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ORIGINAL ARTICLE

The correlation between VitD3 levels and the disease activity of childhood-onset systemic lupus erythematosus

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Abstract

Background: There is growing evidence linking low levels of vitamin D3 to an increased risk of many autoimmune diseases. Compared to the general population, hypovitaminosis D is more prevalent among children with systemic lupus erythematosus (SLE), which can be associated with sun exposure avoidance, long-term corticosteroid treatment, and renal disease. Therefore, we launched this study to assess the correlation between 25 (OH) D3 (VitD3) levels and the disease activity of children with SLE (cSLE) in Taiwan.

Methods: From September to December 2018, we recruited 31 cSLE patients from the Pediatric Out-patient Department of Taichung Veterans General Hospital. Their basic data, including SLE disease index 2000 (SLEDAI-2K) score, laboratory values, prescribed drugs and VitD3 levels were collected and analyzed statistically.

Results: The mean serum VitD3 concentration was 19.7 ± 7.9 ng/mL and SLEDAI-2K 6.2 ± 5.0. Those patients (N = 16) with an SLEDAI-2K≦4 had higher VitD3 levels when compared to those (N = 15) with an SLEDAI-2K>4 (22.9 ± 7.7 vs 16.3 ± 6.7 points, $p = 0.020$). Five patients not taking systemic corticosteroids (SCS) had significantly higher VitD3 levels and lower SLEDAI-2K than those who took SCS (N = 26). Additionally, we found VitD3 levels to be negatively correlated to SLEDAI-2K ($r_s = -0.55$, $p = 0.001$) and daily SCS dosages ($r_s = -0.49$, $p = 0.005$).

Conclusion: This study shows that VitD3 deficiency is common in patients with cSLE. It was also noted that serum VitD3 levels negatively correlate to SLEDAI-2K, which can be partially explained by less usage of SCS.

Keywords: Childhood onset; SLEDAI-2K; Steroids; Systemic lupus erythematosus; Vitamin D

1. INTRODUCTION

Systemic lupus erythematosus (SLE) is a chronic autoimmune disease involving multiple organs, which can ultimately lead to significant morbidity and even mortality. Childhood-onset SLE (cSLE), which represents a diagnosis established prior to 18 years of age, accounts for approximately one-fifth of all SLE cases. Renal involvement and neuro-psychiatric disease are more common in cSLE patients, while the condition also follows a more aggressive disease course than adult-onset SLE.[1,2]

Vitamin D is the principal factor that maintains calcium homeostasis. Vitamin D not only increases calcium absorption from the intestine but also facilitates calcium reabsorption in the kidneys.[3] Additionally, the biologically active vitamin D—1, 25 dihydroxycalciferol [1, 25(OH)D3] can mediate the immune system Vitamin D receptor (VDR), a ligand-activated transcription factor that functions to control gene expression involving immune modulation.[4–6] In the last decade, there has been growing evidence linking low levels of 25(OH)D3 (VitD3) to an increased risk of many diseases, including diabetes, cardiovascular diseases, dermatological diseases, different forms of cancer, and autoimmune diseases.[6,7]

Because of photosensitivity, the risks of long-term corticosteroid treatment, as well as the risk of renal impairment, hypovitaminosis D has become more prevalent among children with SLE as compared to the general population.[8,9] However, there still remains controversial evidence as to whether vitamin D deficiency increases SLE disease activity.[8–13] A meta-analysis study using pooled Pearson correlation test results from 11 studies with significant heterogeneity showed a weak negative correlation between these two items.[11] In terms of cSLE studies, some showed either a negative correlation[12] or slightly higher activity in those with hypovitaminosis D,[13] while others showed no difference.[14] The disparate results can be explained by the differences in race, disease activity, range of vitamin D3 levels, and the percentage of renal involvement in these studies. Therefore, we launched this study and considered all these variables to assess the VitD3 levels of cSLE patients in Taiwan.

2. METHODS

2.1. Patients and data collection

From September to December 2018, we recruited 31 cSLE patients from the Pediatric OPD of Taichung Veterans General Hospital. All 31 patients fulfilled the diagnosis criteria from

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either the 1997-revised American College of Rheumatology or 2012-Systemic Lupus International Collaborating Clinics. Disease activity was measured by the modified SLE Disease Activity Index 2000 (SLEDAI-2K).[15]

After written informed consent was obtained, we checked each patient's basic data, SLEDAI-2K scores, laboratory values, and serum VitD3 levels on the day the serum samples were drawn. Medications were reviewed and calculated from previous medical records. We calculated their average daily systemic corticosteroid (SCS) dosage in the past 28 days and expressed as an equivalent prednisolone dose, mg/kg/d. Additionally, we also checked the use of other immunosuppressants (ISs), as well as the use of self-pay VitD3 supplements before this study.

This study was approved by the Institutional Review Board of Taichung Veterans General Hospital (IRB:CF18207B).

2.2. Measurement of VitD3 levels

VitD3 analysis was done using the commercial kit, Elecsys Vitamin D total. The method for quantitative determination of VitD3 is a direct, competitive electrochemiluminescence immunoassay. Vitamin D deficiency was defined as <20 ng/mL, insufficiency as 21 to 30 ng/mL, and sufficiency as >30 ng/mL, according to the published criteria.[16]

2.3. Statistical analysis

Statistical analysis was completed using the Chi-square test and Fisher's exact test to check for any difference in percentages under various conditions; the Manne–Whitney U test to compare those continuous variables between the two groups; and Spearmans's rho to calculate the correlation coefficient. (SPSS Statistics 17.0.1; SPSS Inc., Chicago).

3. RESULTS

3.1. Demographic and clinical characteristics of participants

A total of 31 patients with cSLE were enrolled in the study. The mean age was 18 ± 6.0 years (range: 4-30 years), while mean SLE duration was 5.4 ± 4.0 years (range: 0.17-12.17 years). The mean serum VitD3 concentration was 19.7 ± 7.9 ng/mL, with SLEDAI-2K at the time of VitD3 measurement being 6.2 ± 5.0 (range: 0-20). All basic data, laboratory results, and medication records of patients are displayed in Table 1. Amongst the 31 patients with cSLE, females accounted for 80.6% of the population (N = 25). We found VitD3 levels did not differ between genders. The serum VitD3 levels were 23.6 ± 7.5 vs 18.9 ± 7.9 ng/mL in boys and girls, respectively (p = 0.237).

3.2. Comparisons between patients with an SLEDAI-2K≤4 and an SLEDAI-2K>4

As shown in Table 2, 15 patients (48.3%) had an SLEDAI-2K>4, while 16 patients (51.6%) had an SLEDAI-2K≤4. Hence, the group of with an SLEDAI-2K≤4 showed higher C3/C4 levels (p = 0.006 and 0.014, respectively), as well as a lower daily SCS dose (p = 0.043). Otherwise, these two groups had similar BMI scores, anti-double strand DNA levels, complete blood counts,

Table 1

Basic data of patients with childhood-onset systemic lupus erythematosus

	Total (n = 31)	
Vit D3 level (ng/mL)	19.7	± 7.9
Age (y)	18.0	± 6.0
ANA titer (n = 31)		
Negative	9	(29.3%)
Positive (titer ≧ 1:80)	22	(71.3%)
SLE duration (y)	5.4	± 4.0
SLEDAI-2K	6.2	± 5.0
BMI (kg/m^2)	21.7	± 6.1
C3 (mg/dL)	83.4	± 25.1
C4 (mg/dL)	15.4	± 7.5
anti-DsDNA (WHO units/mL) (n = 30)	326.2	± 207.2
Hemoglobin (g/dL)	13.2	±1.5
WBC (10^3/mL)	7027.4	±3130.3
Platelet (10^3/μL)	260.4	±85.4
Glucocorticoid dosage (mg/k/d)[a]	0.2	±0.2
Glucocorticoids[b]	26	(83.9%)
Other immunosuppressant(s)	14	(45.2%)
Hydroxychloroquine	29	(93.5%)
Vitamin D supplement[c]	16	(51.6%)
Proteinuria	8	(25.8%)
Hematuria	8	(25.8%)
Pyuria	8	(25.8%)

Data are presented as mean ± SD or % (percentage).

Laboratory test results revealed ANA, complement C3, C4, anti-DsDNA, hemoglobin, WBC, and platelet.

anti-DsDNA = anti-double-strand DNA antibody; BMI = body mass index; SLEDAI-2K = systemic lupus erythematosus disease activity index 2000; WBC = white blood cell.

[a]The daily glucocorticoid dosage of the patients 1 month before the examination (equivalent prednisolone dose, mg/kg/d) was in the table.

[b]Glucocorticoids: Use oral corticosteroid within 1 month of the examination.

[c]Vitamin D supplement: Patient who had vitamin D supplement prior to this study.

Table 2

Comparisons between patients with SLEDAI-2K≤4 and SLEDAI-2K>4

	SLEDAI-2K≤4 (n = 16)		SLEDAI-2K>4 (n = 15)		p
Vit D3 level (ng/mL)	22.9	±7.7	16.3	±6.7	0.020*
Age (y)	16.8	±6.4	19.4	±5.2	0.428
Age of onset (y)	11.4	±4.4	13.9	±2.5	0.093
Male	3	(18.8%)	2	(13.3%)	
Female	13	(81.3%)	13	(86.7%)	
SLE duration (y)	5.4	±4.3	5.5	±3.9	0.737
SLEDAI-2K	2.3	±1.5	10.3	±4.1	<0.001**
BMI (kg/m^2)	21.6	±5.3	21.9	±7.1	0.782
C3 (mg/dL)	95.9	±24.6	70.2	±18.5	0.006**
C4 (mg/dL)	18.2	±5.5	12.4	±8.3	0.014*
anti-DsDNA (WHO units/mL) (n = 30)	297.7	±217.9	358.9	±197.2	0.480
Hemoglobin (g/dL)	13.6	±1.4	12.8	±1.5	0.123
WBC (10^3/mL)	7754.4	±3398.2	6252.0	±2716.0	0.155
Platelet (10^3/μL)	255.6	±89.3	265.4	±83.9	0.890
Glucocorticoid dosage (mg/k/d)[a]	0.1	±0.1	0.3	±0.3	0.043*
Glucocorticoids[b]	12	(75.0%)	14	(93.3%)	0.333
Other immunosuppressant(s)	5	(31.3%)	9	(60.0%)	0.213
Hydroxychloroquine	16	(100.0%)	13	(86.7%)	0.226
Vitamin D supplement[c]	9	(56.3%)	7	(46.7%)	0.862

Data are presented as mean ± SD or % (percentage).

*$p < 0.05$,

**$p < 0.01$

Laboratory test results revealed complement 3,4(C3, C4), anti-DsDNA, Hemoglobin, WBC, and platelet.

anti-DsDNA = anti-double-strand DNA antibody; BMI = body mass index; SLEDAI-2K = systemic lupus erythematosus disease activity index 2000; WBC = white blood cell.

[a]The daily glucocorticoid dosage of the patients 1 month before the examination (equivalent prednisolone dose, mg/kg/d) was in the table.

[b]Glucocorticoids: Use oral corticosteroids within 1 month of the examination.

[c]Vitamin D supplement: Patient who had vitamin D supplement prior to this study.

as well as hydrochloroquine and IS use. Those patients with an SLEDAI-2K≦4 had higher VitD3 levels as compared to those with an SLEDAI-2K>4 (22.9 ± 7.7 vs 16.3 ± 6.7 ng/mL, $p = 0.020$).

3.3. Comparisons between patients using or not using systemic corticosteroids

Amongst these 31 patients, 26 were treated with SCS (mean daily steroid dose 0.2 ± 0.2 mg/kg/d). When comparing patients who used SCSs to those who did not, the latter showed higher VitD3 levels (29.8 ± 9.8 vs 19.8 ± 7.9 ng/mL, $p = 0.0004$). The SCS-free group also had lower SLEDAI-2K scores (2.0 ± 2.4 vs 7.0 ± 5.0, $p = 0.017$), and lower BMI scores (17.1 ± 2.9 vs 22.6 ± 6.2 kg/m^2, $p = 0.024$), but higher C3 levels (107 ± 20.9 vs 78.8 ± 23.0, 5 mg/dL, $p = 0.041$), than those took SCSs, as shown in Table 3.

3.4. Comparisons of patients using systemic glucocorticoids who are or are not taking other ISs

In Table 4, we further divided the 26 patients using SCS by their use of other ISs, among which hydroxychloroquine was excluded. The IS group (14 patients) had comparable VitD3 levels to the 12 cSLE patients not given ISs (19.2 ± 6.8 vs 16.5 ± 5.0 ng/mL, $p = 0.136$). Except for the slightly higher BMI (24.4 ± 6.1 vs 20.4 ± 6.0, $p = 0.039$) in the IS(+) group, other parameters, including SCS daily dosage, were similar in these two groups.

3.5. Comparison of patients by serum vitamin D3 level ≤18.5 or >18.5 ng/mL

Table 5 displays the grouping of patients by mean, as well as median VitD3 levels (18.5 ng/mL), where the group with higher

Table 3

Comparisons between patients using systemic corticosteroids or not

	Corticosteroids (–) (n = 5)		Corticosterids (+) (n = 26)		p
Vit D3 level (ng/mL)	29.8	±9.8	17.7	±5.9	0.004**
Age (y)	12.2	±7.8	19.2	±5.0	0.033*
Age of onset (y)	7.8	±5.6	13.5	±2.6	0.032*
Male	0	(0.0%)	5	(19.2%)	
Female	5	(100.0%)	21	(80.8%)	
SLE duration (y)	4.4	±2.9	5.6	±4.2	0.519
SLEDAI-2K	2.0	±2.4	7.0	±5.0	0.017*
BMI (kg/m^2)	17.1	±2.9	22.6	±6.2	0.024*
C3 (mg/dL)	107.3	±20.9	78.8	±23.5	0.041*
C4 (mg/dL)	17.1	±8.0	15.1	±7.5	0.591
anti-DsDNA (WHO units/mL) (n = 30)	328.5	±217.3	325.8	±209.8	0.933
Hemoglobin (g/dL)	13.5	±0.8	13.1	±1.5	0.360
WBC (10^3/mL)	6016.0	±1884.5	7221.9	±3308.5	0.591
Platelet (10^3/μL)	245.0	±48.2	263.3	±91.2	0.390
Glucocorticoid dosage(mg/k/d)[a]	0.0	±0.0	0.2	±0.2	<0.001**
Other immunosuppressant(s)	0	(0.0%)	14	(53.8%)	0.048*
Hydroxychloroquine	5	(100.0%)	24	(92.3%)	1.000
Vitamin D supplement[b]	3	(60.0%)	13	(50.0%)	1.000

Data are presented as mean ± SD or % (percentage).

*$p < 0.05$,

**$p < 0.01$.

Laboratory test results revealed complement 3,4(C3, C4), anti-DsDNA, hemoglobin, WBC, and platelet.

anti-DsDNA = anti-double-strand DNA antibody; BMI = body mass index; SLEDAI-2K = systemic lupus erythematosus disease activity index 2000; WBC = white blood cell.

[a]The daily glucocorticoid dosage of the patients 1 month before the examination (equivalent prednisolone dose, mg/kg/d) was in the table.

[b]Vitamin D supplement: Patient who had vitamin D supplement prior to this study.

Table 4

Comparisons of patients using systemic glucocorticoids taking other immunosuppressant or not

	Other IS (–) (n = 12)		Other IS (+) (n = 14)		p
Vit D3 level (ng/mL)	19.2	±6.8	16.5	±5.0	0.136
Age (y)	17.8	±4.7	20.3	±5.1	0.301
Age of onset (y)	13.6	±2.6	13.5	±2.6	0.938
Male	2	(16.7%)	3	(21.4%)	
Female	10	(83.3%)	11	(78.6%)	
SLE duration (y)	4.3	±3.4	6.8	±4.7	0.189
SLEDAI-2K	5.3	±4.3	8.4	±5.3	0.108
BMI (kg/m^2)	20.4	±6.0	24.4	±6.1	0.039*
C3 (mg/dL)	83.5	±25.7	74.8	±21.6	0.572
C4 (mg/dL)	15.6	±5.7	14.6	±8.9	0.700
anti-DsDNA(WHO units/mL) (n = 30)	296.4	±224.7	352.9	±200.2	0.514
Hemoglobin (g/dL)	13.0	±1.5	13.3	±1.6	1.000
WBC (10^3/mL)	8246.7	±4262.7	6343.6	±1968.5	0.304
Platelet (10^3/μL)	264.0	±106.4	262.7	±80.2	0.938
Glucocorticoid dosage (mg/k/d)[a]	0.2	±0.2	0.2	±0.2	0.757
Hydroxychloroquine	11	(91.7%)	13	(92.9%)	1.000
Vitamin D supplement[b]	8	(66.7%)	5	(35.7%)	0.238

Data are presented as mean ± SD or % (percentage).

*$p < 0.05$.

Laboratory test results revealed complement 3, 4(C3, C4), anti-DsDNA, hemoglobin, WBC, and platelet.

anti-DsDNA = anti-double-strand DNA antibody; BMI = body mass index; SLEDAI-2K = systemic lupus erythematosus disease activity index 2000; WBC = white blood cell.

[a]The daily glucocorticoid dosage of the patients 1 month before the examination (equivalent prednisolone dose, mg/kg/d) was in the table.

[b]Vitamin D supplement: Patient who had vitamin D supplement before this study.

Table 5

Comparisons of patients by serum Vitamin D3 level ≤ 18.5 ng/mL or >18.5 ng/mL

	Vit D ≤ 18.5 (n = 16)		Vit D > 18.5 (n = 15)		p
Vit D3 level (ng/mL)	14.4	±4.0	25.3	±7.1	<0.001**
Age (y)	19.7	±5.7	16.3	±5.9	0.242
Age of onset (y)	13.8	±2.6	11.3	±4.4	0.093
Male	2	(12.5%)	3	(20.0%)	
Female	14	(87.5%)	12	(80.0%)	
SLE duration (y)	5.9	±5.1	5.0	±2.5	0.812
SLEDAI-2K	8.1	±5.2	4.1	±4.1	0.018*
BMI (kg/m^2)	21.9	±6.2	21.5	±6.2	0.540
C3 (mg/dL)	79.4	±24.6	87.7	±25.9	0.635
C4 (mg/dL)	15.2	±8.0	15.5	±7.1	0.984
anti-DsDNA (WHO units/mL) (n = 30)	333.1	±192.7	319.3	±227.4	0.950
Hemoglobin (g/dL)	13.1	±1.5	13.4	±1.5	0.332
WBC (10^3/mL)	7355.6	±3708.2	6677.3	±2451.5	0.828
Platelet (10^3/μL)	260.9	±101.8	259.7	±67.4	0.859
Glucocorticoid dosage (mg/k/d)[a]	0.2	±0.2	0.1	±0.2	0.008**
Glucocorticoids [b]	16	(100.0%)	10	(66.7%)	0.018*
Other immunosuppressant(s)	10	(62.5%)	4	(26.7%)	0.101
Hydroxychloroquine	15	(93.8%)	14	(93.3%)	1.000
Vitamin D supplement[c]	8	(50.0%)	8	(53.3%)	1.000

Data are presented as mean ± SD or % (percentage).

*$p < 0.05$,

**$p < 0.01$.

Laboratory test results revealed complement 3, 4(C3, C4), anti-DsDNA, hemoglobin, WBC, and platelet.

anti-DsDNA = anti-double-strand DNA antibody; BMI = body mass index; SLEDAI-2K = systemic lupus erythematosus disease activity index 2000; WBC = white blood cell.

[a]The daily glucocorticoid dosage of the patients 1 month before the examination (equivalent prednisolone dose, mg/kg/d) was in the table.

[b]Glucocorticoids: Use oral corticosteroids within 1 month of the examination.

[c]Vitamin D supplement: Patient who had vitamin D supplement before this study.

VitD3 levels displayed significantly lower SLEDAI-2K scores (4.1 ± 4.1 vs 8.1 ± 5.2 points, p = 0.018), lower SCS dosages (0.1 ± 0.2 vs 0.2 ± 0.2 mg/kg/d, p = 0.008), as well as a lower percentage of SCS use (66.7% vs 100%, p = 0.018).

3.6. Comparison of patients taking or not taking a vitamin D supplement before this study

There were 16 patients receiving variable dosages of a vitamin D supplement at the time of this study. However, there was no difference in their VitD3 levels when compared to those not taking a vitamin D supplement (20.9 ± 9.1 vs 18.4 ± 6.4 ng/mL, p = 0.553), as well as other parameters, with the exception of younger age (15.6 ± 5.6 vs 20.7 ± 5.3 years, p = 0.016), and younger age at SLE diagnosis (11.3 ± 4.0 vs 14.0 ± 3.0 years, p = 0.028).

3.7. Simple linear regression of VitD3 levels and SLEDAI-2K/daily SGS dosage

Linear regression was conducted to depict the correlation of VitD3 levels between SLEDAI- 2K, C3, C4, anti-dsDNA, and daily SCS dosages. There was a significant negative correlation between VitD3 levels and SLEDAI- 2K (r_s = –0.55, p = 0.001; Fig. 1A), but no correlation between VitD3 vs C3, C4 or anti-dsDNA levels. A significant negative correlation also existed between VitD3 levels and daily SCS dosages (r_s = –0.49, p = 0.005; Fig. 1B).

4. DISCUSSION

The results of this study suggest that vitamin D deficiency is common in cSLE patients (a mean serum VitD3 concentration of 19.7 ± 7.9 ng/mL). Moreover, serum VitD3 levels are significantly lower in patients having a SLEDAI-2K>4, when compared to those with an SLEDAI-2K≦4. In addition, a significantly negative correlation between VitD3 levels and SLEDAI-2K was also observed. Our data also reveal the negative correlation between daily SCS dosage and VitD3 levels. Several previous adult studies and a meta-analysis did not find any correlation between VitD3 and daily SCS dosage in SLE patients.[9,11] There have been two cSLE studies which revealed no relationship between SCS use and VitD3 levels.[11,13] Their measurements, however, were different from ours. One study correlated cumulative SCS dosage to VitD3 levels,[11] while the other calculated the current SCS daily dose, with no consideration for patient body weight.

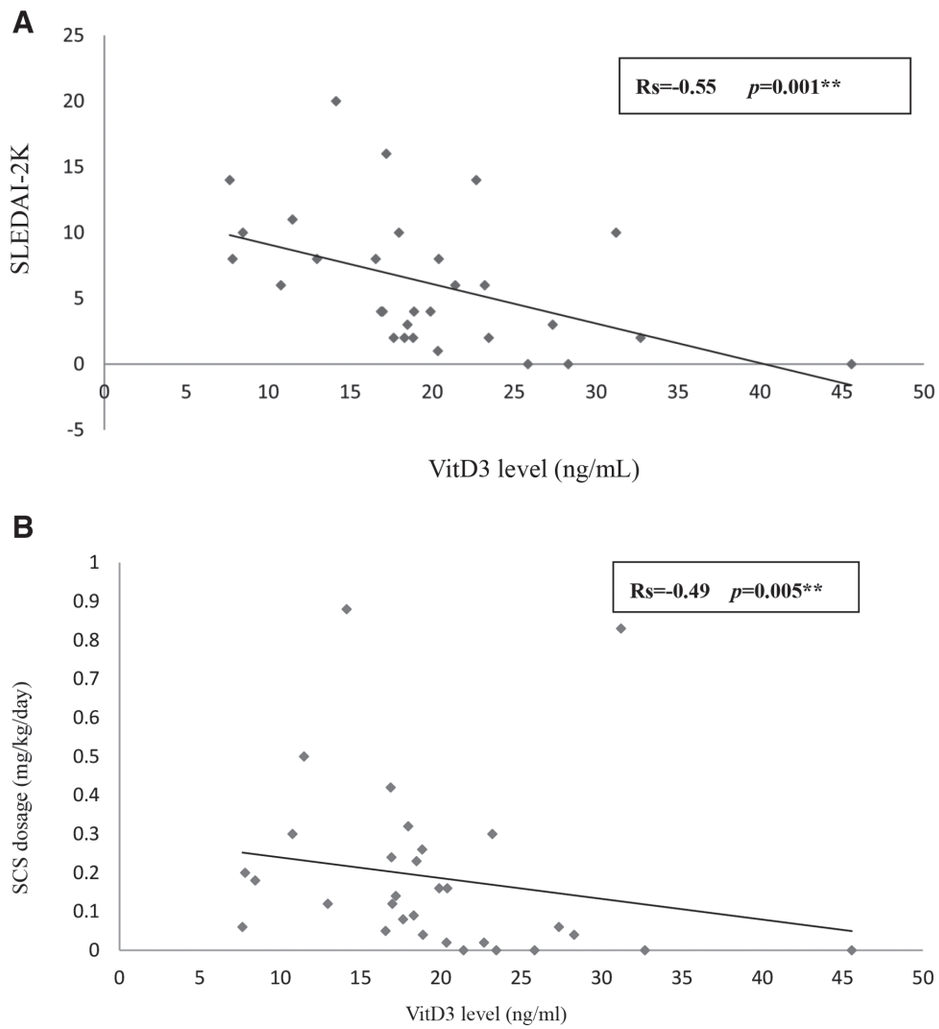

Fig. 1 Plots of simple linear regression. A, Correlation of vitamin D3 levels and systemic erythematosus disease activity index 2000 (SLEDAI-2K). B, Correlation of vitamin D3 levels and systemic corticosteroids (SCS) dosage.

A possible explanation for this is that VitD3 has some immunomodulatory effect on our immune system. It has been suggested that immunocytes, including dendritic cells, macrophages, monocytes, and lymphocytes (B and T cells), cannot only convert 25(OH) D3 to 1,2(OH) D3, but they can also express VDR. After 1,25(OH)D3 binding to VDR, it can mediate downstream gene transcription to regulate autoimmunity.[4,7] Some studies have reported that VitD3 may inhibit Th17 activity and suppress Th17 cell-related cytokines such as IL-17 and IL-22.[17,18] Additionally, some studies have suggested that VitD3 can boost suppressive activity and the numbers of regulatory T cells, as well as induce IL-10 and other co-inhibitory molecules like Programmed cell death-1 and cytotoxic T-lymphocyte–associated antigen 4 (CTLA4).[19] As stated above, vitamin D3 has the potential to modulate the activity of autoimmune disease. Our results are consistent with several studies, particularly those regarding adult SLE patients,[9,12,20–23] but only a few studies have involved cSLE patients.[12,24]

Another explanation for this result is that an increased systemic glucocorticoid dosage may contribute to vitamin D deficiency. Our results reveal that those who took systemic corticosteroids had significant lower VitD3 levels and higher SLEDAI-2K. Moreover, an inverse correlation also existed between VitD3 levels and daily SCS dosages. The mechanism surrounding glucocorticoid and its interaction with vitamin D deficiency is not well comprehended. One possible explanation for this is that an increased systemic glucocorticoid dosage would enhance 24-hydroxylase transcriptions. Subsequently, upregulating 24-hydroxylase activity can degrade vitamin D metabolites such as 25(OH) D3 and 1,25(OH) D3 and inactivate them.[25] This trend corresponds with a large cross-sectional analysis from the National Health and Nutrition Examination Survey (NHANES 2001–2006), which indicates that steroid use is associated with severe 25(OH) D3 deficiency.[26]

There are some limitations in this study. First, 16 of 31 patients received a vitamin D supplement prior to the study. According to our investigation, they took VitD3 at either 400, 600, 800 IU, or alfacalcidol 0.25 μg once per day. Based on existing law in Taiwan, the maximum dose of VitD3 we can purchase here is a mere 800 IU. Thus, the taking of any vitamin D supplement before this study would be too little to make any difference in our results. Dividing the patients into two groups, determined by whether they had previously taken vitamin D or not, those who had showed slightly higher VitD3 levels (20.9 ± 9.1 vs 18.4 ± 6.4 ng/mL), though their p value showed no significance (p = 0.553) (Table 6). Another limitation of this study is the high prevalence of vitamin D deficiency in Taiwanese children. A study published in 2014 had enrolled 1315 participants in Taiwan who were aged 5 to 18 years. Of all, 670 subjects (51.0%) had vitamin D deficiency (defined as serum 25(OH) D3 < 20 ng/mL), while 1187 subjects (90.3%) displayed vitamin D insufficiency (defined as serum 25(OH) D3 < 30 ng/mL).[27] The rates of deficiency/insufficiency were higher than other Asian countries, including China[28] and Korea.[29] However, it is difficult to evaluate the effect that the high prevalence of vitamin D deficiency has on this study.

In conclusion, this study shows that VitD3 deficiency is common in patients with cSLE. Additionally, serum VitD3 levels negatively correlate to SLEDAI-2K. This can be partially explained by the less usage of SCSs in this study. More studies are still required in order to clarify the role that vitamin D has in this disease, as well as to regulate the type of supplementation required, and to determine the minimal beneficial levels.

Table 6

Comparisons of patients with vitamin D supplement before this study or not

	Vitamin D (–) (n = 15)		Vitamin D (+) (n = 16)		p
Vitamin D3 level (ng/mL)	18.4	±6.4	20.9	±9.1	0.553
Age (y)	20.7	±5.3	15.6	±5.6	0.016*
Age of onset (y)	14.0	±3.0	11.3	±4.0	0.028*
Male	4	(26.7%)	1	(6.3%)	
Female	11	(73.3%)	15	(93.8%)	
SLE duration (y)	6.7	±4.6	4.3	±3.2	0.185
SLEDAI-2K	6.3	±4.8	6.1	±5.4	0.781
BMI (kg/m^2)	23.2	±6.1	20.3	±6.0	0.160
C3 (mg/dL)	76.4	±25.1	90.1	±24.1	0.133
C4 (mg/dL)	15.7	±8.7	15.1	±6.4	0.843
anti-DsDNA (WHO units/mL)	348.8	±231.7	306.5	±188.7	0.454
Hemoglobin (g/dL)	13.2	±1.7	13.2	±1.3	0.782
WBC (10^3/mL)	6665.3	±2566.2	7366.9	±3632.8	0.693
Platelet (10^3/μL)	236.9	±107.8	282.3	±51.7	0.286
Proteinuria (n = 6 vs 2)	2.3	±1.2	0.6	±0.0	0.182
Glucocorticoid dosage (mg/k/d)[a]	0.3	±0.3	0.1	±0.1	0.068
Glucocorticoids[b]	13	(86.7%)	13	(81.3%)	1.000
Other immunosuppressant(s)	9	(60.0%)	5	(31.3%)	0.213
Hydroxychloroquine	13	(86.7%)	16	(100%)	0.226
Proteinuria	6	(40.0%)	2	(12.5%)	0.113
Hematuria	4	(26.7%)	4	(25.0%)	1.000
Pyuria	4	(26.7%)	4	(25.0%)	1.000

Data are presented as mean ± SD or % (percentage).

*$p < 0.05$.

Laboratory test results revealed complement 3, 4 (C3, C4), anti-DsDNA, hemoglobin, WBC, and platelet.

anti-DsDNA = anti-double-strand DNA antibody; BMI = body mass index; SLEDAI-2K = systemic lupus erythematosus disease activity index 2000; WBC = white blood cell.

[a]The daily glucocorticoid dosage of the patients 1 month before the examination (equivalent prednisolone dose, mg/kg/d) was in the table.

[b]Glucocorticoids: Use oral corticosteroids within 1 month of the examination.

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