Indian Journal of Forensic Medicine and Pathology
Volume 14 Number 2, April - June 2021 (Special Issue)
DOI: http://dx.doi.org/10.21088/ijfmp.0974.3383.14221.52

REVIEW ARTICLE

Comparative Study on Touch DNA Extraction Method

Sudhanshu Sawhney[1],Kajol Bhati[2], Unnati Gupta[3], Priyanka Chhabra[4]

Authors' Affiliations:
[1,3]Student, [2,4]Assistant Professor, School of Basic and Applied Sciences, Galgotias University, Greater Noida 201310, Uttar Pradesh, India.

Corresponding Author:
Priyanka Chhabra, Assistant Professor, School of Basic and Applied Sciences, Galgotias University, Greater Noida 201310, Uttar Pradesh, India.

Email:
pcchabrah188@gmail.com

ABSTRACT

Touch DNA viz. trace DNA is a perfect example of Locard's exchange principle, formulating the basis of forensic science. It basically states that any contact between two objects exchanges a trace amount of matter. Touch DNA is attained from the shed skin cells whenever a person comes in contact or touches any object. This kind of DNA can be found in every sample of fingerprint but its extraction is a cumbersome task in consideration of its trace amount. There is diversity in methods of its extraction but the main problem arises when task is to preserve fingerprint and extract DNA as well. Scientifically, the evidentiary value of fingerprints is 100% and that of DNA is 99.9%. It becomes crucial to preserve both of them to strengthen our case. In this era of vicious and cunning criminals where evidences are obscured. The extraction of touch DNA is practical but not practiced. This study aims at comparing various methods and finding best one out. The most appropriate method should be able to analyze the smallest possible amount of DNA in an economic way and of course leaving the fingerprint indifferent.

KEYWORDS | touch dna, fingerprint, trace evidence, extraction

INTRODUCTION

Recovering DNA from a crime scene is the most imperative task of a forensic analyst as it can directly link a suspect, a victim and the crime scene. DNA can be found on anything in any form. For example in sexual assaults, it can be found on condoms, bedsheets, clothes, in bite marks and in saliva etc.[5] Similarly, when a person handles or grasps any substrate from his hands a kind of DNA known as 'Trace DNA' or 'Touch DNA' is conveyed to the surface of substrate from the uppermost (epidermal) skin.[3] This DNA is found in the shed skin cells and can be majorly found in the fingerprints. The prerequisite of this type of DNA analysis is just 7-8 cells from the uppermost layer of a person's skin. Touch DNA can act as a ubiquitous tool in forensics by increasing the conviction rates in cases of robbery, sexual assaults as the DNA have a validity of 100%. The nature of Touch DNA deposition is majorly hooked on nature of surface, pressure applied (in case of fingerprints) and nature of contact. Majorly two questions always arise if we talk about touch DNA: 1) which is the best method for extraction of touch DNA? (2) What would be the amount of extracted DNA? According to published research papers, extraction of Touch DNA from various objects such as glass, fiber, clothes, metallic objects etc., is an unwieldly task.[4] But various methods such as Double swab, Hydrogel method, FTA paper, Mini tapes and FDF kit resolve all of these questions. Therefore, the aim of our study is to compare all of the above-mentioned methods and find

How to cite this article
Sudhanshu Sawhney. Comparative Study on Touch DNA Extraction Method. Indian J Forensic Med Pathol. 2021;14(2 Special):374-378.

METHODS & MATERIALS

Fingerprint DNA Finder Kit

In Fingerprint DNA finder kit (FDF), two surfaces were taken to gauge its proficiency.

Self-Adhesive Security seal sticker - On an intermediary polypropylene film layer a fingerprint was taken by pressing any of the thumb or index, which consequently is treated with adhesive acrylate polymer and along these lines disguised with upper film or cover. Around 146 samples were taken.

Latent Fingerprint - Four distinctive samples of Bersa 9 mm pistol, and one Smith&Wesson 357 magnum revolver were taken. For DNA isolation, 30µL of lysis cushion was pipetted on glue layer of seal having unique finger impression or either on a q-tip with wooden shaft to detach the DNA from the weapons having inactive finger impression. Each section of gun and seal was swabbed gently to isolate copious amount of nucleated cells or DNA. The cotton swab was further kept in a 1.5 mL plastic tube having 50µL of lysis buffer. Then incubation was executed for lysis at 60˚C (thermomixer) and centrifuged for 3 hours at 600 rpm. After incubation, cotton swab relocated to spin basket and for 1 min it was centrifuged at its maximum speed. The consequential extracted liquid from swab was added to left over liquid from incubation and the final volume was 55-60 µL. The solution was shifted to Nexttec clean column to centrifuge at 750×g for 1 min after incubation at room temperature for about 3 mins. The final supernatant contained purified DNA and other cellular debris DNA quantitative analysis was performed by Applied Biosystems Quantifile Human DNA Quantification kit.[5]

Double Swab Method

The twofold swab strategy comprises of scouring one pre-wet swab with 150 µL of sterile water followed by a drying swab for around 10 sec. This procedure was performed on both the tape and paper side of each unique finger impression "sandwich", bringing about four complete q-tips per test. All swabs were put away in singular swab encloses and dried for the time being a laminar stream hood before being joined and set in microcentrifuge tubes. All examples taken from the glue side were set in a 1.5 mL microcentrifuge tube, while tests taken from the paper side of a similar unique finger impression were put in another 1.5 mL microcentrifuge cylinder to ensure that all examples were totally lowered in the arrangement. Four individual chronicled inert fingerprints treated with every one of the three perception therapies from each of the 10 volunteers were acquired. A set from every perception treatment was prepared utilizing DNA extraction strategies—phenol-chloroform natural extraction. All DNA extricates were put away at 40C until measurement and fixation.

Lysis of natural material with 400 µL of strain extraction cushion with 15 µL of proteinase K was performed. At that point hatching at 56 ˚C on a shaking stage with turning in turn bins at 7500g for 5 mins was finished. 500 µL of phenol: chloroform: isoamyl liquor was added and turned at 18400 g for 5 min. The fluid layer was then moved to a microcentrifuge tube, 500 µL of chloroform isoamyl liquor, vortexed, and turned at 18400g for 5 mins. The watery layer is then moved to a pre-immersed cellulose film and turned at 350g for 13 min Filtrate was disposed of and TE support was added to each channel unit and turned at 350g for 18 min. Channels are presently rearranged into a clean miniature centrifugation tube and turned at 950g for 5 min. Test cuttings are then moved to miniature centrifugation tubes for decontamination.[2,6]

FTA Paper

In FTA Paper method, de-ionized (4 drops) water were smeared on a 3.2 cm of Whatman WB120205 formerly sample collection. Afterward, FTA Paper were dehydrated for 1 hr in drying box. After the FTA paper was dried, it was divided into small pieces and were placed in withdrawal tube. For the extraction of DNA QIAGEN® QIAamp DNA Kit was used. In the extraction tube 50 µL of nucleated free water was added to open DNA. After the DNA got eluted Real-Time qPCR was used for its quantitative analysis.[4]

Hydrogel Method

The solution of Dextran-methacrylate and LAP (Lithium phenyl-2,4,6 trimethyl benzoyl phosphonate) was newly arranged. Borosilicate magnifying lens cover slips were initiated before functionalization utilizing a Harrick's plasma cleaner for 240 seconds. They were moved to a

vacuum chamber containing 100 µL of 3-(trichloro silyl)- propyl-methacrylate and left under unique vacuum for 4 hours to activate the surface at room temperature.

A newly arranged arrangement of Dextran-methacrylate (10% w/v) and LAP (1% w/v) was applied on surface and functionalised cover slip was placed on it. Then, the sample was irradiated for 30 sec using 405 nm laser pen, after which the cover slip was removed leaving behind cross linked polymer known as hydrogel. Hydrogel was transferred into a beaker with MeOH-sonicated for 30 mins and IS solution (10 µL) was mixed to it. Extracted solution was inverted into polypropylene conical tube and solution was evaporated under Nitrogen. Material is dissolved in MeOH with 5% v/v Formic acid (50 µl) and relocated into injection vial after which quantification and analysis was performed.[9]

Mini-Tape Method

Smaller than normal tapes comprise acetic acid derivation strip with a part of twofold sided cement toward one side and which is secured by paper. The scaled down tapes are provided in clean individual plastic screwcap vials. For inspecting, the small tape was eliminated from vial, the defensive strip eliminated and the glue surface squeezed more than once over the outside of the item. The smaller than usual tapes were supplanted promptly in their vial and put away at room temperature. Little tapes were divided to little pieces and set in 1.5 ml miniature axis tube, at that point 180 ml of ATL cradle was mixed, the example tube was then vortexed and brooded at 85˚C for 10 min. 20 ml of Proteinase K was mixed, vortexed and hatched at 56 ˚C for 1 h. 200 ml of pre-warmed AL support was added, vortexed and hatched at 560c for 10 min centrifuged for 10 sec at 14,000 rpm. 200 ml of ethanol was mixed, vortexed and centrifuged at 14,000 rpm for 10 s. Tests were painstakingly added to the sections in the assortment tubes and centrifuged at 8000 rpm for 1 min. The section was taken out; 500 ml of each AW1 and AW2 support was added and centrifuged at 8000 rpm and 14000 rpm for 1 min and 3 mins individually and the segment was taken out. 65 ml of pre-warmed water was mixed, brooded at room temperature for 5 min from pre-centrifugation at 8000 rpm for 1 min. The concentrate (last volume 65 ml) was put away at 4˚C for the measurement investigation.[10]

Different techniques have different outcomes, depending upon various factors, such as surface (porous or non-porous), individual handler, activity before handling the surface, chemical composition of surface, time of recovery- sooner collection would prevent contamination of touch DNA but however, environmental factors the recovered quantity is independent of handling time.[8]

There were completely different results for swab method in two comparative study viz. FTA versus Double swab and mini tape versus double swab. When FTA Paper card was evaluated against double swab it gave significantly higher results as of chemical composition and better area of FTA Paper card. The chemical composition permits greater preservation and releases significant amount of DNA while on the opposite hand cotton swab traps DNA in its own fibres and this method is also time taking due to smaller area of cotton swabs. But the FTA papers didn't dry as fast because the cotton swab did, so there's requirement of drying procedure before the transportation and packaging. thanks to less sturdy matrix and rigorous applying of water on extraction from rough surfaces, there was loss of paper fibres on the surface itself.[4]

In tape lift method notably more DNA quantity was extracted on using scene safe fast mini tape on cloth material like cotton, but on flannelette material double swab method gave more prominent and better results. The potential reason of this outcome could be the presence of loose fibres on flannelette which either mask the cells underneath it or reduce adhesion of tape after contact. the main drawback of the tape lifting method might be when there's line increase in adhesion, the extraction of DNA could suffer in a huge amount. Another factor possibly implying on collection efficiency of the tape is pressure, however more research is required during this area for providing accurate results.[10,4]

The double swab method systemizes the methodology of cleaning in any case it's a troublesome errand to normalize the amount a swab should be soaked. Also, because it uses two

swabs at one surface it enhances extraction of DNA amount during a generous way. For poor absorbent surfaces, if we continue using one swab only it's going to result into a extended period of your time for drying off of the surface. this example is often avoided if we tend to use two swabs, the dry swab absorbs all the moisture left behind by the primary swab. Moreover, larger the world of interest or greater the absorbance of the surface, the need of additional swabs increases.[6]

This requirement is often fulfilled by using FDF kit which indeed may be a fast and one step protocol combining with the compelling expulsion of PCR inhibitors with suitable yield of DNA. LCN- Low Copy Number, is a section that consists 100 Pg of template DNA. Some samples fall under the category of LCN but most of them shouldn't be considered LCN because it may be an aftereffect of huge variety inside the measure of DNA in examples. With respect to utilize the DNA profiles acquired from the fingerprints kept on the Fingerprint Sticker, the outcomes exhibit the plausibility of utilizing this sort of tests as a DNA source to build data sets. The tactic facilitates various advantages like using of non-invasive sampling, no biological hazard, easy and enormous amount in single, transportation avoiding bacterial contamination as stored in dry condition in contradiction to the swab which require additional drying process etc. The upside of this framework is also that an identical weapon is frequently utilized both for finger impression and for DNA investigation, permitting the two kinds of proof to be acquired from a comparable firearm, yet these necessities cautious taking care of at the crime location and afterward.[5]

Now the comparison involves swab method and hydrogel which yielded 20%- 60% DNA of the amount extracted from swab method. Albeit this is regularly altogether not exactly the swab, still hydrogels go about as an expansion to the current work process, as DNA may be recuperated from fingerprints while enough material is abandoned as an expansion to the current work process, as DNA may be recuperated from fingerprints while enough material has been abandoned for unique mark representation. The greater assortment in DNA yielded by the hydrogels is probably on account of the extra strides inside the example planning, particularly the exchange of the lifted hydrogel to an aliquot, showing that further advancement of the example arrangement is significant. There is no single DNA extraction strategy that has been improved affected by representation treatment (shown in table.1). Hence, given the different testing ascribes identified with contact DNA and documented inert fingerprints explicitly, it is suggested that a post-extraction filtration/fixation step be thought of if tests are prepared utilizing protein-based freedom examines.[9,6]

RESULT & DISCUSSION

The success rate of touch DNA is limited even after so much advancements in technology. The potential reason tends to be the lack of research, knowledge and curiosity about it. The above-mentioned techniques throw a light on the legit techniques which can be further more improved and can deliver unbelievable results. The work here in reported should encourage laboratories and investigators to consider pursuing DNA analysis from archived latent fingerprints, particularly if they are the only potential source of physical or biological evidence available. It shows that DNA can be extracted from latent fingerprints for DNA

Method	Surface	DNA Extracted D(NG)	Mean Percentage Yielded	Fingerprint Extraction	Sample Size	Reference
Hydrogel	Glass	5.9	20%–60%	Possible	3	9
FDF	Gun	2.9	40%	Maybe possible	35	4
FTA	Steering wheel	1.89-7.89	91%	Not possible	3	9
Minitapes	Cotton cloth	0.69-7.8	0%–50%	Possible	28	10
Double Swab	Glass	0.65-5.2	75%	Not possible	100	2
	Steering wheel	0.62-5.33	25%–75%	Not possible	35	4
Hydrogel	Flannellette	0.8-1.8	20%–40%	Not Possible	28	10

Table 1 Organic Comparative study results of different methods that applied on different surfaces.

profiling although it should be considered that the work flow of this procedure might vary depending on the substrate on which the prints are present.

CONCLUSION

The various techniques are suitable for different type of substrate and unfortunately, there is not a single technique that can work as an all-rounder. So, the detailed knowledge of various substrate must be gained before touching any evidence. An important thing to be considered is that the fingerprint and DNA both are the confirmatory evidence and none of them deserves to be ignored in court of law, therefore a technique must be employed in which fingerprint as well as DNA both can be prevailed. However, in case of smudged prints, the highlight can be the Touch DNA. This leads us to the point where DNA extraction procedures must be devised for even treated fingerprints and even progress must be made in fingerprint visualisation techniques so that they do not interfere with the DNA profiling. The motive of this work is to motivate and enlighten forensic scientists and laboratories to treat Touch DNA just not as an option or choice but as a notion that has capability to change the vision. IJFMP

REFERENCES

1. **Bhoelai B, Beemster F, Sijen T.** *Revision of the tape used in a tape-lift protocol for DNA recovery. Forensic Sci Int Genet Suppl Ser. 2013;4(1):e270-e271.*
2. **Daly DJ, Murphy C, McDermott SD.** *The transfer of touch DNA from hands to glass, fabric and wood. Forensic Sci Int Genet. 2012;6(1):41-46.*
3. **Hess S, Haas C.** *Recovery of trace DNA on clothing: A comparison of mini-tape lifting and three other forensic evidence collection techniques. J Forensic Sci. 2017;62(1):187-191.*
4. **Kirgiz IA, Calloway C.** *Increased recovery of touch DNA evidence using FTA paper compared to conventional collection methods. J Forensic Leg Med. 2017;47:9-15.*
5. **Kopka J, Leder M, Jaureguiberry SM, Brem G, Boselli GO.** *New optimized DNA extraction protocol for fingerprints deposited on a special self-adhesive security seal and other latent samples used for human identification: New optimized DNA extraction protocol. J Forensic Sci. 2011;56(5):1235-1240.*
6. **Pang BCM, Cheung BKK.** *Double swab technique for collecting touched evidence. Leg Med (Tokyo). 2007;9(4):181-184.*
7. **Solomon AD, Hytinen ME, McClain AM, Miller MT, Dawson Cruz T.** *An optimized DNA analysis workflow for the sampling, extraction, and concentration of DNA obtained from archived latent fingerprints. J Forensic Sci. 2018;63(1):47-57.*
8. **Tang J, Ostrander J, Wickenheiser R, Hall A.** *Touch DNA in forensic science: The use of laboratory-created eccrine fingerprints to quantify DNA loss. Forensic Sci Int. 2020;2:1-16.*
9. **Helmond W, V O 'brien, Jong R, Esch J, S O, Puit M.** *Collection of amino acids and DNA from fingerprints using hydrogels. Analyst. 2018;143(4).*
10. **10.Verdon TJ, Mitchell RJ,** *van Oorschot RAH. Evaluation of tapelifting as a collection method for touch DNA. Forensic Sci Int Genet. 2014;8(1):179-186.*
11. **Schiffner LA, Bajda EJ, Prinz M, Sebestyen J, Shaler R, Caragine TA.** *Optimization of a simple, automatable extraction method to recover sufficient DNA from low copy number DNA samples for generation of short tandem repeat profiles. Croat Med J. 2005;46(4):578-586.*
12. **Lowe A, Murray C, Richardson P, et al.** *Use of low copy number DNA in forensic inference. Int Congr Ser. 2003;1239:799-801.*
13. **Bruin KG, Verheij SM, Veenhoven M, Sijen T.** *Comparison of stubbing and the double swab method for collecting offender epithelial material from a victim's skin. Forensic science international: Genetics. 2012;6(2):219–223.*
14. **Kanokwongnuwut P, Kirkbride P, Linacre A.** *Visualising latent DNA on swabs. Forensic Sci Int. 2018;291:115-123.*
15. **Plaza DT, Mealy JL, Lane JN, Parsons MN, Bathrick AS, Slack DP.** *Nondestructive biological evidence collection with alternative swabs and adhesive lifters. J Forensic Sci. 2016;61(2):485-488.*
16. **Wickenheiser RA.** *Trace DNA: a review, discussion of theory, and application of the transfer of trace quantities of DNA through skin contact. J Forensic Sci. 2002;47(3):442-450.*
17. **Verdon TJ, Mitchell RJ, van Oorschot RAH.** *Evaluating the efficiency of DNA extraction methods from different substrates. Forensic Sci Int Genet Suppl Ser. 2011;3(1):e93-e94.*
18. **Chow JFC, Yeung WSB, Lee VCY, Lau EYL, Ng EHY.** ** PGT-SR using NGS and haplotype analysis with microsatellite markers to distinguish normal from balanced Robertsonian translocation carrier embryo. Reprod Biomed Online. 2019;38:e21-e22.*
19. **Phipps M, Petricevic S.** *The tendency of individuals to transfer DNA to handled items. Forensic Sci Int. 2007;168(2-3):162-168.*
20. **Thamnurak C, Bunakkharasawat W, Riengrojpitak S, Panvisavas N.** *DNA typing from fluorescent powder dusted latent fingerprints. Forensic Sci Int Genet Suppl Ser. 2011;3(1):e524-e525.*
21. **Schulz MM, Reichert W.** *Archived or directly swabbed latent fingerprints as a DNA source for STR typing. Forensic Sci Int. 2002;127(1-2):128-130.*
22. **Kamphausen T, Fandel SB, Gutmann JS, Bajanowski T, Poetsch M.** *Everything clean? Transfer of DNA traces between textiles in the washtub. Int J Legal Med. 2015;129(4):709-714.*
23. **Gunnarsson J, Eriksson H, Ansell R.** *Success rate of a forensic tape-lift method for DNA recovery. Problems of Forensic Sciences. 2010;83:243–254.*
24. **Sweet D, Lorente M, Lorente JA, Valenzuela A, Villanueva E.** *An improved method to recover saliva from human skin: the double swab technique. J Forensic Sci. 1997;42(2):320-322.*
25. **Van Oorschot RAH, Weston RK, Jones MK.** *Retrieval of DNA from touched objects. 1998.*
26. **Milne E, van Bockxmeer FM, Robertson L, et al.** *Buccal DNA collection: comparison of buccal swabs with FTA cards. Cancer Epidemiol Biomarkers Prev. 2006;15(4):816-819.*
27. **Poy AL, Oorschot RA.** *Trace DNA presence, origin, and transfer within a forensic biology laboratory and its potential effect on casework. Journal of Forensic Identification. 2006;56(4):558.*
28. **Ladd C, Adamowicz MS, Bourke MT, et al.** *A systematic analysis of secondary DNA transfer. J Forensic Sci. 1999;44(6):1270-1272.*
29. **Lowe A, Murray C, Whitaker J, Tully G, Gill P.** *The propensity of individuals to deposit DNA and secondary transfer of low level DNA from individuals to inert surfaces. Forensic Sci Int. 2002;129(1):25-34*

