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Obliteration of Latent Fingerprints

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ABSTRACT: Comprehensive trials have established that latent fingerprints can be rendered partially or totally unidentifiable during print development by the following:

(*a*) ridge smearing, which depends on the type and age of the latent print and also on the type of brush and brushing procedures used, and
(*b*) overpowdering and/or overbrushing of the print.

These causes of pattern obscuration are discussed in terms of their implications for fingerprint development procedures, since up to 10% of prints developed at crime scenes can be difficult or even impossible to identify.

KEYWORDS: criminalistics, fingerprints, obliteration of fingerprints, latent fingerprints

In the United Kingdom, detection of fingerprints at crime scenes is usually carried out using a brush to apply powders to the latent prints. The developed prints are then normally lifted with tape and transferred to cobex sheets for subsequent examination. The majority of prints developed using these standard procedures show distinct ridge patterns, as illustrated in Fig. 1 (left). Unfortunately, up to 10% of developed prints can be difficult or even impossible to identify. An example of a developed print with an obliterated ridge pattern is shown in Fig. 1 (right). Clearly, a poorly deposited latent fingerprint cannot be developed successfully, even by adoption of the best possible development practices. However, in the cases presented in Fig. 1, identical fingerprints were developed using different brushing methods to emphasize that even good-quality latent fingerprints can be partially or fully obliterated by apparently following accepted print development procedures. For this reason, the present investigation was designed to identify possible causes of print obliteration and to consider print development methods which may minimize this problem.

Experimental Procedures

The experimental program was designed to determine the extent to which print obliteration was affected by the following:

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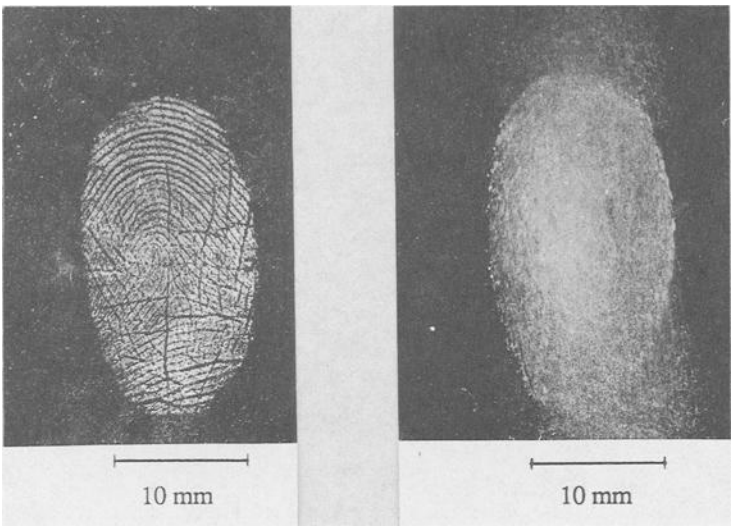

FIG. 1—*Fingerprints developed by brush application of aluminium flake powder showing* (left) *a distinct ridge pattern and* (right) *an obliterated ridge pattern.*

(*a*) the type and age of the latent fingerprints being developed,
(*b*) the type of brush and the brushing procedures used, and
(*c*) the amounts of powder applied to the latent fingerprints.

For all phases of this program, it was necessary to produce sets of identical fingerprints from a number of different donors. Two specific procedures were adopted [*1*]. Most donors were requested simply to rub their hands, to ensure an even distribution of sweat, before pressing a nominated finger onto a clean glass microscope slide. In contrast, the second procedure required the donor to rub a nominated finger against the side of the nose before depositing the print on the glass slide. This results in prints with a high quantity of fingerprint residue, which is rich in sebum, that is, in oils and fatty substances such as lipids, which are secreted from the sebaceous glands on the face. Fingerprints with a high quantity of fingerprint residue may in some cases be left by criminals at the scenes-of-crime, because of the emotional sweating associated with the act of committing a crime [*2*]. In this way, sets of identical ordinary and sebum-rich prints were obtained, allowing a study to be made of the extent to which different print development procedures cause obliteration of prints differing in type and age.

The influence of brushing procedures on print damage was assessed using four different types of brush (Fig. 2). Two of the brush types selected are widely used for print development with aluminium flake powder, namely a glass-fiber brush (zephyr brush) and a squirrel-hair brush (size No. 16). The third brush chosen was a Marabu "blower" brush. With this relatively new type of brush, squeezing a rubber bulb creates an air stream which transfers powder from a small container into the brush head, which consists of a mass of light synthetic feathers; that is, the powder-laden air flow produces a fine powder coating on the feathers, which are then lightly dusted over the latent fingerprints. The fourth type of brush employed was a "magna" brush, consisting of a magnetic applicator or "wand," which carries a small quantity of "magna" powder held to the wand by magnetic attraction. Microstructural examination established that commercial magna powder consists of a mixture of equiaxed iron particles (~50 μm in diameter) and nonmagnetic flake particles, which suggests that the magnetic iron particles act as a carrier for the nonmagnetic flake which attaches to the latent fingerprint.

FIG. 2—*The four types of brush used to assess fingerprint damage:* (a) *squirrel-hair brush (size No. 16),* (b) *zephyr brush,* (c) *magnetic wand applicator, and* (d) *blower brush.*

In order to clarify the effects of brushing on print obliteration, sets of identical latent fingerprints were "developed" with clean brushes; that is, standardized brushing procedures were used but with no powder applied to the prints. The direction of brushing and the brushing action were kept constant, and the number of strokes of the brush over each print was recorded. Examination of the prints, using a Reichert MeF3 optical microscope, then allowed an assessment to be made of the print damage associated with different brush types and brushing procedures.

Since squirrel-hair brushes are widely used by United Kingdom scene-of-crime officers, one further experiment was undertaken using this type of brush. Specifically, a squirrel-hair brush was used to develop a set of standard fingerprints with commercial aluminum dusting powder. However, the amount of powder on the brush was varied to determine the extent to which "overpowdering" can cause print obscuration.

Experimental Results

Brush Damage to Standard Fingerprints

Nine donors were each requested to deposit twelve standard fingerprints, having rubbed their hands to produce an even distribution of sweat before depositing each print. The prints from each donor were divided into three subsets, with each group of four prints to be brushed after 1, 4, and 16 days, respectively; that is, one print of known age from each donor was brushed with one of the four brushes described previously, but with no powder on the brush. For each print, 8 strokes of the clean brush were given and the prints were then photographed.

It should be noted that, in the case of the magna brush, a special procedure was adopted to avoid depositing powder onto the print while simultaneously ensuring realistic brushing procedures. The wand was loaded only with clean iron powder (38 to 45-μm-diameter particles); that is, a loaded magna brush was employed, but without the flake component of the magna powder.

Of the nine sets of standard fingerprints studied, four showed no tendency to smear; that is, it was not possible to detect any differences in the ridge appearances before or

after brushing, irrespective of the age of the prints. A further four sets exhibited only minor smearing in that the ridge edges became slightly blurred. However, the damage was not sufficient to cause the ridges to coalesce, and the fingerprint patterns remained clear, as is evident from Fig. 3. Only with one set of standard fingerprints was smearing sufficient to cause limited ridge coalescence and, even then, the ridge pattern was still identifiable. In this last case, it was just possible to identify a relationship between the smearing tendency and the age of the print: prints aged for 16 days displayed less tendency to smear than prints aged for 1 and 4 days.

Since these standard prints showed little tendency to smear, it was difficult to estimate the relative extent of damage caused by using different brush types. For this reason, several additional sets of standard fingerprints were given 32 strokes, using the four types of brushes. Subsequent examination established that this excess level of brushing created sufficient damage to differentiate between the four brush types. The magna brush and blower brush caused the least damage, with the squirrel-hair brush creating marginally less damage than the zephyr brush.

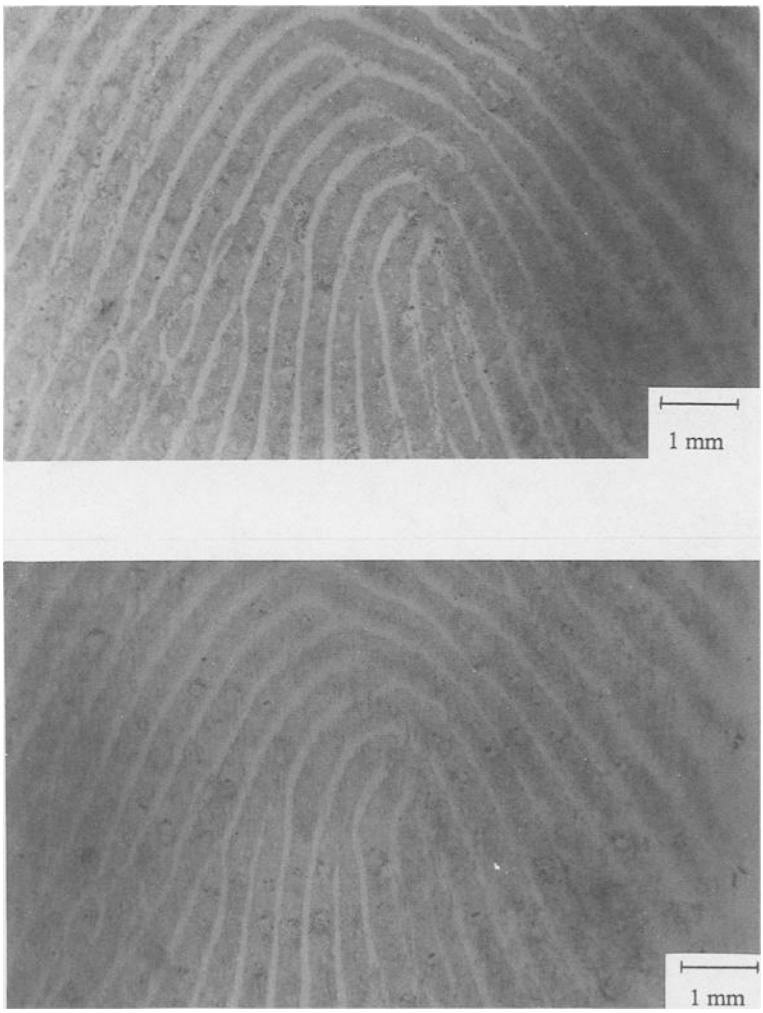

FIG. 3—*Identical "standard" fingerprints:* (top) *as deposited; and* (bottom) *aged for 1 day, then brushed with 8 strokes of a clean squirrel-hair brush.*

Brush Damage to Sebum-Rich Fingerprints

In contrast to the standard fingerprints, sebum-rich fingerprint sets were found to be smeared relatively easily with the clean brushes. For prints aged for 1 and 4 days, eight strokes with any of the brushes resulted in total obliteration of the fingerprint pattern, rendering the print unidentifiable (Fig. 4). For 16-day-old prints, the damage level depended on the type of brush used. While the magna brush and blower brush caused serious damage, some pattern could still be resolved. In contrast, the zephyr and squirrel-hair brushes again totally obliterated the prints.

Since the print damage levels were extremely high in experiments involving eight brush strokes, a further study was made for further sets of sebum-rich prints aged for 1, 4, and 16 days which were subjected to 1, 2, 4, and 8 strokes with each type of brush. The damage caused to 1-day-old prints with just one stroke of a clean squirrel-hair brush is evident from Fig. 5, *a* and *b*. Clearly, at discrete positions along the ridges, streaks can

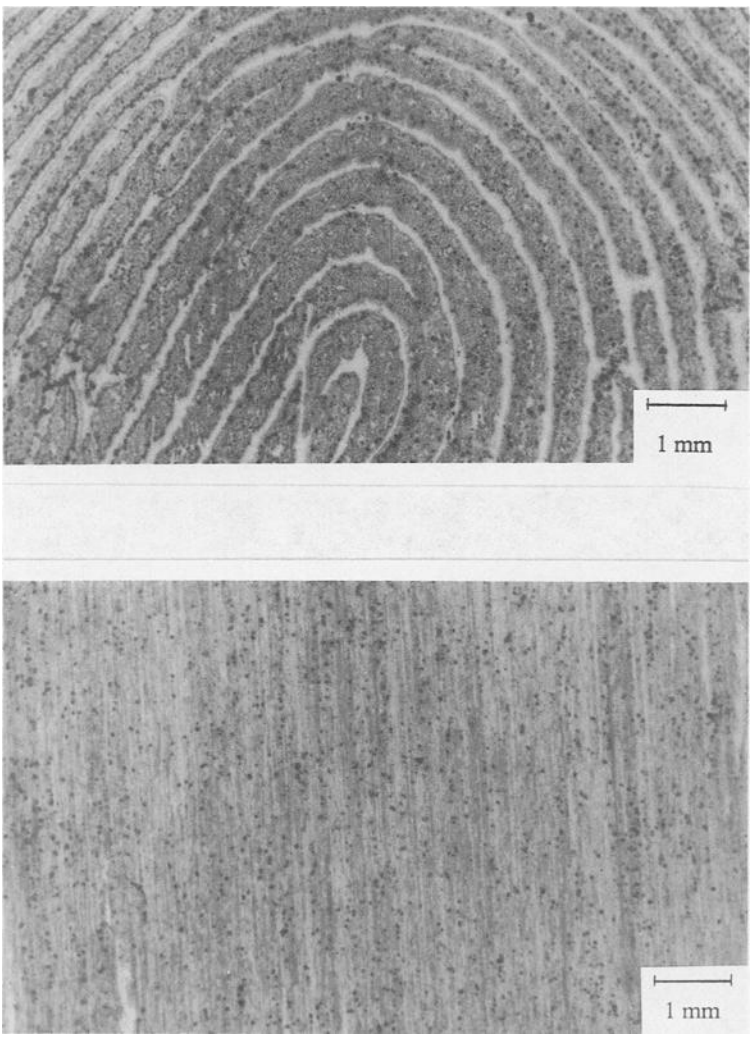

FIG. 4—*Identical sebum-rich fingerprints:* (top) *as deposited; and* (bottom) *aged for 1 day, then brushed with 8 strokes of a clean squirrel-hair brush.*

be seen where the residue from one ridge has smeared into the next. Although the pattern was still recognizable at this stage, further brush strokes caused the damage level to increase. After 8 strokes, the ridges had started to coalesce (Fig. 5*c*) and only a few more brush passes resulted in total obliteration. However, this series of experiments demonstrated that the damage levels decreased with the age of the print. Figure 5*d* shows a 16-day-old print given eight strokes of the brush. Although the image of the print was less clear (probably due to evaporation), the pattern could still be clearly seen and there was no sign of smearing of the ridges.

Print Obscuration by Excess Powder Application

While the brush action itself can cause partial or total obliteration of fingerprints, the present study proved that prints can also be obscured by "overpowdering." In this case, to avoid the high smearing tendency observed for sebum-rich prints, sets of standard prints were obtained and again aged for 1, 4, and 16 days. A squirrel-hair brush was then used to apply a commercial aluminium flake powder to the latent fingerprints. Three levels of powder were considered. First, zero powder was applied; that is, a clean brush was employed. Second, a small quantity of powder was applied by dipping the brush in the powder and tapping the brush firmly several times before dusting the prints. Third, an excess level of powder was applied by only gently tapping the brush once or twice before developing the prints.

The results obtained can be illustrated by the photomicrographs shown in Fig. 6. With a 1-day-old latent print, the ridges could be seen clearly (Fig. 6*a*). After 8 brush strokes with zero powder, the ridges became slightly blurred but the pattern was still distinct (Fig. 6*b*). The results of 8 passes with normal levels of powder on the brush are shown as Fig. 6*c*. The flake particles became attached to the fingerprint ridges, with virtually no particles located between the ridges, so the prints were clearly identifiable. When excess powder levels were used, the flake attached not only to the ridges but also to the regions between the ridges where there is no residue, so the ridge pattern was no longer distinct (Fig. 6*d*). It should be noted that the print obscuration caused by overpowdering was not a result of smearing of the fingerprint residue, since similar brush actions with zero or normal powder levels left the ridges distinct. Moreover, further experiments showed that too great a number of strokes with normal levels of powder on the brush obscured the print in a way similar to overpowdering.

Discussion

The way that latent fingerprints are deposited on contact surfaces may result in prints that cannot be developed successfully, irrespective of the procedures adopted. For instance, high finger pressures may cause ridge overlap. Similarly, lateral movement between the finger and the contact surface may result in irresolvably blurred prints. Yet, while these indistinct print types pose obvious identification problems, the present study demonstrates that even well-defined latent fingerprint patterns could be rendered unidentifiable by the print development procedures adopted.

The type and age of fingerprints are major factors governing the extent to which brushing can cause smearing of the ridge pattern. In particular, sebum-rich prints are more prone to smearing than ordinary fingerprints, with the smearing tendency decreasing with increasing age of the prints. Several interrelated explanations can be advanced to account for these observations.

(*a*) The cross-sectional height of the residue deposits may be related to the distance a ridge can be smeared by a brush stroke. Thus, sebum-rich prints appear to have greater cross-sectional heights and are therefore more prone to smearing than ordinary fingerprints.

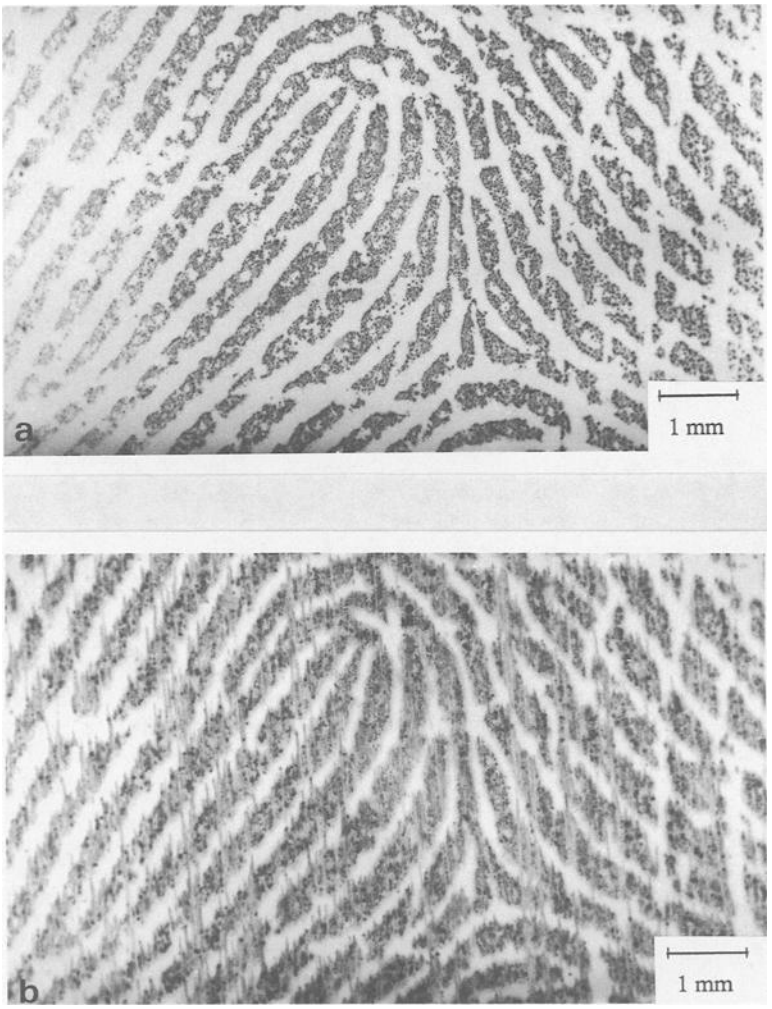

FIG. 5—*Identical sebum-rich fingerprints (from a different donor to those in Fig. 4):* (a) *as deposited;* (b) *aged for 1 day, then brushed with 1 stroke of a clean squirrel-hair brush.*

(*b*) As evaporation of moisture from the fingerprint residue occurs with time, the cross-sectional height of the residue deposit decreases and the viscosity of the residue increases, so that ridge smearing becomes progressively more difficult with increasing print age.

(*c*) Gradual evaporation of moisture may also cause a "skin" to form over the fingerprint residue, analogous to the formation of a skin on drying paint. As the skin develops, the smearing tendency is reduced.

(*d*) Evaporation effects can be expected to be more pronounced with ordinary fingerprints (98 to 99.5% moisture) than with sebum-rich prints so that, for prints of equivalent age, sebum-rich prints are more likely to smear on brushing.

Since prints become less susceptible to smearing with increasing age, this property may be useful in seeking to distinguish between old and new prints at a scene-of-crime. A

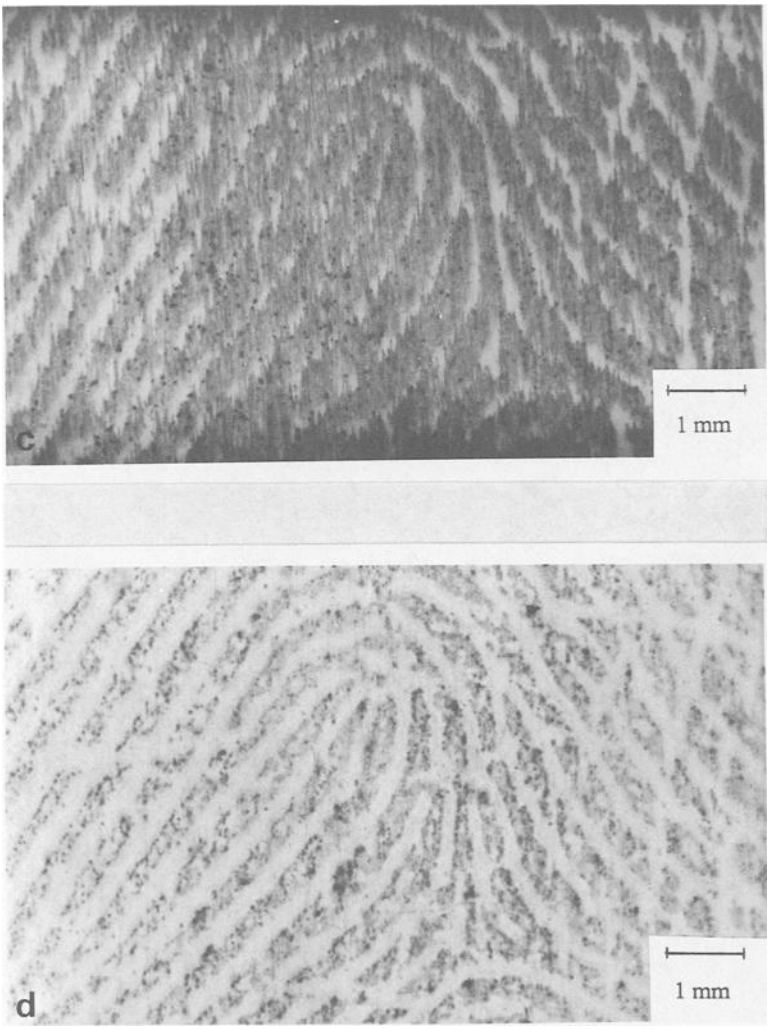

FIG. 5—*Continued:* (c) *aged for 1 day, then brushed with 8 strokes of a clean squirrel-hair brush; and* (d) *aged for 16 days, then brushed with 8 strokes of a clean squirrel-hair brush.*

study was therefore made of the smearing characteristics of ordinary and sebum-rich print sets from many different donors. For each donor, using only clean brushes without powder, a general trend of reduced smearing with increasing print age was apparent. Unfortunately, the smearing characteristics with print age varied considerably for different donors (compare Figs. 4*b* and 5*c*). Furthermore, the results were also found to be dependent on the environmental conditions experienced during aging; for example, temperature, humidity levels, and so forth. It was therefore concluded that "smearing characteristics" did not offer a reliable assessment of the age of a latent fingerprint.

While the susceptibility to smearing varied with print type and age, the extent of ridge smearing also depended on the brush type used. For both ordinary and sebum-rich prints, the magna and blower brushes appeared to cause least damage. Hence, the blower brush may have potential for use at crime scenes, although this type of brush is more expensive than zephyr and squirrel-hair brushes. The magna brush also resulted in lower damage

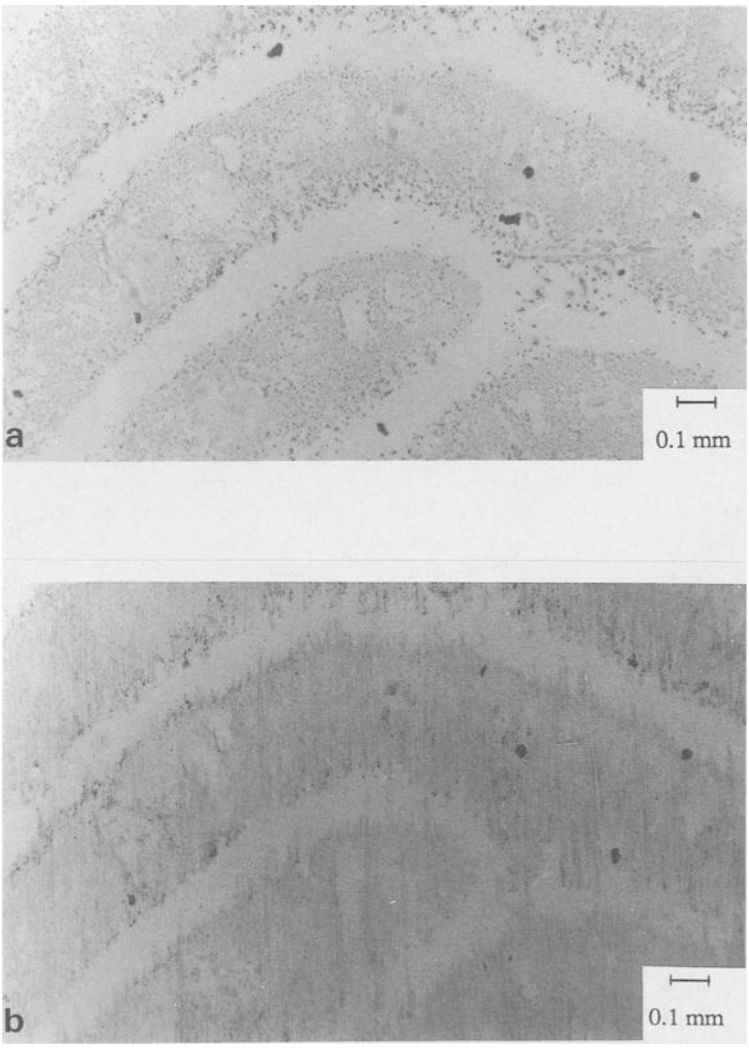

FIG. 6—*Identical "standard" fingerprints, all aged for 1 day:* (a) *prior to brushing,* (b) *given 8 passes of a clean squirrel-hair brush.*

levels, but difficulties are encountered when using this type of brush to develop prints on vertical surfaces.

Even with latent prints not prone to smearing, identification can be made difficult or even impossible by applying excess powder on the brush and/or by using too many strokes of the brush with normal powder levels. These procedures lead to the powder attaching to the ridges and the regions between the ridges, causing partial or total print obscuration.

The present experiments on factors influencing print obliteration have direct implications for scene-of-crime procedures. Clearly, overpowdering and/or overbrushing must be avoided, in line with standard recommendations [3]. Even with the best possible brushing practices, prints may be rendered unidentifiable by smearing, a problem encountered particularly with recently deposited sebum-rich prints. Thus, if the first print developed at a scene-of-crime becomes obscured, on the assumption that other prints

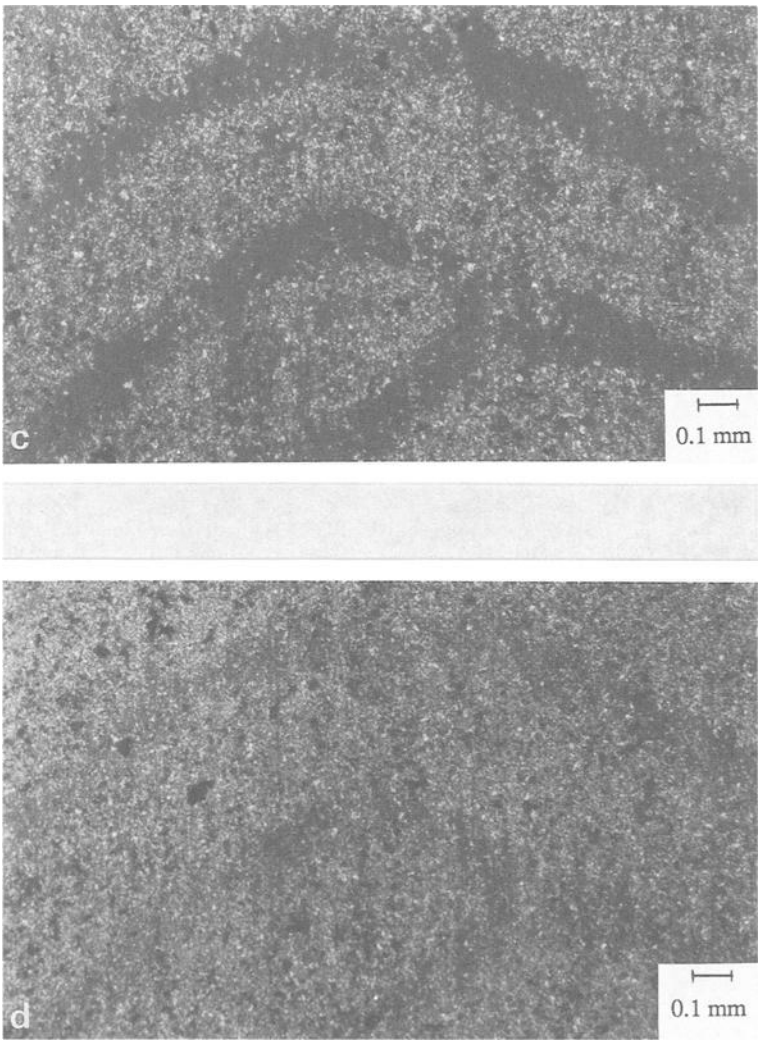

FIG. 6—*Continued:* (c) *given 8 passes of a squirrel-hair brush with a normal level of powder, and* (d) *given 8 passes of a squirrel-hair brush with an excess level of powder.*

present are also likely to smear easily, further searching should be undertaken using more gentle brushing procedures, such as the use of magna or blower brushes.

Conclusions

Several different factors influence the extent to which clearly defined latent fingerprints may be rendered partially or totally unidentifiable during print development. Ridge smearing on brushing represents a major potential cause of pattern obliteration, which is affected by the following:

(*a*) the quantity and type of fingerprint residue, with sebum-rich prints tending to smear far more readily than ordinary prints;

(*b*) the age of the latent fingerprint, with the extent of smearing decreasing with increasing print age; and
(*c*) the number of brush strokes used and the type of brush adopted for print development, with magna and blower brushes tending to cause less smearing than the commonly used glass fiber or squirrel-hair brushes.

Even with prints of a type and age not prone to brush smearing, the prints may be wholly or partially obscured by using excess powder levels on the brush and/or by giving excessive numbers of brush passes with normal levels of powder on the brush.

Acknowledgment

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