Artur Wójcik
Specialist at the Fingerprint Unit of the Warsaw Metropolitan Police Forensic Laboratory
Ewa Rogoża (autor korespondencyjny)
Senior Research and Technical Specialist at the Fingerprint Examination Department of the Central Forensic Laboratory of the Police
ewa.rogoza@policja.gov.pl
Katarzyna Drzewiecka
Research and Technical Specialist at the Fingerprint Examination Department of the Central Forensic Laboratory of the Police
Marcin Wudarczyk
Specialist at the Fingerprint Unit of the Warsaw Metropolitan Police Forensic Laboratory

Improving the readability of fingerprints of corpses using Ardrox and stamp ink

Summary

Fingerprinting of corpses is more difficult than fingerprinting of living people. The level of difficulty of fingerprinting the fingertips depends on the condition of the corpse. Despite a variety of known methods of skin elastification and improvement of readability of fingerprints, better and more effective methods providing higher level of identification corpses are being sought.

This publication presents the course and results of the analysis involving the potential use of Ardrox and stamp ink to improve the readability of fingerprints of corpses in various condition. The above methods were compared to the standard techniques used in forensic examination — black fingerprint ink and English soot.

Obtained findings point to both methods as being highly effective in improving the readability of the fingerprints of corpses.

Keywords fingerprinting of corpses, Ardrox, English soot, black fingerprint ink, stamp ink

Introduction

The sequential order of methods of corpse identification was developed at the 5th Interpol Conference on the Identification of Victims of Mass Disasters and Natural Disasters held in Lyon in 1993. The first and the most reliable method of identification is DNA analysis, being an unquestionable achievement of the 20th century. The second, most reliable method involves fingerprint examination performed for more than a century[1].

Fingerprinting of corpses is more difficult than fingerprinting of living people. The level of difficulty of fingerprinting the fingertips depends on the condition of the corpse.

Despite a variety of known methods of skin elastification and improvement of readability of fingerprints, better and more effective methods providing higher level of identification of victims or persons killed in unknown circumstances are being sought.

Aim of the study

The aim of this study was to confirm the potential use of Ardrox and stamp ink to contrast the fingerprints collected from fingertips of dead bodies and to compare their effectiveness in relation to standard techniques used in forensic examination, black fingerprint ink and English soot.

1 I. Sołtyszewski, B. Młodziejowski, R. Płoski, W. Pepiński, J. Janica, *Kryminalistyczne i sądowo-lekarskie metody identyfikacji zwłok i szczątków ludzkich*, "Problemy Kryminalistyki" 2003, issue no. 239, p. 8.

Conducted experiments

Methodology

The study material consisted of fingertips of dead corpses submitted to the Warsaw Metropolitan Police Forensic Laboratory as well as fingertips of dead corpses stored at the Department of Forensic Medicine, Medical University of Warsaw.

The study included 500 fingertips of corpses, as follows:

- 280 fingertips in putrefaction conditions;
- 100 fingerprints recovered from water;
- 80 mummified fingertips;
- 40 fingerprints subjected to fire.

Before the experiments, fingertips had been photographed in order to document their original condition and then cleaned from environmental impurities. After cleaning, skin ridges were evaluated in terms of quality, readability and potential for:

- treatment with conventional fingerprint methods;
- introduction to the AFIS system.

During the study, four methods of contrasting the fingerprints of dead corpses were used:

- Ardrox;
- English soot;
- black fingerprint ink;
- blue stamp ink.

After application of each technique, the readability of fingerprints of corpses was compared with the original state.

Based on the information obtained in course of study, the effectiveness of methods of contrasting the fingerprints of corpses was assessed using the following formula:

$$E = \frac{n}{I_n} \cdot 100\%,$$

where:

E – method effectiveness expressed in %,

n – number of fingertips rated A (suitable for introduction to AFIS) or K (suitable for conventional fingerprint identification),

$\mathbf{I_n}$ – total number of fingertips of corpses rated A or K after all methods have been applied.

Equipment and reagents

The following reagents were used in the study:

- Ardrox prepared according to the following recipe:
  - Ardrox P133D (concentrate): – 10 ml
  - 2-propanol – 990 ml

Dye solution was sprayed onto the fingertips. Any excess of solution was washed away with running water after approximately one minute. Macroscopic examination was conducted under UV light with use of radiation-protection colorless glasses.

The following substances were used in the course of study:

- **Ardrox concentrate** manufactured by Sirchie, cat. no. LVS 700;
- **English soot** — type of fingerprint powder used by scene of crime officer at the scene of incident. It is a simple fingerprint powder made of pulverized (chemically pure) coal, of deep black color. English soot can be classified as a lightweight, fine powder.

In the conducted study English soot sold by STANIMEX under the catalog name "Fibre Dust Special" was used;

- **black fingerprint ink** — ink in a tube (from LIGHTING POWDER Co., cat. no. 2-0010, 120 ml, sold as "FINGERPRINT BLACK INK") and a fingerprint pad soaked with black ink (from ACE Fingerprint Equipment Labs, Inc., cat. no. 6309, containing a micropore ceramic insert to ensure appropriate dosage);
- **blue stamp ink** — used in polymer and rubber stamps "d.rect®" (distributor: Leviatan – Poligrafia).

For the purpose of macroscopic observations and recording of fingerprint images the following equipment was used:

- Canon EOS 5D camera, with 28–135 mm and
- 50 mm lenses, with EF converter an a Kaiser reproduction column
- forensic light source Multikolor 10Xe.

Furthermore, in the course of the study, the following reagents were used for elastifying solution: ethyl alcohol 96% (Lachner), glacial acetic acid (POCH SA), hydrogen peroxide solution and glycerol (POCH SA); prepared solution was subsequently injected into fingertips.

Preparation and storage of study material

Throughout the examination, stringent health and safety regulations were followed due to the use of sharp tools and hazardous chemicals, including the contact with biologically active material. A duly prepared workplace was therefore set up.

When elastification of fingertips was necessary, in order to restore the readability of fingerprints, every fingertip was placed in a separate glass container (Fig. 1) covered with a glass lid and filled with the elastifying solution.

The solution was selected according to the condition of dead corpse, taking into account the environmental conditions where the body was found. Labels with finger numbers were placed at each glass container.

The containers were stored in a locked metal cabinet with glass doors (allowing for continuous observation of the occurring processes), placed under a hood. The

Fig. 1. Fingertips undergoing elastification

cabinet was labeled with the information on storage of a biological active material.

After the examination, the fingertips were placed in the original boxes and stored in a freezer at approx. -18°C until they have been collected by the originators.

When the fingerprints were made on a tenprint card, the TP was placed in a plastic sleeve in order to prevent a potential contamination with biological material (minor epidermal residues, blood and other body fluids), and then tightly sealed with transparent adhesive tape.

Criteria for selecting fingerprints of the tested corpses

Before the use of contrasting methods, skin ridges on fingertips of corpses were assessed in terms of their quality, readability and potential for fingerprint identification. In order to harmonize the criteria for evaluation of obtained result, the following system was adopted:

- **„A"** — skin ridges suitable for introduction to AFIS
- **„K"** — skin ridges suitable for conventional fingerprint identification
- **„N"** — skin ridges unsuitable for conventional fingerprint identification.

„A" — "A pattern may be considered suitable for introduction to AFIS if it originates from a central fingertip area and at least 7 minutiae can be preliminarily identified"[2].

In the further part of the presented methodology, the following definitions of AFIS minutiae can be found:

"AFIS recognizes all conventional characteristics of the skin ridge pattern that can be interpreted as junction or bifurcations of black or white lines"[3].

"K" — skin ridges suitable for conventional fingerprint identification. "A pattern may be considered as preliminarily qualified for identification if at least 7 characteristic features (minutiae) of the fingerprint can be determined along with other features (poroscopic, crestoscopic, "white lines", skin fold furrows, deformations), whose variations allow the investigator to perform identification..."[4].

"N" — skin ridges are unsuitable for conventional dactyloscopic identification — A pattern is considered as unsuitable for conventional fingerprint identification if the qualification criteria for comparative investigation are not met (less than 7 conventional characteristic features) and the pattern carries insufficient information for issuing a categorical opinion.

In order to assess variations in the readability of skin ridges found on fingertips after using contrasting methods, the above described fingerprint classification was used as well.

In the assessment of the effectiveness of fingerprint contrasting agents, the type of environment in which the fingerprint remained and the processes that had occurred were also taken into account, according to the following:

- "W" — fingertips of corpses remaining in an aquatic environment;
- "G" — fingertips of corpses in putrefaction state;
- "P" — fingertips of corpses recovered from fire;
- "M" — fingertips of mummified corpses.

Fundamental research

The fingertips submitted for examination were removed from the containers once the elastification process was completed, and then they were dried, evaluated according to adopted qualification rules and photographed. At further stages of examination, fingerprint contrasting was performed using reagents below in the following order:

1. Ardrox fluorescent dye solution (applied by spraying);
2. English soot (applied with a brush);
3. black fingerprint ink (applied using a pad or a roller);
4. blue stamp ink (applied by spot-on method).

Before each subsequent method, the fingertips were washed with water or ethyl alcohol and dried. After each method, the investigated material was evaluated according to adopted qualification rules.

Photographic documentation was performed in the following conditions:

2 *The methodology of selection, inspection and registration of anonymous corpses in AFIS databases, no. HJ/W-4/VI/05 1st Edition of Feb 9th 2005*, p. 10.

3 *Ibidem*, p. 17.

4 *The methodology of selection, inspection and registration of anonymous corpses in AFIS databases, no. BJ-Z3-Mb-1/Pb-1, 4th Edition of Nov 22nd 2013*, p. 10.

- after applying Ardrox, the photograph was taken in UV light (forensic light source Multikolor 10Xe);
- after applying English soot, the photograph was taken in white light (forensic light source Multikolor 10Xe);
- after applying black fingerprint ink, the photograph was taken in white light (forensic light source Multikolor 10Xe);
- after applying blue stamp ink, the photograph was taken in white light (forensic light source Multikolor 10Xe).

Ardrox was used in the first place for contrasting because of the possibility of decreasing the intensity of fluorescence after the application of English soot or ink.

Analysis of findings

The results of evaluation for each fingerprint after applying Ardrox, English soot, black fingeprint ink and blue stamp ink were entered into purpose-fit statistical evaluation sheets.

Based on the obtained data, the number of fingertips rated "A" (suitable for introduction to AFIS), "K" (suitable for conventional fingerprint identification) and "N" (unsuitable for conventional fingerprint identification) was determined, combining the results for the original state and those obtained after applying contrasting agents, and taking into account the environment in which the corpses remained or the stage of their postmortem changes, as shown in Table 1.

To be able to fully demonstrate the effect of improved readability of fingertips treated with contrasting agents, it was acknowledged that every fingertip rated "A" also matched the criteria for the "K" category.

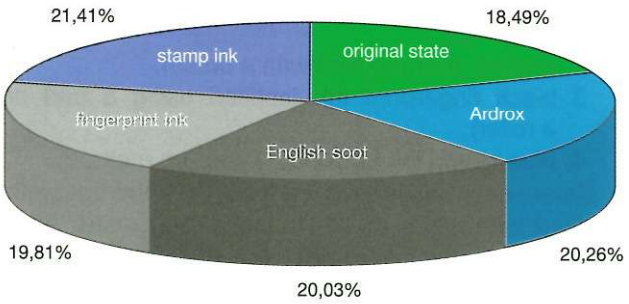
Therefore, for the purpose of this study, the number of fingertips rated "K" was summed up with the number of fingertips rated "A" and a new result taking into account the adopted criteria was obtained.

Using $E = n/I_n \times 100\%$ formula, the effectiveness of contrasting fingertips was assessed. A graphical representation of obtained results is shown in pie charts 1–8.

Table 1 Collation of results of evaluation of fingertips in their original state, taking into account the environment in which the corpses remained or the stage of their postmortem changes.

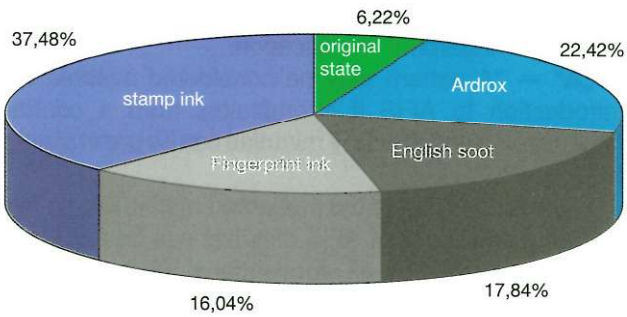
Evaluation	Original state				Ardrox				English soot				Black fingerprint ink				Blue stamp ink			
	G	W	M	P	G	W	M	P	G	W	M	P	G	W	M	P	G	W	M	P
A	38	45	22	0	137	68	39	2	109	46	29	0	98	48	27	0	229	92	77	5
K	202	54	58	7	126	31	41	18	151	53	51	7	158	51	53	11	50	8	3	33
A	240	99	80	7	263	99	80	20	260	99	80	7	256	99	80	11	279	100	80	38
N	40	1	0	33	17	1	0	20	20	1	0	33	24	1	0	29	1	0	0	2

The effectiveness of contrasting fingertips in putrefaction state, qualified for conventional fingerprint identification



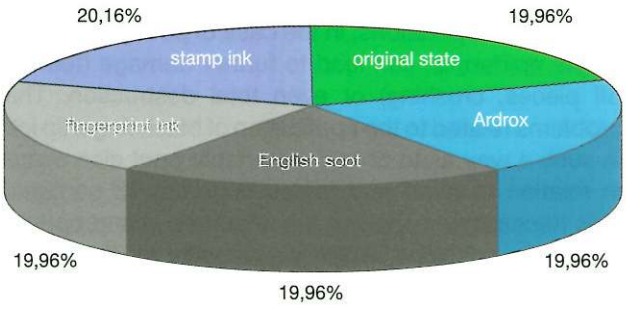
Pie chart 1. The effectiveness of contrasting the fingertips in putrefaction state, qualified for conventional fingerprint identification (I_n = 1298), using Ardrox, English soot, fingerprint ink and blue stamp ink.

The effectiveness of contrasting the fingertips in putrefaction state, qualified for introduction to AFIS



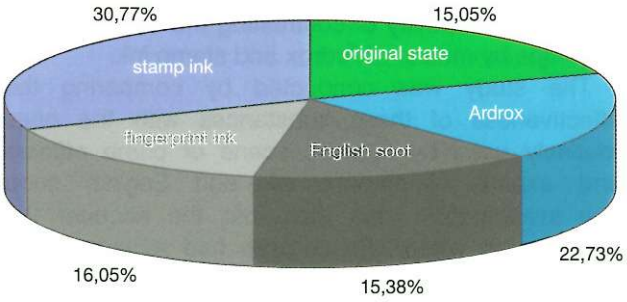
Pie chart 2. The effectiveness of contrasting the fingertips in putrefaction state, qualified for introduction to AFIS (I_n = 611), using Ardrox, English soot, fingerprint ink and blue stamp ink.

The effectiveness of contrasting the fingertips remaining in aquatic environment, qualified for conventional fingerprint identification



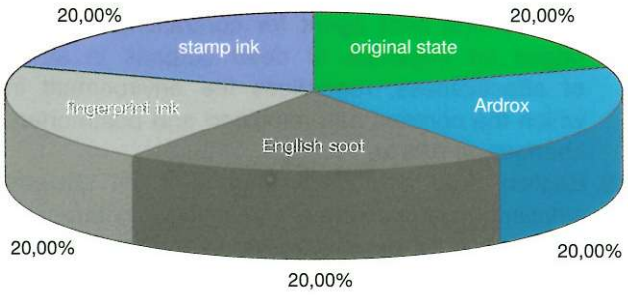
Pie chart 3. The effectiveness of contrasting the fingertips remaining in aquatic environment, qualified for conventional fingerprint identification (I_n = 496), using Ardrox, English soot, fingerprint ink and blue stamp ink.

The effectiveness of contrasting the fingertips remaining in aquatic environment, qualified for introduction to AFIS



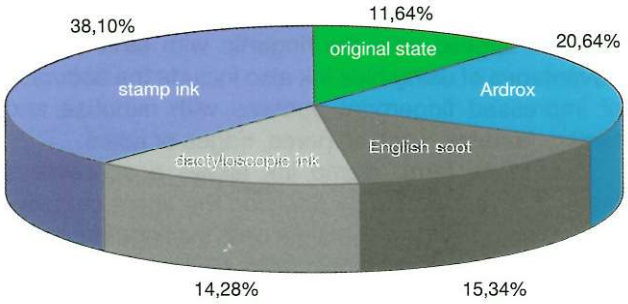
Pie chart 4. The effectiveness of contrasting the fingertips remaining in aquatic environment, qualified for introduction to AFIS (I_n = 299), using Ardrox, English soot, fingerprint ink and blue stamp ink.

The effectiveness of contrasting the fingertips of mummified corpses, qualified for conventional fingerprint identification



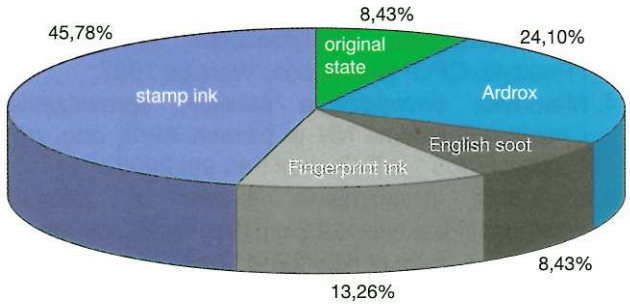
Pie chart 5. The effectiveness of contrasting the fingertips of mummified corpses, qualified for conventional fingerprint identification (I_n = 400), using Ardrox, English soot, fingerprint ink and blue stamp ink.

The effectiveness of contrasting the fingertips of mummified corpses, qualified for introduction to AFIS



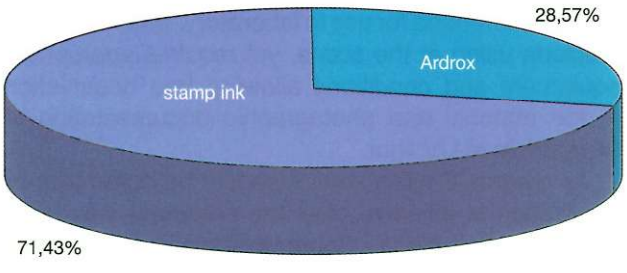
Pie chart 6. The effectiveness of contrasting the fingertips of mummified corpses, qualified for introduction to AFIS (I_n = 189), using Ardrox, English soot, fingerprint ink and blue stamp ink.

The effectiveness of contrasting the fingertips of burned corpses, qualified for conventional fingerprint identification



Pie chart 7. The effectiveness of contrasting the fingertips of burned corpses, qualified for conventional fingerprint identification (I_n = 83), using Ardrox, English soot, fingerprint ink and blue stamp ink.

The effectiveness of contrasting the fingertips of burned corpses, qualified for introduction to AFIS



Pie chart 8. The effectiveness of contrasting the fingertips of burned corpses, qualified for search in AFIS (I_n = 7), using Ardrox, English soot, fingerprint ink and blue stamp ink.

Summary

The analysis of results obtained on the basis of empirical study confirmed the preliminary assumptions about the possibility of contrasting the skin ridges of fingertips by means of Ardrox and stamp ink.

The study was conducted by comparing the effectiveness of these substances with the ones routinely used by forensic scene of crime officers and experts: fingerprint ink and English soot. The investigation also took into the account the environment where the corpses had remained and the type of postmortem changes to which the corpses were subjected.

Blue stamp ink proved to be particularly useful for shallow and narrow furrows, thin skin ridges and skin ridges destroyed, for instance, due to performed occupation (application of other methods did not bring positive results).

Moreover, it was found that additional contrast enhancement in case of destroyed epidermis may be obtained by gently wiping fingertips with a paper towel after former application of ink. Additional contrast enhancement can also be achieved by diluting the blue ink applied onto the fingertip with ethanol. The advantages of using blue ink also include the accuracy of impressed fingerprint patterns with minutiae and tertiary features, such as pores, ridges or scars.

Due to its form, stamp ink allows a contactless method of application by applying the agent drop-by-drop directly from the container onto the fingertip. In the case of damaged epidermis (torn, disintegrating, thin), the contactless method prevents further damages or total destruction.

The rationale for using Ardrox for contrasting the fingerprints of corpses, as in the case of stamp ink, is the possibility of contactless application by spraying the agent over the fingertip, which eliminates the possibility of damage or total destruction. The liquid form of stamp ink does not impose the necessity of thorough drying of fingertips. On the other hand, the method requires the application of UV lamp and creating conditions appropriate for the observation of the material in the UV spectrum (dark room). Therefore, it is recommended for use in laboratory, which does not preclude using at the scene, yet requires appropriate equipment and conditions allowing free observation of the material and photographic documentation of fingerprints in UV light.

As regards English soot, it should be noted that its application is effective after the epidermis has been dried up and clean. Some limitations in applying the soot result from its form, by causing clumping, smudging and filling skin furrows, and consequently decreasing the image contrast and visibility of minutiae. This significantly hinders obtaining positive results in case fingertips are in worse condition or damp.

Black fingerprint ink, similarly as English soot, is effective in relation to dried, clean epidermis and visible skin ridges. Its limitations result from the need of mechanical application on the fingertips or hands, and then transferring prints on a tenprint card or a sheet of paper. Such operations, in the case of poorly dried and fragile epidermis, can lead to further damage (tearing off pieces, crushing) or even total destruction. The problems related to the application of black fingertip ink in such a way as to obtain a readable print also occur in relation to dried and folded fingertips of corpses. This necessitates soaking the fingertips in appropriate elastifying solutions, which significantly facilitates the process of corpse identification.

Conclusions

1. The most effective agent for contrasting skin ridges on fingertips of dead corpses, regardless the environment in which the corpse had remained and postmortem changes, is blue stamp ink. Blue color allows making a precise impression of fingerprints, minutiae and tertiary features, such as pores, ridges or scars. It is also effective in relation to shallow and narrow furrows and destroyed skin ridges.
2. The second best agent for contrasting the skin ridges on fingertips of dead corpses in terms of effectiveness, regardless the environment in which the corpses had remained and postmortem changes, is Ardrox.
3. English Soot and black fingerprint ink showed smaller but comparable effectiveness in contrasting skin ridges of dead corpses in relation to blue stamp ink or Ardrox.

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Source

Fig. 1: authors; Tab. 1: authors; Pie charts 1–8: authors

Translation Rafał Wierzchosławski