Study association among the morphological landmark of Ear print to personal identification in forensics in the Iraqi population

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Received 5 July. 2024, Accepted 27 June. 2024, published 30 Dec. 2024.

DOI: 10.52113/2/11.02.2024/98-108

Abstract: The external ear is a distinctive side of facial characteristics. Ear has attracted significant and elevating interest in biometrics due to its inherent characteristics compared to other traits. This study explores the external ear's physical traits and its suitability as a tool for human identification. Through the use of photographs, evaluation and classification were done on six major human external ear landmarks: shape of ear, helix, tragus, shape of earlobe, earlobe attachment, and thickness of ear lobe. Findings of this study showed that there was variation in morphological features. We found that earlobes with medium thickness had a higher prevalence rate of 54.5% compared to thick and thin earlobes. There is a strong, statistically significant relationship at a p-value < 0.01 between ear shape and earlobe shape. The present study shows that the individualistic characteristics of the ear can provide very useful information for personal identification in forensics.

***Keywords*:** Ear print, Forensic Science, Iraq, Morphological landmark. Personal identification.

1. Introduction

Forensic identification has recently focused on the morphological ear variations in predicting the external ear's shape [1]. The ear maintains some individuality qualities that are distinct because of variances in the external ear's anatomical structure like fingerprints, the iris and other physical traits of the human body, this is useful in distinguishing even between identical twins [2], the human ear can be photographed from a distance without the subject's awareness or consent [3]. From eight to seventy years old, the ear stays intact and is unaffected by emotions, facial expressions, spectacles, and makeup [4], Verifying that disaster victims can greatly benefit from earlobe attachment has made it necessary for the biometric community to show a great deal of interest in the ear because of its unique characteristics, including its measurability [5]. The ear's sturdy structure and rigidity in burned

bodies account for its importance from a medical and legal standpoint [6]. Therefore, they are useful for both surveillance and forensic investigations. Morphological ear prints, including details of shapes, helix and tragus forms, earlobe shapes and sizes, and earlobe forms, have all been recorded in several studies [7-12], which have demonstrate d that ear sizes vary metrically across individuals and populations [13], [14], [15], However, ear size and shape can be predicted for facial reconstruction during forensic investigations [6, 16]. Relationships among the individualist ic characteristics and variations in the expression of their traits of the external ear have received very little research attention. In both studies, the relationships between the characters of helix and lobe tubercles were analyzed [11, 17]. A study on the dependency correlations among the external ear's morphological features highlighted the importance of correlations between the ear's morphological traits and their significance in physical recognition [18]. A developed database has been presented that is of great value to the forensic investigator in predicting the shape and size of the external ear through some factors. 33 features of the ear were examined, and their importance from a forensic perspective was recognized [1].

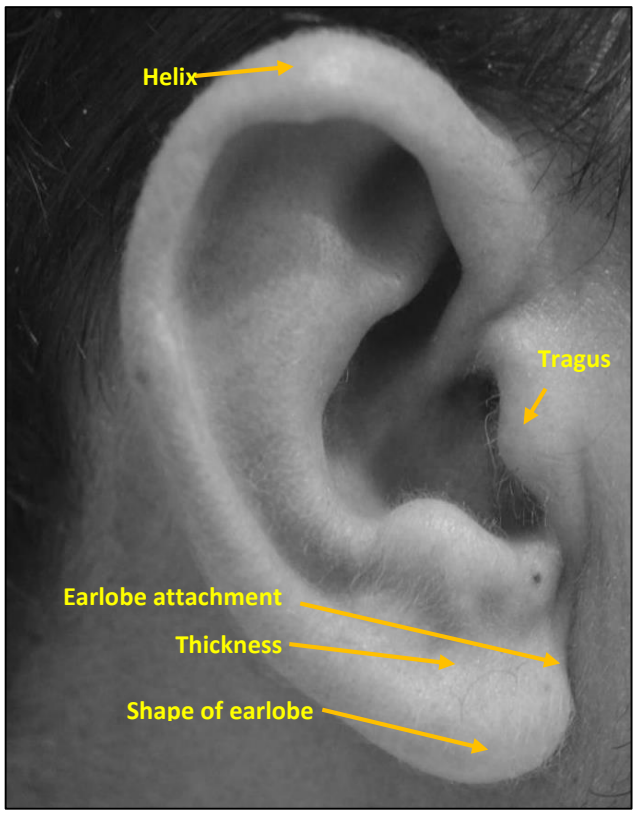

Fig. 1: illustrates the form and position of various ear anatomical markers (Purkait & Singh (2007).

The study aimed to find a correlation amongst the expression variations of morphological characteristics of the ear and attempt to provide a database of ear print services as the human /identification potential of the Iraqi population, according to Purkait & Singh (2007). Figure 1 depicts the principal external ear landmarks that were examined in this study.

2. Methodology

2.1. Subjects

The sample size was 200 Iraqi individuals, ranging age from 18 to 69 years were enrolled in this study (100 females and 100 males). A

history of facial injuries or dysmorphologies, surgery, and a BMI of more than 33 were disqualified (since obesity alters facial features). The Al-Muthanna University ethics committee was approved for this work and written informed permission was acquired by each subject.

2.2 Characteristics of the Ear

To establish population data for the distinct ear markers, the study of ear morphological features was evaluated. Digital photos of the faces were taken at the same distance (~1.5 m): left side (90°), left angle (45°), frontal (0°), right angle (45°), and right side (90°) by using Nikon D7500 camera [19]. Bilateral symmetry match between the right and left ears of the same individual can be verified by comparing their bilateral profile photos, which were taken to prevent bias [20]

- External ear (Oval, Round, Rectangle, Triangle)
- Tragus (long, round, knob)
- Shape of earlobe (arched, tongue, square, triangular)
- Thickness of ear lobe (thin, medium, thick)
- Earlobe attachment (free, attached, partially attached)
- Helix (wide covering scapha, concave marginal, normally rolled, flat,).

2.3 Statistical analysis

SPSS (Pearson Chi-Square) was used to assess for an association between ear parameters, with significance values of $P \leq 0.01$ and $P \leq 0.05$.

3. Results and Discussion

In this study, the association between the ear characteristics was examined, and the viability of using it for forensic human identification was explored. The Oval shape of the ear was common (42%), followed by a round shape (29%), and a rectangular shape (24%), and the lowest percentage was in a triangular shape (5%). Distinct forms for the helix: normally rolled (42.50%), wide covering scapha (37.50%), concave marginal (16%), and flate (4%). The present study recorded the four types of ear lobes: square (46.5%), Arched (29%), tongue (22%), and triangular (2.5%). Variations in the earlobe's form were observed in a square (46.50), Arched (29%), Tongue (22%), and Triangular (2.5%). The earlobe attachment showed variations between attached type (47%), free lobules (40.50%), and partially (12.50%) attached lobules. In nearly half of the cases (52.50%), the shape of the tragus was found to be long shape, in other cases, it was a round-shaped tragus in (33.50%) and the knob shape recorded the lowest frequency (14%). The earlobe thickness was varied, displaying a medium (54.50%) as the most common trait, thick (32%), and thin (13.50%). The distribution ratios of ear features are shown in **Table (1)**. Individual differences in morphology were seen in

the earlobe, tragus, helix, and ear shape. Depending on the individual, the earlobe displayed several traits [19]. Understanding the typical human ear size and morphological characteristics of various populations can be useful from an anthropological and forensic perspective in providing data strategies for including and excluding individuals for identification based on ear variants [20].

Six morphological traits of the auricle were investigated (ear shape, helix, earlobe attachment, earlobe shape, earlobe thickness, and tragus thickness), with every characteristic compared to the other five parameters.

Table 1: Ear morphological variations of traits from Iraqi population sample.

Characteristics	**Trait (sub-classify**	**Percentage**	**(No)**
External ear	Oval	42	84
	Round	29	58
	Rectangle	24	48
	Triangle	5	10
Helix	Normally rolled	42.5	85
	Wide covering scapha	37.5	75
	Concave margina	16	32
	Flate	4	8
	Square	46.5	93
Earlobe	Arched	29	58
	Tongue	22	44
	Triangular	2.5	5
	Free	40.5	81
Attachment	Partially	12.5	25
	Attached	47	94
	Medium	54.5	109
Thickness	Thin	13.5	27
	Thick	32	64

	Long	52.5	105
Tragus	Round	33.5	67
	Knob	14	28

Of the fifteen comparisons between the chosen parameters, only seven showed a statistically significant correlation.

The association between the six morphological parameters of the human external ear was investigated in this study as shown in Table 2.

The shape of the external ear exhibits a substantial association with two out of five morphological traits.

We found the shape of the external ear was strongly associated with the shape of the earlobe (0.630), as shown in Figure 2, which shows the distribution values of the external ear to the shape of the earlobe; furthermore, the association was moderate between the shape of the external ear and the shape of the helix (0.452).

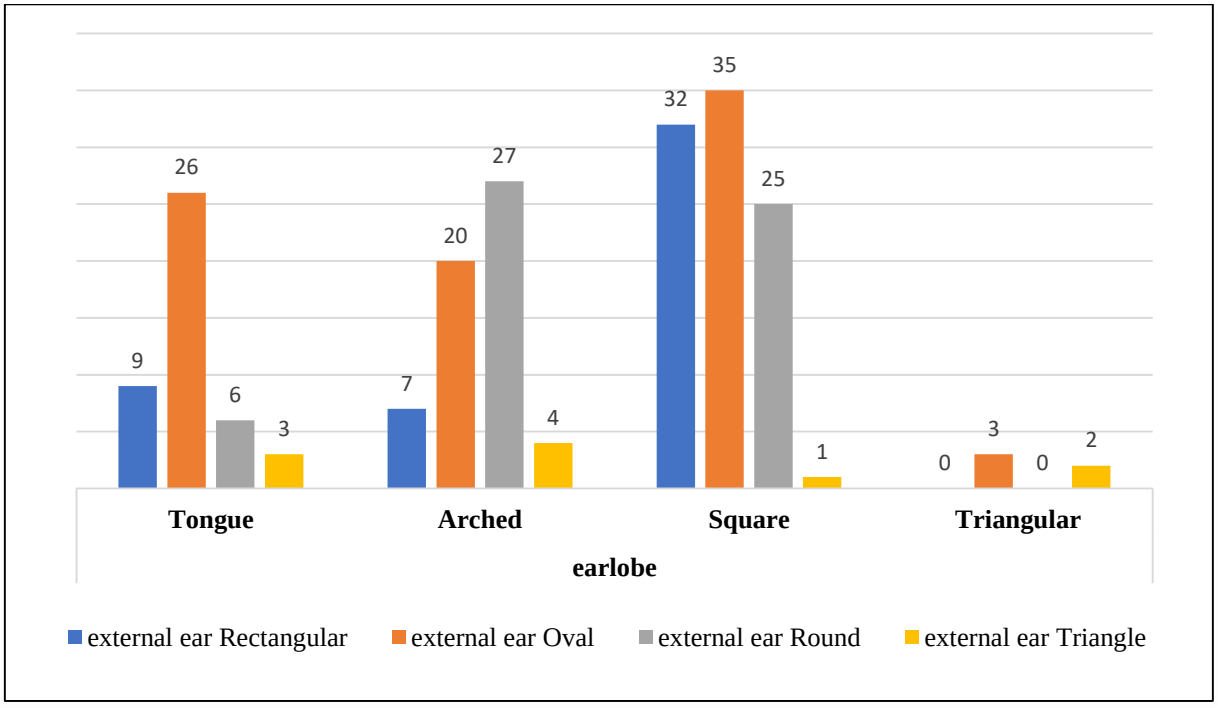

Fig. (2): The distribution of the shape of the earlobe by ratio to a phenotype of the external ear is shown.

Table 2: shows the degree of correlation between ear morphological traits. Pearson's coefficient and Chi-square were used to determine the significant difference.

Parameters	Correlation with (MC)	Pearson's R	(p-values)
External ear	Earlobe attachment	0.096	0.177
	Thickness	-0.106	0.136
	Helix	0.452**	0.039*
	Shape of earlobe	0.630**	0.00**
	Tragus	0.046	0.519
Helix	Shape of earlobe	0.065	0.193
	Earlobe attachment	-0.021	0.766
	Thickness	-0.122	0.01**
	Tragus	-0.147	0.38*
Shape of earlobe	Earlobe attachment	0.456**	0.00**
	Thickness	-0.138	0.05*
	Tragus	0.064	0.366
Earlobe attachment	Thickness	-0.185	0.00**
	Tragus	0.022	0.753
Thickness	Tragus	0.110	0.122

**indicate (p-values< 0.01) of significance, * indicate (p-values< 0.05) of significance.

As shown in Figure 3, which shows the distribution values of the external ear to the helix. While the tragus, Earlobe attachment, and earlobe thickness were parameters that had no association with the external ear's shape (p-value > 0.05). Only two exploratory investigations [1], [2] have been done on the relationship between the physical traits of the human external ear throughout the history of forensic science.

The literature in this field is scarce. Consequently, the current study's findings can be compared to those of Rubio et al. and Rani et al [1, 11]. The external ear's shape has had a significant association with the ear lobe's shape and the rolling of the posterior helix, as well as the protrusion of the helix, while a weak association was with the tragus's Shape, which agreed with our findings.

A moderate association (0.10–0.149) was found between the external ear's shape and the earlobe's attachment.

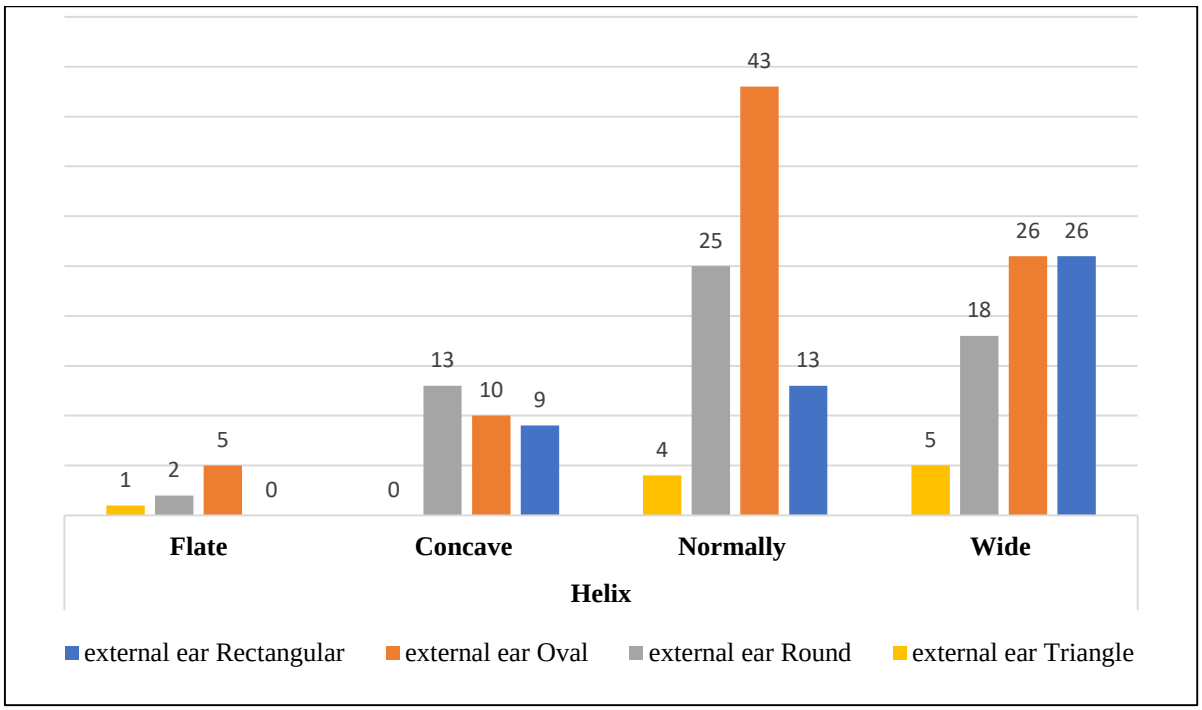

Fig. (3): The distribution of the helix by ratio to a phenotype of the external ear is shown.

This differs from our results, which showed weak associations [1].

In the Spanish population, the round external ear was exclusively linked to a superior protrusion. Furthermore, among the Spanish population, the external ear's rectangular shape was associated with the right-angle contour shape [18].

Helix showed an association with three morphological traits. Our results revealed a weak inverse association between helix and tragus (-0.147), and similarly, the relationship between the helix and earlobe thickness was (-0.122), while the association was moderate between the helix and the shape of the external ear. As we mentioned previously. The attachment of the earlobe and the shape of the earlobe were among the parameters that did not show a statistical association with the helix (p-value > 0.05).

A study of the Gujjars community of North India agreed with our results, reporting that a weak association was observed between a rolling of the posterior helix and the shape of the tragus, the shape of the earlobe, and earlobe attachment, which agreed with our findings. The same study demonstrated there is a moderate association between a rolling of the superior helix and tragus, which disagreed with our findings [1].

A dependence link between the angled contour and other angled forms was not observed in the Spanish population, with the exception of the acute angle of the supero-anterior contour and the obtuse angle contour shape of the supero-posterior helix [18].

In the current population, earlobe shape showed three statistical associations out of five. We found a moderate statistical association between earlobe shape and earlobe attachment (0.456), Figure 4 shows the earlobe shape distribution values for earlobe attachment. Association between earlobe shape and earlobe thickness (-0.138). While the Tragus and helix were among the parameters that did not show a statistical association with earlobe shape.

In contrast to our results, Rani *et al*. reported a moderate association between the shape of the earlobe and the tragus and a weak correlation between the shape of the earlobe and the helix. They also indicated that there was a strong correlation between the shape of the earlobe and the attachment of the earlobe [1].

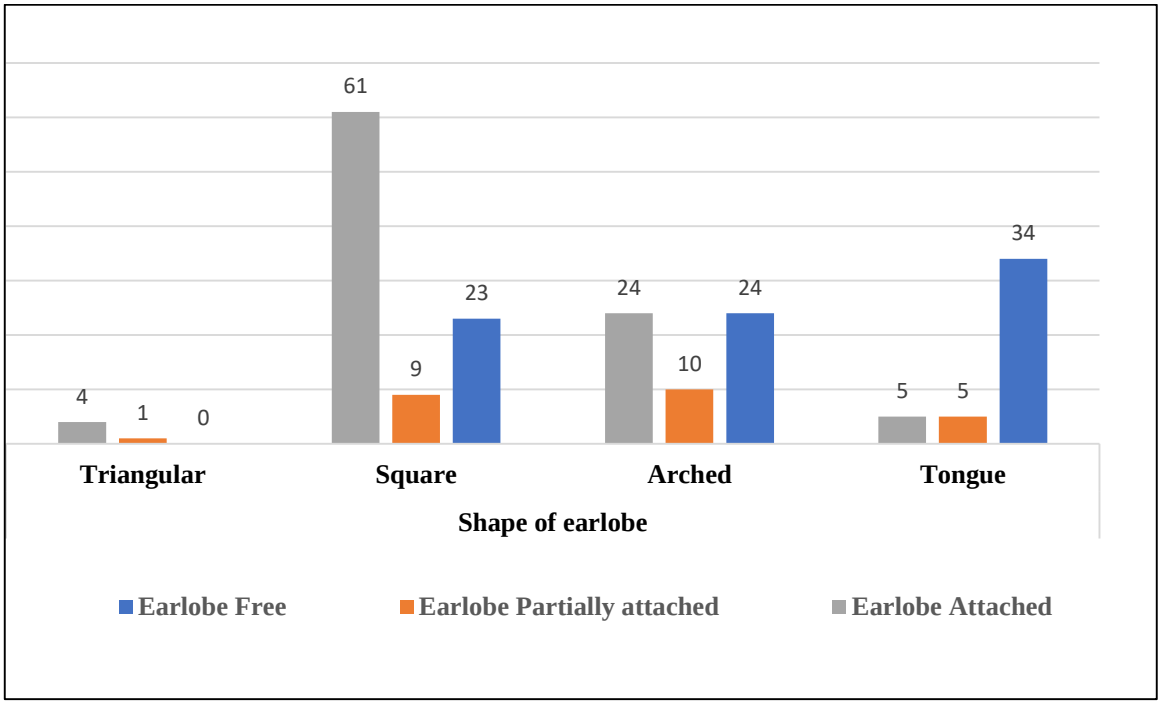

Fig. (4): The distribution of the shape of earlobe by ratio to a ear lobe attachment is shown.

In this study, we found a weak negative statistical association (-0.185) between earlobe attachment and earlobe thickness, while there was no association between earlobe attachment and (ear shape, helix, and tragus), as shown in Table 2.

In comparison with the results of the study of Rani *et al.* [1], where they reported that there is

a moderate association between the earlobe attachment and the shape of the ear, and they found a weak association between the attachment of the earlobe and the rolling posterior helix, this is not consistent with our results. Additionally, they showed no association between tragus and earlobe attachment, which is in line with our findings [1].

According to the study's findings, each ear is distinct in terms of size and morphological shape. In particular, the identification process incorporating facial and ear photos will benefit from the additional information the study offers on the morphological variability of the ear, which will advance anthropological understanding and the ear's variety in the Iraqi population ear,

4. Conclusion

Due to the uniqueness and distinctiveness of the ear print, the print left at the crime scene can be used as a personal identification tool like a fingerprint. The oval external ear shape was common for populations of both sexes; the triangular shape is the least common. The long-shaped tragus and middle earlobe thickness were widespread in more than half of the population. Association between morphological features is beneficial for predicting missing features if unclear or distorted images are used. Weight, gender, and age significantly affect earlobe thickness.

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