■ REVIEW

Ear Print as an Identification Method

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Abstract: In recent years, earprint analysis has been developed in the field of legal and forensic medicine with the aim of converting it into an identification tool analogous to fingerprinting. In the present paper, we review the current status of earprint identification from both a medical and a legal perspective. Our objective is to introduce and present the up-to-date scientific evidence on an area of knowledge that, despite its obvious closeness, is not familiar to otorhinolaryngologists. Firstly, we will situate identification in general -and earprint analysis in particular- within a historical context. Secondly, we will examine the complexity of earprint analysis, introducing some of the conceptual problems of the method and their possible solutions. We then discuss the legal peculiarities of the validity of the method from the forensic point of view, and finally, we indicate the direction that current developments are taking.

Key words: Earprint. Identification.

La huella de oreja como método de identificación
Resumen: En los últimos años se ha desarrollado en el campo de la medicina legal y forense el análisis de las huellas de oreja, con la finalidad de convertirlo en un procedimiento de identificación análogo al de las huellas dactilares. En el presente trabajo se realiza una revisión del estado actual de la identificación por huellas de oreja desde una doble perspectiva médica y legal. El objetivo es, por un lado, introducir un área de conocimiento poco familiar para el otorrinolaringólogo, a pesar de su evidente proximidad, y por otro, presentar la evidencia científica actual. Primeramente, se sitúa en el contexto histórico la ciencia de la identificación en general, y el análisis del pabellón auricular en particular. En segundo lugar, se realiza una aproximación al complejo análisis de la huella de oreja, introduciendo algunos de los problemas conceptuales del método y sus posibles soluciones. Posteriormente se abordan desde el punto de vista forense las particularidades legales de la validez del método, y por último se señala la vía de desarrollo actual.

Palabras clave: Huella de oreja. Identificación.

INTRODUCTION: IDENTIFICATION

"To identify a person, establish their individuality, is to determine those features or set of qualities that distinguishes them from all others and makes them who they are.[1]"

Identification is a fundamental aspect of legal and forensic medicine, and, like this science, is nourished by and interrelated with a large number of medical specialties and related sciences. In daily practice, the forensic medic comes across cases of identification of living subjects, recently deceased bodies and human remains, and in each case uses the technique or techniques most suitable for the material under study.

In a brief historical review of the science of identification, two out-standing figures are César Lombroso (1835-1909), Italian doctor and criminologist, and representative of criminological positivism,[2] and Lambert Adolfo Quetelet (1786-1874), Belgian statistician and astronomer, father of modern quantitative social science and anthropometry.[3] But Alfonso Bertillón (1852-1914) is without question the most important historical figure in this field. Bertillón created his own identification procedure, which is divided into three principal parts according to the object of the operator's/scientist's observations: anthropometric measurements, descriptive measurements, and the measurement of particular

Figure 1. A. Anatomical elements of the outer ear (left ear):
1- external auditory meatus, 2- root of the helix, 3- helix, 4- antihelix, 5- lobe, 6- tragus, 7- antitragus, 8- concha, 9- navicular fossa.
B. Although the ear print can be more or less fragmentary, the helix, antihelix, tragus and antitragus (left ear) are usually identifiable.

marks/features.[4] Bertillón was probably the first scientist to use the ear as a means of identification. Under the category of anthropometric measurements, he made several measurements of the head, one of which was the length of the right ear. In the descriptive category, amongst the morphological characteristics, he continued the analysis of the right ear, including its edges, lobe, folds, general shape, separation and particularities. The ear was the character of greatest importance in the descriptive category on being considered immutable in its shapes and proportions. Bertillón himself, from 1894, added to his file, as a special supplementary mark, the impression of the papillary sulci of the right thumb, index, middle and ring finger.

The aforementioned dactyloscopic identification (fingerprinting) was already being used in Korea more than 1200 years ago in the sale of slaves. Its scientific development began in the early 19th century with Purkinje. Purkinje studied fingerprints and classified them into nine types and, even though he did not apply them to identification, he laid the foundations for Vucetich to subsequently exploit them. In 1880, Faulds had established the immutable character of these prints and between 1891 and 1895 Galton investigated fingerprint inheritance and established a system of classification that was subsequently simplified by Henry in 1901. The Galton-Henry system is still currently in use in Anglo-Saxon countries, while the Olóriz (1904)[1] system is used in Spain.

Analogously, though at a later date, the analysis of earprints was developed in criminological science. The awakening of forensic interest in the description of earprints and in identification by means of earprinting is relatively recent.[5] It constitutes one more step in the interminable race between criminal methods and criminalistic science. It is ever harder to find lophoscopic indications of fingerprints at crime scenes, as criminals are becoming increasingly knowledgeable (and the dissemination of criminalistic techniques in the media undoubtedly contributes to this). The first earprint identification of a criminal was made in Switzerland in 1965.[6]

In Holland there are already more than 200 judicial cases of earprint identifications. In Spain the first condemnatory sentence based partially on this type of evidence was passed on the 19th November of 2001. This sentence has been followed by at least two more, and more than 20 identifications have been made. At the present time, there are earprint databases in Palencia, Valladolid, Santander and Lleida.

EARPRINT ANALYSIS

The outer ear is constituted of a cartilaginous bone structure covered with teguments. The cartilage lamina is folded in on itself, forming protuberances and depressions that give the outer ear its characteristic shape (Figure 1A), which has been only too well described in anatomical texts.[7] Descriptions can also be found in the literature of the variations from the norm that can occur due to multiple causes such as abnormalities owing to disease, mechanical or surgical traumas, or aesthetic reasons.[8]

Modifications caused by aging have also been described, relating to the increase in the laxity of the tissue, which manifests itself in an increase in the vertical length of the outer ear.[9] There are, furthermore, significant variations due to ethnic origin, particularly with reference to the size of the ears.[10]

Diverse methods have been used to systematize the description of the outer ear. Bertillón made a purely descriptive analysis of its parts. Schwalbe[11] described the form of the helix, the lobe, and six variants of Darwin's tubercle, besides the tragus, antitragus, and the angle of the outer ear to the brain. He designed five imaginary lines on the basis of which he spoke about the morphological index and the physiognomical index. Iannarelli[12] used a system of four lines centered in the tragus for the radial partition of the outer ear into eight areas for comparative purposes.

The earprint is a two-dimensional reproduction of the parts of the outer ear that have touched a specific surface, and that are usually the most prominent regions of the same, that is to say, are most commonly the helix, antihelix, tragus, and antitragus (Figure 1B). These types of prints, like fingerprints, are produced by the remains of desquamation, sweat, and grease that the skin leaves on contact with a surface. They are not visible to the naked eye, but are recovered very easily with physical or chemical developers. The most common reason for the prints being left is simple: criminals that are going to burgle a house lean their ear against the door to make sure that there is nobody inside and leave their print on it. The prints may be more or less fragmentary, marked, or well-defined depending on diverse factors such as the degree of greasiness of the skin, the application of the face or hair to the same area, or even the volume of sound that they were trying to hear. It is subsequently necessary to collect the print with a glass slide or methacrylate base. It has been reported that it is possible to determine approximately the height of the suspect by means of the earprint, on the basis of the floor-to-print distance, with certain corrections.[13,14] Once the latent print from the crime scene (unknown print) has been developed, we must compare it with a print of the ear of the suspect

(known print). In general, three methods have traditionally been used for the comparison of prints: superposition (placing one print over another with transparencies and comparing them); direct comparison; and dissection, dividing the print into sections and interchanging them to check the coincidences and superpositions.[15]

The degree to which an earprint represents the original ear can be affected by diverse factors. The size itself can vary, as can the inter-distances between the different points of reference depending on the degree of pressure exerted. The methods of print collection and analysis are designed to attempt to resolve these problems. Maat[16] proposes a method of quantitative classification, using a polar axis designed/drawn on the basis of a vertical line that is the tangent common to the internal margin of the impression of the antero-superior curvature of the helix and the tip of the tragus. Ingleby[16] uses a similar geometric standardization, but claims that the definition of the polar axis proposed by Maat is difficult to employ in practice. Ingleby therefore calculates it with the use of a computer on the basis of "centroids" (centers of intensity). In any case, the description of the inter-individual variations in the earprint represents a genuine challenge. The solution is outlined through image processing techniques with algorithms that permit us to draw from the print a reliable model of the characteristics of a specific outer ear.

VALIDITY OF THE EARPRINT AS FORENSIC EVIDENCE

The forensic validity of the earprint is based on the possibility of identifying a particular earprint as belonging to a particular subject. In practice this can serve to rule out a subject as a suspect, to increase the evidence against a particular suspect or even, if there are no suspects, to search for suspects in future databases.

The limitations of the method are obvious, and relate to the uniqueness of the earprint. Furthermore, it is possible for one single ear to leave different prints. This may be due to the manner in which the prints are made, principally, as has been mentioned, to the degree of pressure or the angle at which the ear was applied to the surface, but also to anatomical modifications of the outer ear. As has been mentioned above, attempts have been made to deal with these intra-individual variations with diverse methods of analysis. The other problem is whether or not two different ears could leave a similar or identical print, or if, on the contrary, there is sufficient inter-individual variability to be able to distinguish between two different ears in all situations. The validity of the method depends fundamentally on the probability of two different ears leaving indistinguishable prints being reasonably small. In any case, the results of the analysis will be always expressed in terms of probability.

Identification by means of earprinting is included amongst the so-called anthropomorphic tests. These are included amongst the body examinations aimed at identifying the accused. What is crucial is to determine the degree of significance that said test should be given as circumstantial evidence.

Jurisprudence has accorded the status of probative evidence to the lophoscopic reports that prove, indisputably, that the prints found at the crime scene belong to the accused. However, there is no jurisprudence, nor doctrinal studies, nor studies relating to comparative law on the value that can be given to an earprint found in a particular place. Legally, there is an important difference between whether the print does in fact irrefutably correspond to the ear of the accused (analogously to fingerprints), or if, on the contrary, it is a print that merely presents similar characteristics to those of the ear of the accused. (In the latter case it would be comparable to a shoe print or the print of a wheel that could be said to be similar to the shoe print or the wheel print of a vehicle belonging to a particular individual.) In the latter case, the probative value of the print would be weaker and more circumstantial elements would be needed to reach the conclusion that a particular person had participated in specific events.

In the opinion of the European scientific police, the study of the ear, due to its morphology and characteristics, is an excellent method of personal identification.[6] It is hypothesized that all ears are different, and that they present a series of characteristics that are capable of leaving prints that are valid for the investigation of certain crimes. Conceptually, the uniqueness of the ear is based on the so-called snowflake paradigm: "nature never repeats itself."[17] However, it is clear that it is not possible to establish the individuality of the ear empirically, even though in practice it would be sufficient to be able to distinguish between any two ears through a finite number of characteristics.

In the United States there have been numerous rulings to the contrary, and identification by earprinting is regarded with great distrust. The Court of Appeals of the State of Washington in 1999 pronounced that "scientific innovation, technical knowledge, or other specialized knowledge can be admitted or can be considered reliable only if, in general, it is considered to be reliable by the technical, scientific or specialist community. General acceptance can be found in the testimony of whoever affirms it, in articles and publications, in its extended use in the community or in other courts. General acceptance can not be found if there is significant dispute between qualified experts with respect to the validity of the scientific evidence." In this case, twelve respected members of the forensic science community declared that identification through earprinting was not generally accepted by the community of forensic science. Despite the progress made over the last several years,[18] the lack of support in scientific literature is the great weakness of the current state of earprinting identification.

CURRENT SITUATION AND FUTURE PERSPECTIVES

In February 2002, the FEARID ("Forensic EAR Identification") project was set in motion. It has been

approved by the European Union, as a response to the need for strict scientific research and a systematic study of earprints and the development of automated support tools for their comparison.[19] The objective is to establish a standard process of detection, recovery, storage and identification of earprints and a computerized pan-European database of earprints that would allow a statistical calculation and increase the value of the evidence, giving scientific and judicial validity to earprint identification. The FEARID project has already produced its first results with the papers published in *Forensic Science International*[16] and in the University of Huddersfield in the United Kingdom.[20] Without doubt, a crucial element is precisely the creation of databases and the development of computerized analysis systems. So far, the process has been semi-automatic, but it can be hoped that the development of image-analysis techniques and recognition of patterns will allow us to resolve the current technical problems.[21]

The ear is a part of the human body that is under-exploited from the forensic point of view, despite the fact that the recognition of its potential as an element of identification has a long-standing history. The current situation is unquestionably controversial, but it is possible that in the next few years we will learn whether the establishment of a solid scientific basis will permit earprints to be used in a similar way to fingerprints. The terms otogram, earprint, and otomorphology belong to a field developed in the area of anthropology, biometry, criminology, and legal and forensic medicine, but their recognition on the part of otorhinolaryngologists is indisputably appropriate.

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