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Comparative Analysis of Human Hair Medulla Types among The Ashanti and Dagomba Ethnic Group of Ghana

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Abstract

Hair is an important piece of evidence in forensic investigations. Analysis of the morphological features (medulla) of hair has been reported since the early 1800's. However, many questions still remain unanswered especially as to, how local populations could be analysed and separated from each other based on the morphology (medulla) of their hair. In the Present Study medulla types of hair have been examined among the Ashanti and Dagomba, two important populations of Ghana by using the Comparison and Compound microscope together with Computer imaging. Statistical analysis has been performed on the data to determine the variability and relationships between the two populations. Medulla have been found to be absent in 51.5% of the Ashanti population examined while among the Dagomba it has been observed to be 33%. The difference between the two populations for their medulla types have been found to be statistically insignificant.

Keywords: Human Hair Medulla Types; Dagomba Ethnic Group of Ghana.

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Introduction

Hair analysis often required in forensic problems. It involves examination of the hair shaft including its medulla (inner core), cortex (intermediate layer) and cuticle (outer covering) using comparison microscopes. (Chatterjee, 2012).

Hair can easily be transferred from one person to another and clings to furniture, carpets, clothing, etc. Since hairs can withstand the vagaries of nature for a very long time they are very useful in crime investigation. Even if a suspect tries to clean up the crime scene, he or she would most likely leave hair behind (Collier, 2004).

Examination of hair is routinely done to determine its species origin, site of the body form which it comes from, sex, ethnic group (race) and individual characteristics which may ultimately help as a very important corroborative evidence in linking the suspect and the victim with one another or with the scene of crime. Hair evidence may also help in the elimination of a particular suspect, thereby exonerating him from his involvement in the crime (Weitzel, 1998).s Comparison of hair is usually done using a comparison microscope to determine if there are any matches in their morphology (Robertson, 2017).

The Ashanti population of Ghana has been described to possess some unique morphological characteristics (Awuah, Dzogbefia and Chattopadhyay, 2017). It is therefore expected that these uniqueness will show in the analysis of their hair medulla as well. The Ashanti and the Dagomba are two important geographically separated endogamous populations of Ghana; intermarriages between them are very rare.

Materials and Methods

Hair samples were collected from students of the Kwame Nkrumah University of Science and Technology, KNUST) Campus with their ages ranging between 15–20 years. Ethical consideration was sought from KNUST School of Medical Sciences.

After obtaining the consent from each subject, hair samples were collected from five different sites of the scalp using scissors as close to the root as possible; details about each subject (donor) such as name, age, sex, hometown, place of residence, place of birth (Town and Region), information on parents and grandparents, ethnic group among others were noted down in a register. Samples were examined with compound and comparison microscopes using Wet-mounting to prepare specimens for microscopic examination. Using a mounting fluid (glycerin) with a refractive index close to that of the hair reveals the medulla and other internal structures of the hair. Hair samples collected were labeled 'DA01' to 'DA200' for Dagomba and 'A01' to 'A200' for Ashanti and were stored in one Ziploc bag. Each hair specimen was examined individually under a Leica Compound microscope with the microscope connected to a Sony Trinitron colour video monitor by a Javelin Smart cam Video camera. This monitor allows a full-screen view of the microscopic image. In addition, the monitor was connected to a Gateway 2000 P-90 computer which allowed a good view of the medulla of hair shaft. Data was gathered from each hair and a database was generated. The medullary index (MI) which is the ratio of the maximum diameters of the medulla to the diameter of the shaft of the hair was calculated for each analyzed hair sample with the formula below:

$$\text{Medullary Index (MI)} = \frac{\text{(Maximum Breadth of Medulla)}}{\text{(Maximum Breadth of Shaft)}}$$

Results and Discussion

Hair is an appendage of the skin that grows out of an organ called the hair follicle. It is composed primarily of the protein keratin and is common feature in all mammals and therefore its relevance is not limited to humans, even in forensic investigations. Variability also exists in types of hairs found on different parts of the body; head, pubic region, arms, legs and other body areas. Human hair is one of the most frequently found pieces of evidence at the scene of a violent crime (Brown and Davenport, 2011). It can provide a link between the criminal and the crime scene due to its varying characteristics within and between populations. Morphological analysis of the shaft by microscopy is usually focused on either the cuticle (usually for specie identification) or on the medulla. From hair one can determine if the source is human or animal, the race (sometimes), origin of the location on the source's body, whether the hair was forcibly removed, if the hair has been treated with chemicals or if drugs have been ingested.

Variability in medulla types among Ashanti and Dagomba ethnic groups.

Fig. 1 is a sample obtained from the Ashanti population which shows an example of hair strand with absent medulla type. This hair medulla type is the most common. The sample's shaft diameter is 159.5 mm.

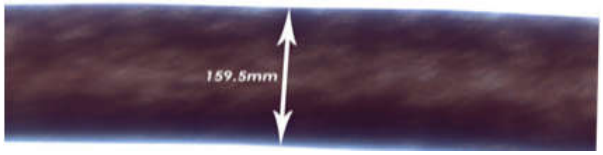

Fig. 1: Hair sample from Ashanti showing absent medulla type.

Fig. 2 is a sample obtained from the Dagomba population. Its microscopic image shows the sample lacked any form of medulla (absent medulla). The sample has a hair shaft diameter of 133.6 mm. The Dagomba population, like the Ashanti population has this hair medulla type being the most common.

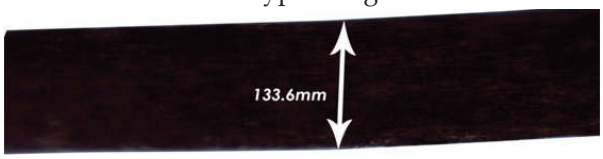

Fig. 2: Hair sample from Dagomba showing absent medulla type.

Fig. 3 is a sample from the Dagomba population. It shows the continuous medulla type. Among the Dagombas about 33.5% of the population possesses the continuous type of medulla. It has medulla diameter of 28.8 mm and a hair shaft diameter of 171.2 mm. This happens to be the most dominant medulla pattern type.

Fig. 3: Hair sample from a Dagomba showing continuous medulla.

Fig. 4 is the microscopic image of a hair sample of a Dagomba showing fragmented medulla type. The hair shaft diameter (161.1mm) is far larger than the medulla diameter (20.6mm).

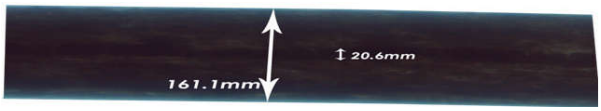

Fig. 4: Hair sample from a Dagomba showing fragmented medulla type.

Morphological hair characteristics are class evidence which can be of help for elimination purposes, but not for actual identification of a specific individual.

Fig. 5: Hair sample from an Ashanti showing continuous medulla.

Fig. 5 is a sample from the Ashanti population. It shows continuous medulla type. In the Ashanti population, only about 17% possesses this medulla type. The shaft and medulla diameters are 204.0 mm and 44.2 mm respectively.

Fig. 6 shows the microscopic image of a hair sample of an Ashanti showing fragmented medulla type. The hair shaft diameter (171.7mm) is far larger than the medulla diameter (23.8 mm).

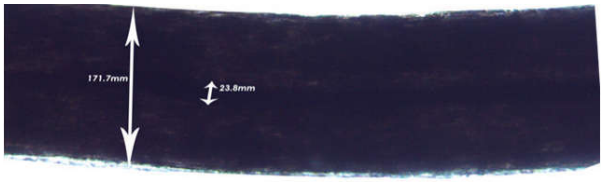

Fig. 6: Hair sample from an Ashanti showing fragmented medulla.

Fig. 7 is a microscopic image of a hair sample obtained from an Ashanti showing discontinuous medulla.

The hair shaft diameter is 156.4 mm for the sample illustrated.

Fig. 7: Hair sample from an Ashanti showing discontinuous medulla type.

It is evident from the above figures (Figs 1 – 7) that the medulla diameter is always equal or less than one-third of the hair shaft diameter, a feature that distinguishes human hair from animal hair (other mammals). The characteristics of hair medulla that prove to be useful in forensic analysis include the medulla diameter and medulla/hair shaft diameter ratio (Robbins, C.R., 2012a).

The frequency of medulla types in the Ashanti population has been summarized in Fig. 8 below. Over 103 sample units representing 51.5% of the total sample size of the Ashanti population had no medulla (medulla absent), 15.5% had fragmented medulla and 16% had discontinuous medulla. The continuous type of medulla represents about 17% of all medulla types in the Ashanti population.

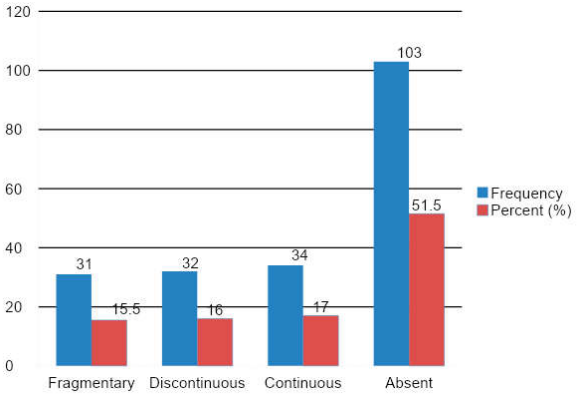

Fig. 8: Histogram of Medulla Types among the Ashanti population.

The greater percentage of the Ashanti population having no medulla therefore makes it very difficult to rely on the use of the medulla types to trace suspects at crime scenes among this ethnic group.

Comparing the medulla types of the Ashanti (Fig. 8) with those of the Dagomba (Fig. 9), there is no statistical difference (p– = 0.522) between the two ethnic groups. Although it has been observed that there is a relationship between these two populations (Taupin, 2004), similarities in one or two characters may not be due to an actual relationship but a matter of coincidence.

The mean medulla diameter and hair shaft diameter of the Dagomba were higher than those of the Ashanti population as shown below. It can be seen that 67 (33.5%) of the sample units have Continuous type of medulla while 38 (19%) of the population show Discontinuous medulla type, a smaller proportion of 29 representing 14.51% have Fragmented medulla type.

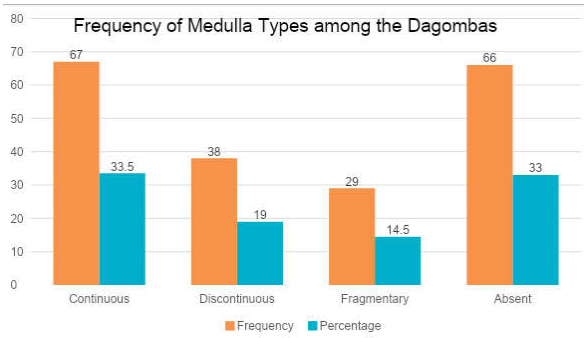

Fig. 9: Histogram of Medulla Types among the Dagomba population studied.

Fig. 9 is a graphical presentation of the medulla type distribution within the Dagomba population.

Unlike the Ashanti population, the Dagomba population is characterized by a higher percentage of medulla presence (14.5% + 19% + 33.5%). The percentage of individuals without medulla (33%) is almost equal to those with continuous medulla type alone (33.5%) as also shown above. Comparing the two histograms it can be deduced that the two ethnic groups have almost the same chart and look the same. Table below is the summary of the test for significance of the variation between the Ashanti and Dagomba populations.

Table 1: Paired Samples Test

		Paired Differences					T	Df	Sig (2 tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
HSD		–2.00202	86.40484	6.14052	–14.11162	10.10758	–.326	197	.745
MD	Ashanti – Dagomba	–.00968	.11834	.01503	–.03973	.02037	–.644	61	.522

From the paired sample T test analysis, it can be seen that the variation between the two populations in terms of hair shaft diameter (HSD) was insignificant. At 95% confidence level, the p-value was 0.745 which is greater than the α-0.05. The variation between the populations for medulla diameter (MD) was also not significant at α–0.05 (p-value 0.522). On the bases of these results, one may conclude that the Ashanti and Dagomba populations of Ghana do not vary significantly. However, Africa has been described as the most genetically diverse continent in the world (Tridico *et al*, 2014), therefore this result was least expected for populations that are geographically, culturally and historically diverse like the Ashantis and Dagombas of Ghana (Table 1).

Medulla types are influenced by age and hence its utility for forensic hair examination is limited (Chattopadhyay, Gonmori and Yoshioka 1994).

From the observation of the microscopic images of this work, it is evident that some level of differences exists between the Ashanti and Dagomba populations of Ghana as shown in the graphs above. However, it is difficult to rely on the results for any kind of identification at this level since the differences are all insignificant as shown in the table above.

Hair may provide evidence indicating either that it probably came from a given individual or that it could not possibly have come from this individual,'' (DiZinno, Wilson, and Budowle, 1999).

Others stated similarly that when comparing an unknown hair specimen with one from a known subject side-by-side, the examiner may conclude: 1) that the hairs are consistent or similar and could have come from the same source; 2) that the hairs are dissimilar and did not come from the same source; or 3) that the hairs possess characteristics which are not sufficiently defined to arrive at a meaningful conclusion (Ogle, 1998).

However, Randall (1994) stated that "The chance of individualizing hair by light microscopy alone is very difficult and in most cases impossible.'' The current research confirms Randall's statement since the findings of this work are inconclusive on individualization. According to the American Association of Physical Anthropologists, (Weitzel, 1998) and Lavker *et al* (2003) the distribution of physical traits resembles the distribution of genetic variation within and between human populations. This may be due to the fact that this investigation focused on only one parameter of hair (medulla).

Some investigators have used a combination of morphological features of hair to achieve stronger conclusions. Tridico *et al.,* (2014) however reported that these factors point to the possibility that human head hair may be positively individualized and used in personal identification. Combination of morphological, chemical and molecular analysis appears as the best method for determining intra-population variability and personal identification.

The findings of this research can therefore serve as an important part of a database of morphological characteristics of hair for the Ashanti and Dagomba populations of Ghana. According to Taupin (2004) "When you are dealing with hair morphology and issues of race you're dealing with range". Even though the study does not provide a method for determining the exact local population associated with an unknown hair of the above named ethnic groups, DNA from their hair would help to support conclusions made from morphological analysis of hair in Ghana.

Conclusion

The present study indicates that morphological characteristics of hair show population variation. Though these are useful for elimination purposes, they are not enough to identify a specific individual

and hence have limited value from the forensic point of view.

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