

# The study of serum vitamin D levels in patients with spinal cord injuries

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## ABSTRACT

**Purpose:** To determine the serum levels of vitamin D and calcium in patients with spinal cord injuries and their association with the scope of the lesion and the time passed since its inception.

**Materials and Methods:** The participants were 147 spinal cord injured patients with the required criteria who had referred to our center. A questionnaire was filled for all of them to gather demographic details and then they were examined by a specialist. Blood sample was taken to determine the serum level of their 25-hydroxy vitamin D.

**Results:** The mean of calcium and vitamin D serum levels were 8.33 mg/dL and 15.30 ng/mL, respectively. Of the participants, 64.6% had vitamin D deficiency and 18.4% had insufficient level of vitamin D. Only in 7.5% of the patients the level of vitamin D was sufficient. In addition, 50.3% of the participants were afflicted with hypocalcaemia and the rest had normal level of calcium.

**Conclusion:** According our study many of spinal cord injured patients suffer from vitamin D deficiency. Considering the major complications caused by deficiency of vitamin D, prevention and treatment of this complication appears to be crucial in such patients

**Keywords:** spinal cord injuries; vitamin D; osteoporosis; fractures, bone; calcium.

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## INTRODUCTION

Injuries to spinal cord and its lesions create numerous complications in the long term plus complications in the sensorimotor and autonomic systems for the patient. One of these problems is disturbing the balance between calcium, phosphorous and alkaline phosphatase, which in turn, causes osteoporosis, hypercalciuria and renal stones.<sup>1</sup> The other problem is vitamin D deficiency. Spinal cord injured patients are susceptible to vitamin D deficiency because of a number of reasons including malnutrition, sunlight deprivation, and hypercalcemia owing to lack of movement and sedentary life.<sup>2</sup>

Vitamin D greatly affects health issues in normal individuals and also in spinal cord injured patients. Its deficiency is an important risk factor for osteoporosis.<sup>3</sup> The existence of this vitamin is indispensable for the absorption of calcium in the intestines. Besides, vitamin

D deficiency causes rickets, osteomalacia and damage to bone mineralization. New evidence has indicated that this vitamin has an important role in bone disorders such as osteoarthritis and stress fractures.<sup>4</sup> Vitamin D deficiency has adverse effects on calcium metabolism, osteoblasts activities, ossification of bone matrix and bone density. Simultaneous occurrence of vitamin D deficiency with disturbance in calcium-phosphorous balance puts patients at higher risks of osteoporosis and bone fracture.<sup>5</sup>

Vitamin D deficiency leads to the stimulation of parathyroid glands and increase of parathyroid hormone (PTH) hormone, Secondary hyperparathyroidism mobilizes calcium from the bone and contributes to the decrease in bone mineral density and in turn osteoporosis.<sup>1</sup> The other cause that susceptible these patients to osteoporosis is long periods of immobility and sedentary life. In addition, the nervous and hormonal factors in such

patients may cause osteoporosis.<sup>6</sup> Osteoporosis increases the risk of bone fracture in these patients. If spinal cord injured patients experience bone fracture, they will be at higher risks of disability and death. In addition, their treatment expenses will increase.<sup>7</sup>

Hence, prevention and treatment of osteoporosis, vitamin D and calcium deficiency in these patients is a critically important issue. While there are approved instructions for controlling secondary complications of spinal cord injured patients, such as bed sore, urinary and digestive problems, there is no national and global instruction about prevention and treatment of osteoporosis in patients with spinal cord injured patients.<sup>8</sup>

In our community, there has been no comprehensive investigation about the serum levels of vitamin D and calcium in patients with spinal cord injuries. So this study investigated this issue in these patients.

### MATERIALS AND METHODS

This was a cross-sectional study on patients who had referred our spinal cord injury rehabilitation center. The inclusion criteria were affliction to traumatic spinal cord injury and having passed six months after the injury. The exclusion criteria were affliction to hyperparathyroidism, chronic kidney failure, cancer, diseases affecting calcium and phosphorous, plus taking calcium and vitamin D supplements. Based on the used kit in the laboratory for vitamin D, the values less than 10 ng/mL were attributed as *deficient*, between 10 and 29 ng/dL were *insufficient* and between 29 and 100 ng/mL were *sufficient*. The normal amount of calcium was between 8 and 10.4. This was between 2.5-5 mg/dL for phosphates.

One hundred forty seven participants were included in the study. Written informed consent was obtained from all participants before their participation. The demographic information of the participants was obtained by a questionnaire. All participants were examined by a specialist in physical medicine and the level of the spinal cord injury was determined with clinical examination. The participants were categorized into four groups: complete and partial quadriplegic and complete and partial paraplegic. The patients' American Spinal Injury Association Impairment Scale (ASIA) level and spinal cord independence measurement (SCIM) were

determined.

The ASIA categorizes patients into five groups of complete A and B and incomplete C, D, and E. On the other hand, SCIM categorizes patients' independence in a quantitative measure ranging from zero to 100. Then, the patients' blood samples were obtained to measure their calcium, phosphorous and 25-hydroxy vitamin D levels.

### RESULTS

A total number of 147 patients (112 men and 35 women) with spinal cord injuries were studied in this investigation. Their average age was  $34.7 \pm 13.25$  years old. The mean time of affliction before their participation in the study was  $51.23 \pm 46.57$  months. The highest injury level was at thoracic level (64%). The majority of the patients were categorized in the complete paraplegic group (**Table 1**).

The average serum levels of calcium and vitamin D were 8.33 mg/dL and 15.30 ng/mL, respectively (**Table 2**). Of the patients, 64.6% had vitamin D deficiency and 18.4% had insufficient levels of vitamin D. Only in 7.5% of the patients the levels of vitamin D was sufficient. Of the patients, 74.5% had normal phosphorous level. Twenty two patients had hyperphosphatemia and only one patient had hypophosphatemia. Of the patients 50.3% were suffering from hypocalcaemia and the rest had normal calcium levels.

**Table 1.** Demographic characteristics of study patients.

Variables	Frequency	Percentage (%)
Injury level		
Cervical	42	28.6
Thoracic	95	64.6
Lumbar	10	6.8
Type of plegia		
Incomplete paraplegia	25	17
Complete paraplegia	85	57.8
Incomplete quadriplegia	24	16.3
Complete quadriplegia	13	8.8
ASIA		
A	87	59.2
B	29	19.7
C	27	18.4
D	3	2.0
E	1	0.7

Key: ASIA, American Spinal Injury Association Impairment Scale.

**Table 2.** Serum levels of calcium, phosphorous, and vitamin D.

Variables	Minimum	Maximum	Mean	Standard Deviation
Calcium (mg/dL)	7.80	9.60	8.33	0.39
Phosphorous (mg/dL)	2.60	5.70	3.88	0.67
Vitamin D (ng/mL)	2.10	68.30	15.30	11.98

There was no correlation between vitamin D and patients' age ( $r = 0.13, P = .470$ ). This also held true for the correlation between vitamin D and the duration of affliction to the spinal cord injury before participation in the study ( $r = 0.15, P = .859$ ). No correlation was observed between levels of calcium and phosphorus, age of the patients and the duration of affliction. The amounts of vitamin D were  $15.7 \pm 11.36$  ng/L, and  $14.1 \pm 13.76$  ng/mL in paraplegic and quadriplegic patients, respectively.

Analysis of calcium serum level based on the patients' gender indicated that this values were  $8.46 \pm 0.45$  mg/dL in women and  $8.28 \pm 0.36$  mg/dl in men. This difference was statistically significant ( $P = .04$ ). The serum level of vitamin D, phosphorous and alkaline phosphates between women and men did not show any significant difference (Table 3).

### DISCUSSION

Based on this study, 64.6% of the participants were suffering from vitamin D deficiency and 18.4% had insufficient levels of vitamin D. These results are similar to many other studies.

In a study by Bauman and colleagues, 32% of the patients with spinal cord injuries suffered from vitamin D deficiency.<sup>9</sup> In Oleson and colleagues' research a higher percentage of patients were suffering from chronic vitamin D deficiency, 81% of the patients in summer and 96% of the patients in winter had vitamin D values less than 32 ng/mL from whom 54% had vitamin D levels less than 13 ng/ml in winter.<sup>8</sup> In a retrospective study by Nemunaitis and colleagues 93% of the patients with spinal cord injury had insufficient levels of vitamin D (i.e. less than 30 ng/mL).<sup>10</sup> Pellicante and colleagues investigated 136 patients with spinal cord injury and found out that 67% of them had relative or absolute insufficient levels of vitamin D.<sup>11</sup>

The recommended vitamin D intake dose by Institute of Medicine Center (IMC) for an adult of 70 years old or younger, and not breastfeeding or pregnant, should be 600 units per day. For a person more than 70 years old, this number is 800.<sup>12</sup> In addition to the changed level of vitamin D in the nervous system injuries, including spinal cord injury, brain stroke, etc., calcium homeostasis is also disturbed. Disabled patients who have to lead a sedentary lifestyle will be afflicted to hypercalcemia because of re-absorption of calcium in their bones. Thus, hypocalcemia in vitamin D deficiency is concealed with hypercalcemia due to sedentary lives and is not recognized.<sup>13</sup>

Several mechanisms in neurologic injuries may result in vitamin D deficiency. An important cause is long sedentary periods of life. In patients with spinal cord injuries, long periods of sedentary lifestyle may lead to the possibility twice to ten times as much as normal in re-absorption of calcium from bones. Other factors, which may lead to vitamin D deficiency, include vitamin synthesis because of bed sore, malnutrition, decreased exposure to sunlight and taking some medicines such as antiepileptic drugs.<sup>14</sup> Another reason for vitamin D deficiency in patients with spinal cord injuries is the reduced mechanical stimulation of the bones which results in reduced bone tissue.<sup>15</sup>

Individuals afflicted with spinal cord injuries are taken care of at home or in hospitals and are not sufficiently exposed to sunlight.<sup>9</sup> This causes reduction of conversion of vitamin D to its active form.<sup>16</sup> Many of spinal cord injured patients have to observe a set of specific dietary rules to prevent stone development. For example, they have to reduce the volume of dairy products, which, in turn, leads to reduction of vitamin D intake.<sup>17</sup> Several medicines such as antiepileptic and sedative drugs give rise to liver enzymes, a factor which is considered to contribute to vitamin D metabolism.<sup>16</sup> In addition,

**Table 3.** Average of vitamin D, calcium, phosphorous, and alkaline phosphates based on gender.

Sex	Mean	Standard Deviation	Standard Error Mean	P Value
<b>Calcium (mg/dL)</b>				
Woman	8.46	0.45	0.07	.04
Man	8.28	0.36	0.03	
<b>Phosphorous (mg/dL)</b>				
Woman	3.87	0.65	0.11	.93
Man	3.88	0.68	0.06	
<b>Alkaline phosphates (IU/L)</b>				
Woman	148.93	46.85	8.15	.37
Man	140.07	57.85	5.46	
<b>Vitamin D (ng/mL)</b>				
Woman	18.82	13.20	2.29	.80
Man	15.63	18.65	1.76	

the low level of vitamin D may cause osteopenia, osteoporosis, and increased fracture risk.

## CONCLUSION

According to our study many of spinal cord injured patients suffer from vitamin D deficiency. With considering to serious complication caused by deficiency of vitamin D, they need regular monitoring and prescribe supplementation at right time.

## CONFLICT OF INTEREST

None declared.

## REFERENCES

- Lips P, Hosking D, Lippuner K, et al. The prevalence of vitamin D inadequacy amongst women with osteoporosis: an international epidemiological investigation. *J Intern Med.* 2006;260:245-54.
- Kuno H. Vitamin D status and nonhemiplegic bone mass in patients following stroke. *Kurume Med J.* 1998;45:257-63.
- Lazo MG, Shirazi P, Sam M, Giobbie-Hurder A, Blacconiere MJ, Muppidi M. Osteoporosis and risk of fracture in men with spinal cord injury. *Spinal Cord.* 2001;39:208-14.
- Christodoulou S, Goula T, Ververidis A, et al. Vitamin D and bone disease. *Biomed Res Int.* 2013;2013.
- Villareal DT, Civitelli R, Chines A, et al. Subclinical vitamin D deficiency in postmenopausal women with low vertebral bone mass. *J Clin Endocrinol Metab.* 1991;72:628-34.
- Dionyssiatis Y. Spinal cord injury-related bone impairment and fractures: an update on epidemiology and physiopathological mechanisms. *J Musculoskelet Neuronal Interact.* 2011;11:257-65.
- Sato Y, Asoh T, Kondo I, et al. Vitamin D deficiency and risk of hip fractures among disabled elderly stroke patients. *Stroke.* 2001;32:1673-7.
- Oleson CV, Patel PH, Wuermsler LA. Influence of season, ethnicity, and chronicity on vitamin D deficiency in traumatic spinal cord injury. *J Spinal Cord Med.* 2010;33:202-13.
- Bauman WA, Zhong YG, Schwartz E. Vitamin D deficiency in veterans with chronic spinal cord injury. *Metabolism.* 1995;44:1612-6.
- Nemunaitis GA, Mejia M, Nagy JA, et al. A descriptive study on vitamin D levels in individuals with spinal cord injury in an acute inpatient rehabilitation setting. *PM R.* 2010;2:202-8.
- Pellicane AJ, Wysocki NM, Schnitzer TJ. Prevalence of 25-hydroxy vitamin D deficiency in the outpatient rehabilitation population. *Am J Phys Med Rehabil.* 2010;89:899-904.
- Ross AC, Taylor CL, Yaktine AL, et al, eds. *Dietary reference intakes for calcium and vitamin D.* Washington: The National Academies Press; 2011.
- Sato Y, Kaji M, Honda Y, et al. Abnormal calcium homeostasis in disabled stroke patients with low 25-hydroxyvitamin D. *Bone.* 2004;34:710-5.
- Carbone L, Chin AS, Lee TA, et al. The association of anticonvulsant use with fractures in spinal cord injury. *Am J Phys Med Rehabil.* 2013;92:1037-46.
- Dionyssiatis Y, Trovas G, Galanos A, et al. Bone loss and mechanical properties of tibia in spinal cord injured men. *J Musculoskelet Neuronal Interact.* 2007;7:62-8.
- Bauman WA, Emmons RR, Cirnigliaro CM, et al. An effective oral vitamin D replacement therapy in persons with spinal cord injury. *J Spinal Cord Med.* 2011;34:455-60.
- Alexandre C, Vico L. Pathophysiology of bone loss in disuse osteoporosis. *Joint Bone Spine.* 2011;78:572-6.

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