T. Kahana,[1] Ph.D.; A. Grande,[2] M.D.; D. M. Tancredi,[2] M.D.; J. Penalver,[3] and J. Hiss,[4] M.D.

Fingerprinting the Deceased: Traditional and New Techniques

REFERENCE: Kahana T, Grande A, Tancredi DM, Penalver J, Hiss J. Fingerprinting the deceased: traditional and new techniques. J Forensic Sci 2001;46(4):908–912.

ABSTRACT: Idenfication of the deceased is an important task in medicolegal investigations. Fingerprints rank as the most widely used identification method, although obtaining the prints from the cadaver is not always easily accomplished. Various techniques for fingerprinting decomposed, mummified, and burn victims have been suggested in the literature. In the present review, the diverse fingerprinting procedures implemented for cadavers in various conditions, with an emphasis on mummified fingers, are presented.

KEYWORDS: forensic science, identification, fingerprints, postmortem changes

Among the various personal identification techniques used in forensic sciences, fingerprint comparison yields the most successfully resolved cases (1). The existence of Automatic Fingerprint Identification Systems in most western countries has greatly expedited the identification process.

Fingerprinting the deceased poses some difficulties due to postmortem changes and the physical changes associated with the mechanism of death, i.e., burns, drowning, etc. The majority of these obstacles can be overcome swiftly by implementing a variety of methods, specific to the condition of the digit to be printed.

Contact with whole or part cadavers in various stages of preservation carries a potential danger associated with the microbiological agents that are likely to be present in human tissue. The main hazards include hepatitis B and C, various prions, tuberculosis, HIV, rabies, and encephalitis (2).

In the present paper, we review the different postmortem fingerprinting techniques proposed in the literature for diverse cadaveric conditions and suggest some new procedures mainly for mummified and charred bodies, where the traditional manner of inking can't be applied. All these techniques should be implemented while exercising precaution to avoid direct contact between the cadaver and the operator's skin or mucous tissues. Furthermore, some of the procedures involve the use of harmful chemicals which should not be inhaled.

[1] Division of Identification and Forensic Science (DIFS), Israel Police, Headquarters, Jerusalem, Israel.
[2] Scientific Police Service, Medicolegal Investigation Section, Italian Police, Rome, Italy.
[3] National Police Corps, Almeria, Spain.
[4] National Centre of Forensic Medicine, Tel Aviv, Israel.

Received 17 April 2000; and in revised form 14 August 2000; accepted 15 August 2000.

Cadaveric Conditions

Rigor Mortis

After cadaveric rigidity has set in, the main hindrance in printing a body is to open the clenched fists. This can be accomplished prior to autopsy through forced hyperflexion of the cadaver's hand dorsum, then by pushing on the metacarpo-phalangeal articulation of each finger at a time; the digit will be fully extended and easily printed.

During the necroscopy, an invasive approach to break the rigor mortis can be implemented. Through a small (1.5 to 2 cm) horizontal incision in the volar aspect of the wrist, the tip of a surgical blade is inserted under the superficial and deep flexor tendons. Sliding the blade back and forth without enlarging the incision, the tendons can be severed rendering the fingers limp.

Early Decomposition

"Laundress fingers" is another common obstacle often encountered in early decomposition, and in cadavers recovered from wet environs. Here, the fingertips are wrinkled due to imbibition of the underlying tissue, precluding a complete impression. An injection of tissue builder, glycerin or water, at the level of the second interphalangeal articulation of the digit to be printed will usually correct this condition (3).

Intermediate and Advanced Decomposition

As the decomposition process progresses, the epidermis tends to separate from the dermis due to putrefaction gases and leaking blisters; this is commonly called "slippage" of the skin. The serous fluid that often covers the skin impedes the ink from binding to the surface. The digits can be sprayed with ninhydrin to dry the surface, and then, the skin may be peeled off in one piece, placed over the finger of the operator like a glove, inked, and printed as though it was his own finger. The loose skin or fingerstalls can also be flattened between two glass plates and photographed (4).

Advanced putrefaction renders the skin very fragile, making the cleaning process of the epidermal surface almost impossible. In these cases, the operator can excise the pattern area or cut off the finger at the level of the first inter-phalangeal articulation and soak it in a 10 to 15% solution of formaldehyde for a few hours and then roll and print it (5).

A process similar to that used to develop latent fingerprints from hard surfaces can be used on extremely decomposed bodies. The faint ridge pattern in these cases can be enhanced with "superglue fuming," or cyano-acrylate vapor, and the ninhydrin process. This technique requires specialized equipment and skills, not always available to the operator. Awareness of the hazardous nature of cyano-acrylate (a major component of Superglue®) is recommended. This chemical has been known to produce severe allergic reactions, headaches, and tremors. Adequate ventilation and the use of protective goggles and rubber clothing are suggested (6). When possible, the severed fingers can be submitted to a latent fingerprints laboratory that is prepared to handle this type of material (7).

Mummification

In some instances of advanced decay, due to high environmental temperature and low moisture, the cadaver's skin resembles a tuff parchment. In this stage, known as mummification, the fingers are extremely dry, and the skin and underlying tissues tend to shrivel and get tough and unyielding (Fig. 1*a*), making the printing task almost impossible.

A number of techniques to obtain fingerprints from mummified cadavers have been proposed in the literature:

Direct Reading—When the ridge pattern is visible, it may be read and classified directly from the fingers without taking impressions. Later on, portions of the fingertip suitable for inking can be chosen for ridge counting and tracing. This method should be attempted only by those extremely familiar with fingerprint comparison (4).

FIG. 1*a*—*Mummified finger. Note the deep creases that preclude complete inking.*

FIG. 1*b*—*Mummified finger after rehydration with ammonium hydroxide solution.*

Casting—Fingerprints can be reproduced with various casting materials, which usually consist of a base and a catalyst. The emulsion can be directly applied to the thoroughly cleaned fingertip and once set, removed and classified. The dried reproduction can be used as a permanent negative record of the print.

Comparative studies of different impression materials, available in the market, suggest that the use of Kerr wax-based type I compound produces the clearest images and is low in cost, as well as easy to handle (8). Common modeling clay has been recently recommended to obtain clear and undistorted prints (9). Dental casting materials and plaster of Paris are also convenient materials, although they tend to reproduce artifacts, rendering the specimen difficult to interpret (8).

The use of the Scanning Electron Microscope for the actual examination of the casts has been suggested, stressing the superiority of three-dimensional and reversion of the image as the main advantages over direct examination of the cast (10).

Photography—A one-to-one photograph of the fingerprint is recommended, as comparisons will usually be made with inked impressions, which are natural size. Correct lighting is of paramount importance and should be chosen according to the prevailing condition of the skin; although, in mummified fingers, where the fingertip is deeply wrinkled, the results are very limited regardless of the manner of lighting. Oblique illumination will enhance the appearance of the ridges (9). Aluminum powder brushed on lightly to the skin ridge areas and flash illumination will produce partial reproduction of the fingertip, especially on blackened mummified hands.

Radiography—The use of X-rays to obtain fingerprint patterns from mummified hands has been advocated by some investigators (11). The procedure involves covering the surface of the fingertip with a light coat of bismuth subcarbonate, lead carbonate, or barium sulfate, taking a radiograph of the finger, and finally transferring the X-ray to photographic paper (12).

The poor resulting image, which will include the shadow of the underlying phalange, does not always compensate for the expense, time, and skill required.

Ionic Rehydration of the Fingertip—In order to obtain a complete direct print from a mummified fingertip, the tissues must be rehydrated. This can be accomplished by fixating the tissues of the severed finger or fingerstall in 10% formaldehyde for several days, and then, immersing it in 1 N potassium hydroxide solution for a time period varying from 24 to 48 h. This process causes swelling of the tissues, and sloshing off of the epidermis, thus exposing the dermal surface. The distended fingertip must be then fixed again in formaldehyde in order to be handled. Staining with 0.05% toluidine blue solution to better display the ridges is recommended before photographing the volar surface (13). A 1 to 3% solution of sodium hydroxide for distending the desiccated fingertip has also been suggested, as with potassium hydroxide, the skin must first be fixed in formaldehyde (14).

The use of potassium or sodium hydroxide on dermal tissue carries the danger of permanently destroying the volar surface. Continuous inspection of the specimen is required to stop the disintegration action of the fluid (12).

FIG. 2*b*—*Fingerprint obtained by digital acquisition from a burnt finger.*

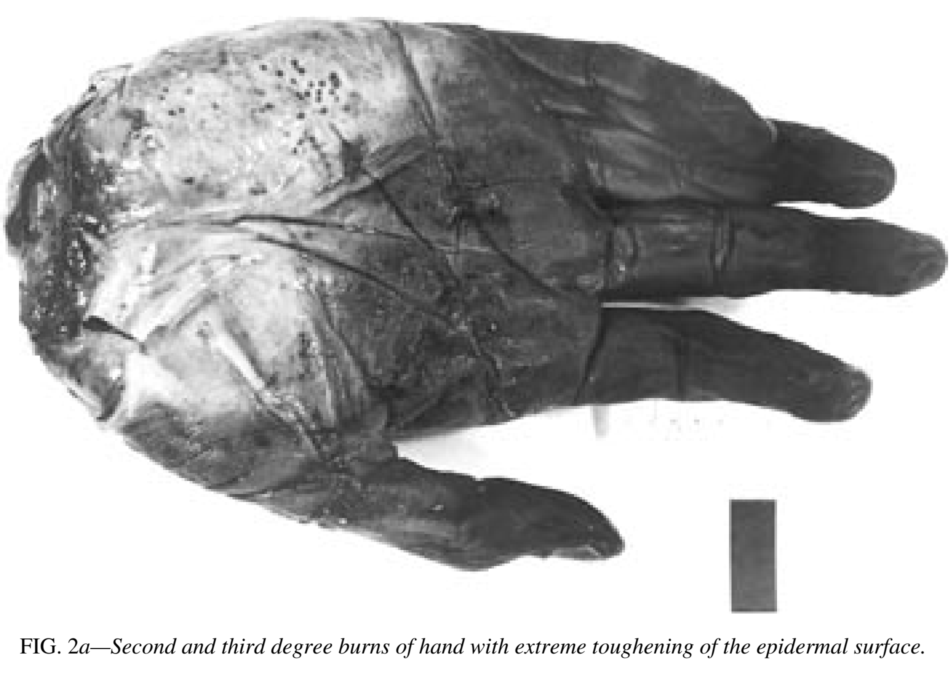

FIG. 2*a*—*Second and third degree burns of hand with extreme toughening of the epidermal surface.*

Another method of returning the turgescence and elasticity to mummified fingers is the use of a 25% ammonium hydroxide solution. Instead of using formaldehyde for the initial fixation, the tissues are hardened for 12 to 24 h in 96% ethyl alcohol, which does not pose health dangers to the handler, and its effects on the dermal tissues can be easily reversed if necessary. Once the tissues are fixed, the severed finger is immersed in 25% ammonium hydroxide solution for 24 h. If the finger has not returned to its natural size, the concentration of ammonium hydroxide should be raised to 50% and the finger soaked in it overnight. Since ammonium hydroxide does not damage the tissues, its concentrations can be raised every day up to 100% until the finger is ready to be inked and printed (Fig. 1*b*) (5).

The use of "tanning solution," consisting of two oz of saturated salt solution with two drops of 50% sulfuric acid, has been proposed on the ridge area of the fingertip after removing it from the phalange. Immersion of the segment for 72 h in this solution will render the skin pliable (15). Zugibe and Costello sustain that the application of this last technique affords inconsistent results. They suggest instead to successively immerse the severed fingers in acetic acid for one h, then in Coleo® detergent solution, and finally, in a softening solution consisting of disodium or tetrasodium ethylenediamine tetraacetate adjusted to pH 7.5 with 0.01 N hydrochloric acid (16).

Charring

Digital fingerprinting is the latest technique devised to obtain readable prints, not only from badly charred hands, but also from mummified and decomposed fingertips (Fig. 2*a* and *b*) (17). The fingerprint is acquired by a 3D image analyzer (laser-scanner), similar to that utilized in Automatic Fingerprint Identification Systems, which can detect as many as 250.000 points in the print. The reduced dimensions (9.5 × 7 × 13 cm) (Fig. 3*a* and *b*) of the newer portable models are extremely practical to work with in most conditions. Optic reading of the print offers a high degree of reliability and a significant improvement in the length of time required to obtain prints from difficult cases. In fact, a print can be registered in 30 s (reading and verification require additional 4 s) (17). The infrared sensor that tests the temperature of the finger during the scanning process is neutralized in order to avoid interference with the reading.

This innovation allows bypassing chemical techniques that pose the danger of destroying the fingerprint. Furthermore, the system permits correction of the quality of the print without repeatedly handling the severed finger. The authors suggest photographing (1:1) the finger before severing it at the level of the metacarpo-phalangeal articulation and lightly cleaning it with physiological solution prior to the scan acquisition.

Discussion

This paper briefly reviews the main techniques available for obtaining fingerprints from cadavers in various postmortem circumstances. Some of the methods suggested in the literature require extreme care, due to the destructive nature of the ingredients involved in the process, while others demand a great deal of experience in fingerprint comparison.

FIG. 3*a*—*Portable optical scanner for fingerprinting.*

FIG. 3*b—Enlargement of the scanning window where the finger is placed.*

From the various methods for regenerating fingerprints in mummified fingers, the authors advocate the use of ammonia hydroxide. This method, which does not destroy the skin, has been in use for sometime in the Laboratories of Scientific Police in Spain and has been adopted recently by the Division of Identification and Forensic Science of the Israel National Police with excellent results. Also, the use of digital fingerprinting, devised at the Italian Division of Scientific Police for fingerprinting digits that have been subjected to extremely high temperatures, has yielded very satisfactory prints.

Given the risk of getting seriously infected while fingerprinting a cadaver, and the number of pathogens for which no effective treatment exists, a good protective practice must be established and pursued when handling human remains. Immunization for hepatitis B and BCG inoculation for tuberculosis are recommended for all those technicians that often take fingerprints from bodies. There is currently no protection against hepatitis C and Creutzfeldt-Jakob-related diseases; therefore, extreme care should be implemented with these "high risk" cadavers (2).

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Additional information and reprint requests:
T. Kahana
National Centre of Forensic Medicine
67 Ben Zvi St.
P.O. Box 49015
Tel Aviv 61490, Israel