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Forensic Examination of Ear Morphology and Earprint of Malay Students in USM Health Campus

Dissertation submitted in partial fulfillment for the Degree of Bachelor of Science in Forensic Science

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CERTIFICATE

This is to certify that the dissertation entitled

"Forensic Examination of Ear Morphology and Earprint of Malay Students in USM Health Campus."

is the bonafide record of research work done by

Ms NAWALTUL AKMA BT AHMAD SABRI

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CONTENT

LIST OF FIGURES AND TABLES

FIGURES

TABLES

ABSTRACT

Human ear was first used for identification purposes in the late of 19th century. However, due to lack of research, this evidence has been taken for granted. Earprint, has long been overshadowed by the popularity of fingerprint. The purpose of this study is to characterize human ears for classification purposes as well as to assess the evidential value of earprint in forensic investigation. This research was carried out in two phases. In the first phase of this study, photos of right ear of the subjects (both female and male) were collected and class characteristics of the external ears have been determined. Eighty Malay students of USM Health Campus were used as subjects in this study. Results reveal some characteristics are observed to be common in examined subjects. The second phase of this study focuses on earprint. This phase is divided into three tests; surface test, ageing test and earprint profile test. The earprints developed by powdering technique were collected and compared against the photos of the ears in order to examine the 'presence' and 'absence' of characteristics as well as to figure out the factors that may contribute to this situation. Results show that glass and aluminum surfaces produce earprint of good quality and the quality of the aged earprint decreases as the time increases. The terms good and poor earprint shedder are used to classify the earprint profile of an individual. Most of the earprints in this study belong to poor earprint shedder. This research has demonstrated the potential use of earprint as evidence in forensic investigation.

INTRODUCTION

History of ear as evidence

Earprint has become one of the "out-of-like-ordinary" evidence left at the scene of crime. This phenomenon has attracted the attention of the police and the prosecuting attorneys. However, the use of ear and earprint evidence in court is somehow limited because it is not well-established in certain region regardless it has proved to be useful for identification purposes. History has already shown that ear was touted as one of the individuality marker that can be useful as to the much utilized fingerprint (Abbas and Rutty, 2003).

The potential of the ear for recognition purposes was recognized and advocated as long ago as in 1890 by the French criminologist Alphonse Bertillon, who claimed that the small valleys and hills that plough across the ear are the important factors from the point of view of identification. Alphonse Bertillon, who devised a manual system of identifying individuals by using 11 anthropometric body measurements, included the ear as one of the components in this system. Earprint has been used in forensic investigations since the mid-1960s. Hirschi was among the first to recognize the value of earprints in the field of forensics in 1970.

The most famous work in ear identification was carried out by Alfred Iannarelli in 1989. He gathered up over 10,000 photographs of ears and found that they all were different morphologically (Burge et al. 2000; Victor et al., 2002; Chang et al., 2003; Hoogstrate et al., 2000). A Prague doctor, Imhofer (1906) examined set of ears and he found out that in the set of 500 ears only 4 characteristics was needed to state the ears as unique.

Overview anatomy of the external human ear

The ear structure is rich, changes little with age, and is unaffected by facial expressions (Hurley DJ et al., 2007). It is firmly fixed on the side of the head so that the immediate background is predictable. The morphology of the ear is generally known to be the distinctive feature of familiar rim or helix and ear lobe. Apart from that, ear also has other prominent features such as the anti-helix which runs parallel to the helix, and a distinctive hairpin-bend shape just above the lobe called the intertragic notch. The central area or concha is named for its shell-like appearance.

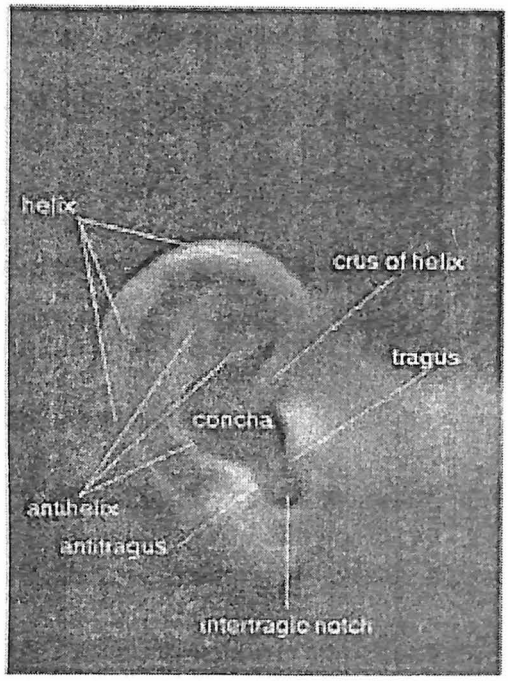

Figure 1 shows the anatomy of the ear. The basic anatomy of the external ear contain helix, earlobe, anthelix, intertragic notch , concha, tragus and antitragus.

Variability of human ear

Each individual possesses a unique ear pattern. Variation in the anatomical structures of the ear, their position, elevation or indent, will affect the print left by a given ear. Also, variation in ear morphology does not easily lead to a similar amount of variation in earprints. It is very informative to know the extent of variation in ear morphology, as it helps to

interpret the features of a print and facilitate the recognition between the print made by the same ear and from those made by different ears.

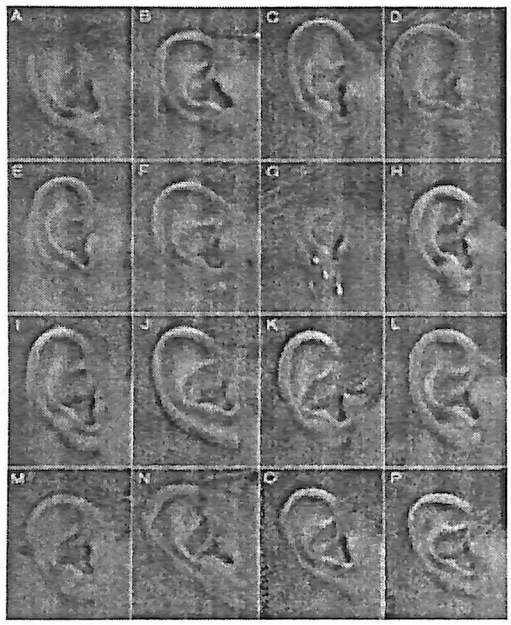

Figure 2 shows some collections of human ear. It shows the variability of human ear.

Why ear?

Some of the advantages of using ear as a source of data for person identification have been recognized. These include; ear does not change considerably during human life, unlike face that changes more significantly with age (Choraś, 2005). Face can also change due to cosmetics, facial hair and hair styling.

Face changes due to emotions and expresses different states of mind like sadness, happiness, fear or surprise. In contrast, ear features are relatively fixed and unchangeable (Iannarelli, 1989).

In addition, the color distribution is more uniform in ear than in human face, iris or retina and due to this advantage, not much information is lost while working with the grey scale or binarized images. Figures 3 and 4 present two aspects of ear identification. Ear is one of our sensors, therefore it is usually visible (not hidden underneath anything) to enable good hearing. Ear is also smaller than face, which means that it is possible to work faster and more efficiently with the images with lower resolution (Choraś, 2005)

Figure 3: Ear visibility and size. Although the resolution of the picture is not very good, the morphological features of the ear can still be recognized

In the process of acquisition, in contrast to face identification systems, ear images cannot be disturbed by glasses, beard or make-up (figure 4). However, occlusion by hair or earrings is possible, but making ear visible is not a problem for user and takes just single second (Choraś, 2005).

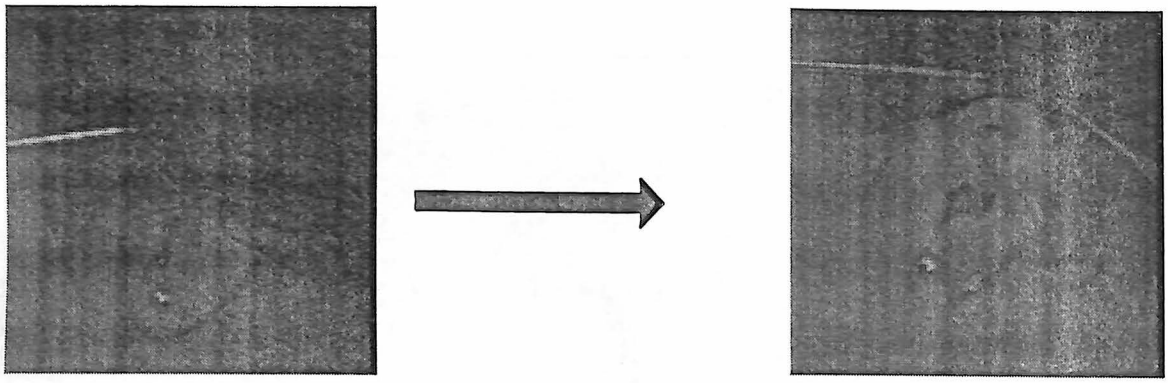

Figure 4. Ear visibility can easily been achieved

Earprint

An earprint is a two-dimensional reproduction of the parts of the auricle that touched a surface. The elevation and the flexibility of the various morphological structures of the auricle result in some structures to leave an imprint, while others may not, or leave partly. This will entirely depend on the position and elevation of each morphological structure in relation to the position and elevation of the other structures. Besides the morphological structure of the auricle itself and the amount of oil that is naturally present on the various parts of the auricle may also play a role. Absence of a feature in a print may tell something about both condition of the person while listening and the morphology of the live ear.

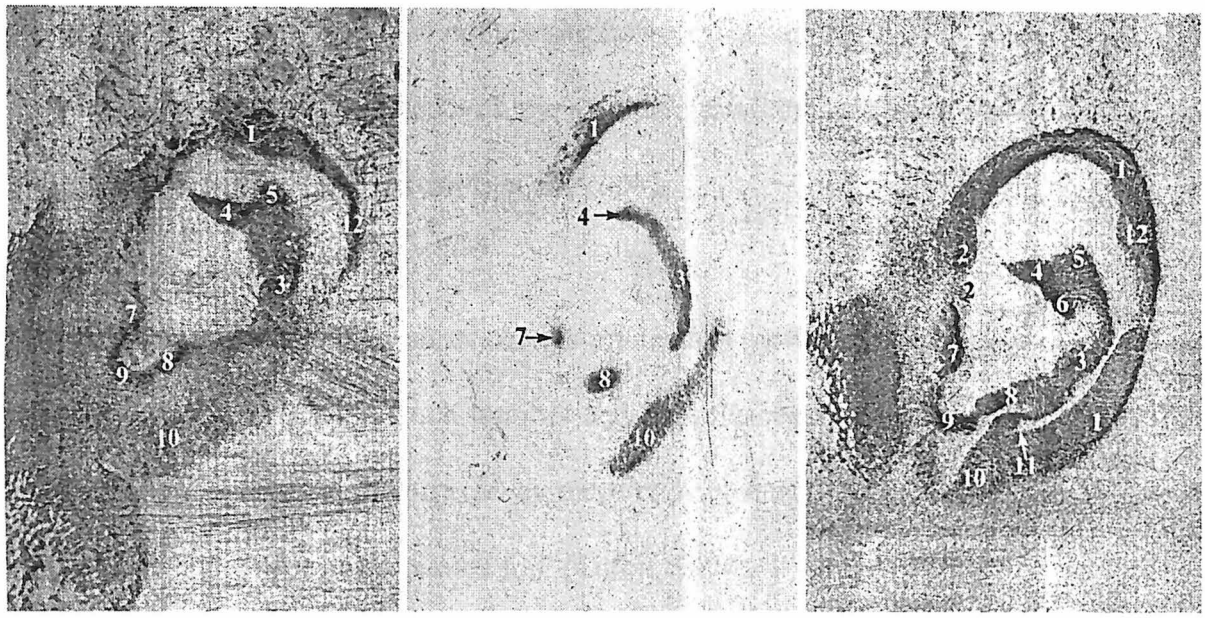

Figure 5. Examples of left-earprints in which imprints of the various anatomical features are indicated.1. helix; 2. crus of helix; 3. anthelix; 4. anterior branch of anthelix; 5. superior branch of anthelix; 6. inferior branch of anthelix; 7. tragus; 8. antitragus; 9. (outline of) intertragic notch; 10. lobe; 11. apex of scaphoid fossa; 12. auricular tubercle.

Individuality of earprint

There are some issues regarding the uniqueness of the earprint although that ear may be uniquely distinguished. Earprint, may not be as unique as an ear. A high variability between ears does not necessarily imply that a high variability is expressed in earprint. The external ear is a malleable, three-dimensional entity, whereas the earprint is merely a two-dimensional representation of the parts that come into contact with the listening surface. The appearance of different prints from a single ear may furthermore vary depending on a number of variables, of which pressure distortion was most frequently examined (Hammer and Neubert, 1989; Neubert, 1985; Saddler, 1996; Sholl et al., 2004; Dubois, 1988).

Uniqueness of earprint can be regarded as not really definite due to the fact that even two prints from a single ear will not be morphologically unique. Instead, one may ask if earprints are uniquely associated with the ear that created them. It should not, however, result in absolute certainties (Meijerman L et al., 2005).

"The individualization of an impression is established by finding agreement of corresponding individual characteristics of such number and significance as to preclude the possibility (or probability) of their having occurred by mere coincidence, and establishing that there are no differences that cannot be accounted for" (Tuthil, 1994).

Evidential value of earprint

The evidential value of earprints is determined by both intra and inter-individual variation. For an earprint to have evidential value in a forensic setting, it needs to possess a feature, or set of features, for which the intra-individual rate of occurrence, is high and the inter-individual rate of occurrence is low. Understanding about how to select and use earprint features as well as the factors that determine the range of intra-individual variation is needed in order to strengthen the scientific basis for earprint individualization.

Significance of earprint in forensic investigation

Earprints in forensic investigation can be used for various purposes. A latent earprint found on a scene of crime may be used to exclude a person as a possible suspect. Besides eliminating possible subjects from further investigation, one may also use the latent earprint to increase evidence against a given suspect. As an earprint is usually created when someone

is intentionally listening at a door or window, this may decisively place the listener at the crime scene which can be linked to the case (Meijerman L et al., 2004)

Earprint as evidence: Related cases

In Washington State in 1999, according to notes from the court case, an earprint was key evidence in the murder case against David Wayne Kunze. Five years earlier, an intruder had entered the home of James McCann and bludgeoned him to death. That same person also attacked McCann's son, fracturing his skull. A fingerprint technician processed the home and he was the one who discovered a partial latent earprint in McCann's bedroom. He lifted the print and preserved it. However, in July 2002, the Court of Appeals re-examined this case. The resulting judgment noted that two experts on earprint had made the critical comparisons and had found that the prints from the scene were consistent in detail with those prints provided by the appellant. Based mostly on this evidence, Kunze was convicted

This demonstrated that earprint can be a significant evidence to associate a criminal to the crime that he/she has committed.

REVIEW OF LITERATURE

The ear is an under-utilized resource in forensic investigations. It can be used to assist in identifying how someone died by the examination of the pathology present in the external, middle and internal parts (Abbas and Rutty, 2003). Apart from that, it can also be of assistance in estimation of the time since death by the use of temperatures recorded from the external auditory canal (Rutty, 2001).

Analysis of ear images or prints, from the living or dead, or through anthropological or radiological examination of skeletal components of the ear can assist in the identification of an individual (Iannarelli, 1989; Champod et al., 2001; Van der Lugt, 2001; Smith et al., 2002; Meijerman et al., 2004).

Besides the original formation of the ear itself, any deformities or any alteration of the ear for example the position of a hole or void which indicates the presence of a piercing may also aid the individualization of an earprint (Abbas and Rutty, 2003).

The identification of individuals by ear characteristic also has been described in a text for scene of crime officers by Soderman and O'Connell. The principal parts of the ears are described as well as peculiarities of the helix and antitragus, descriptions that were recognized to be useful for identification purposes (Soderman and O'Connell, 1945).

Based on its individuality, earprint becomes another tool in the forensic toolbox along with fingerprint kit. Although they don't have the ridges, the cartilage and contours of every ear give it a unique shape that provides clues for identification (Kennerley, 1998).

Dr. Edmond Locard in his book "L'identification des recidivistes" stated: "This organ (ear), that is a part of the face which in present day is the least looked at, can be considered as one of the most important for police science because it contains the most characteristic feature parts. The ear has a double character, on the one side qua sizes and forms is unchangeable from birth till death, and on the other appears to be so variated that it is almost impossible to find two identical ears" (Locard, 1948).

Study of the ear has been carried out on identical and non-identical twins. The findings support the hypothesis on ear uniqueness. Even the identical twins have similar, but not identical ear physiological features (Burge et al. 1998; Hoogstrate et al. 2000; Victor et al. 2002; Chang et al. 2003).

Hunger and Leopold discussed medical and anthropological views regarding the identification of people and referred to the shape of the ear being basically specified by its cartilage. They pointed out that the external ear has many specific features that are very stable throughout the ageing process and even after death. They noted that not all of the characteristic features may be recognized on photographs, which also applies to the prints (Hunger and Leopold, 1978).

There were also a few other occasional attempts in assessing the identification value of ears. For example, a study of 200 babies in 1960 found that no two babies had identical ears and suggested that, with further research, this could be the ideal method for baby identification (Fields et al, 1960).

Iannarelli ascertained that after the fourth month the mutual proportions of the ear do not change further. However, he discovered that although there are no further alterations in the mutual proportions of the ear, the ear continues to increase in size. He also examined the growth differences between races (whites, blacks and Asian) and concluded that growth differences of the ears existed between the races (Iannerelli, 1989).

Research under the Auspices of the Karl Marx University of Leipzig concerned the size and the form of the ear. The result showed that there were differences in the size of the ears between men and women, but these differences were found not useful for the identification process (Neubert, 1985). Research on hereditary factors was also reported. Ancestry reports in forensic medical science in Western Germany had taken the characteristic features of the ear into account since the 1920's. Scientific researchers on this aspect, amongst others Professor Lange of the Goethe University in Frankfurt am Main, showed that the concha region of the ear (Figure 1) was found to be similar in form between parents and their children (Neubert, 1985).

Oepen presented the morphological aspects of ears in his lecture and articles for the German Forensic Medicine Society entitled "The differences between the features of the ears and their appearance in practice in 500 men and women". The study was conducted to assess features of children's ears that were characteristic and could indicate the identity of the biological father. The finding revealed that some aural features and their combination and were found more often in women then in men, and vise versa, and more often on the right side than the left , and vice versa. Attention was paid to the way in which an ear would print and what features of the ear would be visible (Oepen, 1976).

In Malaysia, a study done by Vasu on different ethnicity in USM Health Campus (Malay, Chinese, Indian and other) found that there were several characteristic in ear morphology that are unique to certain ethnicity but absent in others. He found that the same set of variations in 10 traits (ear shape, helix structure, tragus, antitragus, intertragic notch, earlobe attachment, earlobe width, triangular fossa, Darwinian tubercle and ear projection) observed in one ear did not reoccur in the other 199 ears. The result of his study thus supports the application of morphological variation of ear for purposes of personal identification both in instances requiring photo to photo comparison such as in identifying falsified identification documents or comparing surveillance camera images as well as in mass disaster identification of unidentified dead bodies. He also pointed the concept of relationship between the sex and ethnicity and morphological variations of ear such as triangular ear is related more to females; while superior projection of helix and attached earlobe indicate a degree of relationship with ethnicity of the subjects (Vasu, 2005).

Rochaix introduced a classification method for earprints based upon several features of the ears, which are usually visible after listening. There are five features in total to be used in final classification code; these items include the shape of the ear; the attachment of the ear lobe to the cheek; the bending and basis of antitragus. These codes give a series of numbers for both left and right ears and can therefore be stored and found easily. He also concluded that, by employing this classification, 600 different earprints can be stored separately (Rochaix, cited from The Encyclopedia of Forensic Science).

Hammer in his study had summarized the value in earprint identification by stating that, of 100 ears investigated, no two ears could be found to correspond in all features and that the human earprint is therefore suitable for establishing a person's identity in forensic

practice. The reliability of the information however, depends on the quality of the earprint secured at the scene of crime (Hammer, 1986). On different research regarding earprint, which he and his co-worker stated that ear can play an important role in both identification of perpetrators and unidentified corpses. They described the results of the research into the distribution of selected ear characteristics in East German population, recording which type of aural features were found to be rare in group of 350 men and 300 women. They finally made 2 conclusions; first, as regards the identification of ears from a severely dismembered corpse, special care must be taken in preparing the ear for preservation by photography. It appears that the characteristic can be altered when the tissues in the head area are separated from the surrounding. Second, when the ear is pressed firmly against a surface, the ear can change particularly its size and shape. Hunger and Hammer stated that the metric and morphologic characteristics of ear are very well suited for determining identity, especially when rare characteristics are present (Hunger and Hammer, 1987).

In 1985, Neubert compared the dimensions of features in a print directly to the dimensions of auricle. Two levels forces ('soft' and 'hard') were applied on both ears of fifty subjects and the resulted prints were examined. He found that length and width of the auricle usually exceeded the corresponding dimensions of the unstressed auricle and increased as more force was applied. He further noted that length increased more (and more often) than width and the imprint of the upper part of the helix differed more from the actual helix than the imprint of its lower part. In addition, minimal width of the imprint of the anthelix conformed more to the actual minimal width in the auricle than the maximal width. The greatest deviation from the unstressed auricle was in the imprint of the earlobe. The deviation in width was greater than the deviation in length in this feature (Neubert, 1985).

Saddler also studied the influence of changes in applied force on the various features in an earprint. He measured ear length, ear width, anthelix width, and upper helix width in 92 sets of prints (by 46 left and 46 right ears). Each set consisted of one print made with 'soft pressure' and one print made with 'hard pressure'. The width of the imprint of the anthelix in particular varied with a change in applied force. In most cases (79% of left earprints; 70% of right earprints), increased force led to an increase in width. In some prints, however, the width of the imprint of the anthelix decreased when more force was applied. The total length on the ear also increased in most prints (in 70% of left-earprint and 74% of right-earprints). Saddler provided ranges for the increase in millimetres of ear length (1–6.5 mm) and anthelix width (0.5–5 mm). No specification was given for the amount of force that was applied, and there was no indication that the variation in applied force was similar to variation under natural conditions. Hence, there is no indication that the variation in dimensions of features in earprints observed in his study would occur in latent prints by a single ear at the crime scene. For other dimensions included in his study, Saddler found that in the majority of the sets of prints (73% of left-earprints; 60% of right earprints), an increase in width of the upper helix was observed with increased force. Ear width increased in 47% of left-earprints and 53% of right-earprints; the remaining prints showed either no marked difference, or a decrease, with increased force. Saddler concluded that most dimensions increased with increasing force, but that the imprints of some structures may change in an unpredictable way. According to him, this would make searching a database using metrical characteristics ineffective (Saddler, 1996).

OBJECTIVES

1. To determine and recognize the characteristics of anatomical pattern of the external ear.
2. To classify the characteristics associated with the morphological pattern of the external ear of Malay students in USM Health Campus.
3. To learn the method in developing the earprint and its limitation.
4. To observe the variability and individuality of earprint.
5. To evaluate the effect of surface types on earprint recovery.
6. To evaluate the effect of ageing on earprint recovery.

METHODOLOGY

Setting up the project:-

This research was carried in 2 phases. The first phase is to collect photos of right ear (both female and male) by using a digital camera mounted on a tripod. The photos then were examined thoroughly in order to search for characteristics that are unique to particular individual and common characteristics which are shared among individuals.

Ears that show many characteristics will be selected for second phase of this research. In this phase, the morphological patterns of ear were examined through earprint on different surfaces (glass plate, plastic and aluminum) and subjected to ageing process. Surfaces were cleaned using ethanol 70% prior to the deposition of the earprint. Powdering technique was employed to develop the earprint from the surfaces. Black fingerprint powder was used for this purpose. Lifted earprints were compared against the photo of the ears to examine for the characteristics that were present in the photo but present or absent in earprint as well as to figure out the factors that contribute to this situation.