25-hydroxy vitamin D level is associated with sleep disturbances in hemodialysis patients: a cross-sectional study.

1. ABSTRACT

1.1. Background/aim: Deficient levels of vitamin D is an important factor in the pathogenesis of some neurodegenerative diseases. The aim of this study is to determine the relationship between vitamin D deficiency along with depression status and sleep disorders of patients who are dialysed.

1.2. Materials and methods: In this cross-sectional study 121 hemodialysis patients were enrolled. All patients had been on hemodialysis since at least six months at the time of the study. Sleep quality, depression status were all measured by using specific inventories. All the patients fulfilled out Pittsburg Sleep Quality Index (PSQI) and Beck Depression Inventory (BDI) and gave blood samples. Vitamin D levels were measured for 121 patients and statistical analysis was done by using SPSS.

1.3. Results: Regression analyses demonstrated that low levels of 25 (OH) D and high BDI score were independent risk factors for poor sleep quality (OR’s were 0.668 (0.566 - 0.789), 1.080 (1.001 - 1.164) and 1.080 (1.001 - 1.164) respectively).

1.4. Conclusion: Our results suggest that deficiency of 25(OH)D is an important independent risk factor for poor sleep quality in hemodialysis patients.

2. KEY WORDS

Vitamin D level, sleep disturbances, hemodialysis patients
3. INTRODUCTION

Vitamin D is a complex lipophilic molecule which interacts with a specific nuclear receptor and plays a central role in calcium and phosphate homeostasis and musculoskeletal functions [1]. Apart from its well known metabolic effects, cumulative data have been demonstrated that vitamin D had multidirectional effects. For example, nuclear receptors of vitamin D are extensively expressed in some specific brain regions which are associated with memory and other cognitive processes [2,3]. Hence, deficiency of vitamin D is thought to be an important risk factor in the pathogenesis of cognitive impairment or some neurodegenerative disorders such as Alzheimer’s disease [4].

The prevalence of vitamin D deficiency or insufficiency is quite high in chronic kidney patients, particularly in the ones with end-stage renal disease (ESRD) [5]. Multiple factors such as low sunlight exposure, poor skin synthesis of endogenous vitamin D, decreased intake of vitamin D-rich foods, inadequate absorption from the gastrointestinal tract and impaired hepatic conversion of cholecalciferol to calcidiol might contribute to vitamin D deficiency in ESRD patients [6]. Similarly, sleep disturbances are also frequent in patients with ESRD and several factors including age, race, uremia, anemia, hypertension, malnutrition are thought to be responsible for poor sleep quality in patients with ESRD [7,8,9]. In addition, both deficiency of vitamin D and sleep disorders in ESRD are also strongly associated with increased risk of mortality [10,11]. The aim of this study is to determine the relationship between vitamin D deficiency along with depression status and sleep disorders of patients who are dialysed.
4. PATIENTS AND METHODS

4.1. Patients and Methods:

121 dialysed patients were enrolled. All patients had been on hemodialysis since for at least six months at the time of the study. All patients underwent hemodialysis three times a week with an average blood flow rate of 300 - 350 mL/min, using a standard bicarbonate dialysis solution and semi-synthetic membranes (surface area 1.1 to 1.7 m²). In order to measure 25 (OH) vitamin D (25[OH]D), all blood samples were obtained between June and August. Serum 25(OH)D concentrations were measured by commercial RIA kit (Immuno-Biological Laboratories, Minneapolis, MN). Single Kt/V that is a measurement of the efficacy of a hemodialysis session was calculated for all patients.

Patients were divided into two groups according to sleep quality. Pittsburg Sleep Quality Index (PSQI) was used for assessing the quality of sleep [12]. The patients with a PSQI score > 5 were considered as poor sleepers (22 women, 34 men) while the patients with a PSQI score ≤ 5 were considered as good sleepers (44 women, 21 men). Survey forms were completed by face-to-face interviews. This self-administered questionnaire consists of seven components, each component is scored from 0 to 3. Global PSQI score ranges from 0 to 21. PSQI was validated for the Turkish population by Agargun et al [13].

Depression status was evaluated by using Beck Depression Inventory (BDI) [14]. The BDI is an inventory that utilizes the existing symptoms of depression. BDI consists of 21 questions. The BDI score ranges from 0 to 63. The standard cut-off areas are as follows: 0-9 indicates that a person is not depressed, 10-18 indicates mild depression, 19-29 indicates moderate depression, and 30-63 indicates severe depression [14]. BDI was validated for the Turkish population by Hisli et al [15].
Exclusion criteria were as follows: age < 18 years, dementia or mental retardation, psychiatric illness, inability to complete survey forms, history of malignancy, acute or chronic infection, chronic inflammatory illness, history of hospitalization within the last six months, parathyroidectomy. The study protocol was approved by our local scientific ethics committee.

4.2. Statistical analysis:

Continuous variables were expressed as mean (SD) or median (min-max) according to the data distribution. Frequencies were expressed as percentage. Chi-square test was used for comparison of the frequencies between two groups. Student’s t test and Mann Whitney U test were used for comparison of the continuous variables between groups. Nonparametric Spearman’s rho analysis was used for the correlation analyses. Logistic and linear regression analyses were performed for determination of the independent risk factors for poor sleep quality.

5. RESULTS

Mean age, mean body mass index (BMI) and median duration of dialysis were similar between good and poor sleepers. Mean Kt/V ratio and female/male ratio was significantly higher in good sleepers when compared to poor sleepers (Table 1). Baseline laboratory parameters were similar between two groups (Table 2). Median 25(OH)D level was found to be significantly higher in good sleepers when compared to poor sleepers (24 [4 – 46] vs 7 [2 – 17] respectively, p < 0.001). Median PTH level was found to be significantly higher in good sleepers than poor sleepers (310 [59 – 1364] vs 170 [15 – 1367] respectively, p = 0.013). Median BDI score was found to be significantly lower in good sleepers than poor sleepers (11 [2 – 35] vs 22 [3 – 42] respectively, p < 0.001).
frequency of depressed patients was significantly higher in poor sleepers than those of the good sleepers (64 % vs 29 % respectively, p <0.001). 25(OH)D level was inversely correlated with both PSQI and BDI scores (r = - 0.82, p < 0.001 and r = - 0.36, p < 0.001 respectively) (Figure 1 and 2). There was a significant positive correlation between PSQI and BDI scores ( r = 0.43, p < 0.001) (Figure 3). Logistic regression analyses demonstrated that low levels of 25 (OH) D and high BDI score were independent risk factors for poor sleep quality (Table 3). Linear regression analyses also demonstrated that low levels of 25(OH)D and low Kt/V value were independent risk factors for poor sleep quality.

6. DISCUSSION

6.1. Discussion:

Sleep disturbances are common problems in hemodialysis patients. Although exact pathogenetic mechanism of poor sleep on hemodialysis patients still remains unknown, many factors are thought to be responsible for this condition such as age, race, renal function and some metabolic parameters [7-9]. In the present study, we evaluated the relationship between 25(OH)D levels, sleep disturbance and depression in ESRD patients. To the best of our knowledge, this is the first report that investigate the effect of 25(OH)D on sleep status in hemodialysis patients. Chronic kidney disease itself has negative effects on mood of the patients and sleep quality. Besides, sleep quality is also affected form pruritis of uremia and electrolyte disturbances seen in chronic kidney disease. As a result, some of our patients are frail patients and it is very important for us to improve their quality of life. Vitamin D replacement may improve sleep quality and mood in deficient patients.
We found that the levels of 25(OH)D were significantly higher in good sleepers when compared to poor sleepers. In the medical literature, the relationship between 25 (OH) vitamin D status and sleep disturbances has been extensively studied in subjects with normal kidney function. In a cross-sectional study, Cakir et al. demonstrated that PSQI scores were significantly higher in patients with vitamin D deficiency when compared to subjects who had normal levels of vitamin D [16]. Another large cross-sectional study, Bertisch et al. found that vitamin D deficiency was strongly associated with short sleep duration depending on ethnicity [17]. In addition, cross-sectional data from the National Health and Nutrition Examination Surveys (NHANES) 2005-2006 also demonstrated that short sleep duration was significantly associated with the levels of 25(OH)D [18].

Depression is an important causal factor for sleep disturbances in patients with chronic renal failure. Hemodialysis and peritoneal dialysis patients who were poor sleepers were found to be more depressed [19,20]. We found that BDI score was significantly lower in good sleepers when compared to poor sleepers. Our results also demonstrated that there was a significant positive correlation between PSQI and BDI scores. At first sight, these results may thought to be confounding factors for relationship between 25(OH)D and sleep disturbances. Because, our subjects with poor sleep were more depressed when compared to good sleepers. However, our regression analyses demonstrated that low level of 25(OH)D was a independent risk factor for poor sleep quality. Another important confounding factor for sleep disturbance in hemodialysis patient is the efficacy and adequacy of the hemodialysis. Kt/V ratio is a way of measuring dialysis adequacy. Hemodialysis patients with sleep disturbances have low Kt/V ratio [21]. In our study, Kt/V ratios and parameters that may affect sleep status such as age, duration of
hemodialysis, body mass index and hemoglobin levels were found to be similar between
good and poor sleepers. Although, frequency of gender and Kt/V were statistically
different between groups, we demonstrated that low level of 25(OH) vitamin D was
independent risk factor for poor sleep quality.

Vitamin D receptors are extensively expressed in the anterior and posterior hypothalamus,
midbrain central gray and basal forebrain. All of these brain areas appear to coordinate
the sleep-wake state [2,3]. On the other hand, many neurotransmitters and
neuromodulators such as dopamine, serotonin, norepinephrine, glutamate and γ-
aminobutyric acid are important players in the regulation and maintenance of sleep-wake-
dependent changes in neuronal activity and the sleep-wake continuum and dysregulation
of these neurochemical systems leads to sleep-wake disorders [22]. The levels of these
neurotransmitters in the brain may be modulated by the vitamin D [23]. Vitamin D
metabolites can also inhibit the synthesis of inducible nitric oxide synthase and increase
glutathione levels like a hormone in brain detoxification pathways [24]. All these features
about vitamin D may partly explain the role of the vitamin D on the pathogenesis of the
sleep disturbance.

In conclusion, vitamin D deficiency and sleep disturbance are common problems of
hemodialysis patients. In addition, both 25(OH)D deficiency [10] and sleep disturbance
Cholecalciferol therapy may increase serum 25(OH)D levels in patients on maintenance
hemodialysis and cholecalciferol supplementation is found to be effective and safe in
hemodialysis patient [25,26]. Our results suggest that deficiency of 25(OH)D is an
important risk factor for poor sleep quality in hemodialysis patients and this result is
independent of other factors such as gender, age, depression and efficacy of hemodialysis.
All hemodialysis patients who suffer from sleep disturbance should be carefully evaluated for vitamin D status.

6.2. Limitations of the study:

Our study is a cross sectional study so it covers a limited time period. That’s why we could not show the annual fluctuation of the effect of vitamin D deficiency on sleep quality and depression status. In order to determine the effect of this new prospective studies are needed.

REFERENCES


7. FIGURES AND TABLES

7.1. **Figure 1.** Correlation analysis between 25(OH)D and PSQI score

![Figure 1](image)

7.2. **Figure 2.** Correlation analysis between 25(OH)D and BDI score
7.3. Figure 3. Correlation analysis between PSQI and BDI scores
### Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Good Sleeper (n:65)</th>
<th>Poor Sleeper (n:56)</th>
<th>(p)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (mean[SD]), years</strong></td>
<td>55 (14)</td>
<td>57 (15)</td>
<td>0.463</td>
</tr>
<tr>
<td><strong>Gender (F/M)</strong></td>
<td>44/21</td>
<td>22/34</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td><strong>BMI (mean[SD]), kg/m²</strong></td>
<td>25.3 (5.5)</td>
<td>27.1 (4.4)</td>
<td>0.232</td>
</tr>
<tr>
<td><strong>Duration of dialysis [median(min-max)], month</strong></td>
<td>38 (6-216)</td>
<td>25 (6-192)</td>
<td>0.444</td>
</tr>
<tr>
<td><strong>Kt/V(mean[SD])</strong></td>
<td>1.4 (0.3)</td>
<td>1.3 (0.2)</td>
<td>&lt;0.001</td>
</tr>
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</table>

Baseline characteristics of the study groups
### Table 2.

<table>
<thead>
<tr>
<th>Mean (SD)</th>
<th>Good Sleeper (n:65)</th>
<th>Poor Sleeper (n:56)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUN, mg/dL</td>
<td>62.1 (14.8)</td>
<td>64.6 (13.7)</td>
<td>0.345</td>
</tr>
<tr>
<td>Creatinine, mg/dL</td>
<td>7.8 (1.9)</td>
<td>7.2 (1.7)</td>
<td>0.081</td>
</tr>
<tr>
<td>Calcium, mg/dL</td>
<td>8.6 (0.6)</td>
<td>8.5 (0.6)</td>
<td>0.165</td>
</tr>
<tr>
<td>Phosphorus, mg/dL</td>
<td>5.1 (1.3)</td>
<td>4.9 (1.4)</td>
<td>0.558</td>
</tr>
<tr>
<td>Total cholesterol, mg/dL</td>
<td>151 (38)</td>
<td>161 (39)</td>
<td>0.183</td>
</tr>
<tr>
<td>LDL, mg/dL</td>
<td>83 (30)</td>
<td>93 (28)</td>
<td>0.055</td>
</tr>
<tr>
<td>Triglyceride, mg/dL</td>
<td>188 (112)</td>
<td>188 (108)</td>
<td>0.997</td>
</tr>
<tr>
<td>Albumin, g/dL</td>
<td>3.9 (0.3)</td>
<td>3.8 (0.3)</td>
<td>0.062</td>
</tr>
<tr>
<td>Hemoglobin, g/dL</td>
<td>11.2 (1.2)</td>
<td>11.3 (1.1)</td>
<td>0.867</td>
</tr>
</tbody>
</table>

**Laboratory parameters between good and poor sleepers**
### Table 3. Risk factor analysis for the sleep quality

<table>
<thead>
<tr>
<th></th>
<th>Logistic Regression</th>
<th>Linear Regression</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI)</td>
<td>P</td>
</tr>
<tr>
<td>25 (OH) D</td>
<td>0.668 (0.566 - 0.789)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BDI</td>
<td>1.080 (1.001 - 1.164)</td>
<td>0.047</td>
</tr>
<tr>
<td>Kt/V</td>
<td>-</td>
<td>NS</td>
</tr>
</tbody>
</table>

7.6. Table 3.