J. Exp. Biomed. Sci. 13 (2007) 369–374

Brief Communication

The High Temperature-Moisturizing Method for Obtaining Quality Postmortem Fingerprints from Decomposed Fingers

Young-Sam Kim[1,4], Hee-Chan Park[2] and Yong-Bin Eom[3,†]

[1]*Crime Scene Investigation, Investigation Division of 4th Department, Gyeonggi Provincial Police Agency, Gyeonggi-Do 480-847, Korea.*
[2]*Crime Scene Investigation, Section of Investigation, Paju Police Station, Gyeonggi-Do 413-010, Korea.*
[3]*Divison of Forensic Medicine, National Institute of Scientific Investigation, Seoul 158-707, Korea.*
[4]*Department of Biomedical Laboratory Science, College of Health Sciences, Yonsei University, Wonju 220-710, Korea*

A fingerprint is an impression of the friction ridges of all or any part of the finger. A friction ridge is a raised portion of the epidermis on the palmar (palm and fingers) or plantar (sole and toes) skin, consisting of one or more connected ridge units of friction ridge skin. There are two fundamental principles underlying the use of fingerprints as a means of identifying individuals - immutability and uniqueness. Friction ridges develop on the fetus in their definitive form before birth. Ridges are persistent throughout life except for permanent scarring. Ridge patterns and the details in small areas of friction ridges are unique and never repeated. Friction ridge patterns vary within limits, which allow for classification. We developed the high temperature-moisturizing method to obtained quality postmortem impressions from decomposing friction ridge skin. This technique is a simple procedure that uses boiling water to recondition the skin. This reconditioning process enhances detail present on the fingers and exposes ridge detail not visible to the naked eye. Therefore, we can recover the quality fingerprints, even from the worst decomposed bodies.

Key Words: Fingerprint, High temperature-moisturizing method, Postmortem impressions, Decomposing friction ridge skin

Fingerprint identification is the process of comparing questioned and known friction skin ridge impressions from fingers, palms, and toes to determine if the impressions are from the same finger (or palm, toe, etc.) (Adams, 1965; Holt, 1961). The flexibility of friction ridge skin means that no two finger or palm prints are over exactly alike (never identical in every detail), even two impressions recorded immediately after each other.

If the fingerprints were obtained, the fingerprint would be better than DNA because fingerprints are not inherited and identical twins have the same DNA configuration but they do not have identical friction ridge configuration (Newman, 1941). Therefore fingerprint is 100% unique to the individual.

More than a century of accumulated fingerprint study and experience has demonstrated that friction ridge patterns do not change naturally during the life of a person (Cooke, 1959; Cummins et al., 1941; Cummins, 1967; Miller, 1973). The pattern of minutiae starts developing in the third month of pregnancy and is fully formed by the fourth month (Kimuras et al., 1986; Mulvihill, 1969). During a person's lifetime, the pattern remains the same, apart from changing in size or by accident, mutilation or skin disease, until death. In fact, the friction ridge patterns will remain after death until the body decomposes.

Friction ridge detail forms in a purely random manner during fetal development in the womb (Xu, 1988). There is sufficient variability in the arrangement of minutiae to ensure that no two friction ridge patterns are identical, whether they are on different fingers of the same person or

*Received: December 2, 2007
Accepted after revision: December 15, 2007
†Corresponding author: Yong-Bin Eom, Division of Forensic Medicine, National Institute of Scientific Investigation, 331-1 Shinwol 7-Dong, Yangcheon-Gu, Seoul 158-707, Korea.
Tel: +82-2-2600-4860, Fax: +82-2-2600-4866
e-mail: omnibin@nisi.go.kr
*co-first author, Young-Sam Kim and Hee-Chan Park contributed equally to this work.

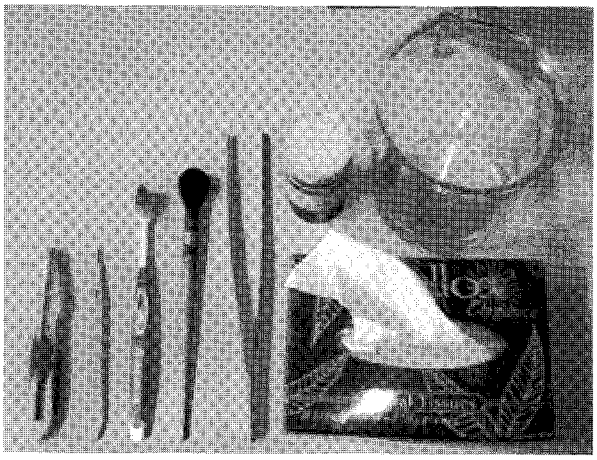

Fig. 1. Materials that used in the high temperature-moisturizing method. Knife, Toothbrush, Fingerprint brush, Black fingerprint powder, Tweezer, Beaker or Electrical hot pot, Hot tap water, Tissue and Towels.

on the fingers of different people (Hirsch et al., 1973). The same principle covers all friction ridge skin. While this principle is difficult to prove empirically, no two fingerprints have ever been found to be identical in over a century of the use of fingerprinting. And the number of people to have been fingerprinted worldwide is now in the hundreds of millions. Additionally, studies have demonstrated that while identical twins share the same DNA profile markers, they can nevertheless be differentiated by their fingerprints (Newman, 1930; Newman, 1941).

The palms and soles are much more comprised to dead keratinous cell than other region in body. The dead keratinous cell is very so dry that it can be easily reconditioned in water condition. Besides, the dead keratinous cell has more and more water activity on tissue in accordance with high temperature, so it puts ahead a swelling rapidly. In this study, our technique uses boiling water to elicit thermodynamic and osmotic responses that rehydrate the skin, raising friction ridge detail and eliminating body fluids associated with decomposition. On the authority of that principle, we apply to high temperature-moisturizing method for take fingerprint in dried decomposing postmortem body.

First, visually examine the friction ridge skin on the hands to determine the type of damage that is present. And then, clean up and remove any loose contaminants from the fingers using a brush (Fig. 2A). Ensure that this process does not further damage the skin, keeping it intact as much as possible. The epidermal layer is separated or soaked in water as occasion demands (Fig. 2B). Decaying hands absent the epidermal layer often show no visible friction ridge detail. The absence of this detail should be expected and does not mean the hands are unprintable. It is often a sign that you are working with dermal skin.

When a sore oozes, it is washed by alcohol, and then dry up by a piece of cloth (or towel). We must do away with impurities in order to display the ridge well. Add black fingerprint powder to epidermal tissue layer as occasion demands (Fig. 2C). We should take a picture in dim down in order to bring into relief a jagged ridge (Fig. 2D).

After taking a picture, we follow up the high temperature-moisturizing method. Fill an electric hot pot approximately half with tap water or with enough water to completely submerge the fingers. After filling the pot with water, plug it in and allow the water to boil. When the water starts to boil, unplug the hot pot and place the finger into the pot of water (Fig. 2E). Place the fingers into the boiling water for 3 to 5 seconds then remove it to observe if friction ridge detail is present. If no detail is visible, place the fingers back into the water for another 3 seconds. This process should be repeated no more than three times as prolonged exposure to intense heat would harm the skin. The boiling water reconditions the friction ridge skin and removes any contaminants still present.

If the friction ridge skin on the fingers contains abrasion or cuts, and alternate form of the procedure should be used. Instead of placing the fingers into boiling water, the examiner should soak a sponge in boiling water and squeeze the sponge so the water washes over the friction ridge skin. This will have the same effect as placing the fingers into the pot of boiling water but will allow the examiner more control over the reconditioning process. Placing a fingers with laceration into boiling water will increase the size of the cuts and can further damage to the friction ridge skin, rendering it unprintable.

After the skin is exposed to boiling water, it will be taut and should have friction ridges clearly visible on the fingers. This observation indicates that the friction ridge skin has been sufficiently reconditioned. Before attempting to print, dry the friction ridges using a blow dryer (warm setting) or

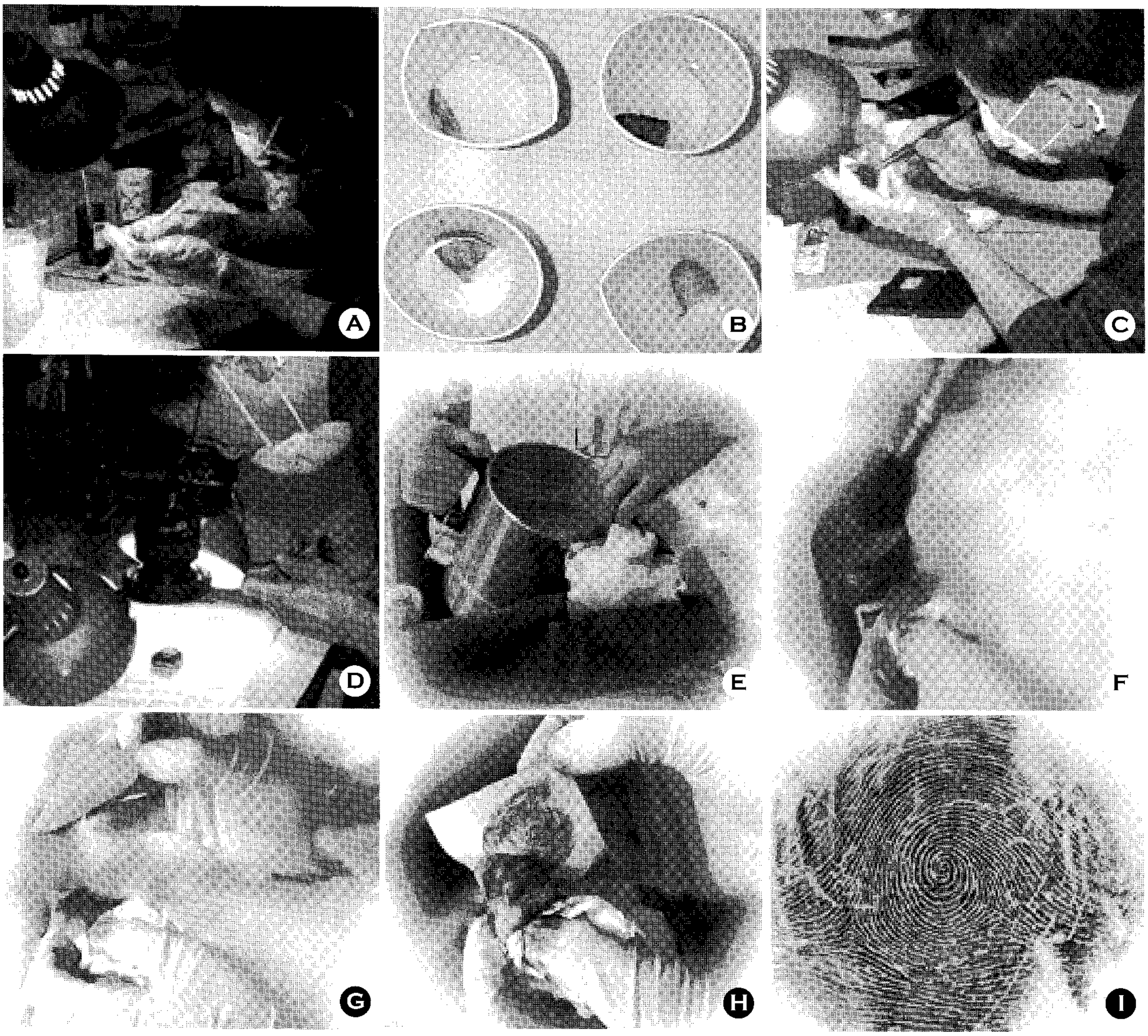

Fig. 2. Procedure of the high temperature-moisturizing method to rehydrate the skin, exposing friction ridge detail. The fingers was cleaned, submerged in boiling water, dried with alcohol and towels and then printed.

by pouring alcohol on the fingers and blotting dry with towels. You may use cloth or paper towels; however, paper towels may leave fiber traces on the hands, which may interfere with printing results. To record powder prints, use a fingerprint brush to dust the fingers with black powder (Fig. 2F). Place each finger on a contrasting adhesive tape, such as Handiprint, to record the impressions (Fig. 2G, H, I). Affix the adhesive tape with the recorded impression to the correct fingerprint block of a transparent ten-print card.

The temperature and time effects on fingerprint quality are shown in Table 1. Excellent fingerprints were obtained in 100 ℃, 3 to 5 seconds. In the recording of fingerprints from a decomposing body, there was no visible ridge detail on the finger. The fingerprint result by the existing method is a poor impression, with virtually no friction ridge detail (Fig. 3A, C, E). Our high temperature-moisturizing method shows an identifiable impression that could then be compared to known standards or searched through an automated fingerprint identification system (Fig. 3B, D, F).

In 1686, Marcello Malpighi, a professor of anatomy at the university of Bologna, noted in his treatise; ridges, spirals and loops in fingerprints. He made no mention of their value as a tool for individual identification. A layer of skin was named after him; "Malpighi" layer, which is appro-

Table 1. The temperature and time effects on the high temperature-moisturizing method

Temp. (℃)‡ \ Time (sec)†	3 seconds	5 seconds	More than 10 seconds
100℃	Excellent§	Excellent	Harm the skin
90℃	Unsatisfactory*	Normal	Normal
70℃	Unsatisfactory	Unsatisfactory	Unsatisfactory
25℃	Not usable	Not usable	Not usable

† Time that the finger is placed into the water, ‡ temperature that the finger is exposed in the water; § result that the identifiable friction ridge impression was produced; * result that the unsatisfactory friction ridge impression was produced

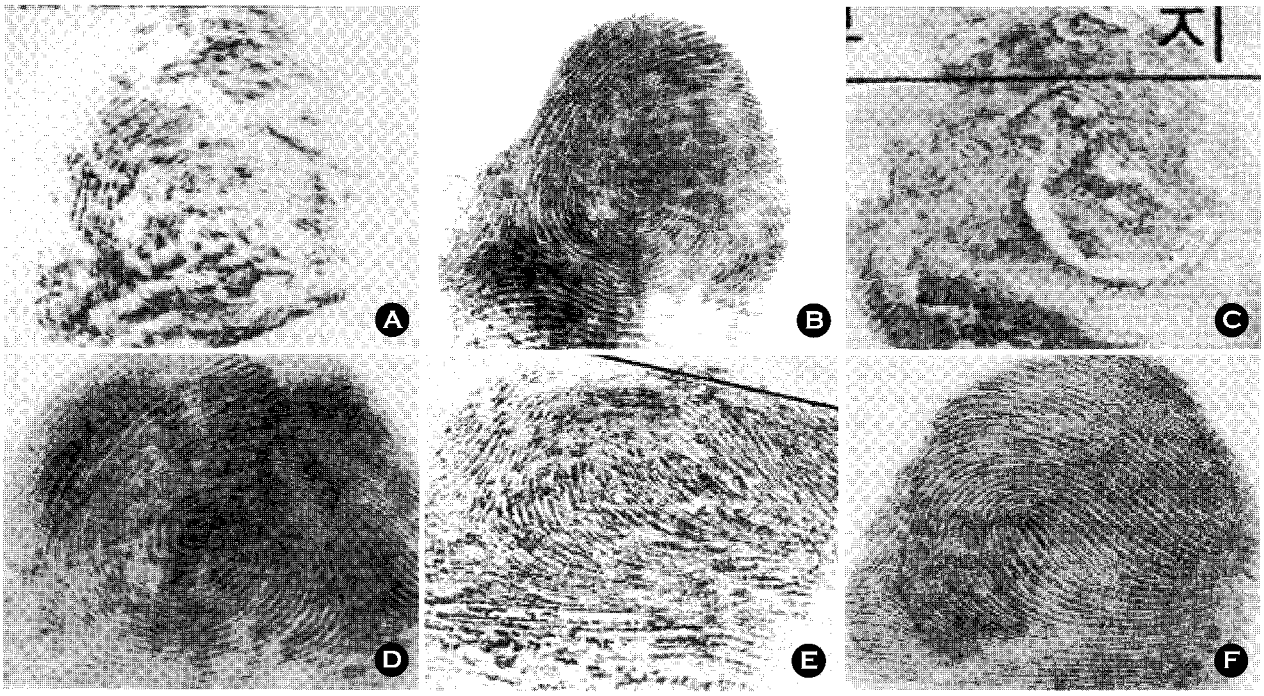

Fig. 3. The comparison results of the two methods. This high temperature-moisturizing method produces better results **(B, D, F)** than standard inking method **(A, C, E)** and allows for the easy recording of each finger.

ximately 1.8 mm thick. In 1823, John Evangelist Purkinji, a professor of anatomy at the university of Breslau, published his thesis discussing 9 fingerprint patterns, but he too made no mention of the value of fingerprints for personal identification.

During the 1870's, Dr. Henry Faulds, the British surgeon superintendent of Tsukiji Hospital in Tokyo, Japan, took up the study of "skin-furrows" after noticing finger marks on specimens of "prehistoric" pottery. A learned and industrious man, Dr. Faulds not only recognized the importance of fingerprints as a means of identification, but devised a method of classification as well. In 1880, Dr. Faulds published an article in the Scientific Journal, "Nature". He discussed fingerprints as a means of personal identification, and the use of printers ink as a method for obtaining such fingerprints. He is also credited with the first fingerprint identification of a greasy fingerprint left on an alcohol bottle.

In 1888, Sir Francis Galton, a British anthropologist and 'father of contemporary fingerprinting', began his observations of fingerprints as a means of identification in the 1888's (De Varigny, 1891). In 1892, he published his book, "Fingerprints", establishing the individuality and permanence of fingerprints (Galton, 1892). The book included the first classification system for fingerprints. He was able to scientifically prove what Herschel and Faulds already suspected: that fingerprints do not change over the course of an individual's lifetime, and that no two fingerprints are exactly the same. According to his calculations, the odds of two individual fingerprints being the same were 1 in 64 billion.

In 1901, the fingerprints were introduced for criminal identification in England and Wales, using Galton's observations and revised by Sir Edward Richard Henry (Henry, 1900). Thus began the Henry Classification System, used even today in all English speaking countries. In 1902, the New York Civil Service Commission used the fingerprints systematically for testing. Dr. Henry P. DeForrest pioneers U.S. fingerprinting.

In the Henry system of classification, there are three basic fingerprint patterns: arch, loop and whorl (Henry, 1900). There are also more complex classification systems that further break down patterns to plain arches or tented arches. Loops may be radial or ulnar, depending on the side of the hand the tail points toward. Whorls also have sub-group classifications including plain whorls, accidental whorls, double loop whorls, and central pocket loop whorls (Engert GJ, 1964).

In 1903, the New York State Prison system began the first systematic use of fingerprints in U.S. for criminals. In 1904, the use of fingerprints began in Leavenworth Federal Penitentiary in Kansas, and the St. Louis Police Department. 1905 saw the use of fingerprints for the U.S. Army. Two years later the U.S. Navy started, and was joined the next year by the Marine Corp. During the next 25 years more and more law enforcement agencies join in the use of fingerprints as a means of personal identification.

Fingerprint identification works best on pliable friction ridge skin in an advanced stage of decomposition. This involves the degeneration of the skin, resulting in the destruction or absence of the epidermal (outer) layer, leaving exposed dermal (inner) skin with little or no visible friction ridge detail. Although the high temperature-moisturizing technique has been used on epidermal skin, it is most effective in reconditioning the dermal skin. It should be aware that the recordings of dermal prints could appear different than epidermal prints under a magnifier. This difference often involves a variation in size with the normal recordings of epidermal skin. In addition, dermal ridge consist of double rows of papillae pegs, which makes them very difficult to compare.

A further premise underlying the use of fingerprinting to identify individuals is that while ridge patterns display immense variability, they can be grouped into pattern categories to facilitate the classification, filing and accessing of very large volumes of fingerprint records

We used the high temperature-moisturizing method on hundreds of bodies recovered and processed in the months following the South Asian tsunami, producing identifiable friction ridge impressions from some of the worst conditioned bodies. That techniques also was used successfully to recondition friction ridge skin on mummified bodies recovered months after death, resulting in friction ridge impressions that were used to determine and confirm the identities of victim (data not shown).

We believe that our technique can reproduce the discernable friction ridges impressions that are easily seen and photographed for the purpose of making an identification of the individual. We also found that this technique is effective, affordable, and relatively easy to use.

REFERENCES

Ashbaugh DR. Ridgeology.: Modern evaluation friction ridge identification. J Forensic Identification 1991. 41: 16-64.

Adams MS. Palm prints and a ring - D chromosome. Lancet 1965. 286: 494-495.

A methodological approach to the development of epidermal ridges viewed on the dermal surface of fetuses. Prog Dermat Res. 1982. 20: 175-188.

Bade WF. Fingerprints on pottery aid in tracing past. Soc Sci New Lett. 1934. 261-262.

Bansal IJS, Shobha RD, Harminder K. A study of the inheritance of palmar mainlines. Ind. J Phys Anthrop Hum Genet. 1987. 3: 201.

Cooke TG. Hands of mystery. Finger print Mg. 1959. 3: 4.

Cummins H. Finger prints - Normal and abnormal patterns. Fingerprint and identification Mg. 1967. 49: 3.

Cummins H, Charles M. Palmar and plantar epidermal ridge configurations (Dermatoglyphics) in European-Americans. Am J Phys Antrop. 1926. 9: 471-502.

Cummins H, Walter JN, James TM. The breadths of epidermal ridges on the finger tips and palms: A study of variation. Am J Anat. 1941. 68: 127-150.

De Varigny Henry. Anthropology - The fingerprints according to

MF Galton. Rev Sci. 1981. 47: 557-562.

Engert GJ. "International Corner" Identification News. 1964. 14: 1.

Galton Francis RS. Finger prints. MacMillan and Co. New York. 1892. 216.

Henry ER. Classification and Uses of Finger Prints. London: George Rutldege & Sons, Ltd. 1900. 1-112.

Hirsch W, Schweichel JU. Morphological evidence concerning the problem of skin ridge formation. J Ment Deifc Res. 1973. 17: 58-72.

Holt SB. Palm-prints and their uses in medical biology. Cerebral Palsy Bull. 1961. 3: 333-347.

Kimura S, Tadashi K. Embryological development of human palmar, plantar and digital flexion creases. Anat Rec. 1986. 216: 191-197.

Miller JR. Dermatoglyphics. J Invest Derm. 1973. 60: 435-442.

Mulvihill JJ. The genetics of dermatoglyphics. J Ped. 1969. 70: 579-589.

Newman HH. Palmar dermatoglyphics of twins. Am J Phy Anthrop. 1930. 14: 331-378.

Newman HH. Aspects of twin research. Sci Mon. 1941. 2: 99-112.