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Does routine blood bone biochemistry predict vitamin D insufficiency in elderly patients with low-velocity fractures?

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ABSTRACT

Purpose. Vitamin D deficiency impairs bone mineralisation and can predispose individuals to fractures. This study aimed at testing whether measurement of plasma calcium, alkaline phosphatase, and phosphate levels could detect vitamin D insufficiency.

Methods. During a 10-week winter period from December 2000 to February 2001, all elderly patients presenting to a general hospital in Brighton—a British seaside town—with a fracture of the proximal femur and without known bone mineralisation problems were invited to participate in the study.

Results. 23 (63.9%) of the 36 eligible patients had insufficient levels of vitamin D, with a plasma concentration of less than 30 nmol/L. The mean parathyroid hormone level was 56 pg/mL (range, 12–193 pg/mL). 11 of the 36 patients had an elevated level of parathyroid hormone and were insufficient in vitamin D. The mean plasma concentration of calcium was 2.30 mmol/L (range, 2.05–2.98 mmol/L). The mean phosphate level was 0.98 mmol/L (range, 0.40–1.79 mmol/L), and the mean alkaline phosphatase level was 91 IU/L (range, 46–127 IU/L). There was poor correlation between vitamin D insufficiency and plasma calcium, alkaline phosphatase, or phosphate levels.

Conclusion. Plasma calcium, alkaline phosphatase, and phosphate testing cannot detect vitamin D insufficiency. We recommend that vitamin D and calcium supplementation be considered for patients with low-energy hip fractures.

Key words: *elderly; hip fractures; prevention; vitamin D*

INTRODUCTION

Ageing is associated with reductions in sunlight

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exposure, oral intake[1] and skin activation[2] of vitamin D, and vitamin D absorption. All of these factors may contribute to an insufficiency of vitamin D, which is required for efficient absorption of dietary calcium and for normal bone mineralisation. A reduction in serum vitamin D is associated with a compensatory increase in parathyroid hormone (PTH) release, and this in turn stimulates bone resorption and bone loss.

In Britain, there is a seasonal variation in the serum level of vitamin D,[1] and its decrease during winter and spring is associated with an increase in the rates of hip fractures.[3] The decrease in vitamin D may also be a contributory cause, because vitamin D and calcium supplementation can reduce the level of markers of bone resorption[4] and therefore reduce the incidence of hip fractures. Elderly patients in the United States who present with hip fractures are frequently insufficient in vitamin D.[5] Milk is routinely supplemented with vitamin D in the United States but not in Britain, so the prevalence of hip fractures may be greater in Britain.

Vitamin D assays are a useful research tool but are available in only a few hospitals in Britain. Where the test is not available, the sample for testing needs to be frozen immediately and sent to another laboratory, thus making the test expensive. This is because patients with fractures of the proximal femur usually present to the accident and emergency department, their blood samples from routine tests on hospital admission often cannot be used.

The aim of this study is to confirm that elderly patients presenting to a general hospital with a fracture of the proximal femur are insufficient in vitamin D, and to investigate whether increased levels of plasma calcium, phosphate, and alkaline phosphatase can be used to predict vitamin D insufficiency.

PATIENTS AND METHODS

We prospectively identified all patients who presented to the Royal Sussex County Hospital, Brighton, United Kingdom, with a fracture of the proximal femur between 15 December 2000 and 21 February 2001. Patients were likely to come from Brighton—a seaside town with a large elderly community. Most cases of hip fractures occur in the elderly. We excluded patients with a clinical history of any disease or factor that could lead to secondary bone loss; the remaining patients were clinically assessed. 29 females and 7 males, with a mean age of 81 years, participated in the study.

Participants completed a standard questionnaire on ethnic origin, drug treatments used, mobility, and history of osteoporotic fractures. The local research committee gave ethical approval for the study, and informed consent was obtained from all patients.

Serum in the admission blood sample was separated and frozen without delay and sent to another hospital for 25-hydroxyvitamin D radio-immunoassay and intact PTH two-site immuno-radiometric assay. Plasma levels of calcium, albumin, phosphate, and alkaline phosphatase were measured by standard automated methodology and Vitros slides (Johnson & Johnson, High Wycombe, United Kingdom). The plasma calcium level was corrected using the following equation:

$$\text{corrected calcium level} = \text{total calcium level} + [0.018 \times (40 - \text{albumin level})]$$

RESULTS

Over the 10-week study period in winter, 54 patients presented with a fracture of the proximal femur. 16 cases were excluded because of the following reasons: rheumatoid arthritis (n=7), thyroid disease (n=2), chronic renal failure (n=2), long-term steroid use (n=4), and disseminated malignancy (n=1). The blood samples of another 2 patients were lost.

The 36 patients included in the study were all Caucasians; 29 were female. In all cases, the fall causing the fracture was a low-velocity one that occurred from a standing height or less. The mean age of the patients was 81 years. From their clinical history and past medical notes, 9 of the 36 patients previously had one low-energy fracture. Of the 36 patients, 20 walked unaided, 7 used a stick when outside, 3 always used a stick, 4 were using Zimmer frames, and 2 were wheelchair-bound. None had previously been screened for osteoporosis.

The mean serum vitamin D level was 29.9 nmol/L (range, 10–82 nmol/L). Most studies have defined vitamin D insufficiency as a concentration of less than 30 nmol/L, because osteomalacia has been diagnosed histologically at concentrations below this value.[5] According to this definition, 23 (63.9%) of the 36 patients in this series had insufficient levels of vitamin D.

The mean PTH level was 56 pg/mL (range, 12–193 pg/mL). Compared with the published reference range of 40–65 pg/mL, 11 of the 36 patients had elevated PTH levels. All of them had insufficient vitamin D levels.

The mean plasma concentration of calcium,

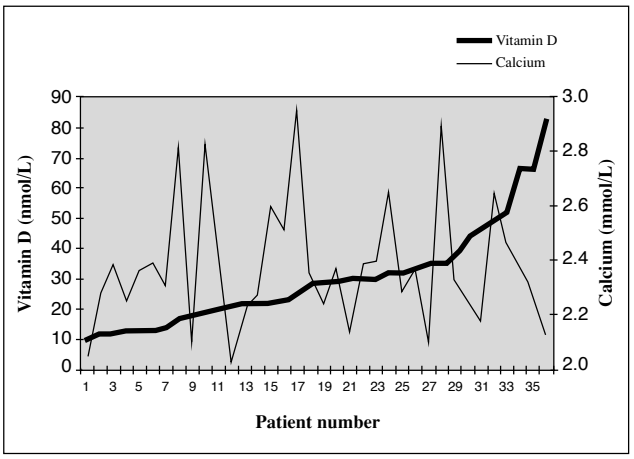

Figure 1 Relationship between vitamin D and calcium levels.

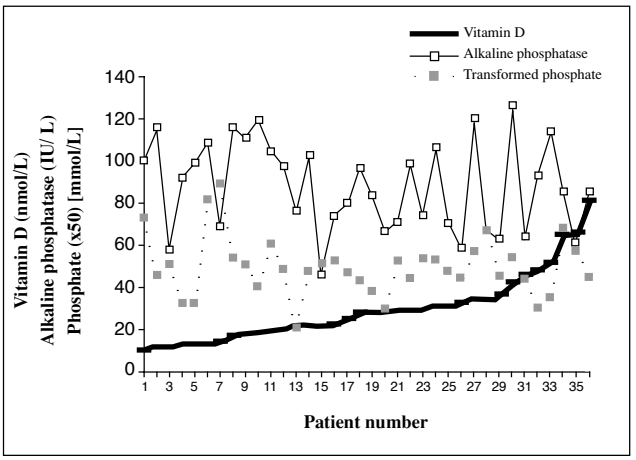

Figure 2 Relationship between vitamin D, alkaline phosphatase, and transformed phosphate (x50) concentrations

adjusted for albumin, was 2.30 mmol/L (range, 2.05–2.98 mmol/L). The mean phosphate level was 0.98 mmol/L (range, 0.40–1.79 mmol/L), and the mean alkaline phosphatase level was 91 IU/L (range, 46–127 IU/L).

Figs. 1 and 2 show the relationship between levels of serum 25-hydroxyvitamin D and levels of corrected plasma calcium, alkaline phosphatase, and phosphate.

DISCUSSION

This study confirms that a large proportion of elderly patents have insufficient levels of vitamin D. The prevalence of vitamin D insufficiency in our study, at 63.9%, is higher than that observed in a similar study in the United States (50.0%).[5]

We used a serum vitamin D concentration of less than 30.0 nmol/L to define insufficiency. Haden et al.,[6] however, observed that serum vitamin D as high as 62.4 nmol/L was associated with a compensatory increase in PTH, which has a detrimental effect on bone turnover. Our study does not support this finding. Although 33 of the 36 patients in our series had a serum vitamin D level of less than 62.4 nmol/L, only 11 of the 36 had an increased plasma PTH level.

Our results show that assays for plasma calcium that adjust for albumin, and assays for phosphate, and alkaline phosphatase cannot be used to predict vitamin D insufficiency. They may however still be required to monitor the need for vitamin D and calcium supplementation.

Vitamin D insufficiency may be prevalent in the general elderly population and ideally, we would like to have compared the fracture group to a matched non-fracture elderly population. Patients undergoing elective hip replacement are often used as the controls,[5] but these patients cannot be directly compared with the fracture group. The control group might have less co-morbid pathology and better nutrition than the fracture group; they are often also more independent, thereby increasing their sunlight exposure.

A meta-analysis of several controlled trials suggests that vitamin D and calcium treatment reduces the incidence of fractures among frail elderly population.[7] Many patients who may benefit from treatment are not receiving it.[8,9] Thus, we suggest that vitamin D and calcium supplements be given to all patients with a fracture of the proximal femur.

In conclusion, this study demonstrates that many elderly patients from a British seaside population, who present with a fracture of the proximal femur, are insufficient in vitamin D. The only reliable way to confirm this finding is by performing a serum vitamin D assay. Other routine blood biochemistry measures of calcium metabolism, such as levels of plasma calcium and alkaline phosphatase, cannot be used to predict vitamin D insufficiency in these patients. We suggest that more hospitals should have facilities for vitamin D assays.

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