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Ali Abbas[1] *and Guy N. Rutty,*[2] *M.D.*

Ear Piercing Affects Earprints: The Role of Ear Piercing in Human Identification*

ABSTRACT: Previous research conducted into the use of the human ear in the field of forensic identification has focused upon the use of grids and manual methods to measure and catalogue the different anatomical features of the ear. To date, few have considered the importance of the presence of ear piercings and their possible role in human identification. This study aims to highlight the common distribution of piercings of both ears in both genders and to explore the effect of piercings on earprints. The presence of a piercing may, in part, help to explain why partial and not whole earprints are sometimes recovered from a scene of crime (suggesting that the offender's ears may be pierced). The presence of piercings through the tragus and the superior part of the helix are shown to be infrequent and thus may be used to assist the identification of a body, due to its relative rarity with respect to piercings found in other areas of the ear.

KEYWORDS: forensic science, ear piercing, earprint, human identification

Body art or modification has been practiced for millennia. Examples of ear piercings can be found throughout the history of man, with earrings being found in Sumerian burials dating from 2500 BC (1). It can be considered temporary, such as mehndi; semi-permanent, such as body piercing; or permanent, such as tattooing. Body piercing is a general term that refers to a semi-permanent opening in the skin or mucosal surface through which an object, such as jewelry, is inserted. Ear piercing remains the most common form of body piercing practiced today and can be classified as lobar or non-lobar (2). The art of ear piercing has been practiced for thousands of years, with earrings being used for many purposes, for example, as a right of passage, as a way of expressing an individual's origin, or as a mark of social standing within a group. They can be found within both genders and at all ages, from infants to elders, although issues related to practice, consent, and legislation have been raised in relation to piercings in childhood (3).

The ear has been used as a tool for human identification since the late 19th century when Alphonse Bertilloni utilized the ear as one of eleven anthropometric measurements for his manual system of identifying individuals (4). However, after the advent of the worldwide adoption of fingerprinting, the use of ear images for human identification was almost lost, until it was revisited in the mid-1900s by Iannarelli (5). In recent years, interest in the ear as a tool for human identification through earprints, also known as "earology", has gained a resurgence, although the use of earprints within the court systems has been dogged with controversy (6–9).

To date, few, if any, have considered the potential role of ear piercing in human identification, despite the fact that they can be observed in the living and the dead, and when considering the latter, even in a decomposed or mummified body (Fig. 1) (10). This paper outlines the findings of a study considering the placement of ear piercing and how this could be used in the identification of the living or the dead. The recording of atypical sites of ear piercings and the use in identifying a body is illustrated through a single case report. We also present the effect of ear piercing on earprints, showing how the print is altered by the presence of jewelry within the piercing and how the position of a piercing may be determined from the print.

Materials and Methods

A review of electronic, international library-based medical (including forensic) literature databases for previously published methods of identification of individuals from their ear piercings was undertaken. It was identified that there are few papers reporting the prevalence of ear piercing within the world community (population, sub-culture, age, gender, or ethnic specific studies), with no previously published papers purely addressing the use of ear piercing as a tool for identification (living or dead, images or prints) (11,12).

Having undertaken this review, ethical permission was granted to seek volunteers from the university, hospital, and community populations of Leicester, United Kingdom (UK) to have both of their ears photographed and printed to assess the distribution of ear piercings and the effect of ear piercings on earprints. Only adults were recruited for this study.

Method 1

A standardized image capture system was designed and used to record digital photographic images of the right and left ear of each volunteer. The apparatus consisted of a piece of Perspex placed at a

[1] Undergraduate Student, Forensic Pathology Unit, University of Leicester, Robert Kilpatrick Building, Leicester Royal Infirmary, PO Box 65, Leicester, LE2 7LX.

[2] Professor of Forensic Pathology and Head of Academic Unit, Forensic Pathology Unit, University of Leicester, Robert Kilpatrick Building, Leicester Royal Infirmary, PO Box 65, Leicester, LE2 7LX.

* Our preliminary data related to computerization of ear image and earprint identification, including the use of ear piercings, were presented as a poster at the Pathological Society of Great Britain and Ireland Summer Meeting, Bristol, United Kingdom, July 2003 as well as The Academy of Forensic Sciences Meeting, Dallas, TX, February 2004. This has also been presented within an invited lecture concerning the role of the ear in forensic investigations presented to the Fingerprint Society, United Kingdom, March 2004.

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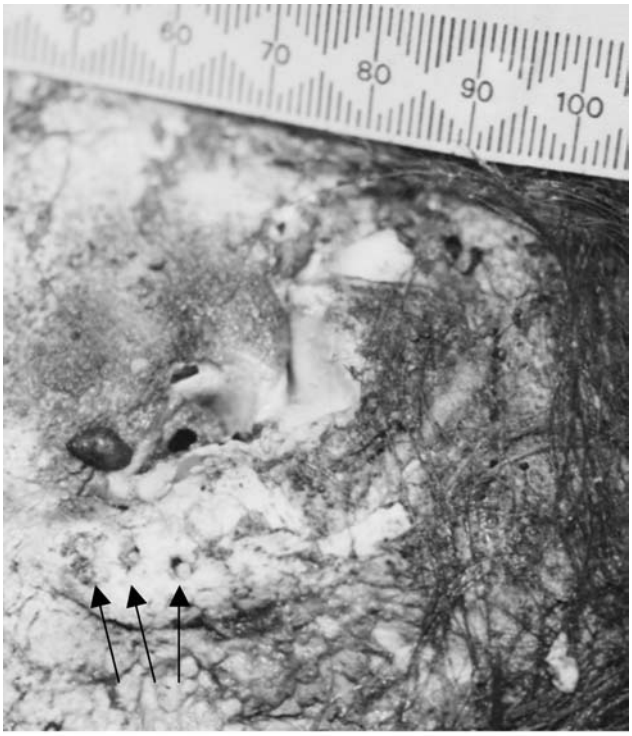
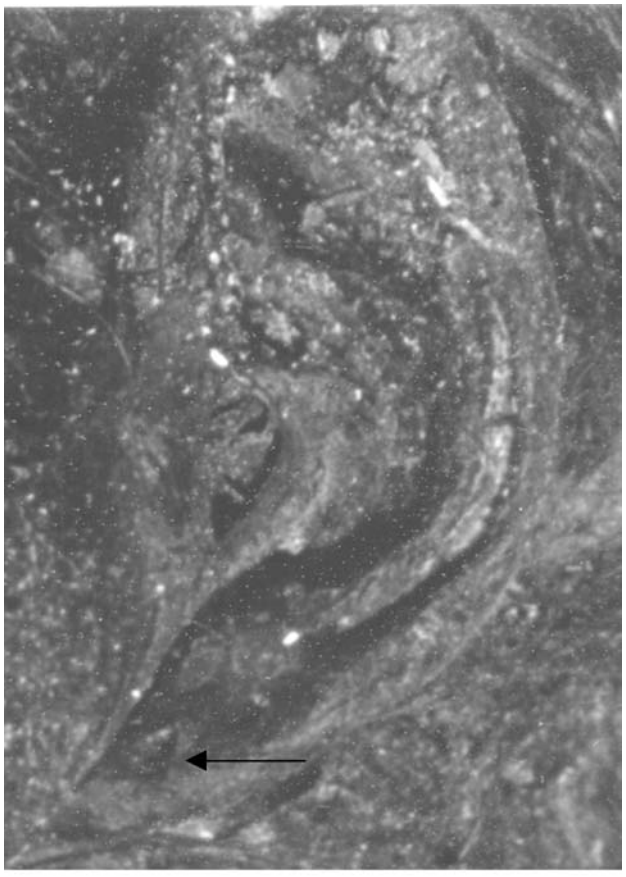


(a)



(b)

FIG. 1—*A decomposed dismembered adult female head with adipocere formation showing three ear piercings to left lobe (arrows) (a) and a mummified ear of predominately skeletalized adult male remains showing a piercing to the lobe of the left ear (arrow) (b).*

fixed distance from a rectangular metal plate using two steel rods. A right-angled scale was present on the Perspex. The metal plate was fixed onto a camera stand, and a Nikon Coolpix 4500 digital camera (Nikon, UK) was mounted onto the stand. This ensured that the piece of Perspex remained at a fixed distance from the camera with all images taken at the same focal length (Fig. 2).

Each volunteer was seated so that his or her profile was to the camera. The height of the apparatus was adjusted to match the sitting height of each volunteer, thus ensuring that their ear lay within the boundaries of the scale on the piece of Perspex. Volunteers were then asked to lightly press the right ear onto the Perspex before it was photographed. The same process was repeated for the left ear. All images were allocated a unique number prior to being downloaded directly from the camera onto a computer database.

It has been shown that when a criminal listens at a window or door prior to entering a property, if the ear makes contact with the surface, it may leave a print, and, through the process of transference, possibly offender DNA (9). Thus, by trying to replicate this, it then allows one to draw comparisons between an ear photograph and its corresponding earprint. A degree of compression of the ear against a surface must occur, to some degree, to leave a print in the first place. Although it could be argued that compressing the ear onto the Perspex deformed its natural shape, this method was selected to simulate the way in which earprints are left on a surface at a crime scene and is a published method for the acquisition of earprints from research volunteers (7). Research groups often refer to the pressure used to leave a print by volunteers by using the subjective terms "soft" or "hard" pressure (7). The method used to acquire the ear images could be classified as "soft" pressure, although as with previous studies the pressure applied was not specifically quantified.

This study considered the anatomical placement of the piercing(s) using pictorial mapping rather than any quantitative measurement technique. Thus, although pressure distortion would affect quantitative measurements, anatomical descriptions, as would be used in practical living patient or cadavic examinations, were considered not to be affected by the use of the method described.

Method 2

A thin plastic sheet of cobex (K9 Forensic Service Ltd™, UK), measuring 4 in. × 6 in. and designed for capturing prints, was marked with the same unique number that corresponded to the number of the ear photograph. The sheet was placed on the palm of the investigator's hand and pressed onto the volunteer's right ear to capture an impression. Pressure was applied in a single upward motion that began by pressing the piece of cobex onto the lobe and ended with printing the helix of each ear. Each sheet was dusted using fingerprinting powder (K9 Forensic Service Ltd™, UK) to reveal the earprint, which was fixed using lifting tape (K9 Forensic Service Ltd™, UK) to prevent it from being damaged or altered. This method of print acquisition was selected following consultation with the local police force, which uses this method for the acquisition of earprints from suspects of crime. The whole process was then repeated for the left ear. All prints were scanned (Epson Perfection 1240 U, Epson UK) into the computer database.

Only one print was taken from each ear. The same individual (AA) undertook the printing procedure in all cases to standardize the amount of pressure used in each case, which, using the subjective scale would be classified as "light". Although it could be argued that at least three prints should have been taken of all ears at three different pressure levels as previously reported by some investigators (7), this study is not designed to assess the effect of

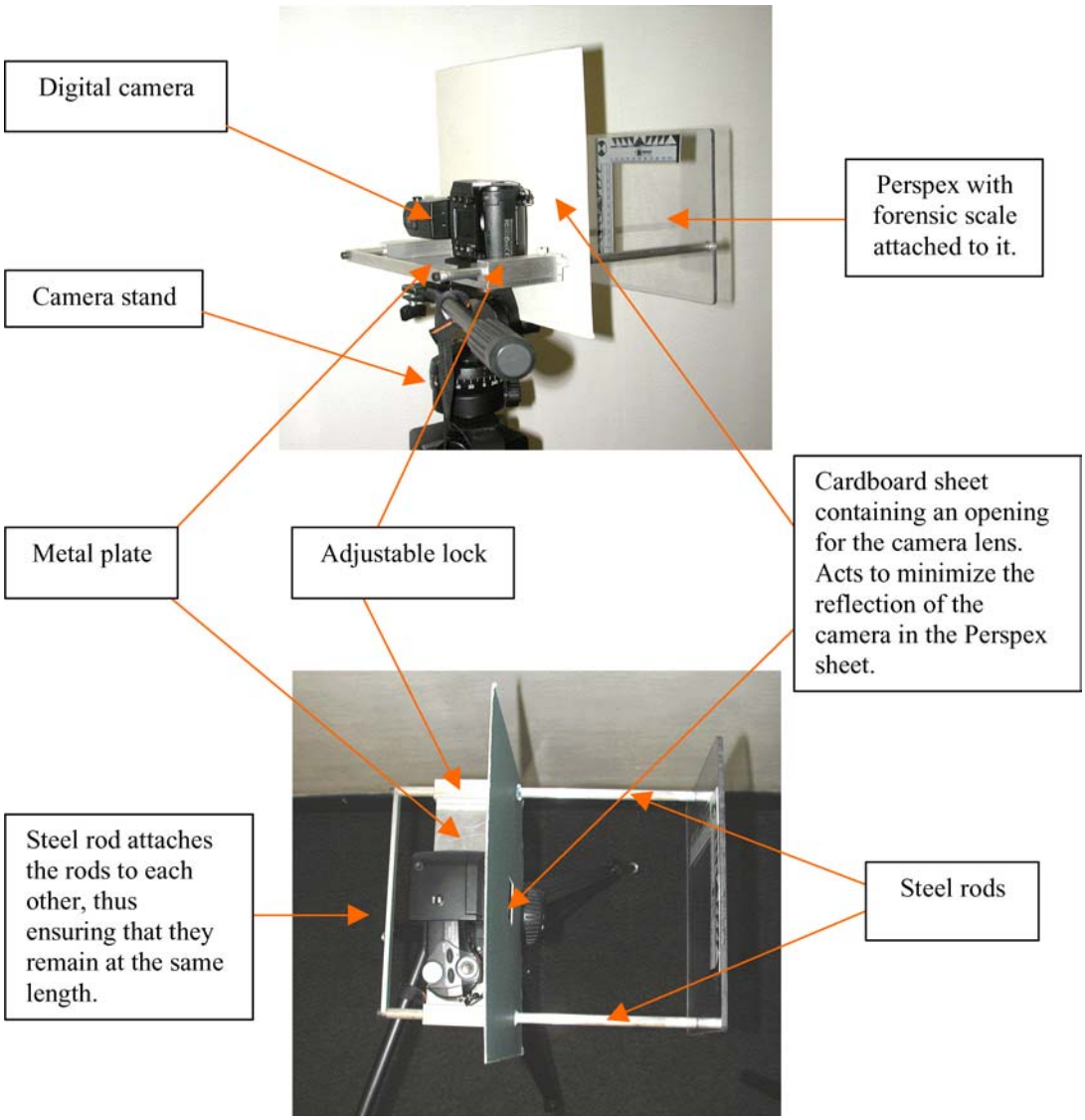


FIG. 2—*The digital photographic apparatus used to capture the ear images.*

pressure upon an earprint, but rather the potential effect of ear piercing on the print, hence only a single print was taken in each case. As with the ear images, the assessment of the prints does not use a quantified measurement system but rather considers the anatomical site of the non-printed area and whether the deficit to the print corresponded to the anatomical site of the piercing recorded from the corresponding ear image.

Mapping the Distribution of Ear Piercing

Each ear image was imported into a prototype computer-assisted ear identification system (software package "Treadmark"© (K9 Scene of Crime™, UK modified for ear image analysis)), which is under development at the authors' institution (13,14). A line drawing of the right ear measuring 14 cm high and 7 cm wide was placed onto a sheet of acetate. This size was chosen because this was the average size of each image when it was displayed on the computer monitor. The computer database was searched to identify all of the right ear photographs in turn. The position of any piercing was noted by superimposing the line drawing of the ear onto the monitor and marking all the piercing sites with a dot. A second line drawing, this time of the left ear, was used to mark all the piercing sites found on each left ear photograph using the same method.

Once all the piercing sites had been recorded on the acetate for both ears, their frequency in each part of the ear was calculated and expressed as a percentage of the total number of piercings for each ear. For each piercing site, the corresponding earprint was identified from the print database to analyze the effect of the piercing on the print. The anatomical site of the piercing was compared to the anatomical site of any deficit to the print.

Results

Paired ear images and prints were collected from 400 adult volunteers (i.e., 800 images and 800 matched prints). The age range of the population sampled was 18–65 with 165 male volunteers and 235 female volunteers. The gender and ethnic origins of the volunteers is shown in Table 1. Of the 400 volunteers, a total of 209 had one or more piercings to one or both ears. A summary of the number of piercings per ear per gender is shown in Table 2.

TABLE 1—*The gender and ethnic origin of the volunteers for the study.*

	Caucasian	Black	Asian	Mixed/Other	Total
Male	108	5	34	17	164
Female	191	3	29	13	236
Total	299	8	63	30	400

TABLE 2—*Number of piercings to each ear per gender expressed as a percentage of the gender within the total population.*

	Total Number Volunteers	Right Ear Only	Left Ear Only	Both Ears
All Cases	400	12	12	187
Male	165/400	1	6	0
Female	235/400	11	6	187

Site of Piercing

The lobe of each ear was the most common site of piercing in both genders with an almost equal distribution of preference of the side of the piercing (all cases left ear lobe 95%, right 96.5%). If one considers each gender separately, the left ear was pierced more commonly in males and the right in females (Table 2).

Piercing to the lobe occurred at four sites. The most common site was to the lowest, most central part (Fig. 3*b*) with a more anterior, superior piercing approaching the tragus less frequent than one below the anti-tragus (Fig. 4).

The remaining piercings (5% right ear, 4.5% left ear) occurred to the pinna. These were found around the rim of the helix between the lobe and the uppermost point. Piercing of the tragus itself occurred in only 0.5% of cases and to the left ear only of a single female in our series. Bilateral piercing of the tragus is rare, as illustrated by the case study below, and to date, in practice, the authors have not seen multiple piercings of the tragus.

Number of Piercings

In those who had piercings, 283 were single piercings, usually to the lobe (51% right ear, 49% left ear). Multiple piercings occurred

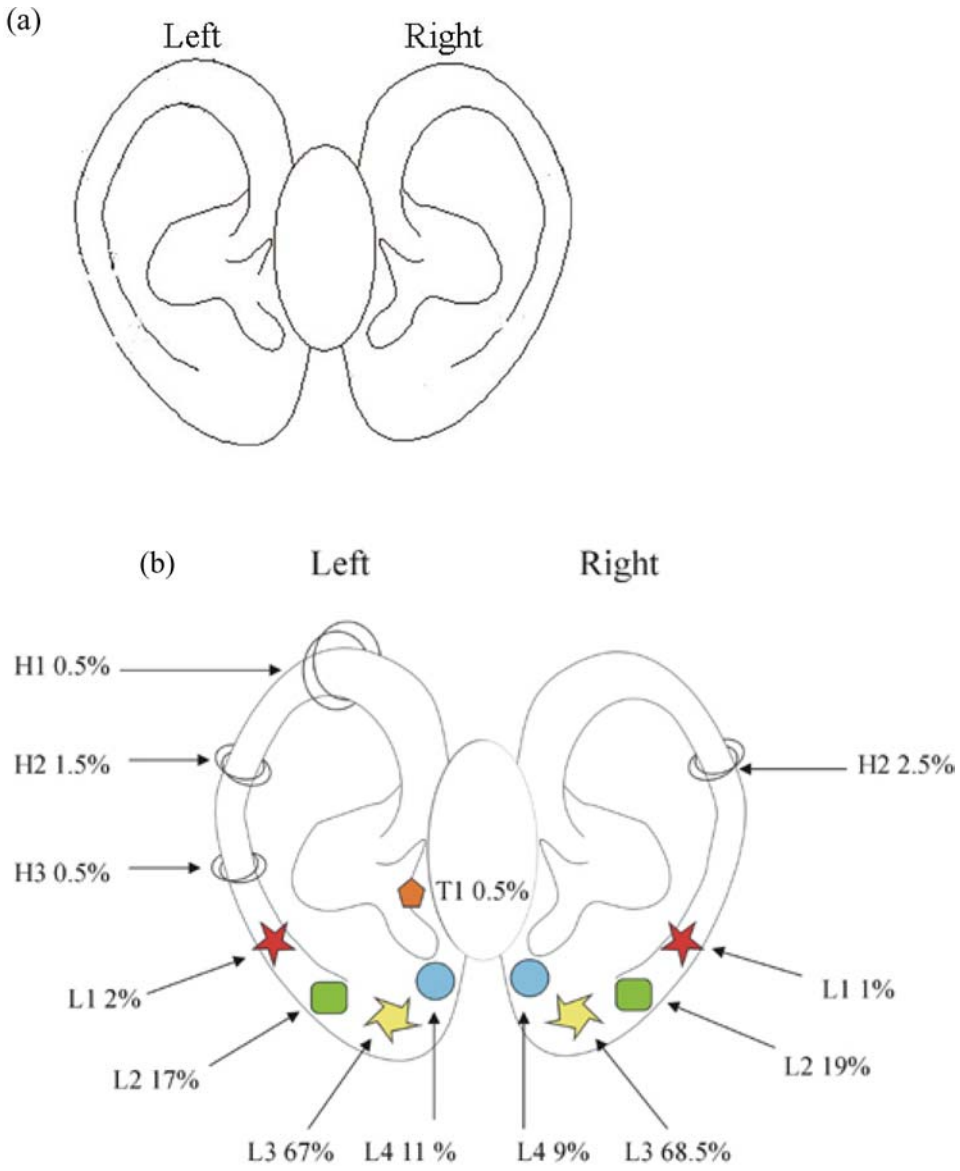


FIG. 3—*A composite line drawing of the left and right ears before (a) and after (b) the site of piercings to the left and right ears of a series of 400 adult volunteers.*

TABLE 3—*Frequency of number of piercings and combined sites to each ear per gender.*

Number of Piercings	Total	Male	Most Common Site Combination	Female	Most Common Site Combination
Single	283	13	Lobe (L2 + 3) Helix (H2)	170	Lobe (L1, L2)
Two	90	...	...	90	Lobe and Helix (L1 + 2), (L1 + 3), (L2 + 3), (L2 + H2)
Three	15	...	...	15	Lobe and Helix (L2 + 3 + H2), (L1 − 3)
Four	2	...	...	2	Lobe and Helix (L1 − 4), (L1 − 3 + H2)
Five	1	...	...	1	Lobe and Helix (L1 − 4 and H3)

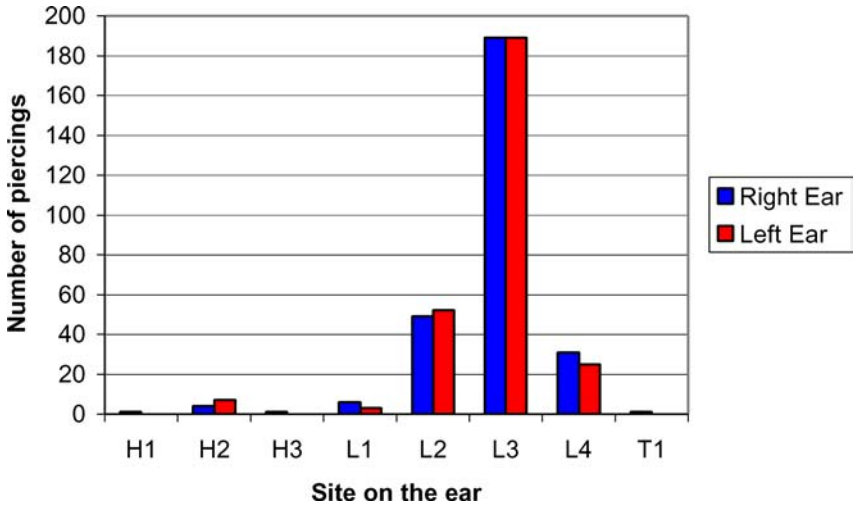


FIG. 4—*The distribution of the sites of ear piercing to right and left ear for both genders of a series of 400 adult volunteers.*

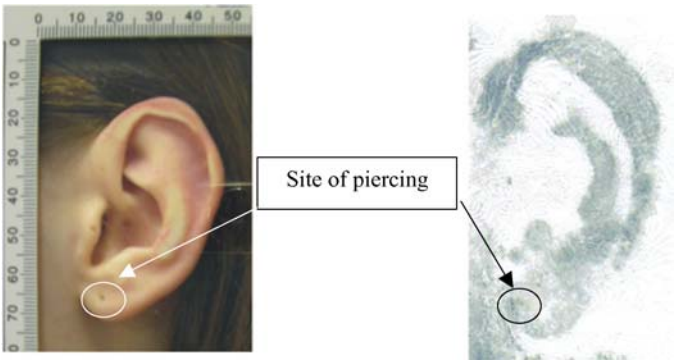


FIG. 5—*An example of an ear with a piercing to the lobe but no jewelry with the corresponding earprint.*

in 28% of our population and all in females. The frequency of number of piercings and sites is shown in Table 3.

Earprints

The effect of a piercing on an earprint was found to be dependent upon the presence of jewelry in the piercing at the time of the deposition of the print and not the actual piercing itself. Thus, if there was a piercing to the lobe but there was no jewelry present, this may not be seen on the print (Fig. 5). When jewelry was present, it caused the area of the ear where there was jewelry to not print. This is because the jewelry lifted the ear from the printable surface. Thus, the presence of jewelry in the ear could be seen as a non-printed area on the earprint (Table 4). However, the presence of jewelry by itself does not imply that the ear is actually pierced, just that there is jewelry present.

Case Study

The naked body of an unidentified adult female was found in the summer face down in a 1.8 m deep ditch that ran alongside an unclassified road. The body had been covered by a duvet and been in the ditch for a number of days, thus showing marked changes of decomposition. She was found to have been drugged with amytriptyline and subject to a blunt trauma assault, specifically to the breast area, prior to her death.

During the external examination of the body it was noted that she had bilateral piercings to the tragus. No jewelry was present in the piercing at the time of body's discovery. The tragus piercings were considered unusual by the pathologist and drew the attention of the investigating officers. Her only other identifying feature was a distinctive metal ring to her left ring finger. The ring was found to be unique to a specific designer who identified the buyer as a named female. When the police went to this female's family home, it was found that she had been missing. It was also discovered that she

TABLE 4—*Examples of ear piercings containing jewelry at each site and their corresponding earprints.*

Site	Piercing	Earprint
L1		
L2		
L3		
L4		
H1		
H2		
H3		
Tragus		

was known to have piercings to the tragus of each ear. This autopsy observation assisted in the ultimate identification of the female.

Discussion

Ear piercing is an example of the formation of a semi-permanent opening in the skin through which jewelry can be inserted. In the case of the ear, the most common type is lobar piercing rather than cartilaginous non-lobar piercing, which, although popular with the Masai tribe of Kenya and the native inhabitants of Indonesia, is a modern trend in Western populations (1). These observations are supported by the findings of this study.

A review of previously published scientific papers related to ear peircings reveals a literature concerned with the complications of ear piercing, including infections of the skin, perichondritis, allergies, keloid formation, deformities, and the need for reconstructive surgery. When one tries to establish the prevalence of ear piercing within our populations, few papers exist. Those that could be identified were concerned with the prevalence of all body piercings, which in an American University cohort was stated as been 51% of the population, rather than purely ear piercings alone (11,12). Within our study population, 46% had at least one ear piercing, with piercings being more common to females than males (ours and previous studies). However, there are no studies published to date to illustrate the prevalence of piercings among men, who commit all forms of crime, and thus, although male ear piercings appear infrequent by our data, within the criminal world it is unknown whether those with piercings may equal or outnumber those without piercings. There were also no papers identified concerning the prevalence or anatomical distribution of piercings by gender, age, or ethnicity or concerning any trends within youth sub-culture. Further studies need to be undertaken in these areas.

Our literature review failed to identify any paper concerned with the potential use of ear piercing and body identification, living or dead, images or prints. At first glance, the presence of an ear piercing may seem of little use to a criminal or unidentified body investigation especially if 50% or more of the population have pierced ears. However, this may not be the case. Theoretically, 50% of one's population can be immediately excluded from an inquiry if the person is known to have, or have had, one or more ear piercings. Although classified as semi-permanent, the site of an ear piercing will close with scar formation, which can still be used to identify the presence of a previous piercing, particularly by the examination of the back of the ear, where, from experience, the scarring may be more pronounced. Traumatic avulsion of the lobe, localized infections, keloid formation, or reconstructive surgery resulting from the complications of ear piercing may also lead to permanent deformities of the ear, which may assist in identification. A rape victim may remember that the offender had pierced ears, which the suspect may deny. A simple clinical examination of the suspect can resolve this question. A Closed Circuit Television (CCTV) image may capture the ear of an offender and show a particular pattern of piercing or item of specific jewelry. Finally, as illustrated by this paper, due to their relative rarity, the presence of non-lobar piercings may assist in the identification of the deceased. Careful documentation of the site of piercings to both ears is required at autopsy examination of unidentified bodies, with the ears photographed with a scale. Under these circumstances, ear piercing may contribute in a similar manner as a tattoo or other form of body modification in the identification of an individual.

The type of jewelry that can be worn in the ear varies in form with the most common types being ball closure rings, studs, and spools (1). Ball closure rings are formed from an incomplete loop of metal with a ball placed within the gap. Studs refer to a main decorative piece held in place by a backing or "butterfly" piece, and the bar, be it straight or curved, is passed through an opening and secured by an end piece screwed into place. The final type that may be seen in the ear is that of the lobar spool, where the lobe is stretched and a spool is placed in the opening. The anatomical site of an ear piercing may carry a stylistic name, for example "Industrial," "Rook," or "Daith," which those documenting ear piercings should be familiar with when investigating an individual's specific type of piercing. The types and manufactures may all be of use in identification issues, especially if the item is of a specific design or by a unique designer. Old photographs of the deceased wearing unique pieces of jewelry in the ear, especially at uncommon sites, may prove invaluable in identifying living or deceased individuals. Missing

persons inquiries often have facial photographs on record, which may show ear piercings or the presence of jewelry.

Earprints may be left and recovered from crime scenes, particularly burglaries, as a result of the offender pressing their ear against a door or window to listen for the presence of a person inside the scene. Although these can be recovered in a similar manner to that of a fingerprint, their use in subsequent court proceedings has been dogged with problems and controversy. A recent case from the English Court of Appeal rejected and criticized the earprint evidence after DNA retrieved from surface at the site of the earprint revealed a different profile to that of the male originally convicted for the offense (9). However, one must remember that, to date, there are no publications concerning the ability of the ear to leave DNA on a surface with which it comes in contact, and the ear may not be the only potential source of DNA at the point of contact (15).

One problem with earprints is that one may not get a complete print. To achieve a complete print, one is dependent upon sufficient pressure of the entire ear on the surface onto which it is being pressed, as well as the nature of the surface onto which it is applied, the elevation and flexibility of the surface, and the environment to which the print is then exposed. Apart from the problems related to the effect of pressure, another reason that only a partial print or localized deficit to the print may be observed may be due to the presence of jewelry within an ear piercing or, in the absence of a piercing, the presence of jewelry on its own. This later observation is hypothesized to be more likely in females (who may wear clip jewelry) rather than males, although, again, there are no published studies concerning the prevalence of clip jewelry to the ear, be it by anatomical site, gender, age, or ethnic origin. Thus, a deficit to the print may imply that jewelry may be present, but it does not imply that the donor ear is necessarily pierced. If no jewelry is present, then a piercing on its own will not affect the print. To our knowledge, we are the first to draw attention to the issues of piercings, jewelry, and earprints within medical literature.

As can be seen from Table 4, the presence of jewelry in the ear lifts the ear off the surface onto which it is being pressed, thus resulting in an area of deficit on the print. Although as stated above, this is not the only reason to yield a partial print or area of deficit within the print; recognition of this process may lead the earprint identification officer to raise the possibility that the causation of a partial print/area of deficit may be due to the presence of jewelry, the anatomical site of which can be documented and given to the investigating officers. Repeat offenders at different scenes may leave similar jewelry related prints.

Piercings may prove to be an important feature of the ear as new computerized systems of bio-informatics are developed. Several groups throughout the world are now developing computerized ear identification systems for use with earprints or images. Computerized ear image identification could be used, for example, with CCTV imaging, immigration, building security, or covert surveillance. As reported by the authors (13), those opting for grid/anatomical point recognition systems similar to those established for use with fingerprint identification, can use the site of ear piercings as fixed points within the system, as long as the system can compensate for a number of potential variables, including different angles and magnification of image capture. However, as with present manual methods of earprint comparison where a suspect's ears are printed and then compared to a crime scene print, if the crime scene print has an area of deficit resulting from the presence of jewelry, then consideration should be given that this jewelry should be worn at the same anatomical site when the comparison print is acquired.

Thus, this paper reports the potential use of a previously unreported tool for offender and body identification, that being the presence of ear piercings and the jewelry associated with it. It also draws attention to the effect of an ear piercing on an earprint and how recognizing this may assist in a criminal investigation. Finally, it draws attention to developments within the field of bio-informatics and the potential for the site of ear piercings to play a role in computerized ear identification systems.

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Additional information and reprint requests:
Professor Guy N Rutty, MD, MB, BS, FRCPath, DipRCPath(Forensic)
Forensic Pathology Unit
University of Leicester
Robert Kilpatrick Building
Leicester Royal Infirmary
PO Box 65
Leicester, United Kingdom
LE2 7LX
Tel: 0116 252 3221
E-mail: gnr3@le.ac.uk