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Study of the Association between Serum Vitamin D 25(OH) D levels, Muscle Strength and fall among Elderly.

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ABSTRACT

Background: Reduced Vitamin D levels are common in elders. Deficiency predominantly affects the proximal muscles and contributes to falls increasing the risk of fractures among elders. Objective: To study the association between serum Vitamin D 25(OH) D levels, muscle strength and falls among elderly. **Methods:** 204 individuals aged more than 60 were included. It was a prospective Cross Sectional study. Historical data included motor weakness, of both proximal and distal muscles, falls &co morbidities. CGA including ADL was done. Motor power was tested using MRC grading. Vitamin D 25 (OH) levels was estimated using CLIA method. **Results:** There were 119 female and 85 male subjects. 86(42.2%), 99(48.5%) of them had severe deficiency (< 10 ng/ml) & insufficiency (10-25ng/ml) respectively. Only 19 (9.3%) had normal Vitamin D levels. 111(54.4%) individuals had proximal lower limb motor weakness (Symptomatic plus MRC grading). 86 (77.5%) among these had severe Vitamin D deficiency (p< 0.001). 77 (37.7%) had proximal upper limb motor weakness. 64 (83%) among them had severe Vitamin D deficiency (p< 0.001) .Strikingly it was found that severe Vitamin D deficiency was also associated with distal muscle weakness. 36 (17.6%) had falls. 35 among them (97.2%) had severe Vitamin D deficiency (p<0.001). 10 of them sustained fractures. According to KATZ ADL, individuals who were dependant or needed assistance had severe Vitamin D deficiency (p < 0.001). **Conclusion:** Deficiency of Vitamin D levels causes proximal and distal. Muscle weakness increasing the risk of falls and influencing ADL. Therefore estimating Vitamin D levels in elders even with minimal symptoms and correcting the deficiency would go a long way in fall prevention and reducing the care givers burden.

Keywords: ADL, Falls, muscle weakness, Vitamin D.

INTRODUCTION

Vitamin D, known as the "sunshine vitamin," is necessary for a wide variety of essential biological functions such as bone and mineral metabolism, muscle function, and immunity.

Reduced levels of serum Vitamin D is common in elderly people because of various risk factors:

1. Decreased dietary intake
2. Diminished sunlight exposure
3. Reduced skin thickness
4. Impaired intestinal absorption
5. Impaired hydroxylation in the liver and kidneys

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Vitamin D Deficiency is common among elderly people living in old aged home, nursing homes, and long stay wards and the same has been identified as an important public health problem.

1,25(OH)D3 exerts its influence on distant target tissues, mediated by a vitamin D receptor (VDR)[1]

VDR has been found in skeletal muscle cells that specifically binds 1, 25(OH)D3.

VDR promotes vitamin D directed protein synthesis and Vitamin D stimulates muscle cell.

Vitamin D deficiency has been reported to affect predominantly the weight-bearing antigravity muscles of the lower limb, which are necessary for postural balance and walking and can cause falls in elderly people.

MATERIALS AND METHODS

Source of data:

Individuals for this study were elderly aged more than 60 years attending our hospital that fulfilled the inclusion and exclusion criteria during the study period.

Study Period:

The study period was from November 2011 to June 2013.

Method of Data Collection:

- Patients were enrolled in this study after obtaining written informed consent.
- Information was collected on various demographic characteristics, covariates of muscle weakness.
- For the purpose of the study the following operational standard criteria/definitions was used

Elderly:

- 60 years of age was considered elderly as per ICMR survey on Indian geriatric population.

Vitamin D deficiency (Estimated by CLIA method)

- < 10 ng/ml : Severe deficiency
- 10- 25 ng/mL : Vitamin D Insufficiency
- > 25 ng/ ml : Normal

The following assessments were made based upon symptoms and signs.

Assessment of Falls:
This was assessed by asking history of falls from both the patient and their relatives.

Assessment of muscle weakness:
Muscle weakness was assessed by taking detailed history about their symptoms with respect to muscle weakness and power was tested as per "MRC grading.

MRC Grading of Muscle Weakness

- Grade 0: no contractions
- Grade 1: flicker or trace of contraction
- Grade 2: active movement when effect of gravity is eliminated
- Grade 3: active movement against gravity
- Grade 4- :active movement against gravity and slight resistance
- Grade 4: active movement against gravity and moderate resistance
- Grade 4+ : active movement against gravity and strong resistance
- Grade 5 : normal power.

Hand grip was assessed using "HAND DYNAMOMETER".
Comprehensive geriatric assessment including KATZ Activity of Daily Living was done.

Inclusion criteria:

- Elderly individuals above 60 years of age attending M.S.RAMAIAH HOSPITALS to MEDICINE and allied Departments were included for the study.

Exclusion criteria:

1. Patients with thyroid dysfunction
2. History of pre-existing neurological disorders
3. Elderly individuals with diabetes mellitus
4. Pre-existing renal and liver impairment
5. Elderly people who are on Vitamin D supplements

- Serum Vitamin D 25(OH)D levels was estimated in all the elderly satisfying the inclusion and exclusion criteria.
- Based on laboratory estimation the elderly were stratified into 3 groups i.e. Normal ,Insufficiency& Severe Deficiency
- The 3 groups were compared to fulfill the study objectives.

Study Design:
This study was a CROSS SECTIONAL STUDY, where data was enumerated after fulfilling the inclusion criteria.

Descriptive statistics:
All quantitative data like age, vital signs and investigations will be presented as mean and standard deviation with 95% Confidence intervals.
All qualitative data like sex, symptoms, baseline medical characteristics, clinical examination findings will be presented as frequency and percentages.

Analytical statistics:

- The proportion of the study subjects with Vitamin D deficiency, Muscle weakness and falls will be presented as frequency and percentages.
- T test will be applied to test for mean differences in Vitamin D levels in the different subject groups of the study.
- Correlation and regression statistics will be applied to assess the correlation and association of Vitamin D Levels with Muscle weakness.
- Chi-square statistics will be applied to assess the association between falls and various levels of Vitamin D levels deficiency in the study population.

RESULTS

In the present study out of the 204 elders there were 119 (58.3%) Females &85 (41.7%) Males. 86 (42.2%) of them had severe Vitamin D deficiency (< 10 ng/ml). 99 (48.5%) had insufficiency (10-25 ng/ml). Only 19 (9.3%) had normal Vitamin D levels.

With respect to gender and Vitamin D deficiency, severe Vitamin D deficiency was present in 42% of both male and female subjects.

Motor weakness referable to proximal muscles of the lower limb& upper limb was noted in 111 (54.4%), 77 (37%) respectively.

27 (13%) of them complained of weakness of distal muscles of lower limb. And 51(25%) had history of weakness of distal muscles of upper limb.

On assessing motor power using MRC grading in these individuals, all individuals who had symptomatic motor weakness had reduced motor power (Power of 4 or less MRC grading)

Out of 111 elders, with proximal lower limb weakness both symptomatically and according to MRC grading 86 (77%) had Vitamin D levels less than 10ng/ml (p< 0.001).77 elders who had motor weakness in proximal muscles of upper limb, 64 (83%) of them had Vitamin D levels less than 10 ng/ml (p<0.001).

Of the 58 elders who had distal lower limb motor weakness (at ankle joint), 52 (90%) of them had Vitamin D levels < 10 ng/ml. (p< 0.001) and of the 52 who had distal upper limb motor weakness (at wrist joint), 47 (90%) had Vitamin D levels < 10 ng/ml (p value < 0.001)

It was found that 36 of them had history of falls .All of them with history of falls had historical motor weakness and MRC grading of 4 or less with severe Vitamin D deficiency.

Among 36 who had falls, 35(97.2%) of them had severe Vitamin D deficiency (<10 ng/ml) and 10 of them sustained fracture.

KATZ activity of daily living was assessed. It was noted that out 61 individuals who needed Assistance, 53 of them had severe Vitamin D deficiency and 23 of them who were completely Dependent on others for their daily activities ,all these 23 had severe Vitamin D deficiency (< 10ng/ml) (P < 0.001).

Table 1: Correlation of Motor Power of proximal muscles with vitamin D level.

Power: proximal	Vitamin D			Total (n=204)	P value
	<10 (n=86)	10-25 (n=99)	>25 (n=19)		
Upper Limb	64(83.1%)	13(16.9%)	0(0%)	77(37.7%)	<0.001**
Lower limb	86(77.5%)	25(22.5%)	0(0%)	111(54.4%)	<0.001**

Table 2: Correlation of Distal Motor Power with vitamin D level.

Power: Distal	Vitamin D			Total (n=204)	P value
	<10 (n=86)	10-25 (n=99)	>25 (n=19)		
Upper Limb	47(90.4%)	5(9.6%)	0(0%)	52(25.5%)	<0.001**
Lower limb	52 (90%)	6(10.3%)	0(0%)	58(28.4%)	<0.001**

Table 3: Correlation of ADL with vitamin D level.

ADL	Vitamin D			Total
	<10	10-25	>25	
Assistance	53(86.8%)	8(13.1%)	0	61(29.9%)
Dependent	23(100.0%)	0	0	23(11.3%)
Independent	10(8.3%)	91(75.8%)	19(15.8%)	120(58.8%)
Total	86(42.2%)	99(48.5%)	19(9.3%)	204(100.0%)

χ^2=138.00; P<0.001**

Table 4: Correlation of falls with vitamin D level.

Falls	Vitamin D			Total
	<10	10-25	>25	
No	51(30.4%)	98(58.3%)	19(11.3%)	168(82.4%)
Yes	35(97.2%)	1(2.8%)	0(0%)	36(17.6%)
Total	86(42.2%)	99(48.5%)	19(9.3%)	204(100%)

χ^2=54.369; P<0.001**

DISCUSSION

In the present study a total of 204 individuals aged more than 60 years were included.

In the elderly individuals who fulfilled inclusion and exclusion criteria a detailed history of symptomatic motor weakness of both proximal and distal muscles was obtained. History of falls was enquired into. However the details pertaining to falls was not the emphasis of the study. All elderly with diabetes, thyroid dysfunction, pre existing neurological diseases were excluded historically and was confirmed by doing relevant investigations.

Regarding manifestation of Vitamin D deficiency, we have noted that symptoms included predominantly motor weakness in form of proximal muscle weakness of lower limb as expressed by.

1. Difficulty in getting up from squatting position
2. Difficulty in climbing stairs
3. Needed assistance while walking
4. Dependant on others for their daily activities due to weakness

This was noted in 111 (54.4%) study subjects.
Motor weakness referable to proximal muscles of the upper limb was noted in 77 (37%) in the form that they had difficulty in raising hand above head and had difficulty in combing hairs.
Strikingly in our study it was noted that 27 (13%) of them complained of weakness of distal muscles of lower limb. And 51 (25%) had history of weakness of distal muscles of upper limb.
On assessing motor power using MRC grading in these individuals all individuals who had symptomatic motor weakness had reduced motor power (Power of 4 or less)
With regards to Vitamin D levels and motor assessment by MRC grading, it was found that out of 111 elders, with proximal lower limb weakness both symptomatically and according to MRC grading 86 (77%) had Vitamin D levels less than 10 ng/ml which was statistically significant.($p< 0.001$)
77 elderly who had motor weakness in proximal muscles of upper limb, 64 (83%) of them had Vitamin D levels less than 10 ng/ml which was also statistically significant. ($p<0.001$).
58 of them had distal lower limb motor weakness (at ankle joint). Out of which 52 (90%) of them had Vitamin D levels < 10 ng/ml.($p< 0.001$)52 of them had distal upper limb motor weakness (at wrist joint). Out of which 47 (90%) had Vitamin D levels < 10 ng/ml. (p value< 0.001)
Our study indicates that severe Vitamin D deficiency may also affect the distal group of muscles to some extent, as all patients symptomatic with distal muscle weakness had severe Vitamin D deficiency, contrary to all studies which have largely proven the proximal muscle association with low Vitamin D levels.
Studies correlating distal muscle weakness with low Vitamin D levels are very limited and in our extensive literature survey we have not found studies referable to distal muscle weakness and low Vitamin D levels. Therefore it is useful to look for distal muscle weakness in patients with severe Vitamin D deficiency as distal muscle weakness adds to the disability in ADL.
It was also found that individuals with Vitamin D levels < 4 ng/ml had very severe weakness with motor power of 3/5. This shows that more severe the Vitamin D deficiency, more severe would be the muscle weakness.
With regards to history of falls, all of them who had falls had historical motor weakness and MRC grading of 4 or less with severe Vitamin D deficiency.

Among 36 who had falls, 35(97.2%) of them had severe Vitamin D deficiency (<10 ng/ml) and 1 0 of them sustained fracture. This is on similar lines with studies of Bischoff et al., Mowe et al., Bischoff Ferrari et al., Snijdir et al., Grant et, al., Muir et al.
Hence we believe that motor dysfunction which is an established major risk factor for falls was probably due to Vitamin D deficiency as neurological problems were excluded.

CONCLUSION

We would like to suggest that Vitamin D supplementation may improve motor function in elders, and it would go a long way in prevention of falls and fractures, thereby reducing the physical and economic morbidity. Also since distal muscles were affected due to severe Vitamin D deficiency, we would also like to suggest that Vitamin D supplementation and correction may improve the distal muscle function and restore ADL which is the ideal goal of healthy aging.
Our study shows that severe Vitamin D deficiency could interfere with the activity of daily living possibly due to motor weakness. Therefore it is evident that correction of Vitamin D can improve ADL and reduce the burden on care givers.
There are very limited studies which directly compares Vitamin D deficiency and Activity of daily living.
Few limitations of study include:

1. Cross sectional study, and a direct causal relation between vitamin D concentrations and motor function is difficult to establish
2. Follow up of the patients after Vitamin D supplementation was not done to assess the degree of improvement in motor power. Further studies after Vitamin D correction would increase the strength of our above said findings.

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