Indian Journal of Orthopaedics (2020) 54 (Suppl 1):S183–S187
https://doi.org/10.1007/s43465-020-00134-2

ORIGINAL ARTICLE

Prevalence of Vitamin D Deficiency Amongst Indian Orthopaedic Surgeons

Shaligram Purohit[1] · Sudhir Srivastava[1] · Aruna Shankarkumar[2] · Aditya Raj[1] · Bhavik Dalal[2] · Nandan Marathe[1] · Chetan Shende[1]

Received: 29 January 2020 / Accepted: 2 May 2020 / Published online: 14 May 2020

Abstract

Background Vitamin D deficiency is a widely prevalent condition with patients in both symptomatic and asymptomatic spectrum. With the lack of routine screening there exists an unknown population of Indian Orthopaedic surgeons who are deficient in Vitamin D and lead to an unexplained loss of quality of work and increased susceptibility to various other diseases. The easiest access to resources for supplementation is available to this group of treating physicians however its use for their personal cure is rarely recognised. This study aims to highlight this endemic disease and to find out its correlation with other parameters

Methods It is a prospective observational study including 150 practicing orthopaedic surgeons from entire India who visited our centre during 3 months duration for various educational meetings. Venous sample was collected after due informed consent and analysed at a single laboratory for 25-OH Cholecalciferol levels by a chemiluminescent assay. All the samples were analysed and a questionnaire was sent to the participants via google forms regarding various parameters under study.

Results The mean serum Vitamin D levels were 18.6 ± 9.67 ng/ml in the sample studied. 17 out of 150 participants (11.3%) were found to have sufficient serum levels of 25(OH) Cholecalciferol. 105 participants (70%) were having deficient levels and 28 (18.7%) had insufficient levels of Vitamin D. Overall 88.7% participants had Vitamin D deficiency among the sample studied.

Conclusion This widespread prevalence of Vitamin D deficiency warrants frequent screening and routine supplementation of Vitamin D in orthopaedic surgeons thereby providing a low cost solution to improve the troublesome situation among healthcare providers.

Keywords Orthopaedic surgeons · Vitamin D deficiency · Routine supplementation

✉ Aditya Raj
adityagmck@gmail.com

Sudhir Srivastava
ortho.hod.sks@gmail.com

Aruna Shankarkumar
arp21@rediffmail.com

Bhavik Dalal
bhavikdalal@gmail.com

Nandan Marathe
nandanmarathe88@gmail.com

[1] Department of Orthopedics, MS (ORTHO), 6th Floor, Multistorey Building, Seth G.S Medical College and King Edward Memorial Hospital, Parel, Mumbai 400012, India

[2] ICMR, King Edward Memorial Hospital, Parel, Mumbai 400012, India

Abbreviations

DBP	Vitamin D binding protein
VDR	Vitamin D receptor
BMI	Body mass index
VDD	Vitamin D deficiency
IU	International Units

Introduction

Vitamin D refers to vitamin D_3 (cholecalciferol). Vitamin D_3 is produced in the skin on exposure to UVB radiation in sunlight from 7-dehydrocholesterol in the skin and then sequential hydroxylation occurs in liver and kidney. It is also found in animal food sources but most dietary sources are not sufficiently rich in their vitamin D content.

Vitamin D (both forms D_3 or D_2) is a pro-hormone which requires two hydroxylation reactions to finally attain its biologically active form—$1,25(OH)_2D$. The first hydroxylation occurs in the liver, at position C25 to form 25-hydroxyvitamin D, also known as 25(OH) Vitamin D or calcidiol. 25(OH)D is the major circulating form of vitamin D. The second hydroxylation occurs at position C1α to form $1,25(OH)_2D$, also known as calcitriol. $1,25(OH)_2D$ is produced primarily but not exclusively in the kidneys. $1,25(OH)_2D$ is released in blood, where it binds to vitamin D binding protein (DBP) and reaches its target tissues to exert its endocrine functions through the vitamin D receptor (VDR). $1,25(OH)_2D$ is also produced in several extra-renal tissues for its paracrine and autocrine functions. Most cells in the body have VDR. Many cell types can also produce $1,25(OH)_2D$. $1,25(OH)_2D$ is capable of regulating a wide variety of genes that have important functions in regulating cell growth and differentiation.

Previous studies have show that the prevalence of vitamin D deficiency is 70%–100% amongst the general population in India [1, 2]. Inspite of such a high prevalence it remains largely undiagnosed and untreated. Chronic Vitamin D deficiency in adults is associated with osteomalacia and vague skeletal ache and pains [3–5]. Recent studies have linked Vitamin D as an indirect marker of the immune status of the individual and deficiency is associated with an increased susceptibility to otitis media, tuberculosis and influenza [6–10]. Deficiency of vitamin D has been linked with modern lifestyle diseases like diabetes and hypertension which in turn is associated with increased cardiovascular mortality [11]. Researchers have shown epidemiological association of vitamin D deficiency and type1 diabetes [12]. A meta-analysis of observational studies showed a 30% reduction in risk of type 1 diabetes mellitus in children receiving vitamin D supplements.

Orthopaedic surgeons are associated with long hours of indoor activity in the wards and the operation theatre. There is minimal awareness regarding the need to take Vitamin D supplements amongst orthopaedic surgeons. Also Indian foods are not yet routinely fortified with Vitamin D.

This research paper aims to find out the prevalence of serum Vitamin D3 deficiency amongst Indian orthopaedic surgeons.

Methods

It was a prospective observational study, carried out across the country with a study duration of 3 months. All practising Indian orthopaedic surgeons were included in the study. The end results will be applicable over pan India orthopaedic surgeons. The surgeons across India visiting our setup during various conferences.

Sampling technique: all the orthopaedic surgeons interested to participate in study were included in the study after taking informed consent for the same. Data collection was confidential using "Google Forms" Application. The blood sample was withdrawn during the time when the surgeons visited our institute for various educational programmes. All the samples were processed at a single laboratory by a single method ensuring standardisation. The study included the participation of surgeons from all over India ensuring that the results could be extrapolated to throughout India.

Questionnaire

1. Age, Sex, Place of work.
2. Number of years in Orthopaedics practice and sub-speciality.
3. Dietary habits- Type of diet (vegetarian, or mixed). History of taking oral or injectable supplements of vitamin D.
4. Number of days per week spent inside the operation room.
5. Body Mass Index (BMI).
6. Medical co-morbidities if any.

Any history of chronic hepatic or renal disorders which could affect the metabolism of Vitamin D was ruled out through the history of medical co-morbidities. Confirmation through renal and hepatic function tests were not done to avoid subjecting the entire study population to a battery of investigations.

Haematological Investigation

Single venous blood sample was withdrawn between 10:00 and 11:00 am in every volunteer. Serum levels of 25-OH Cholecalciferol were done by chemiluminescence assay from a single laboratory.

Statistical Analysis

The Statistical analysis was performed by SPSS 23.0 version. Continuous variables were described as mean and variation of each observation from the mean value (Standard deviation) represented as mean ± SD. Categorical variables were described by taking percentages. Correlation between vitamin D levels and age, BMI, number of years in practice, days in OR/week was done using Pearson correlation test. Correlation between vitamin D levels and supplementation, dietary habits was done using Spearman's correlation test. P value < 0.05 was considered significant. For the purpose of statistical analysis, Vitamin D deficiency will be classified as deficient (< 20 ng/ml), insufficient (20–30 ng/ml) and

normal (> 30 ng/ml). The other parameters in the questionnaire will be assessed to find out any co-relation with the serum Vitamin D3 level.

Results

The mean age of the participants under study was 33.12 ± 6.78 years. The mean BMI of the sample under study was 23.96 ± 1.71. The mean number of years in practice was 6.71 ± 5.62 years. On an average the surgeons spent 2.6 days per week in the operating room with a standard deviation of 0.57 (Table 1).

30 participants had a pure vegetarian diet while 120 (80%) participants had a mixed diet. The mean serum Vitamin D levels were 18.6 ± 9.67 ng/ml in the sample studied. Majority of the participants studied were practising trauma surgeons (69.3%) while 18.7% practiced arthroplasty, 6.7% practised arthroscopy and 5.3% were practicing spine surgeons. When we observed the various medical comorbidities, 5 (3.3%) had diabetes, 1 patient had asthma, 5 (3.3%) had hypertension. One had a history of previous ischaemic heart disease. The number of surgeons using any form of supplementation was 31 (20.7%). Out of these 21 (14%) used oral supplementation and 10 (6.7%) used injectable vitamin D (intramuscular) supplementation. The dosage of supplementation was widely variable. The oral supplementation was mainly taken as 60,000 IU of Cholecalciferol weekly with varied time duration of 6-10 weeks. Injectable preparations were similarly in the form of intramuscular injections of 600,000 IU taken once yearly or 6-monthly.

Out of the above mentioned factors, age of the participant was found to be statistically significant with a p value of 0.003. The number of years in practice and supplementation of Vitamin D was also found to be statistically significant with p values of 0.006 and < 0.001 respectively indicating a positive predictive outcome in these variables. Body mass index and days in the OR per week demonstrated a negative correlation coefficient suggesting their role in hypovitaminosis in this group.

While stratifying the population only 17 out of 150 surgeons (11.3%) were found to have sufficient serum levels of 25(OH) Cholecalciferol. 105 surgeons (70%) were having deficient levels and 28 (18.7%) had insufficient levels of Vitamin D. Overall 88.7% participants had Vitamin D deficiency among the sample studied. None of them had Vitamin D toxicity despite few of them using the intramuscular form for supplementation.

Table 1 Demonstrating demographic details and percentage of patients in each group

Age	Mean ± SD	33.07 ± 6.78
BMI		23.96 ± 1.71
Number of years in practice		6.71 ± 5.62
Days in OR/week		2.64 ± 0.571
Vitamin D LEVELS		18.6 ± 9.67
Dietary habits		
Vegetarian	Number (percentage)	30 (20)
Mixed		120 (80)
Supplementation		
None		119 (79.3)
Oral capsules		21 (14)
Injectables		10 (6.7)
Sub speciality		
Arthroplasty		28 (18.7)
Arthroscopy		10 (6.7)
Spine		8 (5.3)
Trauma		104 (69.3)
Medical comorbidities		
None	Number (percentage)	138 (92)
Asthma		1 (0.6)
Diabetes		5 (3.33)
IHD		1 (0.6)
Hypertension		5 (3.33)

Discussion

India is one of the worst affected nations in terms of the Vitamin D deficiency (VDD) pandemic. The deficiency is well known among health care professionals [13]. The skeletal and extraskeletal benefits of Vitamin D are under recognized by both the general population and individuals in the health care sector including Orthopaedic surgeons. South East Asia is one of the worst affected regions in one of the reports by the International Osteoporosis Foundation [14].

Despite adequate knowledge about the metabolism, adequacy and absorption among the orthopaedic surgeons the need for supplementation is seldom realised. This appears contrary to the fact that they are the professionals most frequently involved in prescription of supplementation or food fortification. Hypovitaminosis D is one of the common causes for a number of nonspecific musculoskeletal symptoms namely—low back discomfort, muscular pains, neck pains and predisposition to fractures [15–18]. Besides these, there is increasing evidence regarding vitamin D deficiency and predisposition to infections like Tuberculosis and other respiratory infections, allergic rhinitis, diabetes, hypertension and migraines. All these when accounted together with osteosarcopenia, become an important cause for reduced work efficiency at the workplace especially in young orthopaedic surgeons and residents. The occasional hospital acquired infections including tuberculosis are an added burden to an already overworked group of individuals.

This is also a consequence of the poor sunlight exposure in addition to excessive indoor working hours.

This study aims to provide an insight into the above-mentioned problem and its endemicity in India. Multiple studies demonstrate VDD in healthy individuals as exemplified by Goswami et al. [19]. It is also reported in health care providers in studies like the one by Arya et al. carried out in urban North Indian population [20]. A multi-centric study has also been carried out by Beloyartseva et al. [13] in a variety of centres in India which demonstrated severe deficiency in most of the participants among the 2119 individuals studied. This study was carried among all health care professionals not specifically among orthopaedic surgeons however the results could be extrapolated to this group of population. The Indian subcontinent is situated between 8.4° N and 37.6° N latitude and has adequate sunshine throughout the year. Despite this, the high incidence of deficiency can be accounted by other important factors like traditional clothing, air pollution and poor exposure to sunlight. Similar studies have also been reported in Boston, Minnesota and Portland [21–23] by reports on health care professionals. However, none of them specifically focus on orthopaedic surgeons. It is one of the most commonly ordered blood tests by the treating physicians due to widespread available data of hypovitaminosis D in the Indian population. However, it was earlier recognised to be more common in the unaware strata of the society which is deterred by the fact that it is equally common in the medical professionals as well. The questions about compliance of supplementation may not completely apply to this group of individuals hence a predictable rise after supplementation can be expected.

Our study demonstrated this important fact that orthopaedic surgeons being the most frequent prescribers for supplementation of Vitamin D are themselves grossly deficient. The irony becomes important in the current scenario of an exceedingly unknown population of orthopaedic surgeons with deficient Vitamin D levels. This study could also be used for routine timely supplementation of Vitamin D to residents and young surgeons who are frequently most severely affected by the burden of this pandemic. There is an immediate need to educate the surgeons regarding this deficiency situation and a need for adequate supplementation to improve on the job productivity [23]. Although the parameter of the amount of time spent in the OR did not have a statistically significant association with the magnitude of Vitamin D insufficiency, it does provide an indirect estimation of the number of hours spent indoors which correlates with the reduced sunlight exposure. This becomes important as more the amount of time spent indoors, higher would be the risk of hypovitaminosis D. Pigmentation of skin, type of clothing and air pollution are environmental factors which accentuate this deficiency thus contributing to a high prevalence of VDD [14].

Conclusion

This study has given conclusive evidence regarding the need for routine vitamin D supplementation in diet amongst Indian orthopaedic surgeons. It will improve awareness regarding this 'SILENT DISEASE' with an endemic occurrence in the medical profession. These results can be applicable across other surgical branches in India as they follow approximately similar routine and dietary practices. The need for food fortification is also highlighted keeping in mind the current scenario of VDD. It also establishes the need for routine supplementation so that the work efficacy could be improved and risk to other conditions can be kept in check.

Limitations

The limitations of the current study include a small sample size, inability to take medical professionals from other domains and inability to correlate sunlight exposure with serum vitamin D levels. We plan to conduct a second part of the study to establish the efficacy of oral and injectable preparation for supplementation of Vitamin as per the current established guidelines.

Authors' Contributions SP: Conceptualization. SS: Methodology. AS: Resources, project administration. AR: Writing- original draft. BD: Data collection. NM: Writing-review and editing. CS: Formal analysis.

Funding No source of funding was used for this study.

Compliance with Ethical Standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethics approval Ethics approval was obtained from the Institutional Ethics Committee at Seth G.S Medical College.

Informed consent Consent to participate was obtained from the participants.

References

1. Ritu, G., & Gupta, A. (2014). Vitamin D deficiency in India: Prevalence, causalities and interventions. *Nutrients., 21,* 729–737.
2. Garg, R., Agarwal, V., Agarwal, P., Singh, S., & Malhotra, N. (2018). Prevalence of vitamin D deficiency in Indian women. *International Journal of Reproduction, Contraception, Obstetrics and Gynecology (IJRCOG), 7,* 2222–2225.
3. Holick, M. F. (2006). The role of vitamin D for bone health and fracture prevention. *Current Osteoporosis Reports, 4,* 96–102.

4. Janssen, H. C., Samson, M. M., & Verhaar, H. J. (2002). Vitamin D deficiency, muscle function, and falls in elderly people. *American Journal of Clinical Nutrition, 75,* 611–615.
5. Bischoff-Ferrari, H. A., Dietrich, T., Orav, E. J., & Dawson-, H. B. (2004). Positive association between 25-hydroxy vitamin D levels and bone mineral density: A population-based study of younger and older adults. *American Journal of Medicine, 116,* 634–639.
6. Nnoaham, K. E., & Clarke, A. (2008). Low serum vitamin D levels and tuberculosis: A systematic review and meta-analysis. *International Journal of Epidemiology, 37,* 113–119.
7. Martineau, A. R. (2012). Old wine in new bottles: Vitamin D in the treatment and prevention of tuberculosis. *Proceedings of the Nutrition Society, 71,* 84–89.
8. Harinarayan, C. V., & Joshi, C. R. (2009). Vitamin D status in India: its implications and remedial measures. *Journal of the Association of Physicians of India, 57,* 40–48.
9. Linday, L. A., Shindledecker, R. D., Dolitsky, J. N., Chen, T. C., & Holick, M. F. (2008). Plasma 25-hydroxyvitamin D levels in young children undergoing placement of tympanostomy tubes. *Annals of Otology, Rhinology, and Laryngology, 117,* 740–744.
10. Cannell, J. J., Vieth, R., Umhau, J. C., Holick, M. F., Grant, W. B., Madronich, S., et al. (2006). Epidemic influenza and vitamin D. *Epidemiology and Infection, 134,* 1129–1140.
11. Martins, D., Wolf, M., Pan, D., Zadshir, A., Tareen, N., Thadhani, R., et al. (2007). Prevalence of cardiovascular risk factors and the serum levels of 25-hydroxyvitamin D in the United States: Data from the Third National Health and Nutrition Examination Survey. *Archives of Internal Medicine, 167,* 1159–1165.
12. Zipitis, C. S., & Akobeng, A. K. (2008). Vitamin D supplementation in early childhood and risk of type 1 diabetes: A systematic review and meta-analysis. *Archives of Disease in Childhood, 93,* 512–517.
13. Beloyartseva, M., Mithal, A., Kaur, P., Kalra, S., Baruah, M. P., Mukhopadhyay, S., et al. (2012). Widespread vitamin D deficiency among Indian health care professionals. *Archives of Osteoporos, 7,* 187–192.
14. Mithal, A., Wahl, D. A., Bonjour, J. P., Burckhardt, P., Dawson-Hughes, B., Eisman, J. A., et al. (2009). Global vitamin D status and determinants of hypovitaminosis D. *Osteoporosis International, 20,* 1807–1820.
15. Fabbriciani, G., Pirro, M., Leli, C., Cecchetti, A., Callarelli, L., Rinonapoli, G., et al. (2010). Diffuse muscoskeletal pain and proximal myopathy: Do not forget hypovitaminosis D. *JCR: Journal of Clinical Rheumatology, 16,* 34–37.
16. Plotnikoff, G. A., & Quigley, J. M. (2003). Prevalence of severe hypovitaminosis D in patients with persistent, nonspecific musculoskeletal pain. *Mayo Clinic Proceedings, 78,* 1463–1470.
17. Kalyani, R. R., Stein, B., Valiyil, R., Manno, R., Maynard, J. W., & Crews, D. C. (2010). Vitamin D treatment for the prevention of falls in older adults: Systematic review and meta-analysis. *Journal of the American Geriatrics Society, 58,* 1299–1310.
18. Bischoff-Ferrari, H. A., WillettWC, W. J., Giovannucci, E., Dietrich, T., & Dawson-Hughes, B. (2005). Fracture prevention with vitamin D supplementation: A meta-analysis of randomized controlled trials. *JAMA, 293,* 2257–2264.
19. Goswami, R., Gupta, N., Goswami, D., Marwaha, R. K., Tandon, N., & Kochupillai, N. (2000). Prevalence and significance of low 25-hydroxyvitamin D concentrations in healthy participants in Delhi. *American Journal of Clinical Nutrition, 72,* 472–475.
20. Arya, V., Bhambri, R., Godbole, M. M., & Mithal, A. (2004). Vitamin D status and its relationship with bone mineral density in healthy Asian Indians. *Osteoporosis International, 15,* 56–61.
21. Tangpricha, V., Pearce, E. N., Chen, T. C., & Holick, M. F. (2002). Vitamin D insufficiency among free-living healthy young adults. *American Journal of Medicine, 112,* 659–662.
22. Jancin, B. (2003). Vitamin D deficiency common among physicians in training: Long- term risk to bone health. *Skin Allergy News, 34,* 55.
23. Plotnikoff, G. A., Finch, M. D., & Dusek, J. A. (2012). Impact of vitamin D deficiency on the productivity of a health care workforce. *Journal of Occupational and Environmental Medicine, 54,* 117–121.