

ASSOCIATION BETWEEN SERUM VITAMIN D3 LEVELS AND DURATION OF CHRONIC TELOGEN EFFLUVIUM IN FEMALES: A HOSPITAL-BASED CASE-CONTROL STUDY

Dermatology

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ABSTRACT

Background: Chronic Telogen Effluvium (CTE) is a common non-scarring alopecia in women, characterized by persistent diffuse hair shedding. The etiopathogenesis is multifactorial, with emerging evidence implicating vitamin D3 in hair follicle cycling and keratinocyte proliferation. However, the relationship between serum vitamin D3 levels, chronicity of CTE, and the prevalence of associated dermatoses remains under-explored. **Aim:** To assess the association between serum vitamin D3 levels and the duration of CTE in females, and to evaluate the prevalence and vitamin D3 status of associated dermatoses in these patients. **Methods:** A hospital-based case-control study was conducted over 18 months, enrolling 62 female patients with CTE and 62 age-matched healthy controls. Detailed clinical history was recorded, including symptom duration, triggering events, and the presence of associated dermatoses (such as seborrheic capitis, premature canities, and acne vulgaris). Comprehensive clinical examination was performed, including hair pull and tug tests, followed by trichoscopic evaluation using DermLite DL4 to assess scalp and hair shaft features. Serum 25(OH)D levels were measured in all participants and classified according to Endocrine Society guidelines. Statistical analysis was conducted using SPSS v25. **Results:** The mean serum vitamin D3 level was significantly lower in CTE cases (18.31 ± 10.20 ng/ml) compared to controls (25.83 ± 9.67 ng/ml; $p = 0.001$). Vitamin D3 deficiency was observed in 66.1% of cases versus 25.8% of controls. Among CTE patients, 85.5% reported at least one trigger, with infective causes (COVID-19, dengue, typhoid) being the most common (30.6%), followed by crash dieting (21.0%), psychological stress (16.1%), and unknown factors (14.5%). The mean duration of hair loss was longest in the vitamin D-insufficient group (17.5 ± 9.3 months), followed by the deficient (14.9 ± 7.1 months) and sufficient groups (11.7 ± 6.4 months). The hair pull test was positive in 61.3% of cases. Trichoscopic features characteristic of CTE included reduced hair diameter variability ($<20\%$ in 100% of cases) and the presence of tapered regrowing hairs (85.5%). A notable proportion of CTE patients (45.2%) exhibited associated dermatoses, with lower mean vitamin D3 levels recorded in these individuals compared to those without additional dermatoses (e.g., acne vulgaris: 12.3 ± 6.9 ng/ml; seborrheic capitis: 13.8 ± 5.6 ng/ml; premature canities: 12.1 ± 4.3 ng/ml). Patients without dermatoses had significantly higher mean vitamin D3 levels (24.2 ± 10.4 ng/ml). **Conclusion:** Suboptimal vitamin D3 levels are significantly associated with the presence and chronicity of CTE, as well as with the occurrence of associated dermatoses. These findings highlight the clinical value of routine vitamin D3 assessment in women presenting with diffuse hair loss, especially those with concurrent dermatological conditions, and suggest that correction of vitamin D3 deficiency may play a role in comprehensive management strategies.

KEYWORDS

Chronic telogen effluvium, Vitamin D3, hair loss, 25-hydroxyvitamin D, trichoscopy, alopecia

INTRODUCTION

Telogen effluvium (TE) is one of the most prevalent types of non-cicatricial alopecia, defined by the premature transition of hair follicles from the anagen (growth) phase to the telogen (resting) phase, resulting in diffuse, often alarming, hair shedding. The chronic form—chronic telogen effluvium (CTE)—is characterized by telogen-predominant hair shedding persisting for more than six months, with a marked predilection for women, and is frequently idiopathic or presents with a relapsing–remitting clinical course. Since Kligman's seminal description [1], the clinical and scientific understanding of TE has substantially expanded, now recognizing a multifaceted interplay of genetic, metabolic, nutritional, hormonal, and psychogenic factors in its pathogenesis [2,3].

Among the diverse factors implicated in the pathogenesis of CTE—ranging from nutritional deficiencies and endocrine dysfunctions to systemic illnesses and psychogenic stress—vitamin D3 has recently emerged as a biomolecule of particular interest, owing to its pleiotropic effects on skin and hair biology. Traditionally recognized for its regulatory roles in calcium and phosphorus metabolism, vitamin D3 has now been established as a modulator of keratinocyte proliferation and differentiation, an immunoregulatory agent, and a key participant in hair follicle cycling [4,5].

The presence of vitamin D receptors (VDRs) in outer root sheath keratinocytes and dermal papilla cells provides mechanistic support for the influence of vitamin D signaling on hair follicle morphogenesis and maintenance. This is further substantiated by findings from VDR

knockout mouse models, which display profound alopecia attributable to impaired initiation of the anagen phase, thereby underscoring the necessity of adequate vitamin D signaling for hair follicle cycling and sustained hair growth [6,7]. In the clinical context, a growing body of evidence supports the association between vitamin D deficiency and various hair disorders, including alopecia areata, androgenetic alopecia, and telogen effluvium, both acute and chronic [8,9].

Despite accumulating evidence linking vitamin D3 deficiency to hair loss, few studies have directly explored the correlation between serum vitamin D3 status and the chronicity or severity of CTE in women [10]. Questions remain regarding the extent to which vitamin D3 deficiency contributes not only to the onset but also to the persistence of hair shedding in CTE, as well as the utility of vitamin D3 as a modifiable risk factor and therapeutic target in clinical practice.

In addition to primary hair loss, many patients with CTE are found to have concurrent dermatological conditions—such as seborrheic capitis, premature canities, and acne vulgaris—which may share underlying pathophysiological pathways with CTE, or act as confounding factors that influence disease severity and chronicity. These associated dermatoses not only compound the clinical burden and psychosocial distress of affected individuals but may also reflect broader systemic or nutritional disturbances, including vitamin D3 deficiency. However, despite the clinical relevance, there remains a paucity of literature systematically addressing the interplay between CTE, vitamin D3 status, and coexisting dermatoses.

Against this backdrop, the present study was undertaken to systematically evaluate serum 25-hydroxyvitamin D [25(OH)D] levels in women diagnosed with CTE, and to analyze their correlation with symptom duration, clinical and trichoscopic features, and the presence of associated dermatoses. By elucidating these associations and identifying common triggering events, this study aims to inform the potential role of vitamin D3 screening and targeted supplementation as adjuncts in the comprehensive management of chronic telogen effluvium.

MATERIALS AND METHODS

Study Design and Setting: This hospital-based case-control study was conducted in the Department of Dermatology, Mahatma Gandhi Medical College and Hospital, Jaipur, over an 18-month period from April 2023 to October 2024.

Participants

A total of 62 female patients aged 18 years and above, presenting with diffuse hair shedding of more than six months' duration and clinically diagnosed with chronic telogen effluvium (CTE), were recruited as cases. Sixty-two age-matched healthy female volunteers with no personal or family history of hair disorders served as controls.

Inclusion Criteria

Female participants aged ≥ 18 years with persistent hair shedding for more than six months and no receipt of treatment for hair loss or vitamin/mineral supplementation in the preceding four weeks were included.

Exclusion Criteria

Exclusion criteria comprised patients diagnosed with other types of alopecia (e.g., alopecia areata, androgenetic alopecia), those with systemic illnesses or malignancies, and individuals on medications known to affect vitamin D metabolism or levels (such as anti-convulsants, glucocorticoids, or vitamin D supplementation within four weeks prior to enrollment).

Clinical and Trichoscopic Evaluation

Detailed clinical histories were obtained from all participants, documenting demographic data, duration of hair loss, possible triggering events (e.g., infection, stress, diet changes, medication use), and the presence of associated dermatoses (including but not limited to seborrheic capitis, premature canities, and acne vulgaris). All subjects underwent comprehensive clinical examination, including the hair pull and tug tests, to assess active telogen shedding and hair shaft integrity, respectively. Trichoscopic examination was performed using a DermLite DL4 dermatoscope (3Gen Inc., USA), with evaluation for characteristic features of CTE.

Biochemical Assessment

Venous blood samples were collected from all participants to measure serum 25-hydroxyvitamin D [25(OH)D] concentrations using chemiluminescence immunoassay (CLIA). Vitamin D status was classified according to Endocrine Society Clinical Practice Guidelines [3]:

- Deficient: <20 ng/ml
- Insufficient: $20\text{--}30$ ng/ml
- Sufficient: >30 ng/ml

Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee of Mahatma Gandhi Medical College and Hospital, Jaipur. Written informed consent was obtained from all participants prior to enrollment.

Statistical Analysis

All data were entered and analyzed using IBM SPSS Statistics for Windows, Version 25.0. Descriptive statistics (means, standard deviations, and proportions) were computed. Continuous variables were compared using the unpaired t-test or ANOVA as appropriate, and categorical variables using the Chi-square test. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

Participant Demographics

A total of 124 participants were enrolled, including 62 female patients with clinically diagnosed chronic telogen effluvium (CTE) and 62 age-matched healthy female controls. The mean age of cases was 26.26 ± 6.94 years and that of controls was 26.19 ± 7.01 years, with no statistically significant difference ($p = 0.947$). Most participants were

unmarried and students by occupation, and the 21–30 year age group was most common (53.2%).

Clinical History and Triggering Events

Among CTE cases, 85.5% reported at least one identifiable precipitating factor. The most common triggers were infective causes (including COVID-19, dengue, and typhoid), reported in 30.6% of cases. Other common triggers included crash dieting (21.0%), psychological stress (16.1%), and unknown factors (14.5%). Less frequent triggers included pregnancy, hormonal contraceptive use, isotretinoin therapy, post-surgical state, anti-tubercular therapy, and Ayurvedic medicine use. Hair care practices differed between groups: CTE patients reported a higher frequency of infrequent hair washing, greater use of hair dye (35.5% vs. 24.2% in controls), and higher blow dryer use (51.6% vs. 30.6%; $p = 0.01$). Hair straightening was less common among CTE cases ($p = 0.002$), and hair combing frequency was similar in both groups.

Hair Pull and Tug Tests

The hair pull test was positive in 61.3% of CTE cases, indicating ongoing telogen shedding, while the hair tug test was positive in 12.9%, reflecting some degree of hair shaft fragility.

Trichoscopic Findings

Trichoscopy performed in all cases revealed reduced hair diameter variability ($<20\%$) in 100% of CTE patients, with tapered regrowing hairs noted in 85.5%. Additional findings included greasy yellowish-white scales in 17.7% and white dots in 8.1%. No follicular miniaturization or scarring was observed, supporting a diagnosis of non-cicatricial diffuse alopecia.

Serum Vitamin D3 Levels

The mean serum vitamin D3 level was significantly lower in CTE cases compared to controls (18.31 ± 10.20 ng/ml vs. 25.83 ± 9.67 ng/ml; $p = 0.001$). Among CTE patients, 66.1% were vitamin D3 deficient (<20 ng/ml), 25.8% insufficient ($20\text{--}30$ ng/ml), and 8.1% sufficient (>30 ng/ml); among controls, the corresponding rates were 25.8%, 48.4%, and 25.8%. Analysis by vitamin D status showed that the mean duration of hair fall was longest in the vitamin D-insufficient group (18.31 ± 12.16 months), followed by the deficient group (12.71 ± 7.21 months), and shortest in the sufficient group (11.00 ± 6.40 months), with the trend approaching statistical significance ($p = 0.07$).

Associated Dermatoses

A substantial proportion of CTE patients (69.4%, $n = 43$) had at least one associated dermatosis. The most frequently observed were acne vulgaris (21.0%), seborrheic capitis (19.3%), canities (11.3%), melasma (6.5%), periorbital melanosis (4.8%), and premature canities (6.5%). Nineteen cases (30.6%) had no associated dermatosis. Patients without dermatoses had significantly higher mean serum vitamin D3 levels (24.17 ± 10.41 ng/ml), while those with acne vulgaris, seborrheic capitis, and premature canities had lower levels (12.34 ± 6.91 , 13.85 ± 5.63 , and 12.10 ± 4.28 ng/ml, respectively; $p = 0.01$ for group differences).

Vitamin D3 Levels

In the present study, the mean serum 25(OH)D level among CTE cases was 18.31 ± 10.20 ng/ml, which was significantly lower than that of controls (25.83 ± 9.67 ng/ml). This reduction in vitamin D3 levels in patients with CTE supports the hypothesis that vitamin D deficiency may contribute to impaired hair follicle cycling and the pathogenesis of diffuse hair loss, as vitamin D receptors (VDRs) play a crucial role in anagen initiation and hair maintenance [3,4,11]. Similar findings have been reported by Rasheed et al., who observed a mean vitamin D level of 13.25 ± 6.18 ng/ml in Egyptian women with telogen effluvium compared to 27.38 ± 2.47 ng/ml in controls [1]. Nayak et al. also noted lower mean vitamin D3 levels in Indian women with diffuse hair fall (19.23 ng/ml) compared to healthy controls (23.64 ng/ml) [2]. Thus, our findings, in concordance with the literature, suggest that lower vitamin D3 levels are a consistent biochemical feature of CTE [12,13].

Prevalence of Vitamin D Deficiency and Insufficiency

We found that 66.1% of CTE patients were vitamin D3 deficient and 25.8% were insufficient, leaving only 8.1% with sufficient levels. The mechanism underlying this high prevalence may involve reduced dietary intake and inadequate sun exposure, as well as increased requirements in rapidly proliferating tissues such as hair follicles. Banihashemi et al. reported vitamin D3 deficiency in 76.7% of women with telogen effluvium compared to 36.7% of controls, closely

matching the pattern in our cohort [4]. Rasheed et al. found deficiency in 66.7% of patients and only 10% of controls, and Nayak et al. reported deficiency in 71.2% of patients versus 48.8% of controls [1,2]. These findings from diverse populations reinforce the association between suboptimal vitamin D3 status and the risk of developing CTE [14,15].

Triggering Events

Infective causes (COVID-19, dengue, typhoid) were the most common triggers in our cohort (30.6%), followed by crash dieting (21.0%) and psychological stress (16.1%). Infectious illnesses are hypothesized to trigger telogen effluvium by inducing systemic inflammation and abrupt metabolic shifts that prematurely terminate the anagen phase. The predominance of infections as a precipitant has been accentuated in the post-COVID era, with Tammaro et al. and Moreno-Arrones et al. documenting a surge in telogen effluvium following SARS-CoV-2 infection, with a median onset of 57 days post-infection [5,6]. Our data support the growing consensus that post-infectious telogen effluvium has become a leading cause of CTE globally [16,17].

Trichoscopic Findings

Trichoscopy in our study showed reduced hair diameter variability (<20%) in all CTE patients, tapered regrowing hairs in 85.5%, and greasy yellowish-white scales in 17.7%. These features reflect the underlying non-scarring, anagen-to-telogen shift and are highly characteristic of CTE. The diagnostic utility of these findings is corroborated by Rakowska et al., who reported similar trichoscopic features—especially uniform hair shaft diameters and a high frequency of regrowing, tapered hairs—distinguishing CTE from androgenetic alopecia [7]. Our results validate the value of trichoscopy as a practical, noninvasive diagnostic tool for CTE [18].

Associated Dermatoses

A substantial proportion of our CTE cases had associated dermatoses, most commonly acne vulgaris (21.0%), seborrheic capitis (19.3%), and canities (11.3%). Vitamin D's immunomodulatory properties may explain its role in hair disorders and other cutaneous diseases. Previous studies, including those by Rehman et al. (acne) and Bhat et al. (canities), found an increased frequency of vitamin D deficiency in patients with these dermatoses [8,9]. Thus, our findings further highlight the clinical overlap between vitamin D-responsive cutaneous conditions and CTE [19,20].

Table 1. Demographic and Clinical Characteristics of Study Participants

Parameter	CTE Cases (n = 62)	Controls (n = 62)	P-value
Mean Age (years)	26.26 ± 6.94	26.19 ± 7.01	0.947
Unmarried (%)	50.0	50.0	1.000
Student (%)	37.1	37.1	1.000
Housewife (%)	32.3	30.6	0.847
Employed (%)	30.6	32.3	0.847

*Age range of participants was 18–52 years in both groups, with the 21–30 year age group being most common (53.2%).

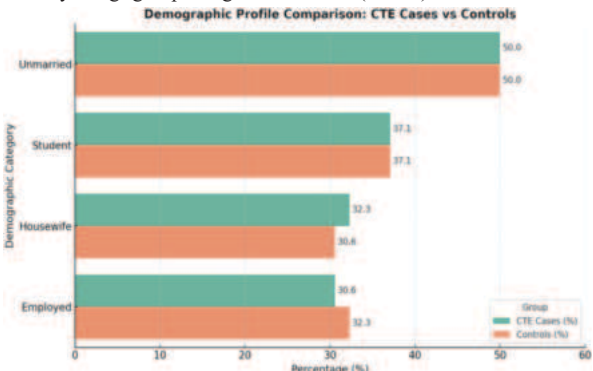


Table 2. Triggering Events in Chronic Telogen Effluvium Cases (n = 62)

Triggering Event	Frequency (n)	Percentage (%)
Infectious Illnesses (total)	19	30.6
— COVID-19	8	12.9
— Dengue	5	8.1
— Typhoid	6	9.7

Crash Dieting	13	21.0
Psychological Stress	10	16.1
Unknown	9	14.5
Pregnancy	3	4.8
Hormonal Contraceptive Use	3	4.8
Isotretinoin Therapy	2	3.2
Post-Surgical Stress	1	1.6
Anti-Tubercular Therapy	1	1.6
Ayurvedic Medicine Use	1	1.6

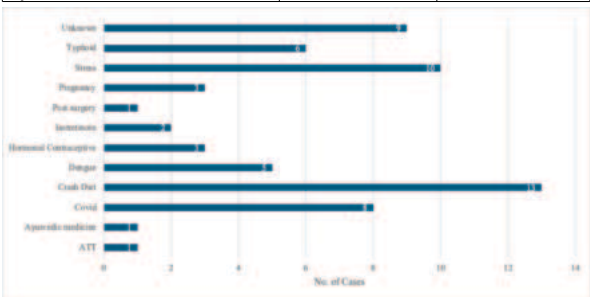


Table 3. Serum Vitamin D3 Status and Mean Levels among Participants

Vitamin D3 Status	CTE Cases (%)	Controls (%)	Mean Duration of Hair Fall (months)	SD
Deficient (<20 ng/mL)	66.1	25.8	12.71	7.21
Insufficient (20–30 ng/mL)	25.8	48.4	18.31	12.16
Sufficient (>30 ng/mL)	8.1	25.8	11.00	6.40
Overall Mean Vitamin D3	18.31 ± 10.20	25.83 ± 9.67	—	—

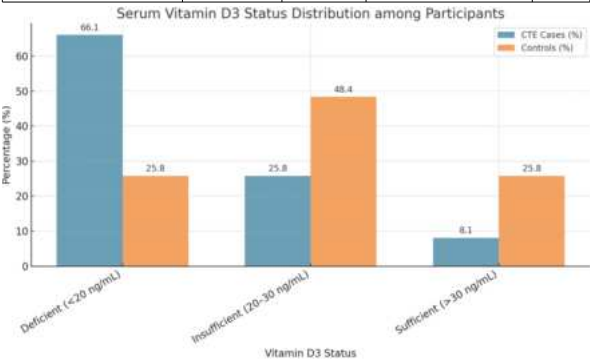
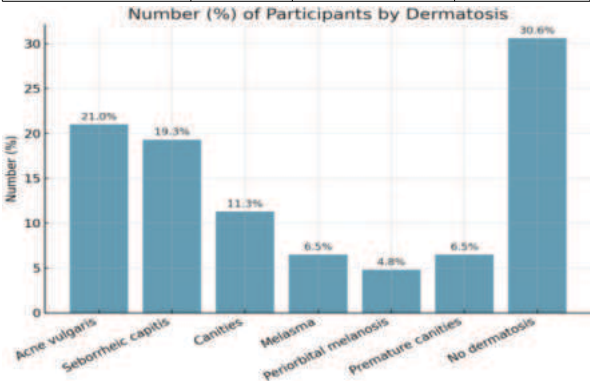


Table 4. Associated Dermatoses and Mean Serum Vitamin D3 in CTE Cases

Dermatosis	Number (%)	Mean Vitamin D3 (ng/mL) ± SD	Mean Duration (months)
Acne vulgaris	13 (21.0%)	12.34 ± 6.91	13.2
Seborrheic capitis	12 (19.3%)	13.85 ± 5.63	12.7
Canities	7 (11.3%)	14.11 ± 7.20	13.0
Melasma	4 (6.5%)	16.16 ± 5.72	11.5
Periorbital melanosis	3 (4.8%)	16.72 ± 5.70	10.8
Premature canities	4 (6.5%)	12.10 ± 4.28	14.2
No dermatosis	19 (30.6%)	24.17 ± 10.41	9.3

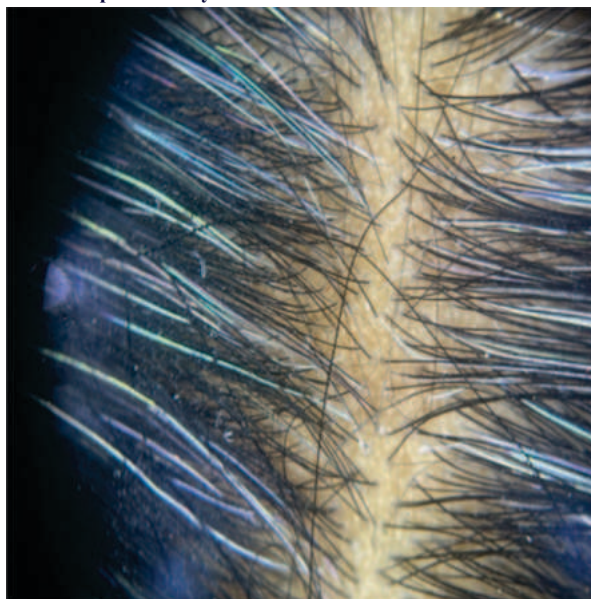




Lateral Scalp View of a Patient with Advanced Diffuse Hair Loss, Displaying Marked Thinning Over the Temporal and Parietal Areas with Preserved Follicular Openings



Patient Reported Daily Hairfall



Multiple White Dots Along with Presence of White Hair (10× Magnification, DermLite DL4)

CONCLUSION

This hospital-based case-control study elucidates a significant association between serum vitamin D3 status and chronic telogen effluvium (CTE) in young adult females. Patients diagnosed with CTE demonstrated markedly lower mean serum 25(OH)D concentrations compared to age-matched healthy controls, with a high proportion categorized as vitamin D deficient or insufficient. The observation of prolonged hair loss duration among individuals with suboptimal vitamin D3 levels suggests a contributory role of hypovitaminosis D in the chronicity and persistence of CTE. Distinctive trichoscopic features, in conjunction with a notable prevalence of coexisting dermatoses, further substantiate the clinical diagnosis and highlight the systemic relevance of vitamin D3 in hair and skin health. Collectively, these findings support the integration of serum vitamin D3 assessment into the routine diagnostic and therapeutic paradigm for CTE. Prospective interventional studies are warranted to elucidate further the therapeutic efficacy and clinical outcomes of vitamin D3 supplementation in this patient population.

Limitations

Limitations of this study include its relatively small sample size and lack of post-supplementation follow-up, which restrict the generalizability of results and preclude assessment of long-term clinical outcomes. Future studies should employ larger, multicenter designs with longitudinal and interventional arms to better establish the therapeutic role of vitamin D supplementation in CTE.

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Ethical Approval

The study protocol was approved by the Institutional Ethics Committee of Mahatma Gandhi Medical College & Hospital, Jaipur (Ref. No. MGMC&H/IEC/DERM/2023/054; Date: 15-03-2023).

Conflict of Interest

The authors declare no conflicts of interest.

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