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Frail Elderly Hip Fracture Patients and Vitamin D

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Abstract

Background: According to Danish national guidelines, elderly should take vitamin D supplements.

The aims of this study were to examine the prevalence of non-supplemented and the prevalence of suboptimal serum vitamin D level among frail elderly hip fracture patients. Furthermore, to determine the gain from serum-25-hydroxyvitamin D (25(OH)D) analysis upon admission and three months later.

Methods: The subjects were frail elderly, defined as 65+ year olds living in nursing homes or sheltered housings, admitted with a hip fracture to the orthopaedic ward. We assessed vitamin D supplementation before and after hip fracture surgery and measured serum-25-(OH)D upon admission and three months later. Serum levels below 75 nmol/l were defined as suboptimal.

Results: A total of 121 patients (59%) did not receive vitamin D supplements, and 73% had suboptimal levels upon admission. We found that the serum-25(OH)D level did not influence the subsequent decision of whether or not to start treatment in the non-supplemented patients. Three months after hip fracture surgery all patients that started treatment, or whose dose was increased, reached optimal vitamin D levels.

Conclusions: A high percentage of frail elderly hip fracture patients did not receive vitamin D supplements. Furthermore a high percentage had a suboptimal level upon admission. Measurement of serum-25(OH)D upon admission seems unnecessary in non-supplemented patients, and may also be so three months later if compliance to vitamin D supplements is closely monitored and no antiresorptive treatment is intended.

Keyword

Vitamin D; Serum 25-hydroxyvitamin D; Frail elderly; Hip fracture

Abbreviations

Serum-25-hydroxyvitamin D: serum-25(OH)D; The TRIFE study: The Transfusion Requirements In Frail Elderly study

Introduction

Vitamin D deficiency has been linked to an increased risk of hip fracture [1-6]. Previous studies have found low levels of vitamin D in institutionalised elderly [7-10], among medical inpatients [11], and hip fracture patients [12]. Elderly living in nursing homes or sheltered housings are at particularly high risk of developing vitamin D deficiency; as increasing age, reduced sunlight exposure, and inadequate dietary intake of vitamin D are all factors that increase the risk of hypovitaminosis D [11,13]. The skin's ability to produce vitamin D3 from the pre-vitamin 7-dehydrocholesterol also declines with advancing age [14]. In addition, many frail elderly have medical, cognitive, and functional disabilities [15], which can adversely affect dietary intake of vitamin D. These elderly have also been found to have an increased risk of hip fracture when compared to elderly without need for assistance in daily living [13].

For the last ten years the Danish Health and Medicines Authority has recommended that elderly, 70 years or older, and institutionalised elderly, should supplement their diet with vitamin D and calcium [16]. However, previous studies have found that not all hip fracture patients benefit from supplements [17,18], and that as many as up to 56% may still be in the suboptimal range after three months of treatment [17].

It is recommended to examine the serum-25(OH)D in elderly hip fracture patients when they are admitted to hospital. If a suboptimal level is detected, or the attending physician finds other indications, supplementation is started, or the on-going dose increased. To ensure that the desired level has been reached the patient's general practitioner may repeat the analysis three months later, since this is the time needed for the vitamin D supplements to have their full effect [16]. Considering the cost of the serum-25(OH)D analyses and the number of hip fracture patients it would be desirable, from a socioeconomic point of view, if some of the tests were dispensable.

In this study of frail elderly hip fracture patients living in nursing homes or sheltered housing we wished to examine the prevalence of those not receiving vitamin D supplementation upon admission, and the prevalence of suboptimal vitamin D levels. Further we wished to assess the need for serum-25(OH)D measurements upon admission and three months later.

Materials and Methods

Study design and study population

This paper is primarily a descriptive article, which comprises a cross-sectional and a follow-up study. The cross-sectional part was a sub-study of the Transfusion Requirements in Frail Elderly (TRIFE) study, which examined the effect of expanding the target for blood transfusions [19]. The participants were frail elderly, defined as 65+ year olds living in nursing homes or sheltered housings. They were all admitted with a hip fracture to Aarhus University Hospital between 18th of January 2010 and 1st of October 2012, treated surgically, and had a haemoglobin level between 6 and 7 mmol/l within the first six postoperative days. The patients were excluded if they had an active cancer, a pathological fracture, or rejected blood transfusions. Informed consent, or deputy informed consent, was obtained for all participants. In this sub-study we examined the percentage of patients not supplemented with vitamin D and the prevalence of suboptimal vitamin D levels. We only included patients whose serum-25(OH)D was measured upon admission.

In the follow-up study, we evaluated the effect of three months of vitamin D supplementation on the levels of serum-25(OH)D. This study was also a sub-study of the TRIFE study with an inclusion period from 1st of July 2012 to 25th of March 2013. We examined the patients' vitamin D status three months after their hip fracture if they had had a suboptimal level upon admission and had initiated treatment (or been increased in treatment dose) during admission.

Data collection

From the medical records of participating patients, we extracted baseline demographic information, including gender, age, and type of housing (nursing home or sheltered housing). Dose of vitamin D supplementation (µg/day), if any, upon admission was registered. Patients were categorised as non-supplemented if supplementation dose was 5 µg/day or lower since this is the dose found in normal vitamin pills. Diagnoses up to ten years prior to admission were also extracted from the medical records and comorbidity, measured by Charlson Comorbidity Index (CCI), was calculated.

For patients enrolled in the follow-up study we also collected data on the vitamin D supplementation dose prescribed after surgery and the following three months. These data were extracted from the discharge drug list, and compared to the information found on the drug list in the patients' homes three months later. If a discrepancy was found, the drug list from the patient's home would be used.

Blood sample analysis

Blood samples were obtained from the patients during hospitalisation or on an outpatient basis, no longer than 14 days prior to admission or no more than 14 days after discharge. Measurement of serum levels of vitamin D is a standard recommendation in hip fracture patients. From the patients included in the follow-up study an additional blood sample was collected three months after their surgery.

All blood sample analyses were performed at the Department of Clinical Biochemistry at Aarhus University Hospital. Blood samples were analysed for levels of serum-25(OH)D3 and serum-25(OH)D2, as indicators of vitamin D status by using high-throughput liquid-liquid extraction and liquid chromatography-tandem mass spectrometry methods [20].

Levels of serum-25(OH)D below 75nmol/l were defined as suboptimal according to the limit set by a consensus panel [21].

Statistical considerations

Data on serum vitamin D levels are presented as mean with a standard deviation. Association between serum levels upon admission and the subsequent dosage of vitamin D supplementation was examined by simple linear regression analysis with p=0.05 as the significance level.

Results

The cross-sectional study

The TRIFE study included 227 patients. Of these, 23 had missing serum-25(OH)D values upon admission, and 204 were included in our cross-sectional study (Figure 1 and 2). The characteristics of the patients are shown in Table 1. 121 (59%) did not receive vitamin D supplements when admitted (Table 2). Amongst all included 73% had a suboptimal vitamin D level. In the subgroup of non-supplemented patients the prevalence of suboptimal levels was 88%. Among supplemented patients, who received 10-76 µg of vitamin D daily, suboptimal levels were found in 51% of patients.

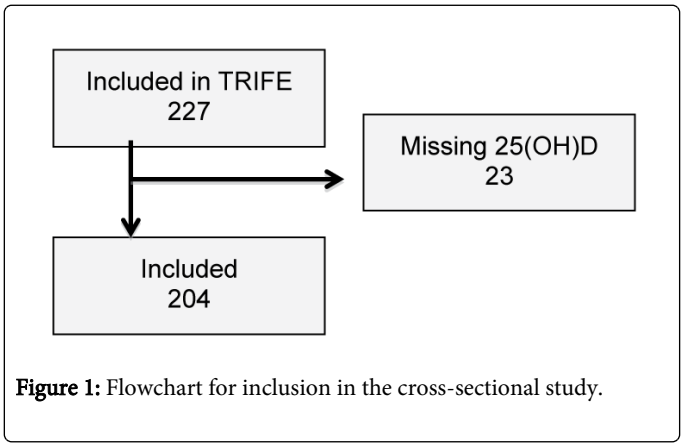

Figure 1: Flowchart for inclusion in the cross-sectional study.

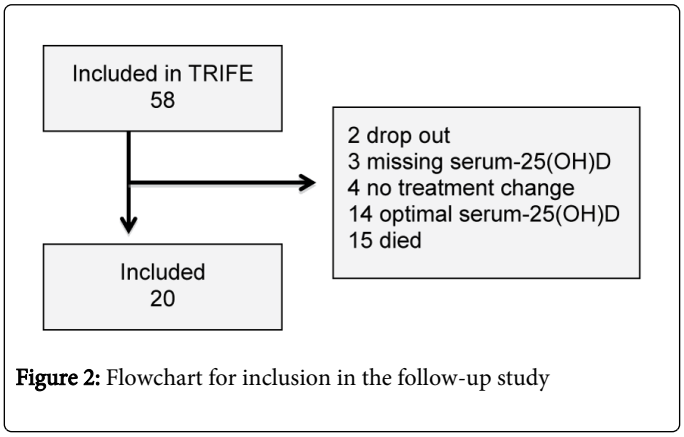

Figure 2: Flowchart for inclusion in the follow-up study

There were 15 non-supplemented patients who had optimal serum levels, 13 of these still initiated vitamin D supplementation (25-43 µg) during admission and only two remained untreated. There was no association (p=0.09) between serum levels upon admission and the subsequent supplementation doses in this subgroup.

Characteristic	Included (n=204)
Men n (%)	54 (26)
Women n (%)	150 (74)
Age: mean-years (range)	87 (65-100)
Senior housing n (%)	82 (40)
Nursing home n (%)	122 (60)
Comorbidity (IQR)	1 (0-2)

Table 1: Baseline characteristics for the cross-sectional study.

Vitamin D level	Non-supplemented n=121	Supplemented n=83	All included n=204
Suboptimal level (<75 nmol/l)	106 (88%)	42 (51%)	148 (73%)
Optimal level (≥75 nmol/l)	15 (12%)	41 (49%)	56 (27%)
Total <50 nmol/l	121 (100%) 71 (59%)	83 (100%) 13 (16%)	204 (100%) 84 (41%)
≥50 nmol/l	50 (41%)	70 (84%)	120 (59%)
Total	121 (100%)	83 (100%)	204 (100%)

Table 2: Vitamin D levels in hip fracture patients.

The follow-up study

From the 1st of July 2012 to the 25th of March 2013 58 patients were included in the TRIFE study. Upon admission 14 patients had an optimal vitamin D level, three did not have their serum-25(OH)D examined, and four were not started on/increased in vitamin D supplementation. This left us with 37 patients to include in the study. During the follow-up period fifteen patients died and two were lost to follow-up since they did not wish to have the second blood sample taken. Twenty patients were left and had their serum-25(OH)D was analysed three months after their hip fracture surgery.

Three months of supplementation resulted in optimal levels in all 20 patients, ranging from 75 to 147 nmol/l. The supplementation dose of vitamin D differed quite a lot between patients; some achieved optimal levels on doses as low as 15 µg daily, while others were prescribed up to 78µg daily.

Discussion

In spite of the recommendations given by The Danish Health and Medicines Authority, more than half (59%) of the frail elderly hip fracture patients did not receive vitamin D supplementation upon admission. These findings suggest that there is not enough focus on the importance of vitamin D supplements to frail elderly at risk of hip fractures.

The percentages of hip fracture patients with suboptimal vitamin D levels found in the present study were lower than found by Lauretani et al. where 94% of hip fracture patients had suboptimal levels [12]. However, in the study by Lauretani et al. the participants were older and this could explain some of the disagreement. Due to different cut off values it is hard to compare our results with results found in other studies. Meyer et al. examined nursing home residents and found that a third of the included had serum levels below 30 nmol/l, while 15% had levels below 20 nmol/l [7]. Gloth et al. found that 38% had levels below 25 nmol/l in the same type of population [9], while Liu et al. in long term care facility residents found 9-18% with levels below 25 nmol/l depending on the time of the year [10]. Thomas et al. examined patients admitted to a general medical ward and found that 57% had levels below 15 ng/ml equalling 40 nmol/l [11]. It is possible that these studies would have found percentages similar to ours if the cut off value had been set at 75 nmol/l.

The mean serum-25(OH)D among non-supplemented in our study was 47±25nmol/l, this was similar to the 51 ± 33 nmol/l and 47 ± 26 nmol/l found by Meyer et al. among elderly living in nursing homes who received no more than 10 µg of vitamin D daily [7]. A lower level of 11.9 ± 1.2 µg/l, equalling approximately 30 nmol/l, was found by Krieg et al. in a similar population of institutionalised elderly women [8].

Part of the explanation for the discrepancy between studies may be found in geographical location with different latitude and therefore differences in sun exposure. Dietary intake of vitamin D may also differ depending on geographical location. Furthermore, there have been an increased focus on the importance of a varied diet, including vitamin D rich fish, but this may also differ between countries.

Among the non-supplemented patients, 106 (88%) should be given extra vitamin D due to their suboptimal levels. In 13 of the remaining 15 patients, the physician still decided to start vitamin D supplementation. These numbers suggest that all (>98%) frail elderly hip fracture patients who do not already receive supplements should start during admission, regardless of the measured serum-25(OH)D. Furthermore we found no pattern between the serum level measured at admission and the subsequent supplementation dose started. This means that the serum analysis upon admission had no subsequent influence and may therefore be discarded in this particular subgroup. However, there are still situations, e.g. start of antiresorptive treatment, where the analysis may be essential.

Among patients, who according to their records received supplements, more than half (59%) still had suboptimal vitamin D levels when admitted with a hip fracture. This is in agreement with the study by Papaioannou et al. who found that 25-56% of hip fracture patients had suboptimal levels after three months of supplementation with 25 µg of vitamin D daily [17]. However, it is in contrast to the results from our follow-up study where we demonstrated that it is possible for all frail elderly hip fracture patients to achieve an optimal serum-25(OH)D level within three months. Part of the explanation for this discrepancy may be found in the fact that the information about supplementation was obtained from the drug list in the patient's admission papers. The drug lists contain no information about treatment duration or compliance, factors that impact the serum-25(OH)D level [16]. Patients and caregivers may have an increased focus on the supplementation treatment after a hip fracture, which is likely to increase compliance after discharge.

The follow-up study only included 37 patients, of which 15 died and two were lost to follow-up. The small number makes it difficult to expand the results to the general population of frail elderly hip fracture patients. However, the fact that not a single patient stayed in the

suboptimal range indicates that this should be possible for all frail elderly surviving three months after a hip fracture.

In conclusion, we found a high percentage of patients not supplemented with vitamin D in a population of frail elderly hip fracture patients, though all elderly should receive supplements according to the Danish national guidelines. Furthermore, we found a high prevalence of suboptimal vitamin D levels, both among supplemented and non-supplemented patients. Regarding the supplemented patients, this could reflect a lack in treatment compliance, since we demonstrated that it is possible for all frail elderly hip fracture patients to reach optimal serum-25(OH)D levels after three months of vitamin D supplementation.

The serum-25(OH)D analysis upon admission in non-supplemented frail elderly hip fracture patients may be discarded as it does not influence decisions about vitamin D supplementation. However, vitamin D should be measured if antiresorptive treatment is intended. Furthermore, our results indicate that serum-25(OH)D analyses three months after surgery may be discarded, if compliance to treatment is closely monitored.

This study has several limitations. In the cross-sectional study we only had few baseline measurements, and no data on compliance prior to admission. Furthermore, we only had the CCI and no specific data on comorbidities that could influence the effectiveness of treatment such as e.g. gastro-intestinal disorders. In the follow-up study the supplementation dose varied between patients (15-78 μg daily). Therefore we cannot give clear recommendations on the supplementation dose needed for frail elderly to reach optimal levels. Furthermore, the study only included 37 patients, of which two were lost to follow-up. We did not examine any adverse effects to treatment like obstipation or toxicity. At present we have no data to explain the apparent contradicting results between our studies where a large percentage of supplemented patients have suboptimal levels upon admission, while our follow-up study found that all patients reached optimal levels. This could be a question of treatment compliance, health related issues, or other unmeasured factors.

Future studies should include more baseline characteristics, regarding both socio-demographic and health related data, which could influence the effectiveness of supplements. Furthermore, future studies should examine treatment compliance and elucidate reasons for non-compliance among the frail elderly. Studies examining the response to vitamin D supplementation are recommended to include a larger number of patients, and to examine if patients reach a serum-25(OH)D too high, or experience any adverse effects to the treatment.

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