Dermatology

TENSILE STRENGTH OF SCALP HAIR IN WOMEN WITH HAIR LOSS

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**ABSTRACT** BACKGROUND: Hair loss may occur due to increase in breaking of hair due to a reduction in tensile strength of hair stretch up to 20% of its original length before breaking if its dry and up to 50% if its wet.

AIM&OBJECTIVE: To evaluate the tensile strength of scalp hair in women with alopecia.

**METHODS:** A case control study of about 50 cases with alopecia (assessed by Ludwig scale) and 50 controls with age and sex matched subjects of above 18 years of age were included. 5 - 10 samples of 15 cms hair were collected from each subject and evaluated for tensile strength of both dry and wet samples with the help of zwick/roell machine.

**RESULTS:** This study found that tensile strength breaking point Fmax (gF) dry was statistically significantly lower in cases( $82.36\pm24.13$ ) compared to controls ( $93.66\pm23.08$ ), t(98)=-2.382, p=0.02. Similarly tensile strength breaking point Fmax (gF) wet was statistically significantly lower in cases( $86.10\pm23.38$ ) compared to controls ( $94.92\pm16.69$ ), t(98)=-2.171, p=0.03. In the same way our study results showed that tensile strength breaking elongation dL at Fmax(%) dry and wet didn't show any statistical significance between the two groups(p=0.50, p=0.53 respectively).

**CONCLUSION:** This study shows that tensile strength of hair in women with alopecia had increased breakability in both dry and wet samples when compared with controls and also statistically significant whereas elasticity of hair was not statistically significant

# **KEYWORDS**:

# INTRODUCTION

Hair is a natural fiber fashioned by keratin, a macromolecule containing a high concentration of sulfur returning from the organic compound amino acid cysteine<sup>1</sup>. Each hair follicle has a cycle of its own, independent of the neighboring hairs. Normally, less than 50 hairs are lost per day<sup>2</sup>. Twenty five percent of head hair may be lost without significant notice<sup>2</sup>. Alopecia Areata (AA) is a common form of non-scarring alopecia involving the scalp and/or body, characterized by hair loss without any clinical inflammatory signs<sup>3</sup>. It is one of the most common form of hair loss seen by dermatologists and accounts for 25% of all the alopecia cases<sup>4</sup>.

The factors affecting tensile strength of hair are relative humidity, temperature, diameter of hair, twisting and stretching, weaving and grooming<sup>5</sup>. Human hair fibers are subjected to physical stress as they're combed and styled; therefore, several of the studies have centered on the mechanical properties in tension<sup>6</sup>.

Female Pattern Hair Loss (FPHL) has been evolved as the ideal term for AndroGenetic Alopecia (AGA) in women due to the uncertain relationship between androgens and this entity. Female pattern hair loss is the commonest hair loss disorder among women. Initial symptoms may be seen during the teenage years and can lead to progressive hair loss with a distinct pattern distribution. Female pattern hair loss from the progressive miniaturization of hair follicles and further reduction in the quantity of hairs, mainly in the central, frontal, and parietal scalp regions<sup>7,8</sup>.

Female pattern hair loss show 3 important clinical manifestations<sup>9</sup>.

- Ist pattern- diffuse thinning of the upper biparietal and vertex regions and no damage to anterior hair implantation line.
- IInd pattern- thinning of the vertex region and upper bitemporal region. accentuation of frontal region that takes up as a triangular or Christmas tree form with loss of hair in a triangular shape in the frontal-vertical area
- IIIrd pattern- recession of the frontal-temporal hairline and true vertex balding, which is typically seen in men but occasionally occurs in women.

### **AIM & OBJECTIVE**

To evaluate the tensile strength of scalp hair in women with alopecia.

# MATERIALS AND METHODS

Study Design: case control study.

Period Of Study: August 2017-August 2018.

### Study Participants:

Study Subjects: 50 female patients with signs of alopecia above18 years of age who attended the Out Patient Department at Vinayaka Missions Medical College & Hospital, Karaikal from August 2017 to August 2018 are the study subjects.

Controls:50 age matched with no signs of alopecia female individuals who attended dermatology Out Patient Department, Vinayaka Missions Medical College, Karaikal were included as controls.

# Inclusion Criteria

- 2. Women patient with alopecia
- 3. Participants who gave consent

# **Exclusion Criteria**

- 1. Patients who undergo hair straightening procedure
- 2. Patients who use hair dryer regularly
- 3. Patients who are chronically ill or having major systemic illness
- 4. Patients who are non-compliant

Ethical committee clearance was obtained before starting the study. The purpose of the study was explained to the subjects in their own dialect and informed consent was obtained from them.

### METHODOLOGY

Data were collected using a pretested proforma meeting the objectives of the study.

Socio-demographic data were collected and laboratory investigations were carried out after recruitment.Both the patients and controls were instructed to wash their hair with shampoo (15ML) on the day of sampling.Ten samples from each patient and control were collected.Each sample measuring 15 cm in length is collected by plucking of hair from the scalp. Tensile strength was assessed in all subjects in the study by using zwick/roell machine at SITRA with a preload of 0.1N and test speed rate at 2.5 mm/min and the parameters are recorded.Normal or predicted range of values was obtained from the controls.All patients were evaluated as follows with respect to history, general examination, systemic examination, dermatological examination and Investigations.

# **Statistical Analysis:**

Data was entered into microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of frequencies and proportions. p value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.

### RESULTS

A total of 100 female subjects aged above 18 years attending the department of Dermatology ,Venereology and Leprosy Out Patient Department , Vinayaka Missions Medical college and Hospital, Karaikal between August 2017 and August 2018 who have consented for the research purpose were taken up for the study. All the patients were randomly allocated to any one of the following two groups. • Group I (50 patients with alopecia)

• Group II (50 Controls with no alopecia)

#### Table No.1-Age Distribution Of Patients (N=100)

Age in Years	Group I (n=50)	Group II (n=50)	Total
18- 30 yrs	32 (64)	42 (84)	74
31- 40 yrs	16 (32)	7 (14)	23
41-50 yrs	2 (4)	1 (2)	3
Mean±SD	27.90±7.28	25.52±5.89	0.075
Total	50 (100)	50 (100)	100

• Samples are age matched with P=0.07, Independent t test





Table no.1 and Graph no.1 shows that out of the 50 patients studied in Group I, maximum number of patients belonged to age group of 18-30 years i.e. 32 patients (64%) followed by the age group 31-40 years, i.e. 16 patients (32%) and 41-50 years of age, i.e. 2 patients (4%). Out of the 50 controls in Group II, maximum number of controls belonged to age group of 18-30 years i.e. 42 controls (84%) followed by the age group 31-40 years, i.e. 7 controls (14%) and 51-60 years of age, i.e. 1 control (2%).

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Table No.2– Distribution Of Patients According To Ludwig Classification (N=50)





Graph 2: Distribution Of Patients According To Ludwig Classification (N=50)

Table no.2 and Graph no.2 shows that according to Ludwig classification out of 50 patients in Group 1, majority 46% (23 patients) of them are having Type 2 followed by 44% (22 patients) having Type 1 and remaining 10% (5 patients) are having Type 3.

Table No: 3	- Distribution	<b>Of Patients</b>	According	To Hair	• Tensile
Strength (N	=100)		_		

Variable	Group 1	Group 2	p value
	(n=50)	(n=50)	(Independent t
	Mean±SD	Mean±SD	test)
TENSILE	82.36±24.13	93.66±23.08	0.02*
STRENGTH			
BREAKING			
POINT Fmax			
(gF) DRY			
TENSILE	86.10±23.38	94.92±16.69	0.03*
STRENGTH			
BREAKING			
POINT			
Fmax(gF) WET			
TENSILE	39.82±3.86	39.34±3.28	0.50
STRENGTH			
BREAKING			
ELONGATION			
dL at Fmax(%)			
DRY			
TENSILE	37.60±5.68	38.20±3.60	0.53
STRENGTH			
BREAKING			
ELONGATION			
dL at Fmax(%)			
WET			

\*Significant

Table no.3 shows that tensile strength breaking point Fmax (gF) dry was statistically significantly lower in Group 1( $82.36\pm24.13$ ) compared to group 2 ( $93.66\pm23.08$ ), t(98)=-2.382, p=0.02. Similarly tensile strength breaking point Fmax (gF) wet was statistically significantly lower in Group 1( $86.10\pm23.38$ ) compared to group 2 ( $94.92\pm16.69$ ), t(98)=-2.171, p=0.03.In the same way this study results showed that tensile strength breaking elongation dL at Fmax(%) dry and wet did not show any statistical significance between the two groups(p=0.50, p=0.53 respectively).



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Series Graph Controls Sample - Dry



Series Graph Cases Sample - Wet



Series Graph Controls Sample - Wet

## DISCUSSION

In the present study, group I are the case group and group II are controls.Findings of the study showed that, out of the 50 patients studied in Group I, maximum number of patients belonged to age group of 18-30 years i.e. 32 patients (64%) followed by the age group 31-40 years, i.e. 16 patients (32%) and 41-50 years of age, i.e. 2 patients (4%). Out of the 50 participants in Group II, again maximum number of controls belonged to age group of 18-30 years i.e. 42 controls (84%) followed by the age group 31-40 years, i.e. 7 controls (14%) and 51-60 years of age, i.e. 1 control (2%). Ablon G et al<sup>10</sup> conducted a randomized control trial on women with self-perceived thinning hair and the age of the participants in that study was found to be 21-65 years.

This study found that tensile strength breaking point Fmax (gF) dry was statistically significantly lower in Group 1(82.36±24.13) compared to group 2 (93.66±23.08), t(98)=-2.382, p=0.02. Similarly tensile strength breaking point Fmax (gF) wet was statistically significantly lower in Group 1(86.10±23.38) compared to group 2 (94.92±16.69), t(98)=-2.171, p=0.03. In a study conducted by Urban VM et al<sup>11</sup>, effect of the association of nystatin with a tissue conditioner on its ultimate tensile strength was studied. Results of the study showed that mean (force-grams (gf) +/- standard deviation) of the tensile strength was: GI-634.29 +/- 122.80; GII-561.92 +/- 133.56; and GIII-547.30 +/- 73.47 for 24-hour storage, and for 7-day storage it was, GI-536.68 +/- 54.71; GII-467.50 +/- 143.51; and GIII-500.62 +/- 159.76. The mean ultimate tensile strength of all experimental groups after 7 days were significantly lower than what being observed after 24 hours.

In the same way this study results showed that tensile strength breaking elongation dL at Fmax(%) dry and wet did not show any statistical significance between the two groups(p=0.50, p=0.53 respectively).

Normally if we take fibers of 5 cm long and stretch them to 20% of their length at a rate of extension and recovery of 0.25 cm/min. The rate of extension will influence the tensile results<sup>12,13</sup>.

Extension to about 30% or slightly higher, in the wet state, can produce multiple circumferential fracturing of the cuticle, with separation of entire cuticle section from the cortex<sup>12,13</sup>.

Harris coined the term "30% index" as the ratio of tensile values to 30% extension<sup>12,13</sup>.

Usually 30% or higher can produce cuticle damage that is not normally detected in load-elongation parameters; hence, stretching hair to lower percentage extensions (15-25%) is preferable<sup>12,13</sup>.

Use of bleaching of hair commonly produces decreases in the wet tensile properties of up to 25%, with greater loss occurring when the fibers are frosted or stripped and in many cases bleaching changes in the dry tensile properties are very small and close to the limits of detection<sup>12,13</sup>.

V Velasco MV et al<sup>14</sup> studied hair fiber characteristics and methods to evaluate hair physical and mechanical properties. Article highlighted that physical proprieties of hair depend mostly on its geometry. Caucasian hair is oval; Asian hair is circular; Afro hair is elliptic. Hair is surprisingly strong. Cortex keratin is responsible for this property and its long chains are compressed to form a regular structure which, besides being strong, is flexible. Hair fiber has an elastic characteristic and it may undergo moderate stretching either wet or dry. Stretching is a hair attribute under the action of a distal force (length) and the thread returns to the original status, when this force stops acting.

Fernanda M et al<sup>15</sup> studies shows that the hydrophobicity of the hair is possible thanks to the 18-MEA lipid layer. Removal of this covalently linked fatty acid renders the fiber hydrophilic. When wet, virgin hair can be stretched by 30% of their original length without damage; however, irreversible changes occur when hair is stretched between 30% and 70%. Stretching to 80% causes fracture.

Hu Z et al<sup>16</sup> studied the Young's modulus and Poisson's ratio of Human Hair using Optical techniques. Human hair fibers undergo tensile forces as they are groomed and styled. Experiments were conducted for testing the mechanical properties after acid, aqueous alkali and neutral solution treatment of human hair. Results of the study showed that the Poisson's ratio of original human hair from a female hair was 0.38. Poisson's ratio and Young's modulus of human hair was lesser than the original value after it has been treated by chemical solutions. On comparing, the three groups on the basis of chemical treatment, highest Young's modulus and Poisson's ratio was seen in the water solution treated hair, followed by acid and alkali solutions treated.

Natarajan K et al<sup>17</sup> studied the effect of oil application, diet, age and pigmentation on the tensile strength and breaking of hair. Study included four categories of participants. Each category had two groups for comparison. Four categories were as follows; first group was vegetarian and non-vegetarian, second group included the individuals who regularly apply oil and those who do not apply oil; third group was children and elderly, fourth group was pigmented and non-pigmented hair. Thus, the four categories included eight groups in total. 15 participants were under each group. Thereby, total participants were 120. Results of the study showed that elasticity among children's hair was more than the elasticity of adult hair (P = 0.05) even though tensile strength in children hair was not statistically significant (>0.05). in the same way, the tensile strength was more among those who regularly consumed non-vegetarian food but the difference was not statistically significant (P>0.05). No statistically significant difference was seen in other groups (P>0.05).

#### CONCLUSION

This study found that tensile strength breaking point Fmax (gF) dry was statistically lower among cases compared to controls. Similarly tensile strength breaking point Fmax (gF) wet was lower among cases compared to controls. This study results showed that tensile strength breaking elongation dL at Fmax(%) dry and wet did not show any significant difference between the two groups.

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