FORENSIC SCIENCE JOURNAL SINCE 2002

Forensic Science Journal
2024;23(1):35-48
fsjournal.cpu.edu.tw
DOI:10.6593/FSJ.202412_23(1).0004

Transference of Fingerprint between the Adhesive Side of an Adhesive Tape and Ziplock Bag

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Received: 20 August 2024; Received in revised form 6 September 2024; Accepted 11 September 2024

Abstract

Adhesive tapes, including duct and insulation tapes, and Ziplock bags are common packing materials for illicit drugs, such as diamorphine, methamphetamine, and cocaine for distribution purposes. These illicit drugs are often packed in Ziplock bags and taped with adhesive tapes into bundles, usually to avoid detection, before they are moved down the supply chain to consumers. When a drug bundle is seized by law enforcement agencies such as the Central Narcotics Bureau in Singapore, fingerprint and deoxyribonucleic acid (DNA) analyses are commonly deployed by investigators or forensic specialists to determine who touched and/or possessed the drug bundles. However, due to the destructive nature of these two forensic tools, investigators often perform DNA analysis over fingerprint analysis even though the presence of fingerprint evidence on the tapes, especially on the adhesive side, is highly incriminating. The present study examines the transference of fingerprints between a tape's adhesive side and a Ziplock bag's surface. Our findings conclusively showed that fingerprints could be transferred between the tape's adhesive side and Ziplock bag's surface. Moreover, retrieving useful prints for examination from the tape's adhesive side using the Wet Powder™ method is more likely to achieve better quality prints. If the lifted print had an identical minutiae pattern with the reference print, it was considered a print directly deposited onto the surface, whereas if the lifted print had a symmetrical minutiae pattern as compared to the reference print, it was considered a print that was transferred from the opposing surface.

Keywords: forensic science, fingerprint, transference, adhesive tapes, transferred, DNA

Introduction

Illicit drugs, including diamorphine and methamphetamine, are often trafficked in drug bundles, comprising of Ziplock bags and adhesive tapes, such as duct or insulation tapes [1]. The opaque nature of these tapes is often used by drug traffickers or couriers to support their claims of not knowing specifically the contents in the drug bundles.

To show possession and control of these drug bundles, investigators will often subject these seized bundles to forensic analysis, including fingerprint or deoxyribonucleic acid (DNA) analysis. The presence of a fingerprint or DNA profile on the adhesive sides and/or the inner layers of these drug bundles is important not only in proving who has touched the drugs inside the bundle, but also in helping the Courts determine whether the person arrested had the specific knowledge of the

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nature of the drugs since he/she will have a clear sight of the drugs within the drug bundles.

However, due to the destructive nature of these two common forensic identification tools [2,3], investigators will often subject the drug bundles to DNA analysis rather than on fingerprint analysis [4], despite the numerous disadvantage in solely relying to the DNA analysis [5].

To address this issue, the present study aimed to look into the transference of fingerprints within the inner layers of a drug bundle, specifically the areas of contact between the adhesive tape and outer surface of the Ziplock bags. If such transference does occurs, the present study will explore the most suitable method for retrieving these prints and consequentially, interpreting these prints.

Given that the adhesive side of the tape and the surface of the Ziplock bag do come into contact with each other, the hypothesis is that the fingerprint deposited on either of the substrate (deposited print) will be transferred over to the other substrate (transferred print) due to the tape's adhesive nature. Our research data show that transference of prints is likely to occur, regardless of where the fingerprint was deposited.

The utility of this research is twofold. First, if a fingerprint of sufficient quality can be obtained from either the tape's adhesive side or the Ziplock bag's surface, the other substrate can be subjected to other forensic processing tools, such as DNA analysis, to maximize the chance of securing additional objective evidence in a case. Second, when a partial or a latent print with limited level 2 details is obtained from one of the substrates, investigators can still process the other substrate for fingerprints to examine for complementary level 2 details, which will aid in the identification process.

Anderson [7] investigated the transfers of latent prints between the adhesive side of a duct tape to its non-adhesive side when the tapes are overlaid against each other, and he found that such transference did occur. This previous study also described the need for examiners to horizontally flip the prints for comparisons when assessing such prints. Draxel [8] investigated on the secondary transfer of latent prints involving adhesive tapes and other substrates. They also concluded that transfers could occur between the tape's layers and that comparing latent prints in its laterally reversed orientation to a reference is important.

Materials and methods

The materials to be used in this research are as listed below:

- Duct tape (Supreme Brand), Insulation tape (Supreme Brand) and Insulation (Astee Brand) tape purchased from the shop, SKP Ptd Ltd, in Singapore .
- Empty Ziplock bags that were seized by the Central Narcotics Bureau of Singapore (CNB) from actual drug raids conducted
- Wet Powder™ Black and White from Kjell Carlsson Innovation for development of latent prints
- Un-Du® (St Louis Park, MN) adhesive removal solution, a commercially available heptane-based dissolvent, has been reported to enable easy separation of adhesive tape.
- Canon EOS 200D mark II (Tokyo, Japan) digital camera for documentation of the latent prints lifted (ISO: 200, F-stop f/4)

Deposition of fingerprints

We conducted a pilot test to determine the method of fingerprint deposition. Figure 1 shows the latent prints lifted from the adhesive side of either a duct or an insulation tape, which was deposited using a charged fingerprint and stamps stained with different fingerprint simulants, including Sirchie standard, amino acid, and sebaceous oil simulants.

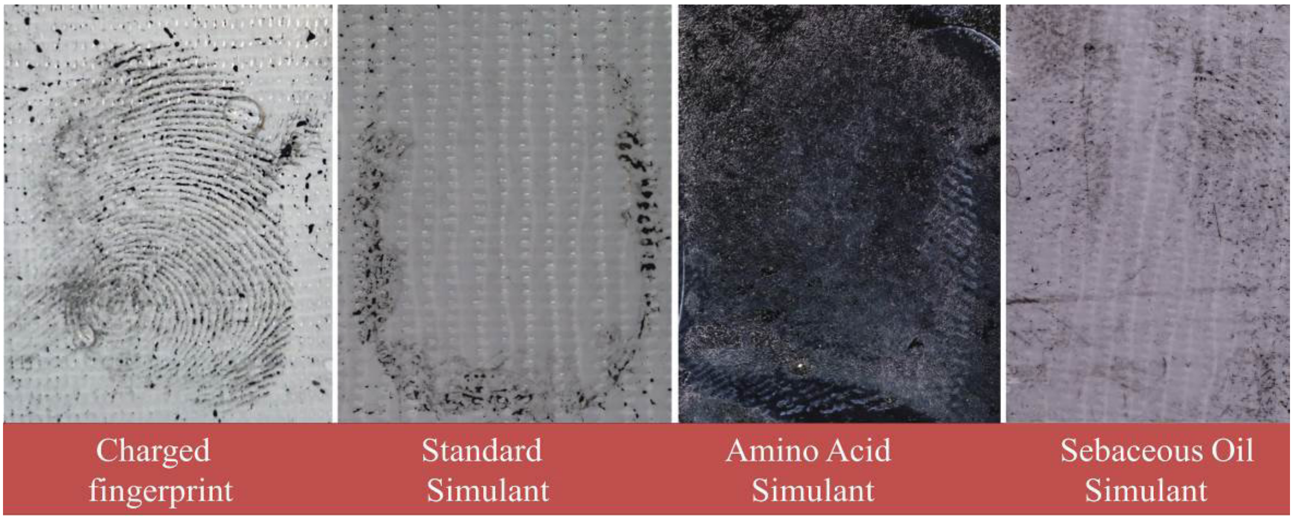


Fig. 1 The picture shows the latent prints lifted from the adhesive side of tapes using a Wet Powder™ solution from different deposition methods.

A charged fingerprint is defined as a print deposited by a donor after he/she washed his hands and refraining from washing his/her hands and wearing gloves for the subsequent 30 mins before taking them off. The donor then charged his/her finger by rubbing them together before depositing the print on the substrate.

A comparison was made in the quality between latent prints and it was concluded that a charged fingerprint is more likely to produce a consistent deposition as compared to stamps stained with simulants. Given this result, we deployed a charged fingerprint as the default fingerprint deposition method for the present study.

Standard of measuring fingerprint quality

It is important to determine a standard method for measuring any latent prints that were found in this experiment to ensure better insights. According to our literature reviews on the methods used for conducting fingerprint assessments, no clear standards have been universally accepted, as approximately 45% of fingerprint research studies utilize the Novel Scales, followed by the Centre for Applied Science and Technology scale from the International Fingerprint Research Group range of scales, which accounts for 40% of the fingerprint research studies [9].

Sears [10] established a minimum standards and criteria for ensuring consistency of fingerprint enhancement research and this author created a grading reference that included an assessment of whether the latent print is an identifiable print in addition to its development method. To further reduce the subjectivity of the grading reference, it is recommended to define how identifiable a print is through the number of minutiae that can be identified visually. Table 1 shows a comparison of the recommended assessment reference used in this research to the grading reference developed by Sears. Figure 2 shows the latent prints associated in each grade of the assessment reference. Fraser [11] has provided a history of how the number of minutiae required for an identification has changed from 16, to between 10 to 16 and to a minimum of 12 for the rest of the Europe over the years. In fact, in the case of McAteer, only 8 minutiae were accepted by the courts. As such, the standard of 8 minutiae was being used as the dividing line for interpretable print.

Table 1 Grading scheme for assessing the developed marks created by Sears with the interpretation of the identifiable fingermarks

Scale Score	Sears scale	Our modified scale
0	No evidence of mark	0 minutiae found with no evidence of mark
1	Weak development; evidence of contact but no ridge details	0 minutiae found with evidence of contact but no ridge details
2	Limited development; about 1/3 of ridge details are present but probably cannot be used for identification purposes	Between 1 minutiae to 7 minutiae found with about 1/3 ridge details present
3	Strong development; between 1/3 and 2/3 of ridge details; identifiable finger mark	Found more than 8 minutiae with between 1/3 and 2/3 of ridge details
4	Very strong development; full ridge details; identifiable finger mark	Found more than 8 minutiae with full ridge details

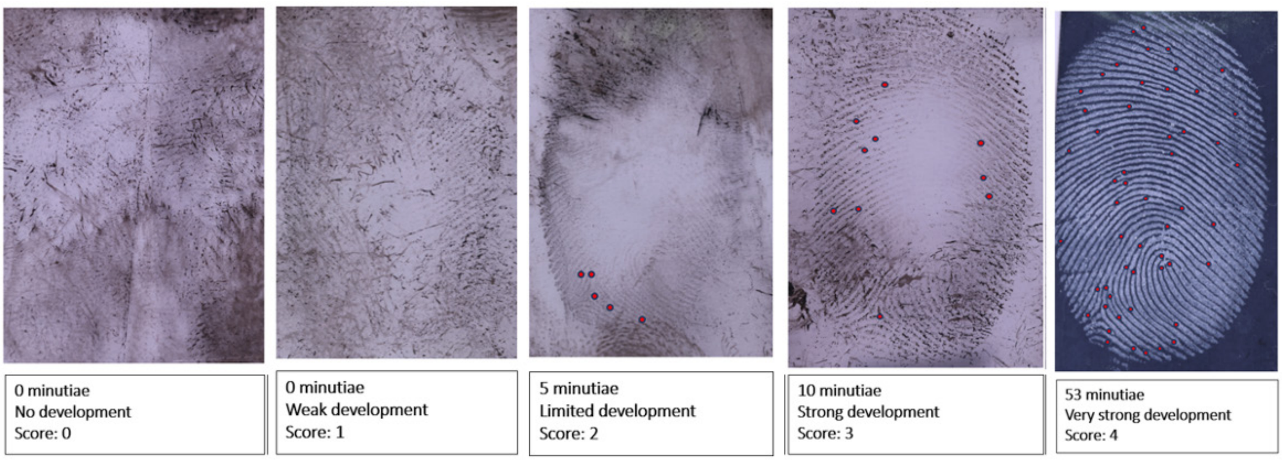


Fig. 2 Example of the extracted latent prints based on their assessed quality.

Fingerprint processing method

The substrates tested in our research were the adhesive side of either a duct or insulation tape and the surface of a Ziplock bag. According to Christophe and Paul [12], cyanoacrylate (superglue) fuming can be utilized to enhance a non-porous substrate, whereas a sticky side powder or a Wet Powder™ solution can be used to enhance latent prints from the adhesive side of a tape.

Although an earlier pilot study has demonstrated the possible use of a wet powder solution method for retrieving latent prints from both the adhesive sides of a duct or an insulation tape, we have also performed experiments to determine whether cyanoacrylate (superglue) fuming can be utilized for this research. The results show that the magnetic powder used to dust the prints enhanced by cyanoacrylate fuming may stick to the adhesive residue left on the tape or the surface of the Ziplock bag, leading to unreadable results, even though there were clear prints observed on the surfaces of the Ziplock bag after the fuming process. As such, in this research, we utilized the Wet Powder™ for the adhesive side of the tape and the surfaces of the Ziplock bag.

Experiment design

To test for the transference of latent prints from the surfaces of the Ziplock bag to the adhesive side of the selected tapes, charged fingerprints were deposited on either the surfaces of the cut pieces of the Ziplock bag or the adhesive side of the selected tape before sticking them together for contact and separating them subsequently to test for the transference of latent prints from the deposited surface to the corresponding surfaces (Figure 3).

Fig. 3 Specific steps of the experiment

Donors were first asked to wash their hands, to put on gloves, and not to wash their hands for approximately 30 mins before removing the gloves and charging their thumb by rubbing their fingers together. The charged fingerprint was deposited on the respective substrate before sticking the two substrates together as a set of sample. Preparing all the samples for each experiment took approximately 30 mins, and once all the samples are stuck together, they were separated one at a time before testing the substrates with the Wet Powder™ solution.

Each separated substrate was subjected to approximately 30 seconds of soaking using a Wet Powder™ solution before the solution was washed off to reveal any possible latent prints. The latent prints retrieved were photographed using the Canon EOS 200D mark II digital camera.

To determine and understand the transference of fingerprint between the adhesive side of either a duct or an insulation tape with the surface of a Ziplock bag, an experiment comprising four experiment segments (experiment segments A, B, C and D) was formulated (Table 2) for each donor. Each experiment segment comprised five prepared samples, resulting in ten latent fingerprints, which were to be lifted. Five of the latent fingerprints were lifted from the substrate where the charged fingerprint was deposited (deposited print), whereas another five of the latent fingerprints were lifted from the opposing substrate that contained fingerprints transferred over from the deposited print (transferred fingerprint).

Table 2 Profile of the experimental design

Experiment Segment	Tape Type	Ziplock Bag	Print deposition location	Total Samples	Total latent prints
A	Supreme duct tape	CNB Seized	Ziplock Bag	5	10 (5 deposited, 5 transferred)
B	Supreme duct tape	CNB Seized	Adhesive side of tape	5	10 (5 deposited, 5 transferred)
C	Supreme insulation tape	CNB Seized	Ziplock Bag	5	10 (5 deposited, 5 transferred)
D	Supreme insulation tape	CNB Seized	Adhesive side of tape	5	10 (5 deposited, 5 transferred)
Total				20	40 (20 deposited, 20 transferred)

Experiment segments A and B are experiments conducted involving the Supreme duct tape and cut pieces of the Ziplock bag seized by the Central Narcotics Bureau of Singapore, whereas experiment segments C and D involved the Supreme insulation tape and cut pieces of the Ziplock bag seized by the Central Narcotics Bureau.

For this research, a total of four donors were invited to participate in this research, resulting in a total of 160 latent prints that were lifted for analysis. All 160 lifted latent prints were assessed based on the grading reference shown in Table 1 and compiled using Microsoft Excel for analysis (Figure 4).

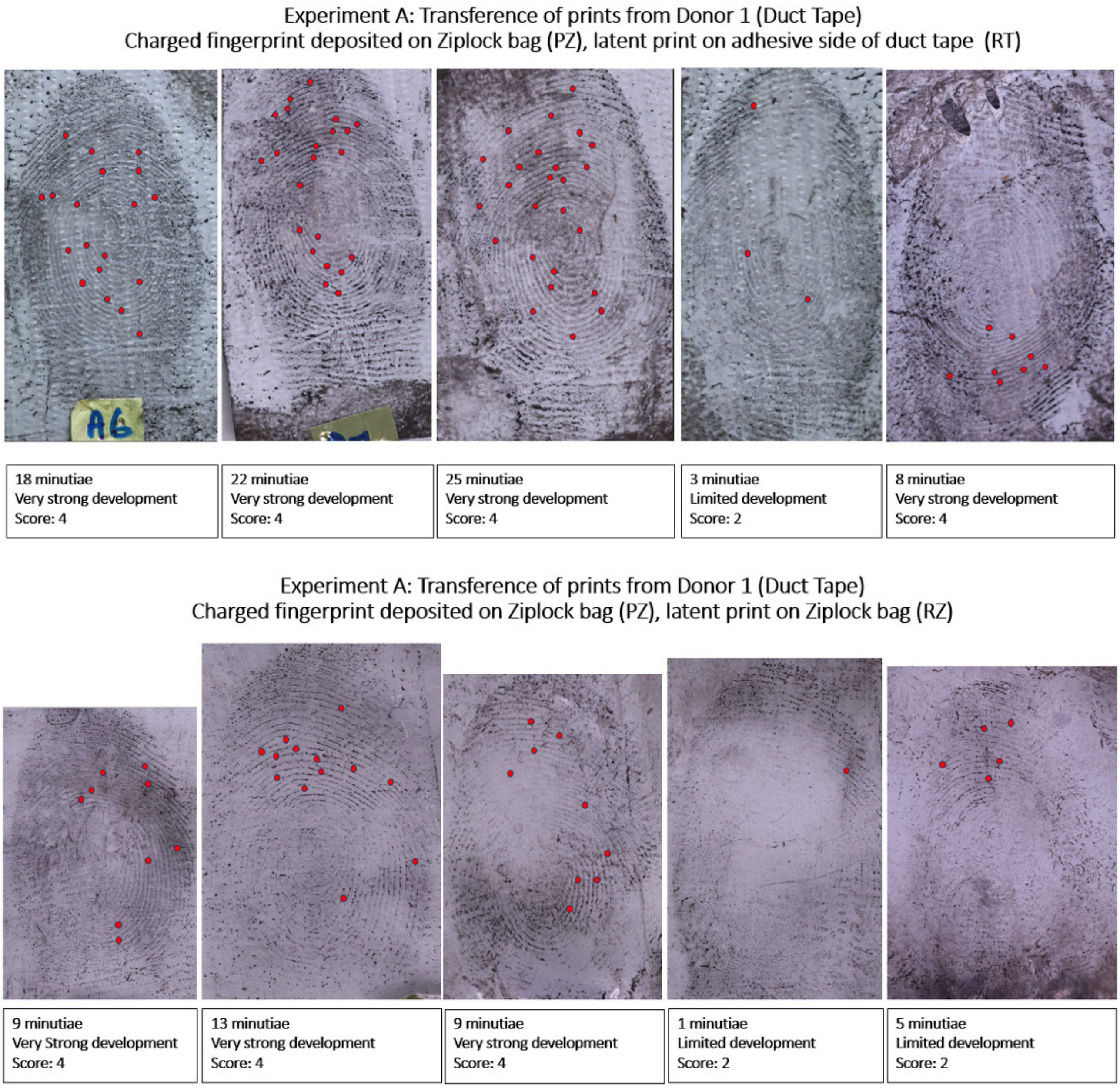


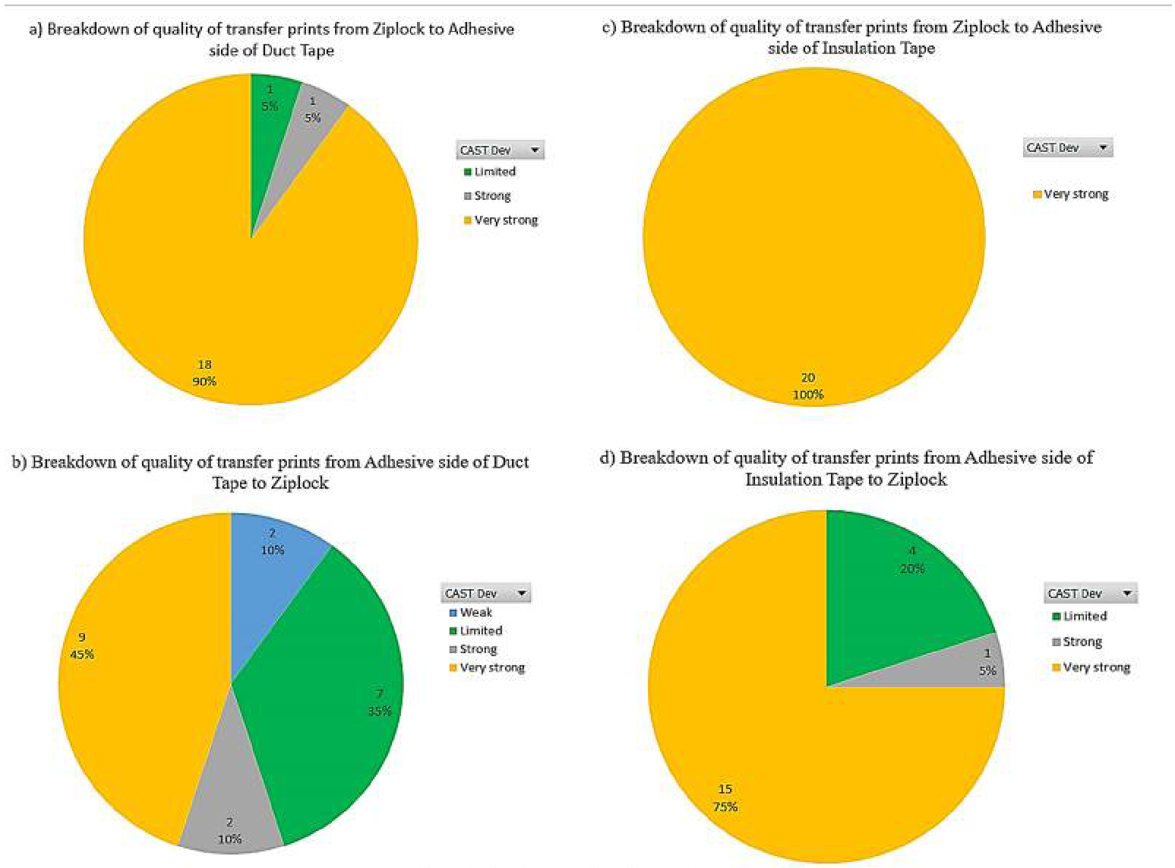
Fig. 4 Examples of the assessed latent prints

The profile of the collected prints in this experiment is as follows: a total of 80 deposited prints and 80 transferred prints were obtained among the 160 latent prints collected; and a total of 80 prints each were lifted from the adhesive side of the tape and from the surfaces of the Ziplock bag

Results and discussion

Transference of prints

To address the research question on whether transference of prints exists between the adhesive side of either a duct or an insulation tape and the surface of a Ziplock bag, we examined the quality of all the transferred latent prints retrieved from our experiments (Figure 5). Transference of prints is considered present when transferred prints were found on the opposing substrate.



Charts showing quality of transferred latent prints.
(a)Latent prints lifted from the adhesive side of a Duct tape transferred from a print deposited on the surface of the Ziplock bag
(b)Latent prints lifted from the surface of the Ziplock bag transferred from a print deposited on the adhesive side of the Duct tape
(c)Latent prints lifted from the surface of the Ziplock bag transferred from a print deposited on the adhesive side of the Insulation tape
(d)Latent prints lifted from the adhesive side of a Duct tape transferred from a print deposited on the surface of the Ziplock bag

Fig. 5 Breakdown of all the transferred fingerprints obtained from the experiments

Among a total of 80 transferred fingerprints lifted, 66 were found to have a strong or very strong development, 12 showed limited development, and 2 had weak development. This data indicated that 82.5% of the transferred prints were considered interpretable, because at least eight minutiae were identified in each of those prints. It was also observed that none of the lifted transferred latent fingerprints had no development. Given that the origin of the fingerprints was from the deposited prints, it could be concluded that print transference had occurred in all these 80 samples.

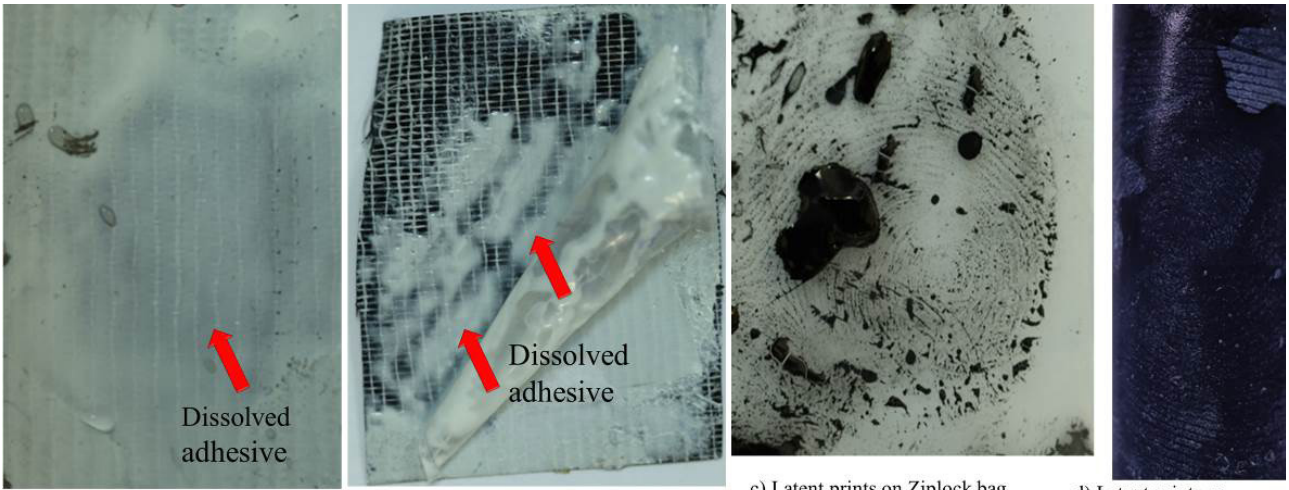
Effects of aging (4 and 24 hours) and separation

To determine the transference of prints and the presence of deposited and transferred prints after 4 and 24 hours of contact, the samples were prepared and allowed to age for 4 and 24 hours before they are separated for processing. The steps for this experiment are the same as those described in Figure 3, except that this experiment only used three samples for each category, resulting in a total of 12 deposited prints and 12 transferred prints for each of the time frame.

During the experiment, the aged samples involving a duct tape were more difficult to separate as compared to the fresh samples as they were gummed together over a longer period of time. Direct physical peeling to separate the aged samples were often impossible and usually ended up with damages to the samples as compared to freshly prepared samples.

According to Tan et al. [1], several methods can be utilized to separate an adhesive tape from other materials, including physical peeling, heating, freezing, and using chemical solvents.

To facilitate the separation of these aged samples, chemical solvents, like sodium bicarbonate and heptane, and commercial solvents, Un-Du® solution, were utilized. During this experiment, applying heptane and the Un-Du® solution on the adhesive side of duct tape dissolved the rubber adhesive of the duct tape; however, their applications had limited effect on the surfaces of the Ziplock bag and insulation tape (Figure 6). This phenomenon is likely due to the fact that most duct tapes are rubber-based adhesives while heptane can be used as a thinner for rubber cement.



a) Effects of direct application of Heptane on the adhesive side of duct tape with a deposited print

b) Effects of application of Heptane on sample involving duct tape

c) Latent prints on Ziplock bag processed by wet powder solution after direct application of Heptane

d) Latent prints on insulation tape processed by wet powder solution after direct application of Heptane

Fig. 6 Effects of heptane on the adhesive side of the duct tape, Ziplock bag, and adhesive side of the insulation tape

Therefore, instead of entirely soaking the samples in the chemical solvent to loosen the contact of the entire sample, this step was modified to incorporate the application of the chemical solvent to loosen contacts on a small part of the sample before physical peeling was performed. This technique has minimized the damages to the rubber adhesives caused by the separation process in the duct tape. For the insulation tape, the use of the Un-Du® solution or heptane helped in the separation of the more tightly gummed samples.

Figure 7 shows the results of the assessment of latent prints from the samples aged for 4 and 24 hours after they were separated through physical peeling with the aid of solvents, including sodium bicarbonate, heptane, and the Un-Du® solution, whenever physical peeling becomes impossible.

Figure 7 similarly did not reveal any transferred prints with no development. This supports the occurrence of print transference and the presence of both deposited and transferred latent prints both on the adhesive side of the tapes and surfaces of the Ziplock bag, even after the samples were taped together for 4 and 24 hours. Our results also showed the possibility of lifting interpretable latent prints for aged samples.

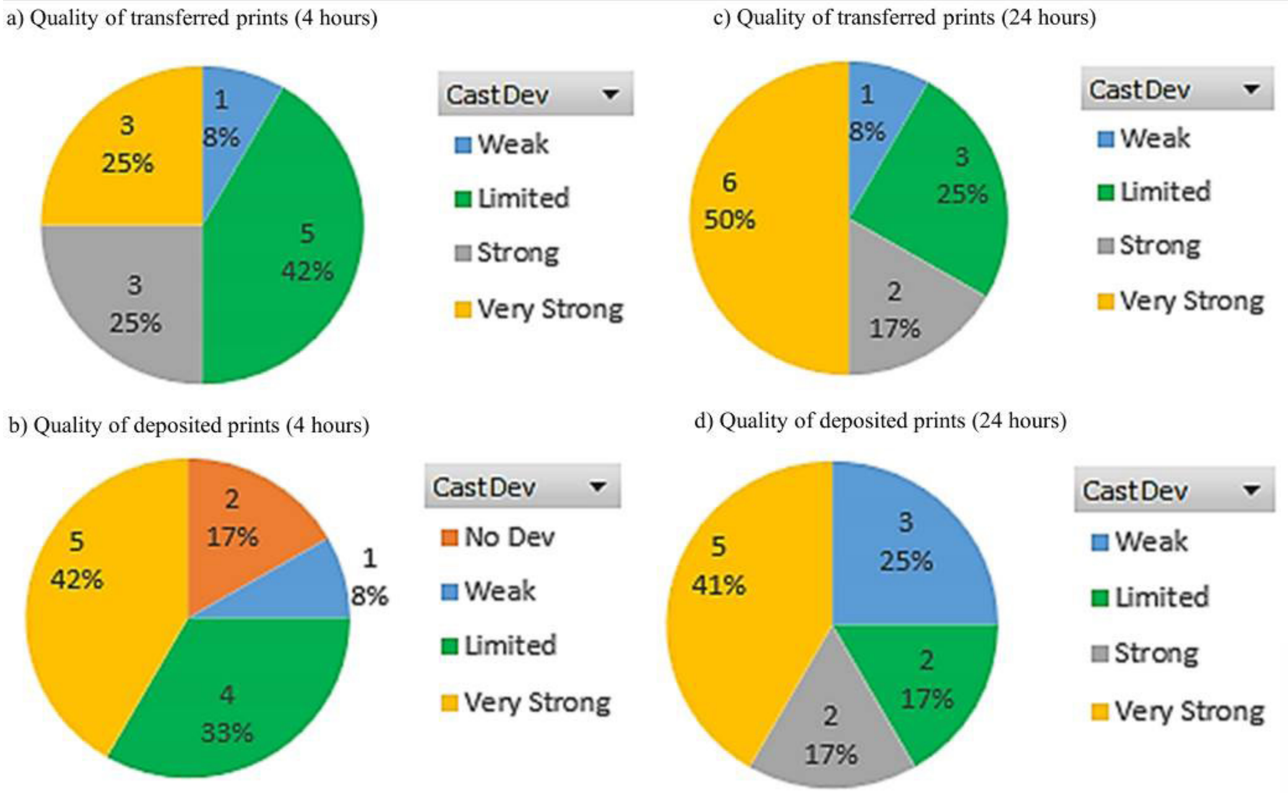


Fig. 7 Assessed quality of prints lifted from the separation process and aging experiment

As shown in Figure 8, retrieving latent prints from the adhesive side of the tape was more likely to result in an interpretable print as compared to retrieving prints from the Ziplock bag using the Wet Powder™ solution method.

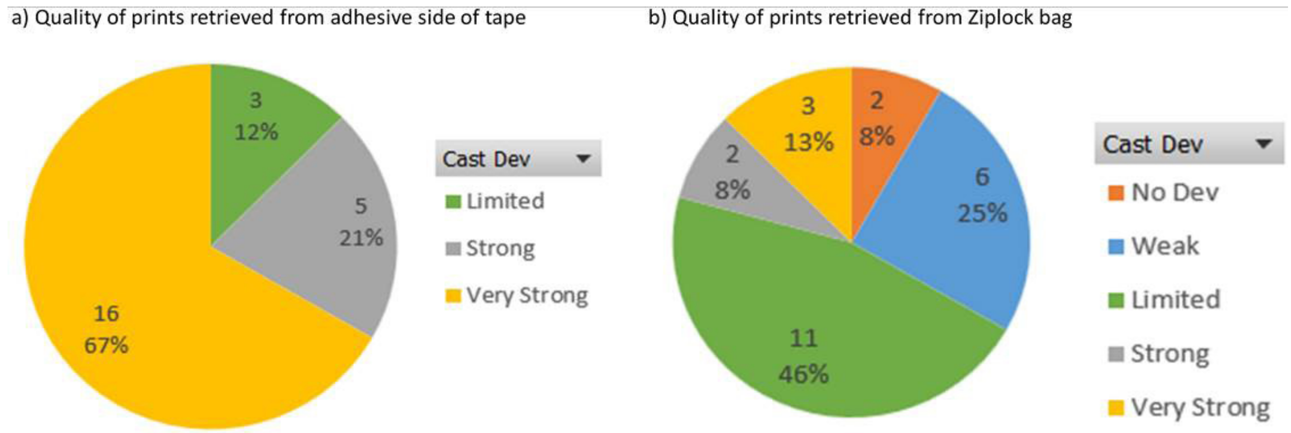


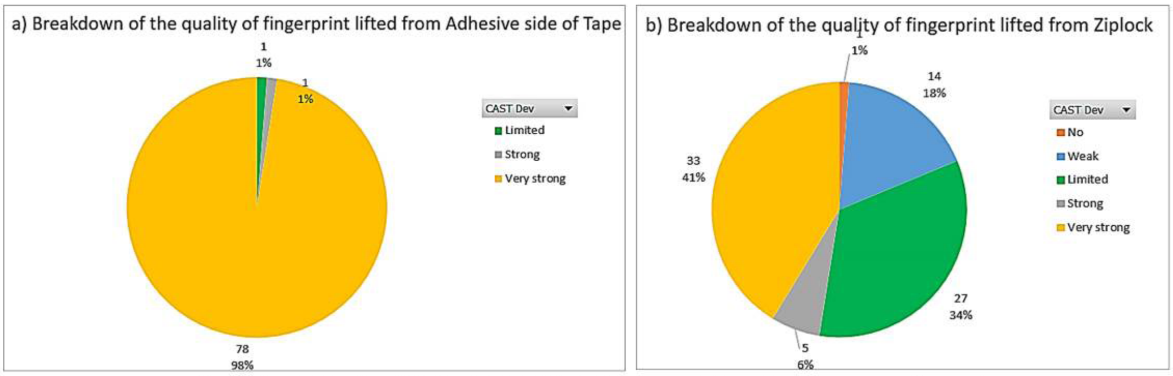
Fig. 8 Assessed quality of prints lifted from the adhesive side of the tape and Ziplock bag during the separation process and aging experiment

In summary, the results of our research confirmed the transference of prints between the adhesive side of a duct tape/insulation tape and a Ziplock bag for fresh samples and samples that were aged for 4 and 24 hours.

Methods of retrieving latent prints

Better chance of getting an identifiable print from the tape's adhesive side

Figure 9 shows the breakdown of the quality of latent prints lifted from the adhesive side of the two types of tapes and the surface of the Ziplock bag. Given that the latent prints lifted from the surfaces included both transferred and deposited prints retrieved from the stated surfaces, the maximum number of latent prints within each category was 80.



Charts showing quality of fingerprints lifted from the adhesive side of the tapes and the Ziplock bag.
(a)Latent prints lifted from the adhesive side of the tapes, regardless of the tape type or whether they are deposited or transferred
(b)Latent prints lifted from the surface of the Ziplock bag, regardless of the tape type or whether they are deposited or transferred

Fig. 9 Breakdown of the lifted latent prints retrieved from the adhesive side of the tape

Comparing the qualities of the latent prints lifted from the two substrates, retrieving prints from the adhesive side of the tape, regardless of whether the prints were deposited or transferred, was more likely to obtain an interpretable print, as compared to retrieving prints from the surface of the Ziplock bag.

This is an important finding as it may help investigators in their decision-making process, if they were to decide on the optimal surface or substrate for fingerprint analysis because our experiments suggested a 99% chance of getting an interpretable print when retrieving from the adhesive side of the tape as compared to a 47% chance when retrieving from the surfaces of the Ziplock bag using the Wet Powder™ solution method.

Improved quality of latent prints from the surface of a Ziplock bag using cyanoacrylate fuming

During our experiments, it was observed that the use of different adhesive tapes on the surface of the Ziplock bag may result in varying quantities of adhesive residues left on the surface of the Ziplock bag (Figure 10).

Fig. 10 Adhesive residues left behind by the different adhesive tapes

Thus, it was necessary for us to determine whether using cyanoacrylate fuming on the surfaces without adhesive residues could improve the quality of the latent prints. An experiment similar to our main experiment was conducted using three samples for each tape type. A profile of the lifted prints in this experiment segment is shown in Table 3, depicting examples of the prints on the different surfaces in Figure 11.

Table 3 Profile of the lifted fingerprints using cyanoacrylate fuming

Experiment	Tape Type	Processing Method	Total number of samples	Number of latent prints
E (Prints on Ziplock bag)	Supreme Duct Tape	Cyanoacrylate fuming (SG)	3	3
	Supreme Insulation Tape		3	3
	Astee Insulation Tape		3	3
	Supreme Duct Tape	Wet Powder™ (WW)	3	3
	Supreme Insulation Tape		3	3
	Astee Insulation Tape		3	3
F (Prints on Adhesive Tape)	Supreme Duct Tape	Cyanoacrylate fuming (SG)	3	3
	Supreme Insulation Tape		3	3
	Astee Insulation Tape		3	3
	Supreme Duct Tape	Wet Powder™ (WW)	3	3
	Supreme Insulation Tape		3	3
	Astee Insulation Tape		3	3

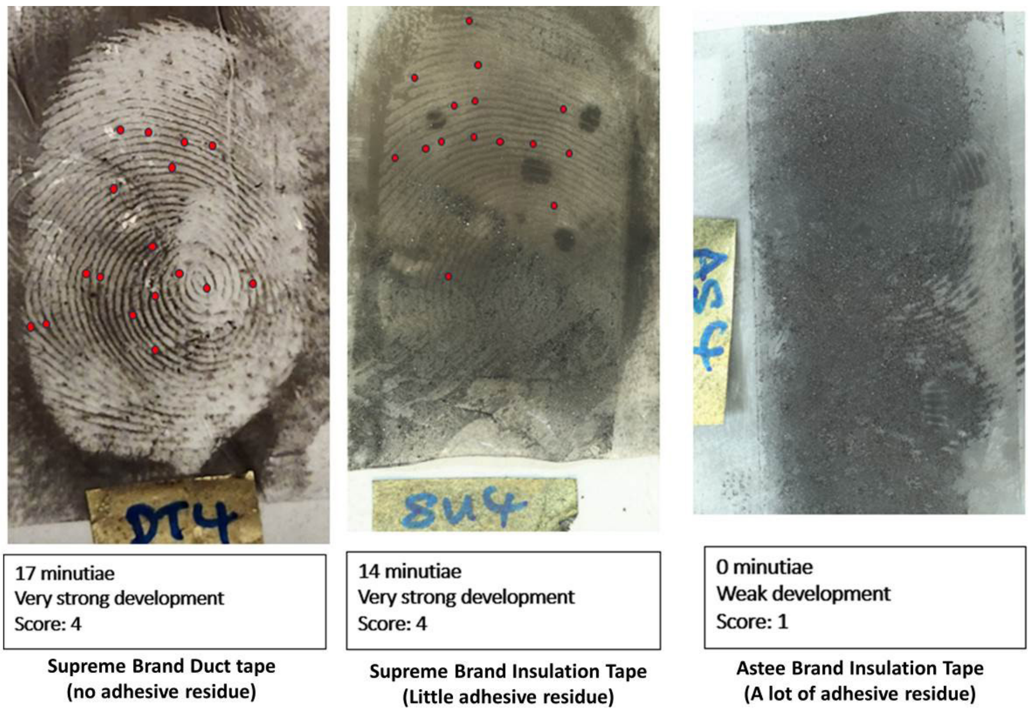


Fig. 11 Examples of the lifted latent prints from the surfaces of Ziplock bag with different adhesive residues

Figure 12 shows an improved quality of latent prints for surfaces without adhesive residues (DT) and surfaces with little adhesive residues (SU) and a decrease in print quality for surfaces with many adhesive residues (AS) when cyanoacrylate fuming was utilized over the Wet Powder™ solution method. This result suggests that the quality of print retrieved from utilizing cyanoacrylate fuming is inversely related to the amount of adhesive residues left on the surfaces of the Ziplock bag. When cyanoacrylate fuming was utilized, rather than the Wet Powder™ solution method, we observed that the lesser the amount of adhesive residues on the surfaces of the Ziplock bag, the better is the print quality.

The abovementioned data indicated that utilizing the Wet Powder™ solution is a viable method for retrieving both deposited and transferred latent prints from both the adhesive side of the tapes and Ziplock bag. However, for the surfaces that are relatively free from adhesive residues, cyanoacrylate fuming method can be used to improve the quality of latent prints lifted from the surfaces of the Ziplock bag.

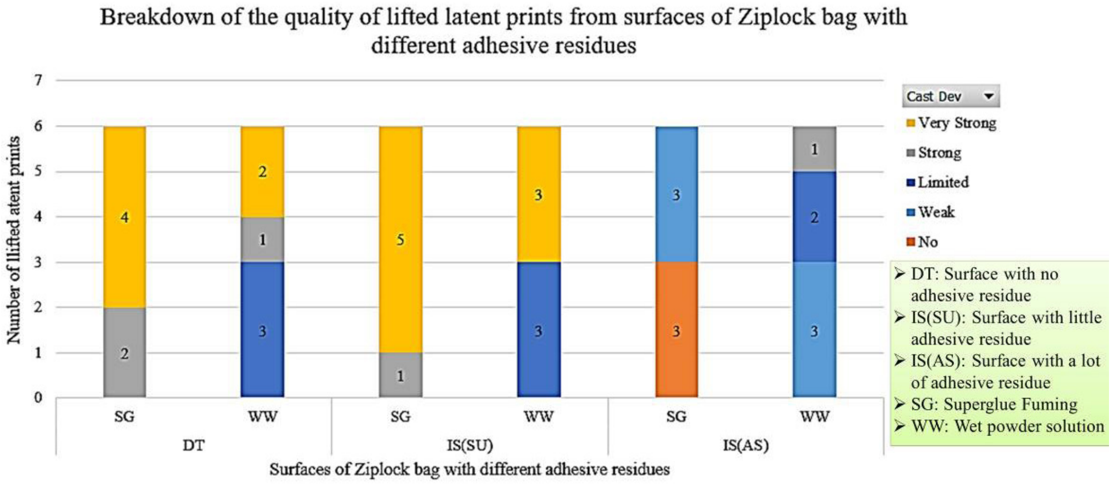


Fig. 12 Breakdown of the lifted latent prints processed using cyanoacrylate fuming and a Wet Powder™ solution from the surfaces of Ziplock bag with different amounts of adhesive residues

Interpretation of prints

To determine whether a lifted latent print is a deposited or a transferred print, we should examine the pattern created by the identified minutiae of the lifted latent print against a reference print (Figure 13). The reference print is created by depositing a charged fingerprint onto a piece of paper before powdering it with magnetic power.

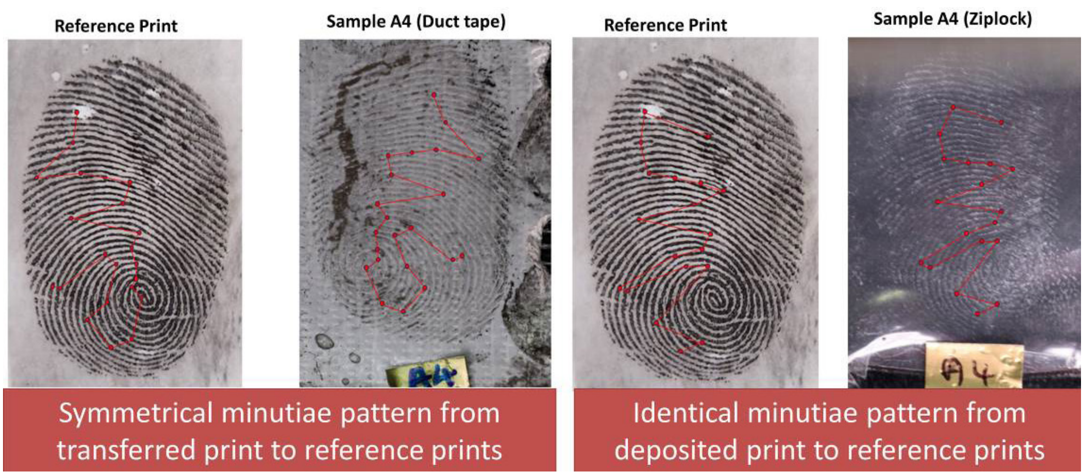


Fig. 13 Comparison of a transferred print on the adhesive side of a duct tape to a reference print

To determine whether a latent print is a result of a direct deposition or is a result of a print transference, we can simply look at the minutiae pattern that was created by the lifted latent print against its reference print. If the pattern created by connecting the minutiae on the latent print and the reference print is identical, the lifted latent print is considered a result of a direct deposition or contact, whereas a symmetrical pattern indicates a transferred print from the other substrate.

Conclusions

Our research data confirms the transference of prints between the adhesive side of either a duct or an insulation tape with the surface of a Ziplock bag when they come into contact with each other. The deposited and transferred latent fingerprints on such substrates could be lifted using a Wet Powder™ solution. Regardless of whether the fingerprint was deposited or transferred, lifting the fingerprint from the tape's adhesive side is more likely to result in a print with an interpretable/examination quality. Once lifted, we would be able to differentiate the fingerprint type by comparing the minutiae pattern with that of its reference print.

Acknowledgements

Financial support provided by Ministry of Interior (Grant No. 113-0805-02-28-01) and National Science and Technology Council (Grant No. NSTC 112-2410-H-015-002-MY2), Taiwan, R.O.C. We would like to thank two anonymous reviewers and the editor for their comments.

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