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Research Article

Hair Medulla and its variations in *Doshaja Prakruti* – An observational study

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Abstract

Background: *Dosha* specific external appearance of hair and diseases related to hair have been described in Ayurveda but description of its internal structure is lacking. Hair tissue has been extensively studied in modern anatomy with reference to its types, regional variations, and microscopic structure. The medulla forms the inner core of the hair and has been associated with strength, stability and appearance of the same. This raises the possibility of medullary patterns of hair being *Prakruti* specific. An observational study was conducted in healthy individuals of specific *Dwandvaja Prakruti* to visualize the medullary pattern in their hair and search for a *Prakruti* specific association. Objective: To observe the medullary pattern in the hair of specific *Dwandvaja Prakruti* and search for association between the two. Methods: 180 healthy participants, aged 18–25 years, were classified into six *Dwandvaja Prakruti* types and their hair samples were collected and examined microscopically. Descriptive statistical methods were used to analyze the findings, with comparison across *Prakruti* groups and gender. Results: Distinct variations in hair medulla were observed across the *Prakruti* groups. The *Kapha- Vata* group showed the highest proportion of continuous (33%) and solid medulla (20%), while the *Vata-Pitta* group presented none (47%) and fragmented medulla (23%). A pattern of greater structural integrity was observed in *Kapha*-dominant individuals, while *Vata*-dominant individuals exhibited more instability in the medulla structure. Conclusion: This study establishes a potential link between *Dwandvaja Prakruti* types and medullary hair patterns with *Kapha*-dominant *Prakruti* showing stronger hair integrity, while *Vata* and *Pitta*-dominant types associated with weaker, fragmented, or absent medullae. Observing medullary hair patterns can assist *Prakruti* assessment and contribute to *Dosha*-specific hair care regimens and preventive strategies for evidence-based *Ayurvedic* trichology.

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Introduction

Ayurveda, the ancient medical science of India, has been profoundly shaped by the wisdom of Acharyas like Charaka, Sushruta and Vagbhata, who have emphasized the importance of Sharir (knowledge of the body) to understand health and disease. (1)

Healthy, long, and vibrant hair is a symbol of overall well-being and often considered one of the diagnostic parameters of health. Ayurvedic literature has explained formation of hair as well as its characteristics in various body constitutions (*Prakruti*) as well as disease conditions.(2) Hair has also been given prognostic value in Ayurveda by highlighting specific hair patterns leading to terminal conditions and ultimately death (*Arishta Lakshana*). (3)

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While Ayurveda has explained the external features of hair, it overlooks its microscopic structure, limiting its potential to explain body constitutions and hair patterns associated with specific pathological conditions. (4)

Hair is a unique characteristic of mammals, providing protection, thermoregulation, and sensory functions (5) and can be classified into different types based on shape, color, and texture. (13) Hair varies across the body, with fine vellus hair covering most areas and thicker, pigmented terminal hair found on the scalp and face. Puberty triggers the development of terminal hair in certain regions. (13)

Structurally, Hair consists of the follicle (living part beneath the skin) and the shaft (keratinized part above the skin) (10). The hair shaft has three layers: cuticle (outermost), cortex (middle, containing melanin), and medulla (inner core).

The medulla, located at the center of the hair shaft, is composed of loosely packed cells arranged in a disorganized manner (8,10,11) and the air spaces between these cells can create a spongy appearance. (8,9,11) Additionally, the medulla contains keratin, a fibrous protein that imparts structural strength to various parts of the hair. (10,11,12,13) The medulla contains more lipids than the rest of the hair fibre (14), but their composition is unclear.

Cosmetically it is indicated that the medulla impacts the external appearance of hair. (15) The medulla may be continuous, interrupted, or none with reference to its pattern in hair. (10)

While the exact function of the medulla remains uncertain, it is believed to play a role in the overall strength and structure of the hair. (17) Additionally, by trapping air, the medulla may help insulate the hair. (21) Hence a continuous or solid medulla may be positively associated with hair strength and complexion whereas a discontinued medullary pattern may do the opposite.

Variations in the medulla occur across different species and individuals. (22) The presence and structure of the medulla can differ significantly between species; for example, many animal hairs typically have a medulla, whereas it is often none in human hair. (23) Additionally, genetic variations can influence the appearance and texture of the medulla, thereby affecting the overall characteristics of the hair. (24) The medulla can vary in type across different hairs as well. (8,9,11)

In forensic science, the medulla plays a vital role in distinguishing and comparing hair samples where its type, presence, and pattern can help identify specific species or individuals, as well as differentiate between animal and human hair. (25)

The present study aims to study the pattern of hair medulla in healthy individuals belonging to different *doshaja prakruti* in search of any distinct association between the same.

Need of study: External characteristics of hair (*Kesha*) have been mentioned in *samhita's* with reference to *eka doshaja Prakruti*. Exploring the Internal structure of hair (specifically medulla) with reference to *prakruti* will help to identify *prakruti* specific characteristics in the same.

Materials and Methods

Type of study: Observational Cross-Sectional Study

Population: Healthy individuals aged 18 to 25 years from both sexes.

Sample Size: 30 for each *Prakruti* with equal representation of both sexes.

Selection Criteria:

Inclusion Criteria:

Normal, Healthy Individuals, Age group: 18 to 25 years, both genders

Exclusion Criteria:

Subjects with any hair or scalp-related diseases and subjects who have undergone hair straightening, keratin treatments, or other procedures that may alter the pattern of hair medulla.

Sampling Procedure (Figure 1): A total of 600 subjects were assessed using Prakruti Parikshan (a method of determining an individual's Ayurvedic body constitution). (26) After determining the Prakruti, 30 subjects (15 males and 15 females) were selected from each of the six Dwandvaja Prakruti types (Kapha-Vata, Kapha-Pitta, Pitta-Kapha, Pitta-Vata, Vata-Pitta and Vata-Kapha), totaling 180 subjects in all. The selection was made to ensure equal representation of both sexes and a balanced distribution of the six Prakruti types. Hair samples were collected from all 180 subjects through a standard procedure and examined microscopically.

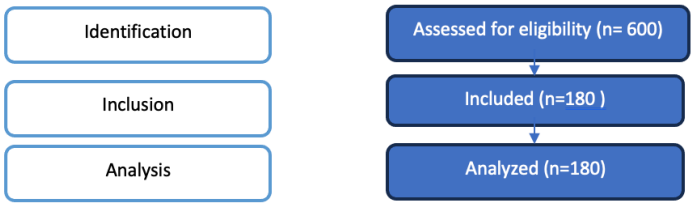


Figure 1 - Identification, Inclusion & Analysis of Participants

Hair Sample Collection Procedure

Hair samples were collected using a standardized and non-invasive procedure designed to minimize contamination and ensure consistency across participants. The following steps were followed for each participant:

Preparation and Consent

Participants were informed about the procedure, and written consent was obtained. They were advised not to use any hair products (e.g., oils, sprays, dyes, conditioners) for at least 48 hours before sampling.

Sampling Site

Hair was collected from the occipital region (the back of the head near the nape of the neck), which is considered ideal due to consistent growth rates and minimal external exposure.

Collection Method

Using sterilized stainless-steel scissors, approximately 1-2 strands of hair were cut as close to the scalp as possible. The proximal end (root end) of each sample was marked or oriented for future reference in analysis. Care was taken to avoid cross-contamination between samples. Scissors were cleaned with isopropyl alcohol between uses.

Storage:

The collected hair was immediately placed in **pre-labelled, clean plastic container**. Each bag was labelled with the participant's unique ID, sex, and Prakruti type. Samples were stored in a cool, dry environment away from direct sunlight and moisture until further processing. (27)

Examination of hair medulla: Each hair sample was examined for its medullary pattern according to sequential protocol (figure 2) (Table1)

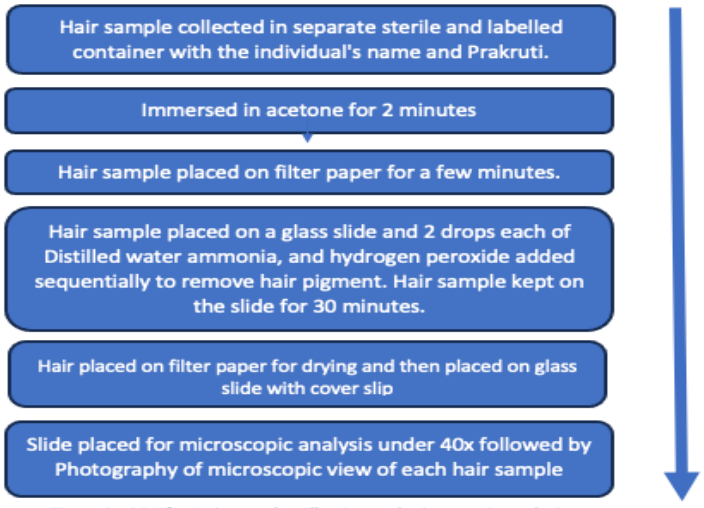


Figure 2 - SOP for Hair sample collection and microscopic analysis

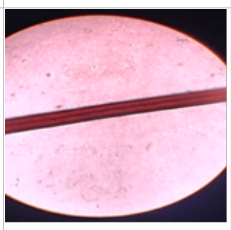
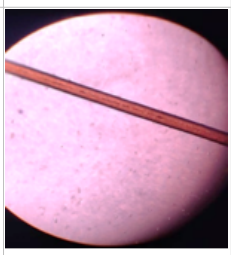
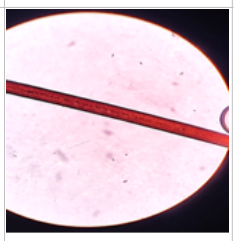
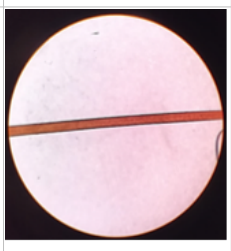
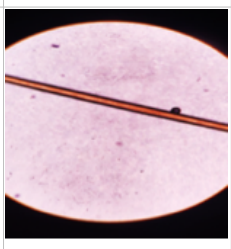
Instruments

Microscope (Magnum MLX-Plus Monocular Illumnation-6v20w halogen Observation tube- 45° Monocular Head Objective -Semi Plan Lens Used Wf-10x), Plastic Container, Forceps, Microscopic Slide, Dropper, Cover Slip

Chemicals

Acetone (Merck life sciences private limited), Ammonia 25% (Merck life sciences private limited), Hydrogen Peroxide 30% (Merck life sciences private limited), Distilled Water (BE pure Tech private limited).

Table 1: Identification of Medulla pattern

Sr. No.	Type of Medulla	Identification pattern	Hair Medulla Pattern
1	Continuous	Runs uninterrupted along the entire length of the hair. (16)	
2	Fragmented	Characterized by sparse, fragmented sections. (17)	
3	Interrupted	Appears in segments throughout the hair shaft. (18)	
4	Solid	Filled with pigmented cells that blend seamlessly with the cortex. (19)	
5	None	Entirely missing from the hair. (20)	

Observations and Results

This observational cross-sectional study was conducted in 180 participants, divided into six groups, with each group having 30 individuals of one particular *Dwandvaja Prakruti*. The hair medulla of these 180 healthy individuals was observed microscopically and the findings were recorded.

1. *Kapha-Vata Prakruti (n=30)*

Table 2: Medulla pattern in *Kapha-Vata Prakruti*

Medulla Pattern	Number of individuals	Percentage
Continuous	10	33%
Fragmented	5	17%
Interrupted	1	3%
Solid	6	20%
None	8	27%

Amongst *Kapha-Vata* individuals, 33% presented a continuous medulla, reflecting strong, resilient, and well-nourished hair due to *Kapha's* stability. 20% individuals showed a solid medulla enhancing the hair's strength and density, making it less prone to breakage. This group, amongst all, showed the highest proportion of continuous and solid medullary pattern.

Fragmented medulla was seen in 17% individuals while 3 % showed an interrupted one whereas the it was none in 27%. The said pattern can be attributed to the association of *Vata* and hence such hair may require additional care to minimise effects of the same.

2. *Kapha-Pitta Prakruti (n=30)*

Table 3: Medulla pattern in *Kapha-Pitta Prakruti*

Medulla Pattern	Number of individuals	Percentage
Continuous	5	16%
Fragmented	6	19%
Interrupted	3	10%
Solid	9	29%
None	8	26%

Kapha-Pitta Prakruti is a blend of *Kapha's* stability and *Pitta's* hot and pungent properties, which can influence the hair structure accordingly. In this group, 45 % individuals reflected moderate to high hair integrity, with 29% having a solid medulla contributing to strong, thick, and resilient hair and 16% presenting a continuous medulla enhances the consistency and stability of the hair.

29 % subjects presented a discontinuous medulla with 10% showing interrupted and 19% showing fragmented pattern. while the medulla was none in 26% subjects. This can be attributed to *Pitta's Teekshna* and *Ushna* effect on the hair pattern thereby affecting the medulla as well.

3. *Pitta-Kapha Prakruti (n=30)*:

Table 4: Medulla pattern in *Pitta-Kapha Prakruti*

Medulla Pattern	Number of individuals	Percentage
Continuous	6	20%
Fragmented	6	20%
Interrupted	1	3%
Solid	5	17%
None	12	40%

This group showed a mixture of stability as well as fragility, where 40 % subjects did not have a medulla in their hair whereas the rest 60% presented a medulla, with 37% covering the continuous and solid pattern and the rest 23 % were seen to have an interrupted and fragmented pattern. Even though *Kapha's* presence brings in stability, the association of Pitta may affect the same, thereby having implications on the medulla.

4. *Pitta-Vata Prakruti(n=30)*:

Table 5: Medulla pattern in *Pitta-Vata Prakruti*

Medulla Pattern	Number of individuals	Percentage
Continuous	7	23%
Fragmented	5	16%
Interrupted	1	3%
Solid	12	39%
None	6	19%

Pitta's pungent, yet *Snigdha* nature and the dynamism of *Vata* must be having implications on hair as well. This group exhibited a somewhat mild to moderate integrity with 19% having no medulla, 16% a fragmented one and 3% exhibited an interrupted medulla. The remaining 39% subjects had a solid medulla while 23% a continuous one. Overall, the Pitta-Vata group, in view of the medulla pattern, presented a balanced scenario.

The rest 52 % were segregated into 39% solid and 23% continuous medulla. Overall, the *Pitta-Vata* group, in view of the medulla pattern, tend to present less stability in hair.

5. *Vata-Pitta Prakruti(n=30)*:

Table 6: Medulla pattern in *Vata-Pitta Prakruti*

Medulla Pattern	Number of individuals	Percentage
Continuous	4	13%
Fragmented	7	23%
Interrupted	2	7%
Solid	3	10%
None	14	47%

The dry, rough Vata becomes agitated with the presence of Ushna and teekshna *Pitta*, thereby making this group a very vulnerable and unstable cohort. This outcome is witnessed in the hair pattern as well, as in this group 13% had a continuous medulla and 10% a solid one. The rest 30% showed a discontinuous one with 7% an interrupted medulla and 23% a fragmented one. While in 47% subjects of this group, the medulla was none.

6. *Vata-Kapha Prakruti*:

Table 7: Medulla pattern in *Vata-Kapha Prakruti*

Medulla Pattern	Number of individuals	Percentage
Continuous	7	23%
Fragmented	5	17%
Interrupted	0	0%
Solid	9	30%
None	9	30%

Though *Vata* exhibits dominance in this group, the soothing and moist nature of *Kapha* somewhat dilutes the dynamic, rough and dry nature of *Vata*. Hence a mix picture was seen in this group representing *Vata and Kapha* characteristics almost equally, with 23% having a continuous medulla and 30% a solid one. *Vata* showed its characteristic in the rest 47 % amongst whom 17% subjects had a fragmented medulla while 30% had none.

Discussion

The current study aimed to evaluate medullary hair patterns among individuals with six *Dwandvaja Prakruti* types, based on Ayurvedic constitutional profiling. The findings provide novel morphological insights into how *Dosha* predominance affects hair structure, particularly the integrity of the hair medulla. To our knowledge, few studies have correlated *Prakruti* assessment with objective anatomical hair features, making this research a step toward integrative morpho-Ayurvedic diagnostics (28,29,30).

Interpretation of Findings

Kapha-dominant combinations, such as *Kapha-Vata* and *Kapha-Pitta*, showed a higher proportion of individuals with solid and continuous medulla, which are typically associated with strong, thick, and resilient hair. Specifically, *Kapha-Vata* individuals exhibited the highest medullary integrity, with 53% of participants having solid or continuous medulla. This finding aligns with Ayurvedic descriptions of *Kapha Guna* such as *Snigdha* (unctuous), *Guru* (heavy), and *Sthira* (stable), which contribute to tissue strength and nourishment, especially of *Asthi* and *Majja Dhatus* that support hair structure (28,31,32).

In contrast, Vata-Pitta individuals demonstrated the poorest hair integrity, with 47% showing absence of medulla and a significant portion exhibiting fragmented or interrupted patterns. The dominance of *Vata* (*Ruksha and Chala*) along with Pitta (Ushna and Teekshna) qualities may compromise the structural composition of the hair shaft, making it more prone to thinning, breakage, and dryness (31,33,34).

The *Kapha-Pitta* group displayed a mixed profile, indicating an interaction between stabilizing and destabilizing forces. While 45% had solid or continuous medullae, 29% had discontinuous types, and 26% showed complete absence. This suggests that although *Kapha* offers structural support, the influence of *Pitta*'s heat and intensity might compromise medullary formation, resulting in hair that is partially resilient but also prone to structural inconsistencies (32,34).

Similarly, *Vata-Kapha* individuals reflected a balanced pattern—*Kapha*'s stabilizing influence was evident in the 53% with solid or continuous medullae, but *Vata*'s dryness was also apparent in the 47% who had fragmented or absent medullae. This supports the classical Ayurvedic concept that *Kapha* can pacify *Vata* to some extent, but not completely override its effects (28,31,33).

Comparison with Existing Literature

The relationship between *Dosha* predominance and physical traits, including skin and hair, is well established in Ayurvedic literature (28,29). However, empirical evidence linking *Prakruti* with microscopic hair characteristics, such as medullary patterns, remains sparse. A few studies have evaluated hair texture and elemental composition in relation to *Dosha* type, showing that *Kapha*-related traits favor robustness, while *Vata* and *Pitta* dominance correlate with fragility and degeneration (32,34,35).

Our findings are in alignment with these trends and extend the evidence by focusing on the anatomical presence, continuity, or fragmentation of the medulla—a feature often overlooked in Ayurvedic clinical assessments.

Possible Mechanisms and Ayurvedic Insights

From an Ayurvedic standpoint, hair (*Kesha*) is considered a by-product (*Mala*) of *Asthi Dhatu*, and its quality is influenced by the balance of *Doshas* and strength of *Dhatu Agni* (tissue metabolism) (28,33). In *Kapha*-predominant individuals, optimal *Asthi Dhatu* function and tissue stability contribute to better hair quality. Conversely, *Vata's* dry and erratic nature impairs proper tissue nourishment while excessive Pitta may overheat tissues, leading to premature weakening - both of which may explain the observed medullary deterioration in *Vata-Pitta* group (31,32,34).

Clinical and Preventive Significance

These findings have important implications for Ayurvedic preventive care and personalized hair management. Understanding *Prakruti*-specific vulnerabilities can guide dietary and lifestyle interventions. For instance, *Pitta-Vata* individuals may benefit from cooling, lubricating, and nourishing regimens, while *Kapha* types may require more maintenance for seborrheic or dense hair conditions (29,31,33). The medullary patterns observed here could potentially serve as biomarkers for hair health assessment in clinical practice (30,35).

Limitations

This study is limited by its sample size, despite equal group representation. Additionally, external variables such as environment, nutrition, genetics, and hair care practices were not controlled and may influence hair morphology independently. The absence of advanced analytical methods like SEM imaging or elemental analysis limits deeper biochemical understanding. Future studies should incorporate these tools to further validate correlations between *Prakruti* and hair structure (31).

Future Scope

Larger, multi-centric studies including mono-dominant *Prakruti* types and correlating with biochemical and mineral composition of hair would enhance the understanding of *Dosha*-specific hair characteristics. Furthermore, evaluating the impact of *Dosha*-specific Ayurvedic therapies on medullary restoration could open new avenues in Ayurvedic trichology (29,32,36).

Conclusion

This study establishes a clear link between Dwandvaja Prakruti types and medullary hair patterns. Kapha-dominant types showed stronger hair integrity, while Vata and Pitta and dominant types were associated with weaker, fragmented, or absent medullae. These findings support Ayurvedic principles and highlight the relevance of *Prakruti* in understanding individual hair characteristics. Medullary analysis may serve as a useful adjunct in personalized Ayurvedic hair care and diagnostics.

Furthermore, observing medullary hair patterns can assist *Prakruti* assessment through objective physical traits, thus imparting more accuracy to the examination. Individuals with *Vata* or *Pitta* dominance, who show weaker medullary structures, can be identified early for targeted interventions. This supports the development of *Dosha*-specific hair care regimens and preventive strategies, contributing to evidence-based *Ayurvedic* trichology.

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