INTRODUCTION

Alopecia areata (AA) is the most common form of nonscarring alopecia that can involve any hair-bearing area. It was first described by Cornelius Census, and the term “alopecia areata” was coined by Savages in 1760. The prevalence of AA is 0.1%–0.2% with a calculated lifetime risk of 2% affecting both children and adults and hair of all colors with no gender predilection, though the disease is shown to be severe in males and those who are affected in early childhood. Pediatric AA constitutes about 20% of AA cases, and 60% of AA patients had their first patch before the age of 20 years. AA is an organ-specific autoimmune disease characterized by T-cell infiltrates and cytokine production around anagen stage hair follicle.

AA has association with human leukocyte antigen – Class I and II and known to occur with various autoimmune disorders such as rheumatoid arthritis, diabetes mellitus, vitiligo, systemic lupus erythematosus, thyroiditis, pernicious anemia, and coeliac disease.

Hair follicle-specific autoantibodies are increased in peripheral blood of AA patients, especially to keratin 16 and trichohyalin. Thus, AA is considered as hair follicle-specific autoimmune disease, triggered by environmental factors in genetically susceptible individuals.

ABSTRACT

Background: Alopecia areata (AA) is an autoimmune disease which is characterized by hair loss and affects any hair-bearing area. Low levels of Vitamin D have been implicated in a variety of autoimmune diseases. This study was conducted to assess the levels of Vitamin D in patients with AA and its correlation with severity, pattern, and extent of the disease. Materials and Methods: This hospital-based study included 135 cases with AA and 135 age- and sex-matched controls. AA cases were grouped according to the severity, pattern, and extent of the disease. The levels of Vitamin D were assessed and compared between cases and controls and among different groups of cases. The data were analyzed, and the correlation was derived. Results: The more number of patients from the case group had deficient and insufficient levels of Vitamin D as compared to controls, the difference being statistically significant (P = 0.01). A highly significant difference was found in mean Vitamin D levels between cases and controls (P = 0.0004). A negative correlation was found between Vitamin D levels and severity of AA as assessed by SALT score. A negative correlation was also found between Vitamin D levels with pattern and extent of the disease. Conclusion: Vitamin D deficiency may be one of the factors having a role either in etiopathogenesis or exacerbation of AA. Supplementation of Vitamin D as a treatment modality may improve the clinical outcome of AA.

Key words: Alopecia areata, SALT score, Vitamin D

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Nail changes are seen in 29% of adults and 50% of children with AA. They are more common in males and in severe AA. Nail changes may precede or follow the hair loss, and they may be limited to one or most nails. Nail changes typical of AA are geometric pitting (multiple, small, and superficial pits regularly distributed along transverse and longitudinal lines), geometric punctate leukonychia (multiple white spots in a grill pattern), and trachyonychia (sandpaper nails). Vitamin D is a secosteroid hormone that plays an important role in calcium homeostasis and bone health. Vitamin D has been hypothesized as a risk factor for the development of AA. The role of Vitamin D in the pathogenesis of AA has been a matter of interest for many years. Evidence has arisen from the reports of AA in patients with hereditary Vitamin D-resistant rickets. Further evidence is provided by the effect of Vitamin D on protecting hair follicles from chemotherapy-induced alopecia.

Expression of Vitamin D receptors in keratinocytes is necessary for the maintenance of normal hair cycle. 1,25-dihydroxyvitamin D3 acts as an immunomodulator targeting various immune cells such as monocytes, macrophages, dendritic cells, as well as T lymphocytes and B lymphocytes, thus modulating both innate and adaptive immune responses.

It has been suggested that Vitamin D and its analogs not only prevent the development of autoimmune disease but could also be used to treat them. In view of emerging evidence of association between AA and Vitamin D deficient levels, it is imperative to reevaluate the correlation between AA and Vitamin D levels for better management of this chronic disease.

**MATERIALS AND METHODS**

The study was conducted after obtaining approval from the Institutional Ethics Committee of Government Medical College and Associated Hospitals, Jammu. Clinically diagnosed 135 cases with AA attending the Dermatology Outpatient Department of SMGS Hospital, Government Medical College, Jammu, from November 2016 to October 2017 were included as cases. The control group included healthy individuals who were age and sex matched with that of case group.

**Inclusion criteria**

1. Clinically diagnosed patients of any age and gender with Alopecia areata
2. Patients willing to participate in the study.

**Exclusion criteria**

1. Concurrent or family history of autoimmune diseases – vitiligo, rheumatoid arthritis, diabetes, thyroid disorder, or lupus erythematosus
2. Vitamin D supplementation
3. Women wearing veil
4. Frequent ingestion of alcohol, gastrointestinal problems, bone or renal disease, or sarcoidosis or any other metabolic systemic diseases treated with systemic steroids, barbiturates, bisphosphonates, sulfasalazine, and psoralen with ultraviolet A/ultraviolet B therapy in the past 3 months
5. Pregnancy or lactation
6. Obesity defined by body mass index (BMI) ≥25.

**Collection of data**

A detailed history was taken after obtaining consent from patients aged >18 years or their attendants in case of <18 years of age, regarding name, age, sex, age of onset and duration of disease, family history, personal history including smoking or drinking, dietary history, and drug history.

Detailed general physical (including anthropometric measurements) and systemic examination was performed. Patients with AA with BMI ≥25 were excluded from the study similar to the various studies conducted in the past as it has been shown that Vitamin D deficiency is associated with obesity. A history regarding the duration of sun exposure and use of sunscreens was taken. Cases and controls were excluded from the study on the basis of history and examination suggestive of any personnel or family history of any autoimmune disease.

On the basis of duration of disease, cases with AA were grouped as follows:

- <3 months (D1)
- 3–12 months (D2)
- 12–24 months (D3)
- >2–5 years (D4)
- >5 years (D5).

Clinical assessment of AA lesions was performed by detecting the site of involvement, number of lesions, and pattern and extent of the disease.

On the basis of pattern of hair loss, patients with AA were grouped as patchy type, reticular type, ophiasis type, and others (complete baldness).

On the basis of the extent, AA cases were grouped in the following subgroups: AA circumspecta, AA subtotalis, AA totalis (AT), and AA universalis (AU).
The extent of scalp involvement was done using SALT scoring (given by the National Alopecia Areata Foundation). A visual aid [Figure 1] showing the division of scalp hair into four quadrants – back, top of scalp, and both sides – with each of the four quadrants giving an accurate determination of % of scalp surface area covered provided by Olsen et al., was used. The percentage of scalp area represented by these quadrants is as follows: top of scalp = 40%, back = 24%, left side = 18%, and right side = 18%.

Further subgrouping of the patients having only scalp involvement into the following SALT subclasses was done as follows:

- S0–S1 = 0%–24%
- S2 = 25%–49%
- S3 = 50%–74%
- S4 = 75%–99%
- S5 = 100%.

The following investigations were performed in both cases and controls: CBC, KFT/LFT, RF, TSH, fasting blood sugar levels (BS-F), and serum calcium and serum Vitamin D.

- Serum Vitamin D analysis: Serum concentration of Vitamin D was determined for each patient and control. The active form of Vitamin D, i.e., 1,25-dihydroxyvitamin D3 is not a good indicator of serum Vitamin D level due to its short half-life and low serum levels. 25-hydroxyvitamin D (25[OH]-Vitamin D) has longer half-life and higher serum levels and is more convenient to measure. It is a better reflection of all sources of Vitamin D exposure and is a stable indicator of Vitamin D status. Therefore, we measured 25(OH)-Vitamin D in our study. The levels of Vitamin D were labeled as:
  - <20 ng/mL: Deficient
  - 20–29.99 ng/mL: Insufficient
  - ≥30 ng/mL: Normal.

Statistical analysis

The data were analyzed using Microsoft Excel and SPSS version 21.0 for Windows. The data were reported as mean ± standard deviation and proportions as deemed appropriate for quantitative and qualitative variables, respectively. The statistical difference in mean value between two groups was tested using unpaired t-test. The qualitative data were compared using Chi-square test/Fisher's exact test. Analysis of variance was also performed to evaluate statistical significance in more than two groups. The correlation between mean serum Vitamin D level and pattern, extent, and severity of alopecia areata was examined using Pearson's correlation test. P < 0.05 was considered statistically significant. All P values reported were two-tailed.

RESULTS

The study enrolled 135 cases and 135 age- and sex-matched controls. The mean age of cases was 26 ± 12.89 years and that of controls was 26 ± 13.20 years. A maximum number of cases belonged to the age group of 21–30 years (34.81%), followed by 31–40 years (20%), 11–20 years (18.52%), ≤10 years (13.33%), and ≥51 years (2.22%). Of 135 patients, 91 (67.41%) were male and 44 (32.59%) were female in both cases and control groups. The male-to-female ratio was 2.06:1.

In our study, among cases, 107 (79.26%) had normal BMI of 18.5–24.9 and 28 (20.74%) had BMI <18.5. Among cases, BMI ranged from 15.58 to 24.96 with a mean BMI of 20.43 ± 2.48. Among controls, 111 (82.22%) had normal BMI of 18.5–24.9 and 24 (17.78%) had BMI <18.5. Among controls, BMI ranged from 15.38 to 24.91 with a mean BMI of 20.72 ± 2.34. The difference was not statistically significant (P = 0.32).

There was no significant difference between cases and controls in terms of dietary habits, occupation, duration of sun exposure per day, and use of sunscreen.
Duration of AA was 3–12 months in 49.63% of patients, followed by <3 months in 26.66%, 2–5 years in 11.85%, 12–24 months in 5.93%, and >5 years in 5.93% patients. The duration of disease ranged from 10 days to 20 years with a mean duration of 1.32 ± 2.44 years.

Of 135 cases, 18 (13.33%) cases had relapsing nature of disease as compared to 117 (86.67%) who presented with the first episode of alopecia. The disease was active in 90 (66.67%) of cases in the form of recent development of new alopecic areas whereas 45 (33.33%) cases had static disease activity.

Of 135 cases, scalp was affected in 122 (90.37%) cases, beard in 39 (28.89%), eyebrows in 13 (9.63%), and other sites including axillary, pubic, and body hair in 10 (7.41%) cases. Nail changes were found in 15 (11.11%) patients.

According to the severity of disease as assessed by SALT score/grade in cases with scalp involvement, maximum patients (n = 52; 42.62%) had S1 grade, followed by 35 (28.69%) in S2 grade, 17 (13.93%) in S3, 11 (9%) in S4, and 7 (5.74%) cases in S5 grade.

According to the extent of involvement, 93 (68.89%) cases had alopecia circumscripta, 35 (25.93%) had alopecia subtotalis, 4 (2.96%) had alopecia totalis, and 3 (2.22%) had alopecia universalis.

According to the pattern of involvement, 97 (71.85%) cases had patchy hair loss, and then 21 (15.56%) had ophiasis pattern [Figure 2], 10 (7.41%) had reticular pattern, and 7 (5.19%) cases presented with complete baldness (AT + AU), [Figures 3 and 4]. Of 97 cases who had patchy hair loss, 13 (9.62%) cases had only beard involvement and 84 (62.22) cases had scalp involvement.

Serum Vitamin D levels were assessed according to the site, severity, extent, and pattern of the disease.

In cases, more patients (n = 51; 37.78%) had deficient serum Vitamin D levels, followed by insufficient levels in 47 (34.81%) cases and normal levels in 37 (27.41%) cases. In controls, more patients (n = 57; 42.22%) had normal serum Vitamin D levels, followed by insufficient levels in 46 (34.07%) cases and then deficient levels in 32 (23.70%) cases. The difference between the two groups was statistically significant (P = 0.01). The mean serum Vitamin D level in cases was 22.87 ± 10.03 ng/mL, whereas in controls it was 27.34 ± 10.54 ng/mL, the difference being statistically highly significant (P = 0.0004) [Figure 5].

The mean Vitamin D levels were 25.98 ± 9.87 ng/mL in S0–S1 grade (0%–24%), 23.41 ± 9.96 ng/mL in S2 grade (25%–49%), 20.12 ± 6.74 ng/mL in S3 grade (50%–74%), 11.24 ± 3.43 ng/mL in S4 grade (75%–99%), and
11.24 ± 5.76 ng/mL in S5 grade (100%). Patients with SALT scores 100% (S5) and 75%–99% (S4) had extremely low serum Vitamin D levels. Association of SALT scores/grade with mean serum Vitamin D levels was highly significant ($P < 0.000$) [Figure 6a]. There was a significant negative correlation between severity of AA as assessed by SALT score and Vitamin D levels ($P = 0.0006$; $r = -0.474$) [Figure 6b].

The mean Vitamin D level was lower in cases with multiple patches over scalp (22.4 ± 9.68 ng/mL) or beard (27.35 ± 7.35 ng/mL) than those cases with single patch over scalp (27.47 ± 12.29 ng/mL) or beard (33.33 ± 1.52 ng/mL), though the difference was not statistically significant ($P = 0.08$ and $P = 0.2$, respectively).

The mean serum Vitamin D level progressively decreased from the circumscripta group (24.42 ± 9.67 ng/mL) to subtotalis (21.08 ± 9.99 ng/mL); totalis (11.87 ± 5.52 ng/mL) and universalis (10.4 ± 7.21 ng/mL) showed least Vitamin D levels. The results were found to be highly significant ($P = 0.004$) [Figure 7a]. The Vitamin D levels negatively correlated with extent of AA ($r = -0.297$) [Figure 7b].

Furthermore, the mean serum Vitamin D level progressively decreased from patchy pattern (23.95 ± 9.78 ng/mL), ophiasis pattern (23.83 ± 10.44 ng/mL), and reticular pattern (18.55 ± 8.44 ng/mL) to complete baldness
pattern (11.24 ± 5.76 ng/mL). The results were observed to be highly significant \( (P = 0.004) \) [Figure 8a]. The Vitamin D levels also negatively correlated with pattern of AA \( (r = -0.273) \) [Figure 8b].

The mean Vitamin D levels were 21.71 ± 6.68 ng/mL in cases having patchy pattern of alopecia over both scalp and beard, 23.75 ± 11.01 ng/mL in cases having only scalp involvement, and 28.73 ± 6.91 ng/mL in those cases having only beard involvement. However, the difference was not statistically different \( (P = 0.13) \). The serum level of 25(OH)-Vitamin D was 17.72 ± 7.41 ng/mL in patients with nail involvement and 23.52 ± 10.15 ng/mL in patients without nail involvement, the difference being statistically significant \( (P = 0.03) \).

The mean serum Vitamin D level was less in patients with active disease \( (21.76 ± 10.41 \text{ ng/mL}) \) as compared to that of patients with static disease \( (25.09 ± 8.91 \text{ ng/mL}) \), though the difference was not statistically significant \( (P = 0.06) \). The mean Vitamin D level in recurrent cases \( (21.11 ± 10.65 \text{ ng/mL}) \) was less as compared to nonrecurrent cases \( (23.14 ± 9.95 \text{ ng/mL}) \); however, the difference was not statistically significant \( (P = 0.42) \).

The mean Vitamin D level was 24.61 ± 9.56 ng/mL in the cases who had duration <3 months, 22.35 ± 10.30 ng/mL in 3–12 months, 20.53 ± 9.12 ng/mL in 12–24 months, 23.79 ± 11.01 ng/mL in 2–5 years, and 19.89 ± 9.42 ng/mL in >5 years. The deficient mean serum Vitamin D was observed in patients with duration of >5 years of disease, while in other duration groups insufficient mean serum Vitamin D level was observed. No statistically significant association was found between serum 25(OH)-Vitamin D levels and duration of the disease in patients with AA \( (P = 0.64) \).

The mean serum calcium was 8.61 ± 0.69 ng/mL in cases and 8.67 ± 0.75 ng/mL in controls, but the difference was not statistically significant \( (P = 0.49) \).

The mean fasting blood sugar level was 82.11 ± 8.39 mg/dL in cases and 79.81 ± 11.26 mg/dL in controls, the difference being statistically not significant \( (P = 0.05) \).

**DISCUSSION**

In the present study, a total of 135 cases with AA and 135 age- and sex-matched controls were included. Due to matching, age and sex distribution was comparable between the two groups. In our study, age ranged from 4 to 65 years with mean age of 26 ± 12.89 in cases. Age ranged from 4 to 68 years with mean age of 26 ± 13.20 in controls. Maximum number of patients i.e. 47 (34.81%) were in age group of 21–30 years, followed by 27 (20.00%) patients in age group of 31–40 Yrs. This is similar to the study conducted by Panda et al.,\textsuperscript{[21]} where a total number of 72 cases with AA were included where maximum number of patients \( (n = 32; 44.44\%) \) were in the age group of 21–30 Yrs followed by 27 (20.00%) patients in age group of 31–40 Yrs. This is similar to the study conducted by Panda et al.,\textsuperscript{[21]} where a total number of 72 cases with AA were included where maximum number of patients \( (n = 32; 44.44\%) \) were in the age group of 21–30 Yrs, followed by 21 (29.16%) in the age group of 31–40 Yrs.

A male-to-female ratio of 2.06:1 was observed in this study, which is consistent with the study from North India conducted by Sharma et al.,\textsuperscript{[2]} which included 532 males (64.09%) and 276 (33.25%) females with a male-to-female ratio of 2:1. Similarly, in another study conducted by Manzoor and Masood,\textsuperscript{[22]} in Kashmir, in which 200 patients with AA were included, 145 were male and 55 were female.

In our study, among cases, 107 (79.26%) had normal BMI of 18.5–24.9 and 28 (20.74%) had BMI <18.5. Among cases, BMI ranged from 15.58 to 24.96 with mean BMI of
20.43 ± 2.48. Among controls, 111 (82.22%) had normal BMI of 18.5–24.9 and 24 (17.78%) had BMI <18.5. Among controls, BMI ranged from 15.38 to 24.91 with mean BMI of 20.72 ± 2.34. The difference was not statistically significant (P = 0.32). Aksu Cerman et al.[23] conducted a study where BMI was found to be normally distributed between cases with AA and controls.

The duration of disease ranged from 10 days to 20 years with mean duration of 1.32 ± 2.44 years; however, maximum number of cases had disease duration 3–12 months (49.63%) followed by duration of <3 months (26.66%). In our study, the disease was active in 90 (66.67%) of cases in the form of recent development of new alopecic areas. In the present study, 18 (13.33%) cases had relapsing nature of disease as compared to 117 (86.67%) who presented with the first episode of alopecia. This is in concordance with the case–control study conducted by Bakry et al.,[24] in which, of 60 cases included, 10 (16.7%) had recurrent and 50 (83.3%) had nonrecurrent disease.

In our study, according to the severity grading of cases who had scalp involvement, maximum patients had S1 grade (n = 52; 42.62%), followed by S5 (28.69%) in S2 grade, 17 (13.93%) in S3, 11 (9%) in S4, and 7 (5.74%) cases in S5 grade. This is similar to the study conducted by Yilmaz et al.,[25] in which severity of AA in cases (according to SALT Score) was seen in decreasing trend as follows: 71.4% cases were in S1 grade, then 14.2% in S2, 7.4% in S3 4.7 in S4, and 2.3% in S5 grade.

In the present study, we sought to assess the levels of Vitamin D and AA. The more number of patients from the case group had deficient and insufficient levels of Vitamin D as compared to controls. Statistically highly significant difference of Vitamin D level was found between cases and controls (P = 0.01). A highly significant difference was found in mean Vitamin D levels between cases and controls (P = 0.0004). The results of our study are similar to the various studies conducted in the past by Yilmaz et al.,[23] El-Mongy et al.,[26] Mahamid et al.,[27] Aksu Cerman et al.,[23] Attawa et al.,[28] Bakry et al.,[24] and Fawzi et al.[29] Furthermore, recently conducted studies by Darwish et al.,[30] Unal and Gonulalan,[31] Bhat et al.,[32] and Ghafoor and Anwar[33] found the same results.

However, the study conducted by Nassiri et al.[34] failed to establish the association between deficiency of Vitamin D and AA. Although the levels of Vitamin D were lower in controls in comparison with patients, no significant difference was detected between cases with AA and healthy controls after adjustment for sex. Similarly, the study conducted by Erpolat et al.[35] failed to find any statistical difference in serum Vitamin D levels between cases with AA and controls.

In our study, association of SALT scores/grade with mean serum Vitamin D levels was highly significant (P < 0.000). Patients with higher SALT grades (S4 & S5) had extremely low serum Vitamin D levels. Thus, a significant negative correlation was found between severity of AA and Vitamin D levels (P = 0.00; r = −0.474) [Figure 6a and b].

Furthermore, the mean serum Vitamin D level progressively decreased from circumscripta group to subtotals, and totalis and universalis showed least Vitamin D levels. The results were found to be highly significant and negatively correlated (P = 0.004; r = −0.297) [Figure 7a and b].

The mean Vitamin D levels of cases of patchy pattern having involvement of both scalp and beard were lower than involvement of each only. Similar findings had been reported in various studies conducted in the past. Aksu Cerman et al.[23] were the first to report the inverse correlation between Vitamin D and severity of AA (P < 0.001; r = −0.409). Similar findings were reported by Unal and Gonulalan[31] and Bhat et al.,[32] where SALT score was used. However, in contrary to this, Yilmaz et al.[25] d’Ovidio et al.,[36] and Darwish et al.[30] found no correlation between concentration of Vitamin D and extent of hair loss.

Patients with multiple patches of scalp had lower serum Vitamin D level (22.40 ng/mL) as compared to those with single patch (27.47 ng/mL). However, the difference was statistically not significant (P = 0.08). Patients with multiple patches of beard also had lower serum Vitamin D level (27.35 ng/mL) as compared to those with single patch (33.33 ng/mL). The difference was not statistically significant (P = 0.20). This is, however, in contrast to the hospital-based case–control study conducted by Bhat et al.,[32] which included 50 patients with AA with involvement of scalp. The patients with single patch over the scalp had mean concentration of 25 (OH)‑Vitamin D of 19.9 ± 4.45 ng/mL whereas those with multiple patches had mean value of 12.0 ± 4.45 ng/mL, and the difference was statistically significant (P < 0.001). It may be because that we have not taken into consideration the area of baldness represented by each patch, while comparing the cases of single patch of hair loss with that of multiple patches.

In our study, the mean serum Vitamin D level progressively decreased from patchy pattern, opifikasi pattern, and
In our study of assessing Vitamin D levels in AA, we found that Vitamin D is deficient in more number of patients as compared to controls. Furthermore, Vitamin D levels inversely correlated with the severity, extent, and pattern of the disease. Hence, Vitamin D deficiency may be one of the factors involved in etiopathogenesis of AA or may be one of the exacerbating factors.

**Recommendation**

Patients with AA should be screened for Vitamin D deficiency and treated accordingly. Further clinical studies are required to confirm the role of Vitamin D as a therapeutic agent in AA.

**Limitations**

1. The sample size was small
2. PTH levels were not measured
3. ANA was not done to rule out associated autoimmune disorder
4. Vitamin D was not given as therapeutic trial.
Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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