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Application of Ardrox, Safranin O and Basic Yellow 40 for contrasting latent fingerprints on both sides of adhesive tapes

Introduction

Characteristic features in form of skin friction ridges appear in palmar surface of the hands and feet. They create various patterns, unique for each individual. These patterns remain immutable and non destroyable through one's lifetime. Epidermal ridges are covered with natural secretions of sweat from the eccrine glands on the entire skin area. Through having contact with various items, any substance (perspiration, oil, grease) which covers the ridges is transferred onto a contacted surface to leave the impression of skin friction ridges of palms or fingers. A generated mark becomes a sort of "invisible stamp" – the evidence proving the presence of a given person in a certain place. Basing upon "invisible stamp" left behind on the crime scene, an offender can be profiled. Prior to carrying out the identification and typing of a criminal, these traces which are invisible to unaided eye need to be developed with use of appropriate chemicals and specialist equipment. The choice of pertinent visualization methods is largely determined by the properties of substrate where the prints have been deposited. In most general terms, the surface can be either absorptive or a non-absorptive one. The latter one is characterized by a concise structure which prevents the penetration of sebaceous substance, to include glass, metal, plastics, enamel or varnished surfaces. Absorptive surfaces are characterized by loose, porous internal structure which gradually absorb the substance and include, among others, paper, cardboard or timber. When homogeneous-structure objects are examined, the choice of visualization method is straightforward. A particular attention must be drawn to heterogeneous surfaces of various properties, such as adhesive tapes. They have either a non-sticky, non-absorptive surface made, for instance, of plastic or a non-sticky, absorptive surface made of paper layer and additionally – an adhesive side covered with glue.

Due to various properties of tapes, it is recommended to determine the sequence of activities to be performed before visualisation methods can be applied. Forensic expert, whilst considering the results of preliminary macroscopic examination, makes a decision on the application – in the first place – of chemical reagents on sticky or non-sticky side. In case the tape is stuck together or was glued onto other substrate, one should start the examination from a non-sticky surface.

In police forensic laboratories in Poland, the experts routinely use cyanoacrylate method and a variety of contrast-making fluorescent dyes, the most popular being Ardrox, Safranin O, Basic Red 28 or Basic Yellow 40 to apply to a non-sticky side of tape. In case of adhesive surfaces, some powder suspensions, such as Sticky Side, Wet Powder or crystalline violet are most commonly applied.

A one-by-one application (imposition) of dyes and suspension can contribute not only to the enhancement but also the deterioration in legibility of deposited latent fingerprints. Up to now it has been a common laboratory practice to use Liqui-Drox solution (Ardrox, detergent, water) to prevent a negative affect of the use of several reagents and shorten the time needed for visualization.

For the purpose of the hereby study, some attempts have been undertaken to use fluorescent dyes (Ardrox, Safranin O and Basic Yellow 40) all at the same time for contrasting latent fingerprints on sticky and non-sticky sides of tapes made of various plastics, following the treatment of non-sticky side with cyanoacrylate vapour.

Purpose of examination

The purpose of examination is to check and compare the possibilities of simultaneous use of fluorescent dyes such as Ardrox, Safranin O and Basic Yellow 40 for visualization of latent fingerprints on sticky surface and non-sticky, non-absorptive sides previously treated with cyanoacrylate fumes.

The examinations took into the account the following:

- the effect of amount of sebaceous substance on the quality of latent fingerprints being developed on adhesive and non-sticky tape sides;
- the quality of developed latent fingerprints vs. time.

Laboratory methods of visualization of latent fingerprints on adhesive tapes

Cyanoacrylate method is the one most commonly recommended and actually utilized in routine laboratory practice for visualization of latent fingerprints on non-sticky, non-porous sides of adhesive tape. The method involves the deposition of cyanoacrylate fumes on a surface, which become fixed in the aqueous-based secretions of eccrine glands, whilst forming whitish and grey residue. Water particles constitute a certain catalyser for the reaction of merging smaller ester (monomer) particles into bigger polymer particles. Latent fingerprints fixed as whitish grey impressions are not often readily available in visible (white light) range. In order to enhance the contrast of developed latent prints, fluorescent dyes (e.g. Ardrox, Cyano-Blue, Safranin O, Basic Red 28, Basic Yellow 40, Europium Chelate) are applied. With no possibility of using a purpose-fit light source for fluorescent macroscopic examination, latent fingerprints can be visualised, for instance, with Sudan Black solution, which becomes deposited on cyanoacrylate polymer, producing a blue-black image of developed latent prints visible in white light.

For contrasting latent fingerprints on adhesive sides of tape, different methods are used, such as application of powder suspension, crystalline violet solution, or fluorescent dyes dissolved in detergent.

The choice of appropriate examination methods is also determined by the properties of adhesive tape; some of them are made of material containing chemical compounds with fluorescent properties, which precludes the use of luminescent dyes.

The effectiveness of the development of latent prints is determined by many factors, such as:

- composition, properties and amount of latent forming substance, i.e. sweat only or combination of sweat and grease,
- background/substrate properties (type of material the tape is made of),
- time which lapsed between the deposition of latent fingerprint and the visualization,
- environmental conditions (ambient temperature and humidity) which may accelerate or slow down the decomposition of sebaceous substance,
- contamination of sebaceous substance with other substances, such as hand cream, grease, paint,
- pressure of deposition or contact of fingertips with the background.

Empirical studies

Methods

In order to check the possibility of simultaneous application of fluorescent dyes for visualising latent fingerprints on both sides of adhesive tapes, marks of decreasing amount of sebaceous-fat substance were left on sticky and non-sticky sides of various types of tapes; subsequently these were contrasted with fluorescent dyes (having been treated with cyanoacrylate fumes in case of non-sticky surfaces).

The next step involved macroscopic examination in relevant radiation range, evaluation of latent marks and photographic recording. The examinations were carried out in four time intervals:

- „fresh" fingerprints,
- a week old,
- two week old,
- four week old.

Types of tapes used for examination

The examination involved four types of adhesive tapes (Fig. 1): silver duct tape, beige filament tape, transparent office tape, and black insulating tape.

Deposition of fingerprints

Fingerprints were deposited on 15 cm fragments of adhesive tapes three times by ensuring contact of fingerprint with sticky and non-sticky surfaces. Sebaceous substance was gradually being decreased and deposition pressure remained equal. Testing samples were collected from ten persons.

Twelve sets (Fig. 2) of adhesive tapes were generated in order to carry out examinations at four intervals.

In total, 2880 testing samples (latent fingerprints) were generated to account for:

- 10 persons applying their fingertips to sticky and non-sticky sides of the tape;
- 4 types of double-sided tapes;
- 3 one-by-one applications of fingertips (decreased amount of sebaceous substance),
- 4 time intervals,
- 3 fluorescent dyes.

Generated testing samples were stored in a closed room in ambient conditions for indicated time intervals (fresh, one week, two weeks, four weeks).

Testing reagents and instrumentation

Latent fingerprints on non-sticky surfaces were treated with cyanoacrylate fumes in STANIMEX KSX 213 chamber.

For contrasting latent fingermarks on both sides of tape, the following reagents were used:

- Ardrox solution:
  - 10 ml Ardrox P133D (concentrate)
  - 990 ml 2-propanol
- Safranin O solution:
  - 1 g Safranin O
  - 1000 ml 2-propanol
- Basic Yellow 40:
  - 2 g Basic Yellow 40
  - 1000 ml ethyl alcohol

Ardrox treatment:

a) Ardrox solution was sprayed onto both sides of tapes;
b) the excess of reagent was rinsed away in running water,
c) tape was left to dry in ambient temperature,
d) macroscopic examination with a magnifying glass was carried out in UV light and the use of colourless protection filter.

Safranin O treatment:

a) Safranin O solution was sprayed onto both sides of tapes;
b) tape was left to dry in ambient temperature,
c) macroscopic examination with a magnifying glass was carried out at 505 nm radiation range and the use of 550-590 nm streamline filter.

Basic Yellow 40 treatment:

a) Basic Yellow 40 solution was sprayed onto both sides of tapes;
b) the excess of reagent was rinsed away in running water after a minute,
c) tape was left to dry in ambient temperature,
d) macroscopic examination with a magnifying glass was carried out in UV light and the use of colourless protection filter.

Multikolor 10Xe light source was used for excitation of fluorescence.

Latent fingerprints were recorded by means of NIKON D40X photographic camera equipped with NIKKOR 60 mm lenses. The images were saved on 1GB ScanDisk memory stick and processed with Gimp image manipulation program.

Analysis of findings

During the examination, the legibility of latent prints visualized with fluorescent dyes was assessed with the following grading:

X – latent fingerprints initially selected for fingerprint identification and having minimum seven minutiae;
– latent fingerprints unsuitable for fingerprint identification and having less than seven minutiae;
0 – no visible friction ridges.

After evaluation of latent fingerprint legibility (Tables 1, 2, 3) with reference to particular dyes, their effectiveness was assessed depending on previously adopted criteria (amount of latent forming substance, age of fingerprints and type of tape).

The absolute effectiveness value was calculated with use of the following formula:

$$E = In/n \times 100\%,$$

where:

In latent fingerprints initially selected for fingerprint identification and having minimum seven minutiae,
n total number of latent fingerprints deposited on testing material.

The effectiveness of individual dyes has been presented in Figs. 3–11.

After analysis of data (Fig. 3) it can be concluded that in case of "fresh" fingerprints the effectiveness of visualizing non-sticky surfaces with Ardrox, Safranin O and Basic Yellow is 100% (Figs. 12–14), irrespectively of the tape used.

The effectiveness of visualization decreases with the age of latent fingerprints; the greatest decline of effectiveness can be observed in case of 4-week old fingerprints (Fig. 15–17) deposited on a non-sticky surface of insulating tape:

- up to 73% for fingerprints contrasted with Safranin O,
- 70% for fingerprints contrasted with Basic Yellow 40,
- 65% for fingerprints contrasted with Ardrox,

The least decline of effectiveness (Figs. 19–20) could be observed in case of non-sticky side of duct tape:

- 98% for fingerprints contrasted with Safranin O,
- 89% for fingerprints contrasted with Ardrox,
- 75% for fingerprints contrasted with Basic Yellow 40.

When visualizing latent fingerprints on sticky sides of tapes (Fig. 4), the effectiveness is also very high in case of "fresh" marks, 100% – in case of fingerprints contrasted with Safranin O and slightly lower – approx. 95% (excluding adhesive type of duct tape) for fingerprints contrasted with Ardrox and Basic Yellow 40 (Figs. 21–23).

A significant decline in contrasting fingerprints on adhesive surfaces can be observed as early as after two week storage of samples.

The highest effectiveness was demonstrated by Safranin O, i.e. 95% of contrasting effectiveness for fingerprints deposited onto adhesive side of office tape to 65% – for fingerprints deposited on sticky sides of duct tape and insulating tape (Figs. 24–26).

Poorer, however comparable results, were obtained for fingerprints visualized on sticky sides with Ardrox and Basic Yellow 40. A four-week period of storage entails a considerable decline, below 50% the effectiveness of contrasting fingerprints on sticky side. The largest amount of fingerprints was successfully recovered on sticky side of office tape with former application of both Safranin O, Ardrox and basic Yellow 40. In case of adhesive surface of duct tape, the successful development of latent fingerprints took place after the treatment with Safranin O only. When summing up the number of fingerprints developed on adhesive and non-sticky tape surfaces with Ardrox, Safranin O and Basic Yellow 40 at particular intervals (Fig. 10), the highest effectiveness was achieved through Safranin O treatment.

It has also been concluded that the effectiveness of contrasting with these dyes is determined by the type of adhesive tape. After the treatment with Safranin O, the poorest results were obtained for insulating tape, whereas for all remaining types (duct, beige filament and office tapes), the results were better and comparable ones.

The application of Ardrox and Basic Yellow 40 provides from dozen up to several dozen percent lower results as compared to the use of Safranin O. Contrasting effectiveness depends also on the type of tape used.

When analyzing the effect of amount of latent print forming sebaceous substance on visualization it can be concluded that less substance contributes to the smaller number of legible prints (Figs. 6–8) both on sticky and non-sticky surfaces. At the same time, a greater effectiveness in contrasting with fluorescent dyes has been found in case of fingerprints deposited on non-sticky tape surfaces. The best results were obtained after the use of Safranin O, then Basic Yellow 40 and Ardrox. Similarly as in case of effectiveness vs. age, also as regards the effectiveness vs. the amount of latent forming substance the best results were obtained for sticky side of office tape, whereas the poorest ones – for sticky side of duct tape (positive only after the treatment with Safranin O). When evaluating the impact of the amount of sebaceous substance on the development of latent fingerprints on non-sticky surfaces it should be concluded that the differences in visualization effectiveness of particular dyes are contained within a several percentage range. The best results in contrasting latent prints were obtained for a non-sticky surface of duct tape, and slightly lower for remaining tapes: beige, office and insulating ones.

Summary

Conducted empirical studies confirm preliminary assumption as to the possibility of using Ardrox, Safranin O and Basic Yellow 40 to improve legibility of latent fingerprints on sticky and non-sticky surfaces of tapes after prior treatment with cyanoacrylate fumes to non-sticky surfaces.

The tests were performed with reference to two aspects:

- quality of developed fingerprints changing in time,
- effect of the amount of sebaceous substance on the fingerprint quality.

The effectiveness of individual dyes in visualizing latent fingerprints was assessed by the relation of the number of prints which demonstrate fluorescence, have at least seven minutiae and were initially qualified for identification to the number of latent fingerprints and determined as follows for each dye:

- Safranin O – 100%,
- Basic Yellow 40–87,1%,
- Ardrox – 86,6%.

The least visualization effectiveness was found for fingerprints stored over the period of four weeks, as below:

- Basic Yellow 40–55,8%,
- Safranin O – 54,6%,
- Ardrox – 41,2%.

From the perspective of the amount of sebaceous substance, the greatest effectiveness of visualization was obtained in the first application, as below:

- Safranin O – 96,0%,
- Ardrox – 80,0%,
- Basic Yellow 40–77,5%.

The lowest effectiveness was achieved for fingerprints visualized in the third application, as below:

- Safranin O – 73,1%,
- Basic Yellow 40–58,1%,
- Ardrox – 55,3%.

When taking into the account the number of latent fingerprints, initially selected for identification and developed over all time intervals/all applications/kinds of tapes, it needs to be concluded that the best results were obtained in case of treatment with Safranin O, followed by Basic Yellow 40 and Ardrox.

Conclusions

The examinations presented in the hereby paper allow for the following conclusions to be made.

The use of Ardrox, Safranin O and Basic Yellow 40 all at the same time for visualizing latent fingerprints on sticky and non-sticky sides of tapes is possible (after former application of cyanoacrylate fumes on non-sticky surfaces).

The highest effectiveness in visualizing latent fingerprints on sticky and non-sticky surfaces of examined tapes has been demonstrated by Safranin O.

Regardless the type of fluorescent dye used, the number of fingerprints preliminary selected (qualified) for identification decreases with age.

The number of fingerprints visualized on sticky and non-sticky sides of adhesive tapes (following prior application of cyanoacrylate fumes on non-sticky surfaces) with fluorescent dyes decreases with diminishing amount of sebaceous substance.