Original Research Article

Journal of College of Medical Sciences-Nepal, Vol-16, No 4, Oct-Dec 2020
ISSN: 2091-0657 (Print); 2091-0673 (Online) Open Access
DOI: 10.3126/jcmsn.v16i4.33279

External Ear Features: Role in Tracing Inheritance

Bhima Neupane,[1] Kanaklata Iyer,[1] Chachhu Bhattarai,[1] Brihaspati sigdel[2]

[1]Department of Anatomy, Manipal College of Medical Sciences, Pokhara, Nepal [2]Department of Otolaryngology & Head and Neck Surgery, Gandaki Medical College, Pokhara, Nepal

ABSTRACT

Introduction

The external ear is unique in shape, size and orientation. It has symmetry and asymmetry among generations. Its morphological variation helps to trace genetic inheritance. The objective of this study was to identify this morphological variation among parents and siblings.

Methods

The study was conducted in Manipal colleges of medical sciences. Images were procured from 147 families. The morphological character of external ears including, shape of pinnae, concha, tragus, ear lobule and attachment of lobule to cheek were matched among parents and offspring.

Results

This study included 882 pinnae in 147 families. Total 4410 morphological characteristics have been analyzed. Tragus was the most common matching character between parents and offspring Kappa measuring coefficient was statistically significant for shape of pinna, concha, ear lobule, ear lobule attachment to cheek.

Conclusions

The most of external ear morphology matches between parents and offspring which may be a helpful tool in tracing hereditary inheritance.

Keywords: external ear morphology; genetic inheritance; matching character.

INTRODUCTION

The use of ear as a tool of human identification began in the late 19th century. [1] Entire pinnae is a single piece of fibrocartilaginous structure having irregular surface with varying degree of elevations and depressions.[2] The morphological character of the external ear has a unique character in every individual.[3]

Due to its unique feature, it is used in personal identification by many scientists. It is a fact that various features of the external ear are under multiple genetic controls and are expected to behave in a similar manner in genetically related persons.[4] It was therefore considered important

Correspondance: Dr. Bhima Neupane, Department of Anatomy, Manipal College of Medical Sciences, Pokhara, Nepal, Email: bhimasigdel@gmail.com, Phone no: 9779846412100.

to evaluate its degree of similarities among generations.[5]

The aim of this study is to observe the external ear features such as shape of pinna, tragus, concha, ear lobule and its attachment to cheek and to find out whether there is similarities between parents and offspring from above mention structures.

METHODS

The study was conducted in Manipal colleges of medical sciences. Informed & written consent was taken from all subjects. Ethical clearance done from Institutional review board of Manipal College of Medical Science (MCOMSs), Pokhara, Nepal. Data was collected from the family of Nepali students, staff, and patient's visitors from MCOMS and Manipal Teaching Hospital from 1st January 2020 to 30th July 2020.

The study covered all cross sections of people. In total, images were procured from 147 families. The final sample for study includes families of two generations.

All the subjects were normal and healthy. None of them were suffering from any auricular (congenital and traumatic) or maxillofacial deformity or had undergone any auricular surgical procedure.

Bilateral images of subjects were taken from a distance of 0.5 m from Samsung Pro android mobile with a 12 pixel rear camera. During photography the head of the subject was oriented in the Frankfort horizontal plane and the focal plane of the camera was parallel to the longitudinal plane of the external ear. The camera was fixed on a tripod so that it could be elevated to the level of ear of the subject. The images were acquired in daylight. The parts of the external ear studied are shape of Pinnae concha, tragus, ear lobule and its attachment to check in both right and left pinnae (Figure 1 and Figure 2). Somatoscopic features of the ears of father, mother and first offspring were categorized according to their character. Morphological features of external ear include shape of pinnae, concha, tragus ear lobule and ear lobule attachment to cheek. Pinnae morphology of the same side were matched between parent and offspring. Matching pairs were calculated in percentage. Measurement of agreement was performed by Kappa Coefficient and association by chi-square on SPSS software 26.0 version. Value of agreement or association less than 0.05 was statistically significant.

Figure 1. Showing right pinnae: A. father B. mother c. daughter

Figure 2. Showing left pinnae: D. father E. mother F. daughter

RESULTS

In this study we includes 882 pinnae of 147 families. Total 4410 morphological characteristics have been analyzed. Each feature were classified into its sub-character. In total we observe 14994 distinct sub-characters.

Tragus was the most common matching character found between parent and offspring [Right father versus offspring: 104(70.7%) and left father versus offspring 106(72.1%)]. The most common character in both right and left ears was round-round 63 (42.8 %). Kappa measuring coefficient was statistically significant for pinna

shape, concha shape, ear lobule shape, ear lobule attachment to cheek. (Table 1 and Table 2)

When comparing mother pinnae and offspring, characteristics such as shape of

Table 1. somatoscopic analysis showing father and offspring pair matching character, Degree of Association (χ^2) and measurement of agreement (Kappa coeff = κ) of Right and left pinnae.

Morphology	Side of ear	Pair matching character	matching (%)	Total	Chi-square (χ^2) and κ -value	P value
pinnae shape	Right	Oval-Oval	30(20.4%)	63(42.8%)	χ^2=32.68	0.001
		Rectang-Rectang*	11(7.4%)			
		Round-Round	11(7.4%)		χ=0.225	0.000
		Triang- Triang†	11(7.4%)			
	Left	Oval-Oval	26(17.6%)	64(43.5%)	χ^2=35.6	0.000
		Rectang-Rectang*	15(10.2%)			
		Round-Round	13(8.8%)		κ=0.231	0.000
		Triang- Triang†	10(6.8%)			
Concha shape	Right	Broad-Broad	5(3.4%)	81(55.1%)	χ^2=7.83	0.25
		Narrow-Narrow	7(4.7%)			
		Proport- Proport‡	69(68.5%)		κ =0.103	0.074
	Left	Broad-Broad	9(6.1%)	95(64.6%)	χ^2=35.2	0.000
		Narrow-Narrow	9(6.1%)			
		Proport- Proport‡	77(52.3%)			
Tragus shape	Right	Knob-Knob	34(23.1%)	104(70.7%)	χ^2=75.3	0.00
		Long-Long	7(4.7%)			
		Round-Round	63(42.8%)			
	Left	Knob-Knob	38(25.8%)	106(72.1%)	χ^2=72.8	0.00
		Long-Long	5(3.4%)			
		Round-Round	63(42.8%)			

*Rectang-Rectang:Rectangular-Rectangular, †Triang- Triang:Triangular:-Triangular ‡ Proport- Proport: proportionate-proportionate

Table 2. somatoscopic analysis showing father and offspring pair matching character, Degree of Association (χ^2) and measurement of agreement (Kappa coeff = κ) of Right and left ear lobule shape and its attachment to cheek.

Morphology	Side of ear	Pair matching character	matching (%)	Total	Chi-square (χ^2) and κ -value	P value
Ear lobule shape	Right	Arched-Arched	19 (12.9%)	66(44.9%)	χ^2 = 64	0.00
		Rectang-Rectang*	7(4.7%)			
		Round-round	23(15.6%			
		Tongue-tongue	14(9.5%)			
		Triang-triang†	3(2.1%)			

	Left	Arched-arched	20(13.6%)	74(50.3%)	$\chi^2 = 99.02$ $\kappa = 0.348$	0.000
		Rectang-Rectang*	6(4.0%)†			
		Round-round	31(21.0%)			
		Tongue-tongue	13(8.8%)			
		Triang-triang†	4(2.7%)			
Ear lobule attachment to cheek	Right	Free-Free	34(23.1%)	76(51.7%)	$\chi^2 = 22.15$	0.000
		Part att-Part att§	28(19.0%)			
		Attached-Attached	14(9.5%)			
	Left	Free-Free	32(21.7%)	72(48.9%)	$\chi^2 = 20.01$	0.018
		Part att-Part att§	26(17.6%)			
		Attached-Attached	14(9.5%)		$\kappa = 0.038$	0.020

*Rectang-Rectang:Rectangular-Rectangular, †Triang- Triang:Triangular:-Triangular ‡Proport- Proport: proportionate-proportionate

pinnae, concha, tragus and ear lobule have been found to be substantially matched with (p value < 0.05).In parents and offspring the most prominent pinnae form was oval-oval. Comparing the right lobule attachment, free lobule was more common. Fathers ear were more matched than mothers (34% versus 21.7%) (Table 3 and 4).

Table 3. somatoscopic analysis showing mother and offspring pair matching character, Degree of Association (χ^2) and measurement of agreement (Kappa Coeff. = κ) of Right and left shape of pinnae , concha and tragus.

Morphology of pinnae	Side of ear	Pair matching character	matching (%)	Total	Chi-square (χ^2) and κ coeff	P value
pinnae shape	Right	Oval-Oval	27(18.3%)	54(36.7%)	χ^2=34.21	0.001
		Rectang-Rectang*	11(7.5%)		κ =0.205	0.000
		Round-Round	16(10.8%)			
		Triang- Triang†	7(4.7%)			
	Left	Oval-Oval	28(19.0%)	59(40.1%)	χ^2=36.84	0.002
		Rectang-Rectang*	15(10.2%)		κ =0.183	0.000
		Round-Round	9(6.1%)			
		Triang- Triang†	7(4.7%)			
Concha shape	Right	Broad-Broad	4(2.7%)	86(58.5%)	χ^2=16.14	0.003
		Narrow-Narrow	13(9.0%)		κ =0.204	0.001
		Proport- Proport‡	69(46.9%)			
	Left	Broad-Broad	2(1.3%)	89(60.5%)	χ^2=21.69	0.001
		Narrow-Narrow	13(8.8%)		κ =0.200	0.001
		Proport- Proport	74(50.3%)			
Tragus shape	Right	Knob-Knob	32(21.7%)	105(71.4%)	χ^2=59.14	0.00
		Long-Long	3(2.0%)			
		Round-Round	70(47.6%)			
	Left	Knob-Knob	38(25.8%)	111(75.5%)	χ^2=78.31	0.00
		Long-Long	3(2.0%)			
		Round-Round	70(47.6%)			

*Rectang-Rectang: Rectangular-Rectangular, †Triang- Triang:Triangular:-Triangular ‡Proport- Proport: proportionate-proportionate

Table 4. somatoscopic analysis showing mother and offspring pair matching character, Degree of Association (χ^2) and measurement of agreement (Kappa Coeff.= k) of Right and left ear lobule shape and its attachment to cheek.

Morphology of pinnae	Side of ear	Pair matching character	matching (%)	Total	Chi-square (χ^2) and κ coeff	P value
Ear lobule shape	Right	Arched-Arched	15(10.2%)	57(38.7%)	χ^2=35.2, κ =0.20	0.004 0.00
		Rectang-Rectang*	5(3.4%)			
		Round-round	25(17.0%)			
		Tongue-tongue	10(6.8%)			
		Triangle-triangle	2(1.3%)			
	Left	Arched-arched	14(9.5%)	66(44.8%)	χ^2=56.6 κ =0.266	0.000 0.000
		Rectang-Rectang*	5(3.4%)			
		Round-round	33(22.4%)			
		Tongue-tongue	12(8.1%)			
		Triang-triang†	2(1.3%)			
Ear lobule attachment cheek	Right	Free-Free	31(21.0%)	74(50.3%)	χ^2=22.72	0.000
		Part att-Part att§	22(14.9%)			
		Attached-Attached	21(14.2%)			
	Left	Free-Free	30(20.4%)	72(48.9%	χ^2=22.90	0.006
		Part att-Part att§	22(14.9%)			
		Attached-Attached	20(13.6%)		κ =0.154	0.00

*Rectang-Rectang:Rectangular-Rectangular, †Triang- Triang:Triangular:-Triangular ‡Proport- Proport: proportionate-proportionate, §Part att-Part att:partially attached-partially attached.

DISCUSSION

The human external ear displays extremely complex shape and symmetry. It has inter-individual variation which is unique for each person.[6] Some forms of human ear shape variation have been known for over a century and were used by physiognomists of the 19th century.[7] We studied matching symmetry in the human pinnae among parents and offspring from view of anatomical perspective. Pinnae has unique characters which can be used for personal identification and similarity among vertical generations.[8]

We studied different external ear characters among parents and offspring and compared with their offspring. On this study, Oval shaped pinnae was found to be the commonest among parents and offspring.

Tragus was found to be the most common matching followed by concha. Round type of tragus was commonly seen followed by knob type. Our study showed more than two third tragus matched morphologically.

While studying attachment of lobule, free lobule were found to be commonest among parents and offspring. In this study, we also found that 50% of the population have similar matching of ear lobules. Bhasin mentioned that, attachment to the ear lobule has been found to be an important marker in population genetics.[9] Male

and female offspring inherited the trait from both mothers and father irrespective of sex.[10] This is in agreement with a study done by Hays F et.al. when he crossed Rhodes island red and leghorns.[11]Free ear lobule were also commonly found in study carried out by Singh P et al [12].In Nigerian families, attached and detached (free) ear lobes of the offspring were in the ratio of 1:3. While observing inheritance pattern of earlobe attachment amongst Nigerian families, when both parents have detached earlobes, 160 (59.93%) of their offspring had detached earlobes whereas 22 (23.65%) had attached earlobes which is highly significant.[10] While observing Korean study, overall attached type of earlobe was more frequent than free type of earlobe. Attached type of ear lobe is more common in both sexes in Korean population.[13]

Overall, External ear characteristics are an important feature not only for personal identification but also for tracing genetic association among family members. Limitation of this study is sample size of this study is small and we have taken picture in 2D photographs. It would be better if the study is carried out in larger population with a 3D picture.

CONCLUSIONS

Matching symmetry was observed in all anatomical sub-structures of the external ear. Tragus and concha have almost two-third matching among parents and offspring. Pinnae and lobule had fairly equal levels of symmetry and asymmetry. So from this study we can conclude that there is similarities in ear features between parents and offspring while observing morphological feature of external ear

Conflict of interest: None.

REFERENCES

1. Dhanda V, Badhan JS and Garg RK. Studies on the development of latent ear prints and their significance in personal identification. Problems of Forensic Sciences. 2011; 88: 285-295. http://www.forensicscience.pl/pfs/88_Garg.pdf
2. Sforza C, Grandi G, Binelli M, Tommasi DG, Rosati R, Ferrario VF. Age-and sex-related changes in the normal human ear. Forensic science international. 2009 May 30;187(1-3):110-e. https://doi.org/10.1016/j.forsciint.2009.02.019
3. Krishan K, Kanchan T and Thakur S. A study of morphological variations of the human ear for its applications in personal identification. Egyptian Journal of Forensic Sciences. 2019; 9: 6. DOI: 10.1186/s41935-019-0111-0.
4. Purkait R. Application of external ear in personal identification: a somatoscopic study in families. Ann Forensic Res Anal. 2015; 2: 1015. https://www.jscimedcentral.com/Forensic/forensic-2-1015.pdf
5. Purkait R. External ear: An analysis of its uniqueness. Egyptian Journal of Forensic Sciences. 2016; 6: 99-107. https://doi.org/10.1016/j.ejfs.2016.03.002
6. Claes P, Reijniers J, Shriver MD, et al. An investigation of matching symmetry in the human pinnae with possible implications for 3D ear recognition and sound localization. J Anat. 2015; 226: 60-72. 2014/11/11. DOI: 10.1111/joa.12252.
7. Beard JS. The physiognomic approach. Classification of plant communities. Springer. 1978, pp.33-64. https://doi.org/10.1007/978-94-009-9183-5_2

8. Verma P, Sandhu HK, Verma KG, et al. Morphological Variations and Biometrics of Ear: An Aid to Personal Identification. J Clin Diagn Res. 2016; 10: Zc138-142. 2016/07/21. DOI: 10.7860/jcdr/2016/18265.7876.
9. Bhasin M. Ear lobe attachment among the Newars of Nepal. Human Heredity. 1969: 506-508. PMID: 5365889,DOI: 10.1159/000152259
10. Ordu K, Didia B and Egbunefu N. Inheritance pattern of earlobe attachment amongst Nigerians. Greener Journal of Human Physiology and Anatomy 2014; 2: 1-7. DOI: 10.15580/GJHPA.2014.1.012214054
11. Hays F. Inheritance of mottled earlobes and stubs in Rhode Island Reds. The American Naturalist .1943; 77: 471-475. DOI:10.1086/281149
12. Singh P and Purkait R. Observations of external ear--an Indian study. Homo 2009; 60: 461-472. 2009/09/15. DOI: 10.1016/j.jchb.2009.08.002.
13. Kim K, Song W and Kim D. Reevaluation of the earlobe types in Koreans. HOMO 2018; 69: 377-380. PMID: 30392739 DOI: 10.1016/j.jchb.2018.10.003

Citation: Neupane B, Iyer K, Bhattarai C, Sigdel B. External Ear Features: Role in Tracing Inheritance. JCMS Nepal. 2020; 16(4):201-7.