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ASSOCIATION OF ANDROGENIC ALOPECIA WITH METABOLIC SYNDROME AMONG FEMALE PATIENTS: A CASE-CONTROL STUDY

Dermatology

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ABSTRACT

Background: Evidence suggests an association between androgenetic alopecia (AGA) and metabolic syndrome (MetS). However, data among women particularly in the Indian population remain limited. **Aim:** To determine the association of AGA with MetS among female patients at tertiary care hospital. **Methods:** This is a case-control study comprised total of 70 patients attended dermatology OPD with the history of AGA. 70 eligible patients were randomly divided in to two groups viz. Control and Cases. The weight and height (for body mass index), waist circumference, and blood pressure were assessed in both groups. The lipid profile was estimated in blood sample. MetS was diagnosed as per the new International Diabetes Federation criteria. Assessment of AGA was done according Savin Scale. **Results:** The study included 35 women with AGA (cases) and 35 age-matched controls, Cases had significantly higher body mass index and waist circumference than controls (both $p = 0.001$). MetS was identified in 65.7% of cases compared with 20.0% of controls, demonstrating a strong association with AGA ($\chi^2 = 14.933$, $p = 0.001$). Among the MetS components, central obesity ($p = 0.008$), elevated triglycerides ($p = 0.001$), and elevated fasting plasma glucose ($p = 0.031$) were significantly more frequent in cases. Most patients presented with early-to-moderate alopecia, predominantly Stage II-1 (20.0%). However, alopecia severity was not significantly associated with the presence of MetS ($\chi^2 = 5.305$, $p = 0.725$). **Conclusion:** Significant association exists between female AGA and MetS, with affected women exhibiting a markedly higher incidence of MetS. Early screening for MetS and its components is beneficial in patients with early-onset AGA.

KEYWORDS

Androgenetic Alopecia, MetS, Central Obesity, Blood Pressure, Fasting Blood Glucose

INTRODUCTION

Alopecia is a chronic dermatological disorder characterized by partial or complete loss of hair, and in certain cases, it may involve the entire body.[1] Although it is neither life-threatening nor typically associated with pain, the condition can have considerable psychological consequences, including anxiety and depression.[2] Among the various forms of alopecia, androgenetic alopecia (AGA) is the most prevalent, presenting as a progressive and symmetrical pattern of hair loss in both men and women.[3] Male pattern AGA is the most frequent form of hair loss, affecting nearly 46% of men aged 20–50 years, predominantly involving the frontal and temporal scalp regions. It generally begins during adolescence and progresses gradually over time. In women, the onset usually occurs later in life and rarely advances to complete baldness.[4]

Although AGA is regarded as a medically benign disorder, its adverse effects on psychosocial well-being can be substantial. It is one of the most frequently encountered conditions in dermatology outpatient clinics worldwide.[5] A population-based study conducted in India involving 1005 participants reported a prevalence of 58% among men aged 30–50 years.[6] In contrast, epidemiological information regarding female AGA remains limited. Norwood reported an overall prevalence of approximately 19% among 1006 Caucasian women.[7] Lower prevalence rates have been documented in Asian populations, with studies reporting 6.0% in Chinese women and 5.6% in Korean women, indicating that, similar to men, AGA appears to occur less frequently in Oriental populations than in Caucasians.[8,9]

The precise etiology of AGA remains unclear; however, it is believed to result from a complex interaction between genetic predisposition and environmental influences.[2] Several contributing factors have been proposed, including hormonal disturbances, insulin resistance, cardiovascular disorders, and malignancies.[10-13] Metabolic syndrome (MetS), a systemic metabolic disorder, has also been implicated in the pathogenesis of AGA because of its associated physiological and anthropometric alterations.[14] MetS is characterized by central obesity (waist circumference >102 cm in men and >88 cm in women), obesity with a body mass index (BMI) >30 kg/m², elevated triglyceride levels (>150 mg/dL), hypertension (blood pressure ≥130/85 mmHg), hyperglycemia (>110 mg/dL), and reduced high-density lipoprotein cholesterol (<40 mg/dL in men and <50 mg/dL in women).[15]

Male pattern baldness has been associated with several systemic disorders, including coronary artery disease,[16] hypertension,17 insulin resistance,[18] dyslipidemia,[19] obesity,[20] prostate cancer,[21] benign prostatic hyperplasia,[22] scalp pain, and smoking. Elevated androgen concentrations have also been implicated in promoting atherosclerosis and thrombosis, thereby contributing to hypercholesterolemia and hypertension.[5]

Despite the rising burden of both AGA,[23] and MetS in India,[24] data describing their association within the Indian population remain limited.[5] Previous investigations have examined the relationship between AGA and the individual components of MetS.[11,25] However, the majority of these studies have focused predominantly on male participants,[26-28] while evidence concerning female patients remains scarce.[29] Hence, the current study was designed with the main purpose to determine the association of AGA with MetS among female patients attended dermatology outpatient departments at out tertiary care hospital.

MATERIALAND METHODS:

Study Design :

This is a case-control study comprised of total 70 patients attending outpatient department with the history of AGA in the Department of Dermatology, Bapuji Hospital and Chigateri Hospital attached to J. J. M. Medical College, Davangere.

Sample Size:

The sample size was calculated using the formula for estimating a proportion:

$$N = \frac{Z^2 pq}{d^2}$$

Where Z is the standard normal deviate corresponding to a 95% confidence interval (1.96), p is the reported prevalence of AGA (77%)in previous study,[5]
q = 100 - P(23%), and
d is the absolute precision (10%).
Substituting these values, the final sample size obtained was 68.03 and it was rounded up to 70.

Inclusion Criteria

Patients:

1. Age: 30-60 years for both controls and cases
2. For cases, women with Grade I AGA according to Ludwig classification
3. For controls, women with a dermatological disease other than AGA
4. Willing to give consent for study.

Exclusion Criteria

Patients with:

1. Psoriasis
2. Hypothyroidism history
3. Pregnancy
4. Drugs which lower the blood sugar and serum cholesterol level
5. Hormonal drug
6. Steroid use

Selection of Cases and Controls:

70 eligible patients were randomly divided in to two groups viz. Control and Cases. 35 consecutive cases of AGA were selected in Cases group, and 35 consecutive age-matched controls were selected in Control group from patients attending the Dermatology OPD.

Data Collection and Assessment Parameters

The socio-demographic details of patients such as age, weight and height (for BMI calculation), waist circumference, socio-economic status (SES), history of tobacco and alcohol consumption were recorded in a structured proforma. Patients undergone through general and systemic examination. History of hair loss & recession of hair line, history of gastrointestinal tract (GIT) dysfunction, thyroid disorders, psycho-social concern, history of local application of hair products, history of use of hair dryers, and/or straightener, and/or curlers were recorded in a structure proforma.

Diagnosis of AGA was based on history and clinical findings including early age of onset (<35 years) and pattern of increased hair thinning on frontal and parietal scalp with greater hair density on the occipital scalp. Assessment of AGA was done according Savin Scale (1994).[30] The Savin scale measures overall thinning of the crown scalp, and consists of 8 crown density reflecting a range from no hair loss to severe hair loss (Stages I-1, I-2, I-3, I-4, II-1, II-2, III, advanced). The ninth and final in the scale demonstrates frontal anterior recession as illustrated in Figure 1.

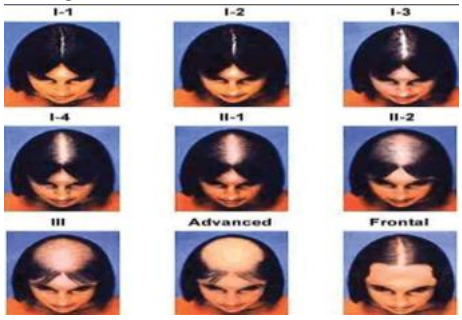

Figure 1. Illustration of Savin Scale for Assessment Hair Loss Severity

Body weight, height, and waist circumference were measured and documented for all participants. Waist circumference was assessed at the midpoint between the inferior border of the last palpable rib and the superior margin of the iliac crest at the end of normal expiration. Systolic and diastolic blood pressure (BP) were recorded after the participants had rested for 5 minutes, followed by a second measurement 10 minutes later; the average of the two readings was considered for analysis. Body mass index (BMI) was calculated by dividing body weight (kg) by the square of height (m^2). Venous blood samples were collected between 8:00 and 9:00 AM following an overnight fast of 12 hours for the estimation of fasting plasma glucose (FPG) and a complete lipid profile.

The MetS was diagnosed according to the new International Diabetes Federation definition as: central obesity (defined as waist circumference with ethnicity-specific value ≥90 cm for Indian men) plus any two of the following four factors:

i. Raised triglycerides ≥150 mg/dL or specific treatment for this lipid abnormality
ii. Reduced high-density lipoprotein-cholesterol (HDL-C) <50 mg/dL in women or specific treatment for this lipid abnormality
iii. Raised BP: Systolic BP ≥130 or diastolic BP ≥85 mm Hg or treatment of previously diagnosed hypertension
iv. Raised FPG ≥100 mg/dL or previously diagnosed type two diabetes.

Statistical Analysis

Data were entered in Microsoft Excel 2021 and statistical analysis was done using IBM Statistical Software for Social Sciences (SPSS) version 23. Categorical variables were represented in the form of frequencies and percentages. Continuous variables were presented as descriptive statistics such as mean and standard deviation (SD). Categorical variables were analysed using the Chi-square test. Comparison of continuous variables between the groups was done using independent sample t-test. $p \leq 0.05$ was considered statistically significant.

Ethical Approval:

The approval of study conduction was obtained from Institutional Ethical Committee of J. J. M. Medical College (JJMMC), Davangere, Karnataka. A written informed consent was obtained from all the patients.

RESULTS

The case and control groups were comparable with respect to age, with no statistically significant difference observed (p = 0.300). In contrast, cases exhibited significantly higher BMI and waist circumference than controls (both p = 0.001). The frequency of tobacco consumption and alcohol abuse was also significantly greater among cases compared with controls (both p = 0.001), indicating a higher burden of modifiable lifestyle-related risk factors in the case group (Table 1).

Table 1. Socio-demographic Characteristics

Variables	Control	Cases	p - value
Age, years	45.4 ± 9.4	47.8 ± 9.3	0.300
BMI, kg/m2	25.2 ± 3.2	32.0 ± 2.4	0.001
Waist, cm	84.0 ± 7.3	102.7 ± 6.8	0.001
Tobacco consumption, n (%)	11 (31.4)	22 (80.0)	0.001
Alcohol abuse, n (%)	15 (42.9)	28 (80.0)	0.001

Values were expressed as mean ± SD unless otherwise stated; BMI, Body mass index

Hair loss was observed exclusively among cases (100%) and was significantly higher than controls (p = 0.001). No significant differences were found between the groups with respect to GIT dysfunction (p = 0.470), thyroid disorders (p = 0.284), patterns of hair product use (p = 0.453), psychosocial concerns (p = 0.200), or use of hair-drying products (p = 0.052). Although hair dryer use and poor body image were more frequent among cases, these differences did not reach statistical significance (Table 2).

Table 2. Patient Characteristics

Variables	Control	Cases	p-value
Hair loss	0 (0.0)	35 (100.0)	0.001
GIT dysfunction	21 (60.0)	18 (51.4)	0.470
Thyroid disorders	6 (17.1)	3 (8.6)	0.284
Psycho-social concern			
Poor body image	8 (22.9)	15 (42.9)	0.200
Reduced self-esteem	13 (37.1)	9 (25.7)	
Social withdrawal	14 (40.0)	11 (31.4)	
Hair product use			
Dye	8 (22.9)	8 (22.9)	0.453
Gel	9 (25.7)	6 (17.1)	
Mehandi	5 (14.3)	11 (31.4)	
Oil	7 (20.0)	4 (11.4)	
Shampoos	6 (17.1)	6 (17.1)	
Hair drying products use			
Curlers	10 (28.6)	11 (31.4)	0.052
Hair dryers	7 (20.0)	14 (40.0)	
Straightener	8 (22.9)	8 (22.9)	
None	10 (28.6)	2 (5.7)	

Values were expressed as n (%) unless otherwise stated; GIT, Gastrointestinal tract

Among women with AGA, Stage II-1 was the most frequently observed severity grade (20.0%), followed by Stage I-3 (17.1%). Early-to-moderate stages (Stages I and II) constituted the majority of

cases. Whereas, advanced disease (14.3%), Stage III (2.9%), and frontal pattern (2.9%) involvement were comparatively uncommon, indicating that most patients presented before progression to severe hair loss (Figure 2).

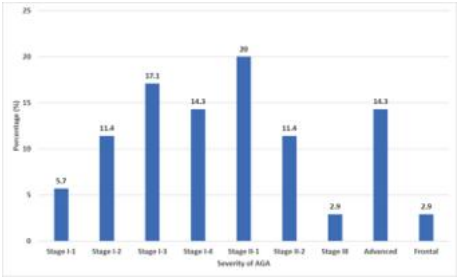

Figure 2. Distribution Cases Based on Severity of AGA

Cases group had a significantly higher prevalence of central obesity (p = 0.008), elevated triglycerides (p = 0.001), and elevated FPG than controls (p = 0.031). Although reduced HDL-C levels and high blood pressure were more common among cases, these differences did not achieve statistical significance (both p > 0.05). Overall, the findings indicate a greater burden of MetS components among women with AGA (Table 3).

Table 3. Distribution of Components of MetS

Variables	Control	Cases	p-value
Central obesity	11 (31.4)	22 (62.9)	0.008
Elevated TG	10 (28.6)	25 (71.4)	0.001
Reduced HDL-C	14 (40.0)	22 (62.9)	0.056
High BP	10 (28.6)	18 (51.4)	0.051
Elevated FPG	12 (34.3)	21 (60.0)	0.031

Values were expressed as n (%) unless otherwise stated; TG, Triglycerides; HDL-C, High-density lipoprotein-cholesterol, BP, Blood pressure, FPG, Fasting plasma glucose

The incidences of MetS was significantly higher among cases than controls (65.7% vs. 20.0%; $\chi^2 = 14.933$, p = 0.001). These findings demonstrate a strong association between AGA and MetS in the study population (Table 4).

Table 4. Incidences of MetS

Incidences of MetS		Group	
		Case	Control
No	Count	12	28
	%	34.3%	80.0%
Yes	Count	23	7
	%	65.7%	20.0%
X2-value = 14.933; p-value = 0.001			

No significant association was observed between the severity of AGA and the presence of MetS ($\chi^2 = 5.305$, p = 0.725). Although MetS was numerically more frequent among patients with Stage II-1 and other intermediate-to-advanced grades, its distribution across alopecia stages did not differ significantly, suggesting that MetS occurrence was independent of disease severity in the study cohort (Table 5)

Table 5. Association of Stages of AGA with MetS

Stages of AGA		MetS	
		No	Yes
Stage I-1	Count	1	1
	%	8.3%	4.3%
Stage I-2	Count	2	2
	%	16.7%	8.7%
Stage I-3	Count	2	4
	%	16.7%	17.4%
Stage I-4	Count	1	4
	%	8.3%	17.4%
Stage II-1	Count	1	6
	%	8.3%	26.1%
Stage II-2	Count	2	2
	%	16.7%	8.7%
Stage III	Count	0	1
	%	0.0%	4.3%
Advanced	Count	2	3
	%	16.7%	13.0%
Frontal	Count	1	0
	%	8.3%	0.0%
X2-value = 5.305; p-value = 0.725			

DISCUSSION

The present study demonstrated a significant association between female androgenetic alopecia (AGA) and metabolic syndrome (MetS), with women affected by AGA exhibiting more than three-fold higher incidences of MetS than age-matched controls. Cases also had significantly higher BMI, waist circumference, and greater tobacco and alcohol consumption. These findings support the concept that female AGA is not merely a cosmetic disorder but a clinical manifestation associated with systemic metabolic abnormalities. Recent evidences have increasingly recognized AGA as a marker of cardiometabolic risk, warranting comprehensive metabolic assessment in affected patients.[31-33]

One of the most important findings of this study was the significantly higher prevalence of MetS among women with AGA (65.7% vs. 20.0%). This finding is highly consistent with the recent systematic review and meta-analysis by Qiu et al., which analyzed 19 studies involving over 2,500 participants and demonstrated that patients with AGA had a 3.46-fold greater likelihood of developing MetS than healthy controls.[31] Importantly, the authors reported that the association was particularly stronger among women, emphasizing that female AGA may represent an early clinical marker of metabolic dysfunction. Similarly, recent hospital-based observational studies have also reported significantly higher frequencies of MetS among women with AGA, recommending routine metabolic screening during dermatological evaluation.[32-34] The concordance between these reports and our findings strengthens the evidence supporting the association between female AGA and metabolic abnormalities.

The present study further demonstrated that central obesity, hypertriglyceridemia, and elevated fasting plasma glucose were significantly more common among cases, whereas reduced HDL cholesterol and hypertension did not differ significantly between groups. Similar observations have been reported in recent literature, where obesity-related indices and insulin resistance consistently emerged as the strongest metabolic correlates of AGA.[31,32] Qiu et al. reported significantly greater BMI, waist circumference, fasting glucose, triglycerides, blood pressure, and adverse lipid profiles among individuals with AGA than controls.[31] Likewise, Zhu et al. observed that female AGA was significantly associated with increased waist circumference and central adiposity despite the absence of a significant association with overall MetS in their community-based Chinese cohort, suggesting that abdominal obesity may be an early metabolic alteration preceding overt MetS.[32] These findings support the hypothesis that insulin resistance and visceral adiposity contribute substantially to the pathogenesis of female AGA.

Although MetS was significantly associated with the presence of AGA, no association was observed between alopecia severity and MetS in the present study. Most patients presented with early-to-moderate disease, predominantly Stage II-1, indicating that metabolic abnormalities may occur irrespective of clinical severity. Similar findings have been described in several contemporary studies where the presence rather than the grade of alopecia was associated with adverse metabolic profiles.[31,32]

The biological mechanisms linking AGA and MetS are likely multifactorial. Hyperinsulinemia promotes ovarian and adrenal androgen synthesis while suppressing sex hormone-binding globulin production, resulting in increased circulating free androgens that accelerate follicular miniaturization. In addition, obesity-associated chronic inflammation, oxidative stress, endothelial dysfunction, and microvascular impairment may compromise follicular nutrition and contribute to progressive hair loss.[31,33] The significantly higher BMI, waist circumference, triglycerides, and fasting plasma glucose observed in our patients support these proposed mechanisms and indicate that metabolic dysregulation plays a central role in female AGA. From a clinical perspective, women presenting with AGA should undergo routine screening for obesity, dyslipidemia, impaired glucose metabolism, and other cardiovascular risk factors to facilitate early intervention and reduce long-term cardiometabolic morbidity.

The present study has several strengths. First, the case–control design with an age-matched control group minimized the influence of age as a potential confounder and enabled a reliable comparison of metabolic

parameters between women with and without androgenetic alopecia. Second, the diagnosis and grading of AGA were performed using standardized clinical criteria, while metabolic syndrome was assessed using established diagnostic definitions, enhancing the validity and reproducibility of the findings. Third, multiple anthropometric, clinical, and biochemical variables were evaluated simultaneously, providing a comprehensive assessment of the metabolic profile of women with AGA. Importantly, this study contributes additional evidence from the Indian population, where data on the relationship between female AGA and metabolic syndrome remain relatively limited.

Despite these strengths, several limitations should be acknowledged. The relatively small sample size and single-center design may limit the generalizability of the findings to broader populations. The case–control nature of the study precludes establishing a causal relationship between AGA and metabolic syndrome. Information regarding lifestyle factors, including tobacco and alcohol consumption, was partly based on self-report and may therefore be subject to recall or reporting bias. In addition, serum insulin levels, homeostatic model assessment for insulin resistance (HOMA-IR), inflammatory biomarkers, androgen profiles, and other cardiovascular risk markers were not evaluated, limiting further exploration of the underlying biological mechanisms.

CONCLUSION

This study demonstrates a significant association between female androgenetic alopecia and metabolic syndrome, with affected women exhibiting a markedly higher incidences of metabolic syndrome and key metabolic abnormalities, including central obesity, hypertriglyceridemia, and elevated fasting plasma glucose. Early screening for metabolic syndrome and its components is beneficial in patients with early-onset androgenic alopecia.

Conflict of Interest:
There was no conflict of interest.
Funding:
There was no funding for the present study.

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