

Comparative Study of Human and Animal Hair in Relation with Diameter and Medullary Index

*Kshirsagar S.V, **Singh B., ***Fulari S. P.

*Associate Professor, Dept of Anatomy, Bidar Institute of Medical Sciences, Bidar, Karnataka, **Associate Professor, Dept of Forensic Medicine & Toxicology, RMC, Loni, Maharashtra, ***Lecturer, Dept of Anatomy, Dr. V. N. Medical College, Solapur Maharashtra

Abstract

Backgrounds: Next to hard tissues like bones, teeth and nails, hair is stable under adverse natural conditions. Hence, hair are recovered along with other skeletal remains and sent for examination. Here the question often asked is whether the hair is of human or not?

Aims: The present study is carried out to find the most reliable quantitative parameter for differentiation of the human hair from the animal hair. **Materials & Methods:** Hair samples from various species of animal and various sites of human hairs were obtained. In the present study the diameter of shaft, diameter of medulla and the medullary index of the human and different animal hair were measured. It was found that, medullary index, which was less than 0.25 in human hair and more than 0.44 in animal hair is useful parameter to distinguish between human and animal hair.

Key Words: Human & animal hair, Diameter, Medullary index, Forensic application.

Introduction

The skeletal remains received by the department of Anatomy for medico-legal examination many times including hair. It is because, the hair is next to hard tissues like bones, teeth and nails, it is stable under adverse natural conditions to which this biological material may often be subjected. Hence, hair are recovered along with other skeletal remains and sent for examination. Here, the question often asked is whether the hair is of human or not?¹.

Human and animal hairs have been used in forensic investigations for over a century. During the course of a criminal investigation, many types of physical evidence are encountered. One of the most common is hair evidence. The identification and comparison of human and animal hairs can be helpful in demonstrating physical contact with a suspect, victim, and crime scene². Depending

upon the structure, there are many differences in human and animal hair. These differences are often descriptive type³. Studies on various parameters of hair have been reported by a number of scientists⁴⁻⁶.

The present study is carried out to find the most reliable quantitative parameter that can be used to differentiate the human hair from the animal hair.

Material and Methods

The present study was carried out in the department of Anatomy, S.R.T.R. Medical College, Ambajogai. The study material included human hair of different sites and hair of different animals. Human hair including scalp, body hair, moustache and pubic hair while Animal Hair including 12 different species of animals 1) Cow, 2) Goat, 3) Buffalo, 4) Dog, 5) Sheep, 6) Pig, 7) Donkey, 8) Rat, 9) Cat, 10) Horse, 11) Squirrel and 12) Camel. Hair strands from five individuals were collected from various sites of the body like scalp, body hair, moustache and pubic hair. Similarly hair strands from five different animals of each species were collected. The tip and the root portion of each sample were cut off so that only shaft region

Reprints Requests: Dr. S. V. Kshirsagar
Associate Professor, Department of
Anatomy, Bidar Institute of Medical Sciences
Bidar, Karnataka
E-mail: svk.brim@gmail.com

was selected for the examination. All the samples were stored in serially marked paper envelopes.

Preparation

Each hair samples were cleaned before examination with soap solution followed by distilled water for 2-3 times to remove dust and debris if any. Latter the each sample was put in the ether/alcohol (50:50) for 2-3 minutes to remove any fatty materials and blot dried. Each dried hair strands were treated with hydrogen peroxide for two hours to bleach the hair, it helps to makes the line of differentiation between cortex and medulla lucid.

Mounting of hair strands

Each dried hair strands were cleaned in xylene and mounted on a microscopic slide by placing hair strand on slide in a drop of xylene. A cover slip is placed on the hair allowing the medium to spread under cover slip-encasing hair. Each slide has been labelled appropriately and allowed it to dry for 48 hours.

Microscopic Examination

The mounted hair's slides were examined for morphological characteristics and micrometry. These are the following distances and different indices were calculated under microscope by using the micrometer scale.

1. Maximum diameter of the shaft.
2. Diameter of medulla.
3. Medullary Index: Maximum diameter of medulla/ Maximum diameter of hair shaft

Table 1. Diameter of the shaft of human hair

Human hair	Mean (μm)
Scalp hair	50
Moustache hair	80
Forearm hair	30
Pubic hair	60

The data and measurements of all specimens were recorded and analyzed by using SPSS software to calculate the mean and standard deviation.

Results

As shown in table-1 the mean diameter of the shaft of human hair varies between 30 μm to 80 μm . The forearm hair having mean shaft diameter of 30 μm (S.D. 2.28) and the moustache hair having mean diameter of the shaft 80 μm (S.D. 3.44).

The table -2 shows that the diameter of the shaft of animal hair varies between 25 μm to 160 μm . The mean diameter of shaft of dog hair was 25 μm (S.D. 2.82) and the mean diameter of the cow hair was 160 μm (S.D. 4.33). The diameter of shaft of hair is more in many but not in all the animals.

Table-3 shows that the mean diameter of the medulla human hair varies between 5 μm to 20 μm . The mean diameter of the medulla in scalp hair was 5 μm (S. D. 0.89) also in forearm hair 5 μm (S.D. 0.63). The diameter of medulla in moustache hair was 20 μm (S.D. 2.36).

Table-4 shows that in animal hair the mean diameter of medulla varies between 20 μm to 100 μm . The mean diameter of medulla in rat hair was 20 μm (S.D. 2.28) and also in cat hair it was 20 μm (S.D. 0.63). The mean diameter of medulla in cow hair was 100 μm (S.D. 5.47).

Table-5 shows that medullary index in human hair is from 0.1 to 0.25. In animal hair,

Table 2. Diameter of the shaft of hair of Different Animals

Animal hair	Mean (μm)	\pm 2SD
Cow	160	4.33
Goat	100	6.16
Buffalo	110	5.83
Dog	25	2.82
Sheep	90	4.97
Pig	120	6.16
Donkey	50	8
Rat	40	1.78
Cat	30	0.89
Horse	90	4.33
Squirrel	50	6.06
Camel	80	11.17

Table 3. Diameter of medulla of human hair

Human hair	Mean (µm)	± 2SD
Scalp hair	5	0.89
Moustache hair	20	2.36
Forearm hair	5	0.63
Pubic hair	15	2.60

Table 4. Diameter of Medulla of Animal Hair

Human hair (Medullary index)		Animal hair (Medullary index)	
Scalp hair	0.1	Cow	0.62
Moustache hair	0.25	Goat	0.50
Forearm hair	0.16	Buffalo	0.45
Pubic hair	0.25	Dog	--
		Sheep	0.55
		Pig	0.66
		Donkey	0.50
		Rat	0.50
		Cat	0.66
		Horse	0.44
		Squirrel	0.70
		Camel	0.50

Table 5. Medullary Index of Human and Animal Hair

Animal Hair	Mean (µm)	± 2SD
Cow	100	5.47
Goat	50	5.40
Buffalo	50	6.44
Dog	--	--
Sheep	50	1.67
Pig	80	3.68
Donkey	25	3.03
Rat	20	2.28
Cat	20	0.63
Horse	40	5.32
Squirrel	35	3.16
Camel	40	5.69

the medullary index varies between 0.44 to 0.70.

Discussion

It is always considered that the medullary index of hair is used to distinguish animal hair from human hair in cases of forensic application. Medullary index is expressed as a ratio of the shaft diameter to the diameter of the medulla. In animals the medulla will make up more than 1/2 of the total diameter of the hair while in humans the ratio is usually less than 1/3. (Saferstein, 2004)⁷.

The result of hair examination on the basis diameter of the shaft may not be reliable as the diameter of the shaft of hair is not proved to be the significant parameter to differentiate between human and animal hair. It is observed that the diameter of the shaft of hair

of some animals like dog, cat etc. are less than the diameter of the shaft of human hair.

The diameter of the medulla is a useful parameter to differentiate between the human and animal hair. It is observed in the present study that the diameter of medulla of human hair was between 5 to 20 µm and the diameter of medulla of animal hair was between 20 to 100 µm. But this parameter may not be useful in borderline cases where the diameter of the medulla is 20 µm.

In the present study, it was observed that the Medullary Index of human hair was from 0.1 to 0.25. Similar value is stated by Krishnan Vij⁸ and Narayan Reddy⁹ in their text book that the Medullary Index of Human hair is less than 0.25.

In the present study, it was observed that Medullary Index of animal hair was from 0.44

to 0.70. The findings are corroborated with Krishnan Vij⁸ and Narayan Reddy⁹ stated that, the medullary index in Animal hair is more than 0.50. Our findings differ with value of medullary index quoted in Krishnan Vij⁸ and Narayan Reddy⁹ as the medullary index in Buffalo is 0.45 and in horse it is 0.44. This findings corroborated with the findings of Sahajpal et al¹⁰ that the medullary index of bear was very low medullary index (<0.15) except for brown bear which showed a comparatively higher medullary index (0.38)¹⁰.

In the present study it was observed that, the medullary index was less than 0.25 in human hair and more than 0.44 in animal hair. Thus, the medullary index is the most significant and hence the most useful parameter to distinguish between human and animal hair. A study was conducted by the Sato et al¹¹ in order to obtain some fine structural informations available for the identification of hair samples collected in small amounts or fragments of hairs at scene of crime. The hair samples can be examined by using the scanning electron microscopy. They observed that the arrangement of the cortical cells of human hairs was to be fairly irregular with conspicuous inter digitations of cell boundaries as compared with that of animal hairs. The medulla of human and animal hairs was filled with cellular remnants of destroyed medullary cells showing fibrous structures. The lamellar structures of cuticular cells became very clearly visible. The number and the overall thickness of cuticular cell layers in human and animal hairs investigated varied considerably between scalp and pubic hairs and from animal to animal¹¹. With these findings it can be concluded that the hair samples in any form

may be prove very good physical evidence in investigation of crime.

References

1. "Modi's Textbook of MEDICAL JURISPRUDENCE AND TOXICOLOGY": Twenty-first edition, 1988; edited by C. A. Franklin, Publishers N. M. Tripathi Pvt. Ltd.
2. Douglas W. Deedrick, Sandra L. Koch, Microscopy of Hair Part 1: A Practical Guide and Manual for Human Hairs, Forensic Science Communications, January 2004, 6: 12-30.
3. Douglas W. Deed Rick, Hairs, Fibres, Crime and Evidence, Forensic Science Communications, January 2000-Vol. 2-No.3.
4. Kirk B.P., Magagnose S, Salisbury D. Casting of hair: its technique and application to species and personal identification. J. Crim. Law, 1940-50; 40: 236.
5. Evans W.E.D. The use of normal incident illuminations in the examination of hair cuticle. J Forensic Sci. Soc. 1964; 4: 217.
6. Bhatia R.Y.P., Rao K.V., Rao N.P. Site variation in scalp hair morphology in pre-school children. Ind. J. Med. Res. 1980; 71: 890.
7. Saferstein, Richard. *Criminalistics: An Introduction to Forensic Science*. (8th ed.) Pearson Education Inc., Upper Saddle River, New Jersey, 2004.
8. Krishnan Vij, Textbook of Forensic Medicine and Toxicology, 4th Edition, 64-67.
9. Narayan Reddy, The Essentials of Forensic Medicine and Toxicology 12th Edition, 83-86.
10. Sahajpal V., Goyal S.P., Jaypal R., Yoganad K., Thakar M.K. Hair characteristics of four Indian bear species, Science & Justice, 2008; 48: 8-15
11. Santo H., Mivasaka S., Yoshino M., Sete S. Morphological comparison of the cross section of the human and animal hair shafts by scanning electron microscopy. Scan Electron Microsc 1982, (pt 1) 115-125.