Original article

Can vitamin D supplementation improve grip strength in elderly nursing home residents? A double-blinded controlled trial

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Abstract

Background: Low vitamin D status is associated with reduced muscle strength, but the benefit of vitamin D supplementation is not clear.
Objective: To study whether a daily supplement of vitamin D could improve grip strength.
Design: A subtrial of a double-blinded, controlled trial studying the effect of vitamin D on the incidence of hip fractures and other osteoporosis fractures in a frail nursing home population. Sixty nursing home residents in 14 nursing homes in the Oslo area were given 5 ml ordinary cod liver oil daily containing 10 μg vitamin D_3 (vitamin D group) or 5 ml cod liver oil where vitamin D was removed (control group). Grip strength was measured at baseline and after 1 year with supplementation.
Results: Grip strength did not improve in the vitamin D group (0.4 kg increase) compared with the control group (1.6 kg increase) after 1 year vitamin D supplementation ($p = 0.22$). Serum 25(OH)D was estimated to increase by 21.1 nmol l^{-1} ($p = 0.002$) in the intervention group compared with the control group.
Conclusion: A group given a daily supplement of 10 μg vitamin D_3 in cod liver oil did not improve grip strength compared with a group not receiving vitamin D from cod liver oil.

Keywords: *controlled trial*; *frail elderly*; *muscle strength*; *hip fracture*; *vitamin D*

Received: 12 Mar. 2007; Revised: 13 Apr. 2007; Accepted: 27 Apr. 2007

Introduction

Hip fractures constitute a large health problem in the elderly. Oslo has the highest incidence of hip fracture ever reported, and about 25% occur in frail nursing home residents (1, 2). Fall is an important risk factor for hip fracture and the tendency to fall is common among frail elderly people (3). A contributor to falls in elderly is declining muscle strength, often in combination with poor balance, poor sight and polymedication (4).

Vitamin D deficiency is common among elderly people in Europe (5). Vitamin D deficiency is a risk factor for osteoporosis and hip fracture (6, 7). Low vitamin D status has also been associated with reduced muscle strength and falls (8, 9). The active hormone of vitamin D, 1,25(OH)D, binds to a highly specific nuclear receptors in muscle tissue. The active hormone stimulates calcium uptake in muscle cells, which is necessary for muscle contraction and strength (10).

Few randomized controlled trials (RCTs) have studied the effect of vitamin D supplementation alone on muscle strength and functional mobility, and the benefits of this intervention are not clear (11, 12). Trials are heterogeneous concerning type and dose of vitamin D given, they have been performed in different population settings, and there are different measurements of functional improvements (11). According to the Cochrane review by Avenell and co-workers, the effectiveness of vitamin D alone in fracture prevention is unclear (13).

The objective of this trial was to study whether a daily supplement of 10 μg vitamin D_3 (in cod liver oil) could improve grip strength in a group of nursing home residents compared with a group not

  ISSN 1748-2976

DOI: 10.1080/03461230701422528

receiving vitamin D supplements (control group). According to the Nordic Nutrition Recommendations (NNR), the recommended dose for elderly people is 10 μg vitamin D_3 daily (14).

Materials and methods

The current study was a subtrial included in the protocol of a double-blinded, controlled trial studying the effect of vitamin D on the incidence of hip fractures and other osteoporotic fractures in a frail nursing home population (15). The main study was carried out in 1144 nursing home residents with mean age of 85 years.

At baseline, 95 participants had a grip strength measurement. Sixty participants had grip strength both at baseline and after 1 year. Thirty-two participants were allocated to the vitamin D group and 28 to the control group. The 35 participants who dropped out were older than those who completed ($p < 0.05$). Twelve of these participants died during the first year, four participants were terminally ill at follow-up, and the remaining 19 people refused for different reasons. However, there was no statistical difference in dropouts between the vitamin D group and the control group.

The study group was recruited from the people who agreed to have blood samples drawn. Further information about the main trial is published elsewhere (15, 16). In brief, to be eligible, the residents should have a life expectancy of more than 6 months, should not be permanently bedridden, and should not have difficulties in taking medicine. People already taking vitamin D supplements (usually in the form of a multivitamin supplement) were included as long as this supplementation did not exceed 10 μg per day. Before the study started the days of the month (1 to 31 days) were divided randomly into group A and B, and based on the day of birth, a participant was placed automatically in group A or group B when registered in the study database. The intervention group received 5 ml cod liver oil per day containing 10 μg vitamin D_3, whereas the control group received 5 ml cod liver oil per day without vitamin D in a double-blind setting.

The blood samples were analysed for 25(OH)D by the hormone laboratory, Aker University Hospital, at baseline and 1 year after the study started (± 1 month). The method is described elsewhere (17).

Grip strength is an economical measure and has been recognized to be a reliable indicator of muscle strength and overall physical performance (18–20). Grip strength was measured with the Harpenden Dynamometer (British Indicators, Luton, UK). The dynamometer was placed in the non-dominant hand with the participant's arm flexed 90 degrees at the elbow and the forearm parallel to the floor. The size of the grip was set so that the subject felt comfortable while squeezing the grip. Subjects were seated. The participant was instructed to squeeze the hand maximally in this position. The measurement was repeated, and the best of three attempts was registered. The coefficient of variance (CV) in repeated measurements was 8.6%. As this was a double-blinded study, grip strength was measured without knowledge of the treatment status of the participants. Differences between the two groups in baseline characteristics were tested by the chi-squared test for categorical variables, and by the independent samples t-test for continuous variables. Grip strength, vitamin D and calcium intake were the only variables judged not to be normally distributed, and were analysed by the Mann–Whitney non-parametric test.

Changes in grip strength and 25(OH)D were calculated as the grip strength (kg) and serum 25(OH)D (nmol l^{-1}) after 1 year minus the baseline levels. The differences between the two groups were tested by linear regression, adjusting for baseline levels of grip strength and serum 25(OH)D, respectively.

In general, it was difficult to recruit participants in the main study to blood samples, and a smaller than intended group was formed. However, the number of participants included gave the study enough statistical power to detect a reasonable small difference in grip strength between the two groups. Given a standard deviation of 4 kg in grip strength difference over 1 year and 30 participants in each group, the study had a power of 80% at a 5% level of significance to detect a difference in grip strength of 2.9 kg between the two groups.

Results

There were no statistically significant differences between the two groups in baseline characteristics (Table 1). Vitamin D intake from butter/margarine, fatty fish and cakes could be estimated in 30 people and was found to be 3.5 μg in the intervention group and 3.6 μg in the control group ($p = 0.8$). Mean grip strength was 16.0 ± 6.1 kg in the control group and 16.0 ± 8.3 kg in vitamin D group at baseline (Table 1).

Table 1. Baseline characteristics of the 60 study participants

	Control group (n =28)	Vitamin D group (n =32)	p
Age (years)[a]	82.0±7.6	82.8±7.0	0.7
Women, number (%)	20 (71%)	19 (59%)	0.3
Body mass index (kg m^{-2})[a]	22.9±4.4	23.0±5.2	1.0
Vitamin D supplementation (%)[b]	14 (50%)	13 (41%)	0.4
Calcium intake from cheese and milk[a,c]	447.3±128.1	490.0±191.0	0.5
Mean serum 25-hydroxyvitamin-D_3 (nmol l^{-1})[a,d]	49.9±34.8	49.3±26.5	0.9
Serum 25-hydroxyvitamin D_3 <30 nmol l^{-1} (%)	10 (37%)	9 (29%)	0.5
Grip strength (kg)[a]	16.0±6.1	16.0±8.3	0.6

[a] Mean values ±SD.
[b] Usually in the form of a multivitamin supplement.
[c] Cheese and milk constitute two-thirds of the total calcium intake (18).
[d] n =58 (27+32).

In the 60 participants included in the grip strength analysis, serum 25(OH)D was measured in 58 participants at baseline, and 30 people had serum 25(OH)D measurements at baseline and after 1 year (16 in the vitamin D group and 14 in the control group).

Serum 25(OH)D was estimated to increase by 21.1 nmol l^{-1} in the intervention group compared with the control group after 1 year (p =0.002).

After 1 year, mean grip strength had increased by 0.4±3.8 kg to 16.4±3.8 kg in the vitamin D group and by 1.6±4.0 kg to 17.6±4.0 kg in the control group. The increase was estimated to be 1.2 kg (p = 0.22) in the control group compared with the intervention group.

A subanalysis restricted to the participants with serum 25(OH)D <30 nmol l^{-1} at baseline did not detect any effect of the intervention, with a change in grip strength of 1.0±5.7 kg in the control group (n =10) and −0.2±4.1 kg in the treatment group (n =9) (p =0.49).

Discussion

In this double-blinded controlled trial in frail elderly nursing home residents, a daily supplement of 10 μg vitamin D_3 in cod liver oil over a 1 year period did not improve grip strength compared with the control group.

It is possible that the dose of vitamin D, which was in accordance with the NNR, was too small to give any detectable improvement in grip strength. In addition, the 25(OH)D level in the study population was relatively high, around 50 nmol l^{-1} at baseline. This is somewhat higher than in other studies (5, 9). Correcting vitamin D levels to normal ranges could be adequate to improve muscle function, with little to gain by giving vitamin D to people with normal vitamin D levels (8, 21, 22). It might be that the baseline vitamin D status in this study was too high to demonstrate an effect of vitamin D supplementation on muscle strength. No effect of supplements to the vitamin D-deficient subgroup (<30 nmol l^{-1}) was found, but this subgroup was small.

It is debated what should be considered the normal level of vitamin D (11, 23). Lips (6) suggests a cut-off point for mild vitamin D deficiency of 50 nmol l^{-1}, and for moderate vitamin D deficiency 25 nmol l^{-1}. Recently, the optimal vitamin D level has been suggested by some authors to be 70–80 nmol l^{-1} or even higher (24). If the optimal vitamin D level is in this range, an oral dose of 10 μg vitamin D per day may be too low to raise vitamin D status to an adequate level. This is in line with no fracture-preventing effect in RCTs intervening with 10 μg of vitamin D, compared with studies intervening with larger doses of vitamin D (7, 25, 26).

A recent meta-analysis reported that vitamin D can reduce the risk of falling in elderly people (11). Although there were insufficient data to test formally the impact of dose, the included studies suggested an effect of 17.5–20 μg vitamin D supplementation, but not of 10 μg. In two studies included in the meta-analysis (27, 28), 1200 mg of calcium was given daily to both the intervention group and the control group. In two RCTs showing a preventing effect of vitamin D on fractures, the intervention consisted of a combined vitamin D and calcium supplementation (25, 26). It is thus possible that effect of vitamin D supplements is better in combination with calcium than as vitamin D supplements alone (25, 27–29). However, another

RCT did not show effect on physical performance of 1000 IU vitamin D_3 and 500 mg calcium after 6 months in 60 older, community-dwelling men with normal vitamin D levels (>60 nmol l^{-1}) (22).

Grip strength is an economical measure and has been recognized to be one of the best indicators of the overall strength of the upper limb (30), but is also associated with physical performance of the lower limb (20). Grip strength has been tested and found to be valid in frail elderly people (18). This method was chosen so that wheelchair-bound people could be included in this study. Bischoff-Ferrari recently found a significant relationship between serum 25(OH)D and better lower extremity function in a population-based survey of ambulatory elderly people (31). Glerup et al. (29) studied the muscular effects in different muscle groups of high-dose intramuscular injections of vitamin D_2 to vitamin D-deficit women. The increase in muscle strength was significant for different muscle groups, but the most pronounced improvements were seen in the weight-bearing muscles of the lower limbs. However, Glerup et al. (29) did not have a placebo group and the participants also received supplements of oral calcium and vitamin D together with vitamin D injections.

The level of the hand grip strength in this study seems low (Table 1), but according to existing norms (32) grip strength in people aged 80 years and older lies in the range 10–20 kg in women and 18–47 kg in men. The mean grip strength at baseline was 13.1 kg in women and 20.3 kg in men.

In conclusion, this double-blinded controlled trial found that an intervention with 10 μg of vitamin D over 1 year did not increase grip strength in a group of institutionalized elderly people. Further studies are warranted, not least focusing on intervening with larger doses of vitamin D.

Acknowledgements

We thank Egil Haug, who was responsible for the blood analyses, and the nursing staff and nursing home residents who participated in the study.

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