

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Abstract

Fingerprints are one of the most valuable evidence due to their uniqueness. Human skin is one of the most useful as probative evidence, but one of the most difficult surfaces to develop fingerprints. This review presents a discussion on the existing methods of fingerprint lifting from human skin. Physical contact between the culprits and the victims are quite common and therefore, it is desirable for investigators to develop a method that help in development of latent fingerprints from the victim's skin. The main hindrance in developing fingerprints from skin is the presence of common chemical substances in both i.e. in prints and on surface. The utility of the different development methods has been tested or successful development of fingerprints, such as alternative light sources, Swedish black powder, iodine/silver transfer, cyanoacrylate, X-ray method, iron powder and RTX technique. The comparative analysis has been presented in this review article for all the exists method with their merits and demerits.

Keywords: Latent impressions; Chemical method; Powder method; Fingerprint recovery; Fingerprint lifter

Introduction

Fingerprints are patterns formed by the raised papillary ridges on fingertips, which contain rows of pores that connect to sweat glands. The basic patterns of fingerprints are loops, whorls and arches that can be found in fingerprints. Fingerprints have been the gold standard for personal identification within the forensic community [1-3].

Fingerprint patterns are genetically determined and remain unchanged from birth till death. They are unique, immutable, universal, easy to classify. Fingerprints collected from a crime scene can be used to identify suspects, victims and other persons who touched the surface [4].

Latent prints are the most viable fingerprints amongst patent and plastic prints as these are not visible to the naked eye, and substantially consist of only the natural secretions of human skin.

Also, there is impact of location on the latent fingerprint development as porous surfaces (Human skin, paper, fabric, unfinished wood, etc.) are more difficult as compared to non- porous surfaces (Glass, plastic, finished wood etc.). In the past, powder dusting, ninhydrin dipping, iodine fuming and silver nitrate soaking were the most commonly used techniques for latent print development. These traditional techniques are quite effective for many surfaces. However, these traditional methods for latent print detection are not always effective and scientists have attempted to improve the existing methods for the visualization of latent prints [5].

Skin is the most critical substrate for the recovery of fingerprints, due to constant renewal, regeneration and elasticity of the skin and also due to regulation of body temperature, perspiration removes latent prints, environmental factors etc. [1].

Therefore, in the historical era (1970-1990), efforts have been put to develop and standardize a reliable method for fingerprint determination by FBI (1970) but in most of the cases, it is possible under ideal laboratory conditions [1,4]. Several methods, including lasers, alternate light sources, iodine/silver transfer, cyanoacrylate fuming, regular and fluorescent powders, specially formulated powders, Swedish soot powder mixture, regular and fluorescent magnetic powders, liquid iodine, iodine/silver transfer, RTX (Ruthenium tetroxide) and ninhydrin etc. have been explored for the development of fingerprints from the human skin [6]. The alternate methods have also been exercised to reveal the latent prints like glue fuming in conjunction with regular magnetic fingerprint powder and iodine/silver transfer method. The study was conducted to summarize all the available information about the fingerprint development on human skin in literature.

Methodology

The data for review was collected from the published research articles available on scientific resource sites like PubMed, Sciencehub, and Researchgate etc. This review paper covers the scientific enhancement on the fingerprint development from 1976-2018. The techniques utilized for latent fingerprint development have been compared on the basis of their utility and result (development) parameters along with their merits and demerits (Table 1).

Sr.No.	Technique Type	Technique Name	Reference
1	**Powder Method**	Black powder	16,15
		Magnetic powder	1,3
		Swedish black powder	3,9
		Fluorescent powder	18,16
		Silver powder	18,16
		White powder	18,21
		Grey powder	18,16
2	**Chemical Method**	Ninhydrin	21,6
		Cynoacrylate fuming	2,10,19
		Iodine fuming	16
		RTX-Ruthenium tetroxide	6
		Iodine/Silver nitrate method	20
3	**Miscellaneous Method**	X-rayfluorescence radiography	12
		Alternatelight source	12
		Photographic paper lift technique	1,7
		Surface enhanced raman spectroscopy	17

Table 1: Methods compared for the Fingerprint development from the human skin

Result and Discussion

Analysis Methodology

The standard methodology used by fingerprint experts to conduct friction ridge examinations is called ACE-V (analysis, comparison, evaluation, and verification) comprising of four fundamental phases utilized in this process [7]. For analysis -substrate (the surface the print is on), matrix (the fingerprint substance), development medium (process to develop), deposition pressure (force used to deposit) and lateral pressure (slipping/twisting movement) are considered [8].The analyzed samples if worth, processed for the comparison [7,8].

Fingerprint development on human skin

Techniques Employed: More than 40 common methods have been reported for retrieving fingerprints from crime scenes. Hebrard and Donche [1994] have achieved positive results of fingerprint recovery from human skin. In recent year, Rozman *et al.* [2014] have also achieved positive results of fingerprint recovery from human skin by fingerprint powder [3].

Fingerprint powders (Magnetic Jet Black, Magnetic Silver, Silver Special and Swedish Black) and chemical methods (i.e., Cyanoacrylate Fuming and Ruthenium tetroxide– RTX) have been extensively studied for the latent fingerprint development from human skin [1,7]. The comparative studies for these methods have been given in Table 2.

S.No	Method	Developer	Result	Live and dead	Reference
1.	**Powder Method**	Magnetic jet black	Best result	Both	7
		Magnetic silver	Poor-no result	Both	7
		Silver special	Poor-no result	Both	7
		Swedish black	Best result	Both	7
		Granular black	Failed-poor result		11
		Lightning grey	Failed-poor result		11
		White powder	Failed-poor result		11
		Magnetic jet black	Most suitable- best result		11
2.	**Chemical methods**	Cyanoacrylate fuming	Poor result	Failed on dead(due to condensation)	7
		Ruthenium tetroxide– RTX	Best result	Both	7

Table 2: Comparison between chemical and powder method for development of finger marks on the skin

The comparative analysis of powder method and chemical methods in these studies indicated that Swedish Black, Magnetic Jet Black powder and RTX spraying are the preferred methods to obtain satisfactory results [7] and in addition a few studies advocated the use of luminescent magnetic powder in conjunction with cyanoacrylate fuming and laser examination to recover fingerprints from human skin surfaces [9].

For the cynoacrylate, fingerprint recovery was addressed with consideration on realistic surfaces and the technique was reported to be the best method for use on these surfaces [2,4,10].

Further, Baran [2009] compared four fingerprint powders (i.e., granular black, lightning grey, white powder, and magnetic jet black) to detect fresh and sebum-enriched fingerprints deposited on the skin [11]. The Magnetic Jet Black powder was considered to the most optimum for use on fresh marks (Table 2) [11].

However, Graham (1969) has successfully utilized X-ray methods like X-ray fluorescence radiography (XFR) and Black – scatter radiography for the fingerprint development [12].

The impact of body temperature was also analyzed and it was observed that the recovery rate is more from cryo-preserved body (4 °C) than the cadaver (37 °C) preserved body at room temperature. The recovery rate is further reduced for live volunteer [13].

Collection and Preservation: Finger marks can either be processed directly on the skin or lifted prior to being processed [3]. There are various methods for fingerprint collection like Mastercraft Silicone, AccuTrans, Zhermack High Definition, Transparent Instant Lifter, Microfilm for microtrace, Fuji glossy paper and silver plate etc.

For lifting and visualization, Trapecar M [2007] compared four fingerprint lifters (Transparent Instant Lifter, Microfilm for microtrace, Fuji glossy paper and silver plate.) for untreated fingermarks from skin. Transparent Instant lifter was concluded as a better method, comparatively for such prints (Table 3) [1].

S.No	Lifter	Result
1.	Transparent Instant Lifter	Most suitable- best result
2.	Microfilm for microtrace	Failed-poor result
3.	Fuji glossy paper	Failed-poor result
4.	Silver plate	Failed-poor result

Table 3: Comparison of four different lifters used for untreated fingermarks from human skin

Another study conducted by Baran [2009] compared three different lifting materials (i.e., Mastercraft Silicone, AccuTrans and Zhermack High Definition) to collect powdered fingermarks (using Magnetic Jet Black) from pig skin [11]. The comparative analysis of this study has been given in Table 4 and the best results were obtained by Mastercraft Silicone [11].

Sr.No.	Lifter	Powder	Skin	Result	Reference
1.	White instant lifter	Swedish black power	Human	Poorest	14
2.	White gelatin	Swedish black power	Human	Best result	14
3.	Black gelatin	Swedish black power	Human	Poor result	14
4.	Silicone casting material	Swedish black power	Human	Best result	14
5.	Transparent adhesive tape	Swedish black power	Human	Poorest	14
6.	Mastercraft silicone casting	Magnetic jet black	Pig	Best result	11
7.	AccuTrans	Magnetic jet black	Pig	No result	11
8.	Zhermack high definition	Magnetic jet black	Pig	No result	11

Table 4: Comparative chart of five lifting methods skin of living bodies, using Swedish Black powder on human skin and Magnetic Jet Black on pig skin

In contrary, Trapecar [2009] projected Silicone casting material and white gelatin as good alternatives with Swedish Black powder for living bodies after analyzing five lifting methods (white instant lifter, white gelatin, black gelatin, silicone casting material, transparent adhesive tape) whereas white instant lifter and transparent adhesive tape were found to give poorest results (Table 4) [3,14]. It can be concluded that different lifters are suitable in different conditions for collection of fingerprint.

Comparison of Development methods: Large numbers of the development methods have been studied for the fingerprint development on the skin. Magnetic Jet Black and Swedish Black were found to be the best powder methods for the development of the fingerprints on human skin.

Magnetic Jet Black and Swedish Black are the most preferred powder methods as indicated by the studies and RTX is the best chemical method to develop the fingerprints from both living and dead bodies. The studies have shown that the magnetic Jet black gives much better results than the Black powder method [15]. The comparative analyses of these methods as observed in the literature have been given in Table 2.

Conclusion

As a result of this evaluation, it can be concluded that fingerprint development of the human body is possible, but the recovery rate is low [16-20]. There are many methods by which we can develop fingerprints on human skin. Powder method is basic and least complicated method but not useful on wet latent fingerprint. In most of the cases, the Cyanoacrylate fuming method is used and is recommended method that develops clear, stable, white colored fingerprints but other methods like Ruthenium tetroxide – RTX can be used effectively, which are efficient and non-destructive. Magnetic powder can be explored to recover any possible latent prints on the victim's skin. However, most of these methods suffer from the recovery time constrains and are influenced by factors like decomposition, environment and circumstantial conditions and longevity of latent prints on skin [21-23].

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