

Ear Prints in Forensic Science: A Unique Tool for Criminal Identification

¹Maryam Qidwai*, ²Rakesh Mia, ³Piyush Kant Mishra

¹Forensic science student, Integral University, Lucknow, Uttar Pradesh, ²President, Applied Forensic Research Science, Indore, Madhya Pradesh, ³Forensic Science student, Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore, Madhya Pradesh

How to cite this article: Maryam Qidwai, Rakesh Mia, Piyush Kant Mishra. Ear Prints in Forensic Science: A Unique Tool for Criminal Identification. Medico-Legal Update / Vol 25 No. 4, October - December 2025

Abstract

This article focuses on the importance of ear prints in forensic science and how it has proved to be an invaluable tool in criminal investigation over time. Ear print analysis is an emerging forensic technique for criminal identification, leveraging unique two-dimensional ear impressions found at crime scenes. Similar to fingerprints, ear prints are distinct biometric identifiers, potentially more resistant to manipulation. Their individuality stems from complex ear morphology, including features like the helix and earlobe. Collected via methods akin to fingerprinting, analysis involves superposition and digital comparison. While useful for suspect identification and height estimation, ear prints face challenges in court admissibility due to reproducibility issues, subjective analysis, and lack of standardized protocols. Ongoing research aims to enhance their reliability and acceptance as a valuable corroborative tool in forensic investigations, necessitating further validation for broader legal use.

Introduction

As forensic science develops further, new techniques for criminal identification are introduced. Ear print analysis is one such technique that has received attention as a possible forensic tool for identifying suspects at crime scenes. An exact replica two-dimensional model of the ear that has been in contact with a particular surface is called an ear print, and most of the time, offenders leave their ear prints at the scene of the crime¹.

Forensic identification in many criminal instances is accomplished using ear print analysis. Because they share characteristics, researchers have based their studies on ear print analysis in a manner similar to fingerprint analysis. The techniques used to secure

ear prints may not differ significantly from those used to lift fingerprints because, for example, both fingerprints and ear prints are obtained from crime scenes and subsequently compared to a database of prints taken from suspects in the crime. Criminals can easily manipulate the fingerprints of innocent individuals, but they may not be able to do the same with ear prints. As a result, ear prints play a larger part in prosecuting offenders, and their presence at crime scenes needs to be made widely known to obtain just convictions and bring about justice. Comparable to fingerprints, each person's ear print is distinct and can be utilised as biometric proof. Ear prints are a powerful but underutilised method of forensic identification since they are more difficult to alter than fingerprints².

Ear Morphology

The ear has a unique anatomical layout.

- Outer rim, helix and earlobe are mainly responsible for the external ear morphology. There is also an inner helix, often known as an antihelix, that generally aligns parallel to the outer helix but splits into two distinct branches at the top.
- The concha, which gets its name from its shell-like appearance, has superior and lateral aspects made up of the inner helix and the inferior branch of these two branches. Anatomically, the lower portion of the concha joins the easily identifiable intertragal notch. It's also critical to pay attention to the helix's crus, or the intersection of the helix with the lower branch of the antihelix.
- When an ear is rubbed against a surface, the crux of the helix dependably leaves an impression despite its varied morphologies. The anatomical characteristic that dictates the external ear's shape is the helix rim. There is much variation in the rim's morphology. Each person has a different starting or ending point for unwinding. An important factor in the identification process is the helix rim's inside edges.
- Helix, antihelix, tragus, and antitragus imprints are frequently seen in ear prints. The latter two substances could appear as separate patches or as an expansion of the intertragal notch shape.

The external ear's uniqueness is responsible for individualisation. Developments in forensic science have made it possible to use morphological characteristics and prints of various body parts to determine a person's identification³.

Several morphological characteristics are studied and taken into consideration while examining an ear print. Different types and shapes have been studied along with variations in helix, shape, size, form of the earlobe, Darwin's tubercles, etc.

- **Helix & Antihelix:** The curved ridges of the outer ear.
- **Lobule (Earlobe):** Shape (attached or free) varies among individuals.
- **Tragus & Antitragus:** Small cartilage projections near the ear canal.
- **Concha:** The hollow near the ear opening.
- **Scars, Deformities, or Piercings:** Unique identifying marks.
- **Ear Shapes:**
 - Oval type: The print's width, measured at tragus level, is less than half ear length, and its side margins are rounded. As it happens, it is the most common form type.
 - Circular type: Edges of the prints are rounded. At tragus level, the impression's width is greater than half of its length.
 - Triangular type: It shows the larger helix of the triangular edge of the impression.
 - Rectangular type: has a pointed helix with a relatively rectangular border.
- **Ear Lobes:**
 - Joined (Attached) earlobe: The Earlobe is jointed at the side of the skull.
 - Detached (Free) earlobe: Below the attachment point, the earlobe is free to hang. Partially attached earlobe: The earlobe is neither fully fused to the cheek nor completely free hanging⁴.

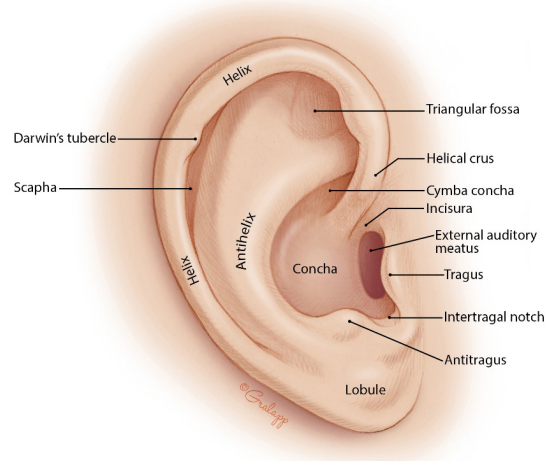


Fig. Morphology of Human Ear⁵

Ear Print and It's Presence on Crime Scene

When ear secretions come into touch with surfaces like walls or glass, a latent ear print is formed. Wax, desquamation, and hormones are among the factors that regulate the secretions. A clear latent ear print may develop when several secretions are present. The regions which are most prominently present on the ear print are tragus, antitragus, helix, and antihelix.

The most frequent explanation for why ear prints are left is straightforward; when a burglar is about to break into a home, they press their ear against the door to make sure no one is there and leave their mark. The degree of skin greasiness, whether the face or hair was applied to the same spot, or even the volume of sound they were trying to hear, can condition the fragmentations, markings and distinct patterns present on the prints. Also, during a fight or struggle, if one person presses the face of the opponent on the wall, an ear print can be formed⁶.

On a crime scene, ear prints can be found on windows, doors, or windowpanes of a car, etc.

Factors which affect ear print pattern are as follows:

- A whole or fragmented impression could result from the pressure used when contacting the surface.
- The length of time spent listening, smudging from the ear moving across the surface, is more likely the longer he or she listens. This can cause the print to become obscure, making recognition a challenge.
- The quality of the listening surface, compared to uneven surfaces, smooth surfaces give a better impression.
- Print may also be influenced by the temperature, since high temperatures cause the ear's natural oil to be secreted.
- If the individual has any abnormalities in their ear.
- Ear piercings and an abundance of earrings may also affect how the pattern develops.

- A fingerprint, palm print, or other secondary print superimposed on top of another print may cause some degree of print degradation.
- Weathering may also occur between the event and the discovery of the print.
- The lifting procedure might destroy or disturb the ear print if appropriate techniques are not applied to lift it.

Collection of Ear Print

The basic process for gathering ear prints is the same as that for gathering fingerprints. It visualises prints using either;

- Physical (powder method using different coloured powders, etc.)
- Chemical methods (cyanoacrylate fuming method, ninhydrin method, iodine fuming method etc.)
- Other techniques include capturing a thermogram image of the ear, putting the ears on a flat glass to collect standards, and snapping photos.
- For casting of ear prints, dental detax resins, procedures involve using resin that solidifies after a cotton plug is inserted to create three-dimensional ear characteristics, can be used to obtain samples from an individual.

Different lifting methods include silicone-based gelatin lifters, adhesive tapes, latex or rubber lifters, etc⁷.

Analysis of Ear Prints

Once the development and lifting of the print is accomplished, it is followed by analysis and comparison of the print with different known samples.

Analysis is done on the principle of individualising and matching the unknown sample with known sample.

Three general techniques have historically been employed for print comparison

- Dissection, which involves splitting the print into sections and switching them to check for coincidences and superpositions.
- The known sample and suspected sample are compared consecutively.
- Superposition, which involves superimposing one print over another with transparencies and comparing them.

Ear print identification is done in several steps, including group identification exams, contour method, methods of common traits, and assessment of supporting and contrasting evidence. Numerous factors can influence how closely an ear print resembles the genuine ear. Depending on the amount of pressure applied, both the size and the distances between the various points of reference can change. The print collecting and analysis techniques are intended to try to address these issues⁸.

Maat suggested a quantitative categorisation approach based on a polar axis that is developed or drawn using a vertical line that is the tangent shared by the tip of the tragus and the internal margin of the imprint of the antero-superior curve of the helix. For this reason, Ingleby uses a computer to compute it using “centroids” (centres of intensity).

Digital techniques are being developed for the ear print analysis, one such technique is “Forensic Identification (FearID)”. It is a study project developed to check the credibility of the ear print found at the crime scene. This study is being conducted in the European Union. Additionally, it is working on creating an international database of ear prints.

The analysis of the length and breadth of the ear can be used for evaluation. Some scholars, however, because they have characteristics in common with the majority of people, these characteristics are referred to as class characteristics rather than individual characteristics. Some studies believe that physical deformities from accidents or diseases, birthmarks, scars, etc., can be used to determine an individual’s level of uniqueness⁹.

Significance of Ear Print in Forensic Science

- According to reports, with some adjustments, the ear print can be used to estimate the suspect’s height based on the floor-to-print distance.
- It can be useful for determining the presence of a person at the crime scene.
- Identifying an individual from ear print can be a challenging task.
- It is possible to identify a mobile phone user by their ear print.
- It has also been concluded in some studies that face recreation can be possible if size and form ear is known.
- Additionally, it can be utilised to compare with the database in cases where there are no suspects¹⁰.

Validity of Ear Print in Court as Evidence

The ability to identify a specific ear print as belonging to a specific subject is the foundation of the forensic validity of the print. This can be used to exclude a subject as a suspect, strengthen the evidence against a certain suspect, or even look for suspects in databases in the future if none exist.

Its widespread use in the community or in other courts, articles and publications, and the testimony of those who affirm it are all examples of general acceptance. There cannot be widespread acceptance if there is significant dispute among informed experts about the validity of the scientific evidence. It can only act as a piece of corroborative evidence which supports other evidence.

Ear prints are becoming more and more acknowledged as a possible forensic identifying tool, although their legality as a stand-alone identification technique is still up for question. These problems are made worse by the subjectivity of the analysis, the lack of defined protocols, and the possibility of print variability brought on by pressure and other variables¹¹.

Limitations of Ear Print

- There are issues with reproducibility and dependability because ear print analysis is primarily subjective, and lacks established scientific procedures.
- Since a single ear can create several prints depending on the angle, pressure, and surface texture, direct comparison is challenging.
- Ear print analysis is frequently utilised in conjunction with other forms of evidence, such as DNA or other biometric data, rather than by itself for identification.
- The broad adoption of ear prints as a trustworthy forensic identification technique is not supported by thorough and consistent scientific study.
- It is typically positioned in easily accessible public spaces that can be significantly disrupted by the presence of other prints.
- The inability to ascertain the imprinting time could lead to innocent people being mistaken at the scene of the crime.
- Whether two different ears could leave the same or a similar print is another question, or if there is enough inter-individual variability to be able to tell two distinct ears apart in any circumstance.
- A print in the database may eventually lose its ability to be recognised as a legitimate match for a variety of reasons over a period.
- It is also essential to note that as years pass, the morphology of the ear of a person changes, which will ultimately result in an inability to identify the individual¹².

Advances in Ear Print Analysis

- Biometric ear print has distinct personal traits that can be utilised for identification, much like fingerprints.
- It is possible to identify suspects or rule them out of the inquiry by comparing databases of

known ear prints with latent ear prints, which are imprints left on surfaces.

- Research projects like the EU-funded Forensic Ear Identification (FearID) project are building extensive databases for ear print analysis.
- To increase the precision and effectiveness of ear print analysis, methods such as thermal image analysis and real-time picture analysis from CCTV are being employed.
- According to studies, male and female ear morphology might differ, which could help with sex identification in forensic situations.
- In cases of mass disasters or when remains are seriously injured, ear prints can be used to identify people.
- To improve identification even more, researchers are looking at the possibility of removing DNA from ear prints.
- The process of comparing ear prints is being automated using techniques like those created in the FearID project, which increases accuracy and efficiency¹³.

Conclusion

Compared to other methods like fingerprints and DNA, ear print evidence is still regarded as a relatively recent identification technique. Its potential seems not fully realised yet. Its scope is likewise constrained because it appears that the problem is only addressed in a small number of circumstances. The main question is whether ear print evidence is a valid and trustworthy means of identification.

To improve the precision and dependability of ear print evidence, more study in this field is required, as well as an adaptation of existing methods. If this were possible, ear print evidence would be readily admitted by the courts and might be a potent instrument for convicting criminals.

Ear print analysis has emerged as a useful forensic method for suspect identification, especially in investigations into violent crimes and burglaries. There are still issues with its admissibility and

dependability despite its benefits, which include resistance to forgery and distinctive biometric features.

To improve the legitimacy and acceptability of ear print evidence in court going ahead, additional research, standardised processes, and expert training are necessary. In the event that these advancements occur, forensic investigations may find ear print analysis to be a useful adjunct tool that facilitates the pursuit of justice.

Source of Funding: This work did not receive any specific grant from funding agencies in the public, commercial or non-profit sectors.

Conflict of Interest: The author declares no conflict of interest related to the content or authorship of this manuscript.

Ethical Considerations: This article is based solely on previously published research papers and extensive literature review. It does not involve any studies with human or animal subjects performed by the authors. Hence, ethical approval was not required.

References

1. Rani D, Krishan K, Sahani R, Shrestha R, Kanchan T. Characteristic features of Ear and Ear-Prints in Forensic identification. *Journal of Craniofacial Surgery* [Internet]. 2021 Aug 3;33(4):1093–8. Available from: <https://doi.org/10.1097/scs.00000000000008056>
2. Sapkotamegha. Ear pattern analysis in forensic investigation [Internet]. *Legal Desire Media and Insights*. 2020. Available from: <https://legaldesire.com/ear-pattern-analysis-in-forensic-investigation/>
3. Rani D, Krishan K, Kanchan T. Association among the morphological characteristics of the human ear - An approach towards forensic identification. *Forensic Science International Reports* [Internet]. 2022 Oct 25;6:100295. Available from: <https://doi.org/10.1016/j.fsir.2022.100295>
4. Moolla Y, De Kock A, Mabuza-Hocquet G, Ntshangase CS, Nelufule N, Khanyile P. Biometric recognition of infants using fingerprint, iris, and ear biometrics. *IEEE Access*. 2021;9:38269–86. doi:10.1109/ACCESS.2021.3062282.
5. Stocker S. External ear [Internet]. *Oto Surgery Atlas*. Available from: <https://otosurgeryatlas.stanford.edu/otologic-surgery-atlas/surgical-anatomy-of-the-ear/external-ear/>
6. Manikam V, Rajamanickam R, Dahlan NK, Dahlan NK. Importance and Reliability of ear print Analysis as evidence. *Journal of Posthumanism* [Internet]. 2025 Apr 9;5(3). Available from: <https://doi.org/10.63332/joph.v5i3.736>
7. Krishan K, Kanchan T, Thakur S. A study of morphological variations of the human ear for its applications in personal identification. *Egyptian Journal of Forensic Sciences* [Internet]. 2019 Jan 24;9(1). Available from: <https://doi.org/10.1186/s41935-019-0111-0>
8. Khalid NM, Ali NS, Shah NW, Akbar NF, Israr NM, Asadullah N, et al. Study of Morphological Variations of The Human Ear for its Applications in Personal Identification. *Indus Journal of Bioscience Research* [Internet]. 2025 May 16;3(5):396–406. Available from: <https://doi.org/10.70749/ijbr.v3i5.1340>
9. Nagrale NK, Nagrale V. Progress and challenges in ear biometrics for secure identification. *Authorea (Authorea)* [Internet]. 2025 Apr 15; Available from: <https://doi.org/10.22541/au.174471555.52636866/v1>
10. Sowmya MV, Mehrotra D, Mohammad S, Singh RK, Tiwari AK, Katrolia R, et al. 3D assessment of ear morphology. *Journal of Oral Biology and Craniofacial Research* [Internet]. 2023 Aug 4;13(5):622–9. Available from: <https://doi.org/10.1016/j.jobcr.2023.08.001>
11. Lähde S, Hirsi Y, Salmi M, Mäkitie A, Sinkkonen ST. Integration of 3D-printed middle ear models and middle ear prostheses in otosurgical training. *BMC Medical Education* [Internet]. 2024 Apr 24;24(1). Available from: <https://doi.org/10.1186/s12909-024-05436-9>
12. Oyebiyi OG, Abayomi-Alli A, Arogundade O 'Tale, Qazi A, Imoize AL, Awotunde JB. A Systematic literature review on Human ear biometrics: Approaches, Algorithms, and trend in the last decade. *Information* [Internet]. 2023 Mar 17;14(3):192. Available from: <https://doi.org/10.3390/info14030192>
13. Chhikara K, Saini V. Ear biometrics and morphological variation in diverse population of world. *Journal of Indian Academy of Forensic Medicine* [Internet]. 2023 Dec 1;45(4):428–33. Available from: <https://doi.org/10.48165/jiafm.2023.45.4.29>