Role of vitamin D levels in rheumatoid arthritis and its correlation with disease severity

Dr. Hari Om Aggarwal, Dr. Gaurav Kumar Gupta, Dr. Sanjeev Sreen, Dr. Girish Sahni, Dr. Sanjeev Kumar and Dr. Nishant Aggarwal

DOI: https://doi.org/10.22271/ortho.2020.v6.i4l.2422

Abstract

Objective: Deficiency of Vitamin D has been linked in the pathogenesis of many autoimmune diseases such as diabetes mellitus type 1 and multiple sclerosis. Deficiency of vitamin D has been associated with high susceptibility of the development of rheumatoid arthritis (RA) and also with increased disease activity in patients with RA. The objective of this study was to evaluate the status of vitamin D in patients with RA, assess the correlation between serum level of Vitamin D and disease severity.

Materials and Methods: This was a prospective, comparative study conducted on 100 participants, 50 cases of RA and 50 healthy controls, all in the age group of 18–75 years. Serum Vitamin D levels were measured and compared in cases and controls.

Results: Ninety two percent patients belonging to the RA group were Vitamin D deficient, whereas only twenty four percent belonging to the control group had Vitamin D deficiency. There was a significant inverse correlation between serum Vitamin D levels and RA disease severity. The mean serum Vitamin D levels were 34.36ng/ml, 32.25±0.395ng/ml, 22.70±4.787ng/ml and 16.41±2.911ng/ml in the remission, low disease activity, moderate disease activity, and high disease activity groups, respectively.

Conclusion: Vitamin D insufficiency and deficiency are more common in patients with RA. In this study Vitamin D deficiency was related to RA patients with older age, RA with female gender and a higher degree of RA activity.

Keywords: Rheumatoid arthritis, Vitamin D, disease activity

Introduction

Rheumatoid arthritis (RA) is a systemic inflammatory disease mainly characterized by synovitis and joint destruction. Etiology of RA is unknown. It is a chronic autoimmune disorder characterized by systemic features and joint involvement which affects 1% of the world’s adults [1, 2]. It can lead to significant morbidity and mortality. Role of Vitamin D deficiency in the pathogenesis of RA was the interest of the study. The role of Vitamin D in modulating immune function is supported by the discovery of Vitamin D receptors (VDRs) in peripheral mononuclear blood cells [3, 4]. Vitamin D causes down regulation of antigen-presenting cells, inhibition of T-cell proliferation, and decreased production of T helper cell-1 cytokines IL-2, interferon gamma and tumor necrosis factor-alpha[5,6]. Researchers have related Vitamin D deficiency with several autoimmune disorders, including insulin-dependent diabetes mellitus, systemic lupus erythematosus (SLE), and rheumatoid arthritis (RA) [7-10]. It has been suggested that Vitamin D is an extrinsic factor capable of affecting the prevalence of autoimmune diseases. The immunomodulatory activities of Vitamin D might be particularly efficient in RA patients and support a therapeutic role of Vitamin D in these patients [11]. The VDRs have been demonstrated in macrophages, chondrocytes, and synoviocytes in rheumatoid synovium and at sites of cartilage erosion in RA patients [5, 6, 11]. In RA patients, measurement of Vitamin D levels is particularly important as its deficiency is highly prevalent in this group [12-14]. Vitamin D may also have a role in modulating RA disease activity and is already known to be important in osteoporosis and falls and fractures, which are common in RA. The antiproliferative, immunomodulatory, and anti-inflammatory properties of Vitamin D could be exploited to treat a variety of autoimmune rheumatic diseases, from RA to SLE, and possibly also multiple sclerosis, type 1 diabetes or inflammatory bowel diseases [15].
The relationship between the severity of RA and levels of Vitamin D is a subject of immense interest and therapeutic implications, hence in this study we compared the serum levels of Vitamin D in the healthy population and in RA patients to correlate the levels of Vitamin D with the RA disease activity.

Materials and Methods

This was a prospective comparative study conducted in the department of Orthopedics in Government Medical College and Rajindra Hospital Patiala. A total of 100 participants were included, and they were divided into 2 groups. Group I included 50 cases of RA and Group II included 50 healthy controls, all participants were in the age group of 18–75 years. Permission was sought from the institutional ethics committee and written informed consent was taken from each participant before enrolling him/her for the study.

Inclusion criteria

Both males and females in the age group of 18–75 years having RA according to the criteria of American College of Rheumatology-European League against Rheumatism 2010.

Exclusion criteria

1. Patients having age less than 18 yr or more than 75yr
2. Patients suffering from malnutrition, hepatic or renal dysfunction
3. Patients who are on medication affecting serum calcium levels, Vitamin D metabolism (such as anticonvulsants, diuretics, and thyroxin).
4. Patients suffering from hyperparathyroidism, hyperthyroidism, diabetes mellitus.
5. Patients on Vitamin D supplementation in the past 6 months
6. Patients currently enrolled in another investigational study.
7. Patients who were not willing to participate in the study.

The patients were included from Out Patient Department of Orthopaedics, Government Medical College and Rajindra Hospital, Patiala after fulfilling the required inclusion criteria. All patients were interviewed regarding their personal details, and detailed history were taken from cases regarding age at onset of symptoms, the progression of disease and pattern of joint involvement, the presence of any swelling and pain in the joints, and drug history (if any). Disease activity score of 28 joints (DAS28) of RA patients were calculated as per the guidelines of American College of Rheumatology, which indicated the disease severity, that is, low, moderate, and high disease activity. DAS28 score was calculated by following measure

1. Counting the number of swollen joints (out of 28)
2. Counting the number of tender joints (out of 28)
3. Taking blood to measure the erythrocyte sedimentation rate (ESR)
4. Asking the patient to make a “global assessment of health” (indicated by marking on a 10 point line between very good and very bad).

Above results were incorporated into a mathematical formula to produce the overall disease activity score [16]:

\[ \text{DAS28} = 0.56\sqrt{(28\text{TJC})} + 0.28\sqrt{(28\text{SJC})} + 0.70 \ln (\text{ESR}) + 0.014 \text{VAS} \]

(Here TJC = Tender joint count, SJC = Swollen joint count, Ln = log, VAS = Visual analog scale)

Disease severity was assessed according to the value of DAS28 score as follows:

1. Remission: DAS28 ≤2.6
2. Low disease activity: DAS28 > 2.6 ≤3.2
3. Moderate disease Activity: DAS28 > 3.2 ≤5.1
4. High disease Activity: DAS28 >5.1.

The investigations carried out in all the participants participating in this study were ESR, RA factor, anticitrullinated cyclic peptide antibody (wherever required), Vitamin D3 level, complete blood count, renal function tests, serum uric acid and liver function tests. Vitamin D3 levels above 30ng/ml were considered as sufficient. X-rays of involved joints and X-ray chest were done wherever needed.

Results

The study consisted of 50 patients diagnosed with RA and 50 age and sex matched apparently healthy individuals as control. Average age of patients in RA group was 50.37±11.68 years, whereas the average age of participants in the control group was 50.67 ± 10.65 years. Among the 50 patients in the RA group, 9 (18%) were males and 41 (82%) were females. Among the 50 patients in the control group, 10 (20%) were males and 40 (80%) were females [Table 1].

| Group          | Number | Males | Females |
|----------------|--------|-------|---------|
| Rheumatoid arthritis | 50     | 9     | 41      |
| Control        | 50     | 10    | 40      |

The mean serum calcium levels were 8.61±0.485 mg/dl in the RA group and 9.31±0.432mg/dl in the control group [Table 2]. Forty-six patients (92%) belonging to the RA group had serum Vitamin D levels <30ng/ ml, that is, they were Vitamin D deficient, whereas only 12 participants (24%) belonging to the control group had Vitamin D deficiency. The mean serum Vitamin D levels were 20.49±6.044ng/ml in patients of RA and 33.71±7.402ng/ ml in the control group [Table 2].

| Group          | Number | Mean serum calcium (mg/dl) | Mean serum vitamin D (ng/ml) |
|----------------|--------|---------------------------|-----------------------------|
| Rheumatoid arthritis | 50     | 8.61±0.485               | 20.49±6.044                 |
| Control        | 50     | 9.31±0.432               | 33.71±7.402                 |

In this study, out of 50 patients of RA, 1 patient (2%) was in the remission group (DAS28 score <2.6), 3 patients (6%) in the low disease activity group (DAS28 score 2.7–3.2), 22 patients (44%) in the moderate disease activity group (DAS28 score 3.2–5.1), and 24 patients (48%) in the high disease activity group (DAS28 score >5.1).
The mean serum calcium levels were 8.9 mg/dl, 8.9±0.0243mg/dl, 8.68±0.458mg/dl, and 8.49±0.517mg/dl in the remission, low disease activity, moderate disease activity, and high disease activity groups, respectively [Table 3]. The mean serum Vitamin D levels were 34.36ng/ml, 32.25±0.395ng/ml, 22.70±4.787ng/ml, and 16.41±2.911ng/ml in the remission, low disease activity, moderate disease activity, and high disease activity groups, respectively [Table 3].

Table 3: Mean serum calcium and vitamin D levels in rheumatoid arthritis patients according to their disease activity

| Disease severity group | Number of cases | Mean serum calcium (mg/dl) | Mean serum Vitamin D (ng/ml) |
|------------------------|-----------------|---------------------------|-----------------------------|
| Remission              | 1               | 8.9                       | 34.36                       |
| Low                    | 3               | 8.92±0.0243               | 32.25±0.395                 |
| Moderate               | 22              | 8.68±0.458                | 22.70±4.787                 |
| High                   | 24              | 8.49±0.517                | 16.41±2.911                 |

Discussion

Most of the RA patients have poor nutritional status which can predispose to low Vitamin D levels. Patients with RA are on multiple drug therapy including steroids which affect Vitamin D metabolism. These factors reinforce the significance of Vitamin D monitoring in RA patients.

Vitamin D deficiency and insufficiency are common among persons having inadequate sun exposure. Pakchotanon et al. [17] in a study upon Thai RA patients reported that cutaneous Vitamin D synthesis is markedly reduced during November through February in countries located above 37 degree latitude because of the decreasing number of UVB photons reaching the surface of earth. They reported that though Vitamin D deficiency and insufficiency was more in Thai RA patients as compared to controls, yet it was less than that found in RA cases from United States and European countries. According to them Latitude influences the zenith angle of sun and Thailand was closer to equator than those countries. The mainland of India is between 8°4′ and 37°6′ latitude and that can affect cutaneous synthesis of vitamin D.

Cen et al. [18] in their study reported that the mean serum Vitamin D level was significantly lower in RA patients (35.99 ± 12.59 nmol/L) as compared to the normal participants (54.35 ± 8.20 nmol/L). Patients with RA in our study (92%) had higher rates of Vitamin D deficiency and insufficiency as compared with controls. However in control group 76% patients have Vitamin D levels in sufficient range and 24% had Vitamin D levels in insufficiency range. Merlino et al. [11] also demonstrated an inverse association between greater intake of Vitamin D and RA risk. They analyzed data from a prospective cohort study of 29,368 women without a history of RA at study baseline, and through 11 years of follow-up, 152 cases of RA were diagnosed. Greater intake of Vitamin D was inversely associated with risk of RA. In our study we found that rheumatoid arthritis patients with moderate and high disease activity (92%) had low Vitamin D levels <30ng/ml, (48% patients had levels <20ng/ml) while RA patients with low disease activity had high Vitamin D levels.

Sabbagh et al. [19] also found inadequate Vitamin D status in patients with systemic autoimmune rheumatic diseases (SARDs), along with considerably strong association with disease activity in RA cases. This study indicated the need for proper evaluation of Vitamin D status in these patients to ensure the intake of the recommended amount of Vitamin D.

Studies conducted by Ibrahim et al. [20], Yagiz et al. [21] and Kareem et al. [22] found significantly lower Vitamin D levels in patients with RA, SLE, ankylosing spondylitis, and Behcet’s disease as compared to control population thus supporting the possible role of Vitamin D in the pathogenesis, activity and treatment of various autoimmune diseases. Most of the patients with RA in our study were females (82%). Pakchotanon et al. [17] also reported most of their RA cases were middle aged or elderly women and had Vitamin D levels less than 30 ng/ml. We had 92% RA patients with Vitamin D less than 30ng/ml and most of them were females in age group of more than 40 years.

Kerr et al. [23] found that serum Vitamin D correlated with TJC only in patients with deficiency but not in those with 25(OH) D insufficiencies. Results observed in this study as regards the association of Vitamin D and VAS-pain comes in agreement with the concept of the association between hypovitaminosis D and musculoskeletal pain. Although TJC and VAS-pain were inversely associated with Vitamin D concentration in the univariate analysis, these associations failed to meet significance following multivariate adjustments whereas SJC and DAS28-CRP remained statistically significant following adjustments for age and sex, suggesting that the association of TJC and VAS-pain is explained primarily by the disease activity.

Conclusion

Vitamin D insufficiency and deficiency are common in patients with RA. In our study Vitamin D deficiency was related to RA patients with older age, RA with female gender and a higher degree of RA activity. Vitamin D levels had no relation with functional disability or radiological damage in RA. In our opinion regular Vitamin D monitoring in RA cases is invaluable in determining current disease activity and may prove to be a key factor in ultimate disease outcome.

Conflict of interest: None

References

1. Alamanyos Y, Drosos AA. Epidemiology of adult rheumatoid arthritis. Autoimmun Rev 2005;4:130-6.
2. Azzeh FS. Relationship between vitamin D and rheumatoid arthritis disease. Pak J Nutr 2012;11:293-300.
3. Cantorna MT, Zhu Y, Froicu M, Wittke A. Vitamin D status, 1,25-dihydroxyvitamin D3, and the immune system. Am J Clin Nutr 2004;80:171S-20S.
4. Deluca HF, Cantorna MT. Vitamin D: Its role and uses in immunology. FASEB J 2001;15:2579-85.
5. Tetlow LC, Smith SJ, Mawer EB, Woolley DE. Vitamin D receptors in the rheumatoid lesion: Expression by chondrocytes, macrophages, and synoviocytes. Ann Rheum Dis 1999;58:118-21.
6. Cantorna MT, Hayes CE, De Luca HF. 1,25 dihydroxyvitamin D prevents andameliorates symptoms in two experimental models of human arthritis. J Nutr 1998;128:68-72.
7. Jones BJ, Twomey PJ. Issues with Vitamin D in routine clinical practice. Rheumatology (Oxford) 2008;47:1267-8.
8. Cantorna MT. Vitamin D and autoimmunity: Is Vitamin D status environmental factor affecting autoimmune disease prevalence? Proc Soc Exp Biol Med 2000;223:230-3.
9. Kamen DL, Cooper GS, Bouali H, Shaftman SR, Hollis BW, Gilkeson GS, et al. Vitamin D deficiency in

www.orthopaper.com
systemic lupus erythematosus. Autoimmun Rev 2006;5:114-7.
10. Lips P. Which circulating level of 25-hydroxyvitamin D is appropriate? J Steroid Biochem Mol Biol 2004;89-90:611-4.
11. Merlino LA, Curtis J, Mikuls TR, Cerhan JR, Criswell LA, Saag KG et al. Vitamin D intake is inversely associated with rheumatoid arthritis: Results from the Iowa women’s health study. Arthritis Rheum 2004;50:72-7.
12. Als OS, Riis B, Christiansen C. Serum concentration of Vitamin D metabolites in rheumatoid arthritis. Clin Rheumatol 1987;6:238-43.
13. Oelzner P, Müller A, Deschner F, Hüller M, Abendroth K, Hein G et al. Relationship between disease activity and serum levels of Vitamin D metabolites and PTH in rheumatoid arthritis. Calcif Tissue Int. 1998;62:193-8.
14. Kröger H, Penttilä IM, Alhava EM. Low serum Vitamin D metabolites in women with rheumatoid arthritis. Scand J Rheumatol 1993;22:172-7.
15. Adorini L, Penna G. Control of autoimmune diseases by the Vitamin D endocrine system. Nat Clin Pract Rheumatol 2008;4:404-12.
16. Prevoo ML, van ‘t Hof MA, Kuper HH, van Leeuwen MA, van de Putte LB, van Riel PL, et al. Modified disease activity scores that include twenty-eight joint counts. Development and validation in a prospective longitudinal study of patients with rheumatoid arthritis. Arthritis Rheum 1995;38:44-8.
17. Pakchotanon R, Chaianmuay S, Narongroeknawin P, Asavatanabodee P et al. The association between serum vitamin D Level and disease activity in Thai rheumatoid arthritis patients. International Journal of Rheumatic Diseases 2016;19:355-361.
18. Cen X, Liu Y, Yin G, Yang M, Xie Q. Association between serum 25-hydroxyvitamin D level and rheumatoid arthritis. Biomed Res Int 2015;2015:913804.
19. Sabbagh Z, Markland J, Vatanparast H. Vitamin D status is associated with disease activity among rheumatology outpatients. Nutrients 2013;5:2268-75.
20. Ibrahim MH, Bakheet MS, Sater KA, Shakoor MA. Relationship between Vitamin D and disease activity in some rheumatic diseases. Wyno Acad J Med Sci 2013;2:52-6.
21. Yagiz AE, Ustun N, Paksoy H, Ustun I, Mansuroglu A, Guler H, et al. Association of Vitamin D with disease activity in rheumatoid arthritis and ankylosing spondylitis. J Clin Anal Med 2015;6:486-9.
22. Kareem MI, Mohammed RH, Abozaid HS, Rayan MM, Mohamed AM, Fathi NA. Hypo- vitaminoD D in patients with rheumatoid arthritis, systemic lupus erythematosus and ankylosing spondylitis. J Clin Cell Immunol 2015;6:1-6.
23. Kerr GS, Sabahi I, Richards JS, Caplan L, Cannon G, Reimold A et al. Prevalence of vitamin D insufficiency/deficiency in rheumatoid arthritis and associations with disease severity and activity. J Rheumatol 2011;38(1):53-9.