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Histomorphological and Quantitative Characteristics of Black and Gray Human Scalp Hair

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ABSTRACT The objective of the present study was to understand the histomorphological and quantitative characteristics of black and gray human scalp hair. A total of 440 hair samples (220 black hairs and 220 gray hairs) were collected from 22 adult Bengalee males of West Bengal, aged between 30- 80 years. The hair samples were washed, scanned and measured by standard techniques. Medullary index was calculated. Comparison of medullation types revealed that continuous type of medulltion was more common (44.09%) in gray scalp hair compared to the black scalp hair (12.72%). Medullation was absent in 48.18% black scalp hair. However, the occurrence of discontinuous medulation was nearly equal in both black and gray scalp hair (39.09% vs. 38.63%). Crenate type of cuticle was more common than flattened in both types of scalp hair, although the prevalence was comparatively higher in gray scalp hair (71.80%) than black scalp hair (67.70%). Compared to the black scalp hair, gray scalp hair revealed significantly ($p < 0.05$) higher mean medullary diameter and medullary index. However, there was no significant difference in the mean shaft diameter between black and gray scalp hair, though, a trend of higher shaft diameter in gray scalp hair was observed.

INTRODUCTION

Biological variations are the prime important properties of evolution which through the process of selection shapes the animal body which are generally being considered as signatures for understanding the evolution. Like other organs and parts of animal body, hair has also a range of diversity and the microscopic details of hair strands offer certain definite and variable features as well. These are found to be useful for the purpose of identification.

Hair is a complex structure of keratinized epithelial cells and provides nature's most effective sun block (Slominski and Paus 1993; Rees and Flanagan 1999). Variation in hair color is one of the most striking visible aspects of human genetic variation and is the major co-variant of ultra-violate sensitivity (Naysmith et al. 2004). Our visual appearance derives predominantly from our skin and hair color, and much of the perceived variation between human sub-groups and mammalian species can be ascribed to the different levels and/or types of the pigments involved (Tobin and Paus 2001).

However, compared to other primates, the most striking feature of human scalp hair is that, it is very thick, long and highly pigmented. Teleologically, this phenotype is likely to reflect particular evolutionary selective pressures that were present during the early stages of human evolution along the seacoasts and riverbanks where fish were a dominant part of the diet, which concentrate heavy metals. The selective and avid binding of toxins and metals to melanin within a rapidly growing and highly melanized tissue (without further biogenic change) would have been an important adaptation. There may have been further evolutionary pressures for pigmented hair growth including those which pertained to mate selection strategies and to the fact that our relative nakedness draws much attention to our scalp hair (Tobin 2008). The hair follicles represent one of the few organs of the body which throughout life, undergoes alternating cycles of growth, senescence and rest (Stenn and Paus 2001). Morphologically, the hair follicle is composed of external epithelial compartments, the outer and inner root sheaths, the companion layer and a central hair fiber forming (trichocytic) compartment, comprising the matrix, cuticle and cortex.

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The main structural proteins of the hair fiber are the hair keratins and the hair keratin associated proteins, KAPs1, the latter being encoded by a large number of multigene families (Powell and Rogers 1997). Hair keratins, a subset of the large keratin family whose members are found in all cells of epithelial origin (Fuchs and Weber 1994; Steinert and Roop 1988), represent two multigene families, the type I (acidic) and type II (basic) families which comprise 15 members in humans (Rogers et al. 2000).

Another important evolutionary features of human scalp hair is the onset and progression of hair graying, correlates closely with chronological ageing and occurs to a varying degrees in all individuals, regardless of gender or race/ethnic group (Trueb 2006; Sarin and Artandi 2007; Tobin 2008), particularly in those of Eurasian origin (Tobin 2008). However, the continuing extension of human longevity focuses increasing interest in elucidating the mechanisms of the hair ageing, whether these are contributed from intrinsic (e.g. genetics, evolutionary selective pressures) or extrinsic (e.g. sun exposure, environmental insults and stress) factors (Tobin 2008). In recent decades a number of studies has been undertaken concerning the molecular insight into the diversity of scalp hair colour and its progression of graying (Tobin and Paus 2001; Ha and Rees 2002; Rees 2003; Naysmith et al. 2004; Tobin 2008). However, to best of the knowledge, study concerning the histomorphological and quantitative characteristics of black and gray human scalp hair is yet to be made. In view of the above, the present study in adult Bengalee male was attempted to understand the histomorphological and quantitative characteristics of black and gray scalp hair.

MATERIALS AND METHODS

The present study was conducted on 22 adult Bengalee males from West Bengal, India, age ranged between 30- 80 years (mean ± SD = 53.27±12.14 years). The samples (black and gray hair) were collected from the head by cutting as far as possible near to the scalp. A total of 440 samples (220 black hairs and 220 gray hairs) were collected and washed by standard method (Sarkar and Banerjee 1956; Banerjee 1957; Banerjee and DasChaudhuri 1978). These washed samples were then scanned under 10X ocular and 0.40mm objective. The Shaft and medullary diameter (in mm) of each hair strand was measured randomly at 3 different sites with a micrometer. The medullary types were classified into continuous, discontinuous and absent, following Banerjee (1963, 1965). The cast of the hair cuticle had been prepared by using the standard technique (Heyn 1954; Bhattacharya 1968; Biswas 1979) and classified in the following way flattened, crenate and others. Medullary index (MI) was calculated from shaft and medullary diameter (MI = medullary diameter/ shaft diameter). All the quantitative measurements were re-checked before analysis for possible typological error. Descriptive and inferential statistics including frequency distribution, mean, standard deviation, chi-square and F-test were performed using SPSS (version 10.0) software.

RESULTS

Comparison of histological variables in terms of medullation types in black and gray HSH are presented in table 1. The result revealed that continuous type of medulltion was more common (44.09%) in gray HSH compared to the black HSH (12.72%). In most of the black HSH the medullation was absent (48.18%). However, the occurrence of discontinuous medullation was nearly equal in both black and gray HSH (39.09% vs. 38.63%). It would be apparent from the Table 2 that in both black and gray HSH crenate type of cuticle was more common than flattened (20.4% in black HSH and 16.80% in gray HSH) and other types (11.90%

Table 1: Medullation types in black and gray human scalp hair

Medullary type	*Male*			
	Black HSH		*Gray HSH*	
	No.	*%*	*No.*	*%*
Continuous	28	12.72	97	44.09
Discontinuous	86	39.09	85	38.63
Absent	106	48.18	38	17.27

*Significant at $p<0.05$

Table 2: Cuticular types in black and gray human scalp hair

Cuticular type	*Male*			
	Black HSH		*Gray HSH*	
	No.	*%*	*No.*	*%*
Flattened	45	20.4	37	16.8
Crenate	149	67.7	158	71.8
Others	26	11.9	25	11.4

Table 3: Shaft diameter, medullary diameter and medullary index of black and gray human scalp hair

Variables	Mean ± SD (mm)		
	Shaft	*Medulla**	*Medullary Index**
Black HSH	88.02 ± 24.13	5.3 ± 6.50	0.06 ± 0.08
Gray HSH	84.92 ± 21.43	11.42 ± 8.20	0.13 ± 0.09

*Significant at p<0.05

in black HSH and 11.40% in gray HSH) of cuticle, although the prevalence was comparatively higher in gray HSH (71.80%) than black HSH (67.70%). Comparison (Table 3) of quantitative characteristics between black and gray scalp hair revealed significantly ($p < 0.05$) higher mean medullary diameter and medullary index in gray hair. However, there was no significant difference in the mean shaft diameter between black and gray scalp hair, though, a trend of higher shaft diameter in gray scalp hair was observed.

DISCUSSION

From an evolutionary standpoint, the processes that contribute to aging appear to have evolved in order to maximize fitness in early life (Tobin 2008). Like in other parts of the body, scalp hair is also change with the advancement of age. The hair aging comprises weathering of the hair shaft and aging of the hair follicle in terms of decrease of melanocyte function or graying, and decrease in hair production in androgenetic and senescent alopecia (Trueb 2005). However, the functions of the hair is to excrete melanin, graying of the hair is, therefore, a quantitative expression of the total amount of melanin to be excreted by the body, which in some way, not explained, depends on the metabolism (Gibbs 1942). At its simplest, graying is because of a marked reduction in melanogenically active melanocytes in the hair bulb of anagen hair follicles. The precise events by which melanogenically active melanocytes are lost from anagen adult hair follicles with increasing age remain rather speculative (Tobin 2008). One hypothesis of canities is that hair graying results from an age-related slowdown/ breakdown in the re-population of the new anagen hair bulb with fresh melanocytes from the outer root sheath reservoir. This scenario would involve the loss of the most pigmented and differentiated hair bulb melanocytes during catagen by apoptosis followed by the defective migration of melanocytes from the outer root sheath into the new anagen hair bulb (Tobin and Paus 2001; Tobin 2008).

However, the comparison of histomor-phological and quantative characteristics between black and gray scalp hair in the present study revealed a trend of higher incidence of medulltion in gray scalp hair, compared to the black scalp hair. Moreover, the incidence of discontinuous medullation was nearly equal in both black and gray scalp hair. Sanyal (1990) also demonstrated a positive association of medullation with increasing age. Analysis of cuticle types in the studied population indicated that in both black and gray scalp hair crenate type of cuticle was more common, although the prevalence was comparatively higher in gray scalp hair. Contrary to that, flattened type of cuticle was more common in black scalp hair. Comparison of quantitative characteristics between black and gray scalp hair revealed significantly higher mean medullary diameter and medullary index in gray hair. However, there was no significant difference in the mean shaft diameter between black and gray scalp hair, though, a trend of higher shaft diameter in black scalp hair was observed. Contrary to this, higher mean medullary diameter and medullary index were observed in gray scalp hair than in black scalp hair. This was in corroboration with the previous study (Sanyal 1990) in terms of age effect in medullary diameter in the same population, but in lower age group. Similar result of increasing medullary diameter was observed by Luell and Archer (1964). The association of increasing medullary index with increasing age was also observed by Longia (1966). However, the smaller shaft diameter of the gray hair compare to the black hair might be due to the reduction of pigment granules from the cortex of gray hair. Moreover, the empty space due to the reduction of pigment granules helps to increase the diameter of medulla in gray hair as well as medullary index (Wyncoop 1929; Longia 1966). Study also revealed changes in surface morphology of hair with the advancement of age, most particularly with the reduction in the cuticular scale size (Tobin and Paus 2001). However, the graying of hair was not only associated with the histomorphological and quantitative characters, but studies also revealed that graying of hair was associated with several disease including osteopenia, lower bone mineral density, familial osteoporosis, cardiovascular disease and myocardial (Rosen et al. 1994; Orr-Walker et al. 1997; Tobin and Paus 2001).

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