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Preventing Falls with Vitamin D

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Abstract

Falls are the number one cause for injury-related morbidity and mortality in West Virginia's seniors. Multiple independent variables contribute to the risk of a fall: previous falls, alterations in balance and vision, impairments in gait and strength, and medications most highly correlate with the risk for a fall. Vitamin D supplementation is emerging as an easy, safe and well-tolerated fall reduction/prevention strategy due to the beneficial effects on the musculoskeletal system with improvements in strength, function and navigational abilities. From meta-analysis data, maximal fall reduction benefit in seniors is achieved when correcting vitamin D deficiency and when using adjunctive calcium supplementation. It is therefore recommended that practitioners in our state screen for fall risks and consider the addition of supplementation protocols that provide sufficient vitamin D and calcium to our seniors.

Introduction

The May/June 2012 issue of this Journal highlighted that falls are the number one cause of injury-related morbidity and mortality in West Virginia (WV) senior citizens.¹ The prevalence of falls is strongly correlated with advancing age: 30% prevalence in > 65 years of age; 50% prevalence in > 80 years of age

with an increased risk of falls noted in institutionalized seniors.²⁻⁴ Since WV ranks second nationally for the percent of population ≥ 65 years of age, we are at greater risk for fall related injuries. Over 106,000 WV seniors will suffer at least one fall this year with up to 50% of these falls causing minor trauma (lacerations and bruises) and 10% resulting in major injuries (traumatic brain injury and fractures).^{5,6} Nationally, there has been a 50% increase in fall related injury hospitalizations from 2001-2008 with over 2.2 million emergency room visits and over 580,000 hospitalizations in 2009 with costs expected to soar to \$32.4 billion by 2020.^{5,7,8}

What is a fall and what increases the risk of a fall?

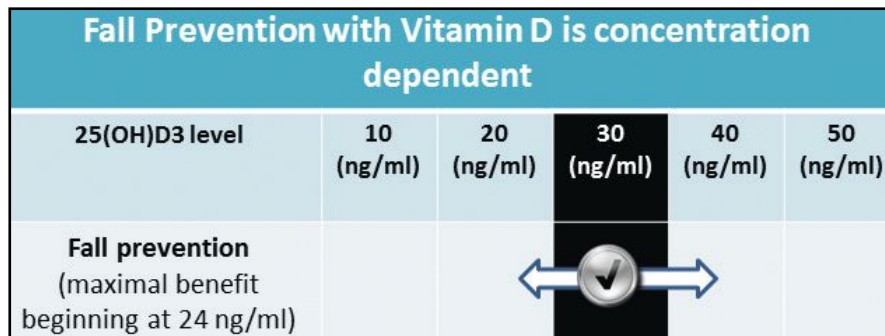
The World Health Organization defines a fall as the action of finding oneself involuntarily on the ground.² Identification of those most at risk for falls is critical. A screening summary was elegantly highlighted in this Journal.¹ Multiple independent variables contribute to the risk of a fall with previous falls, alterations in balance and vision, impairments in gait and strength, and medications most highly correlated with a fall.⁵ The more risk factors one has, the greater the risk of falls with some factors associated with a higher relative risk than others.⁵ Factors that double the risk of falling include alterations in vision, cognitive impairment, depression, age > 80 years old, and arthritis.⁹ Previous falls increase the risk of additional falls by 300% while lower-extremity muscle weakness increase the risk of falling by 400%.⁹ Because of the high correlation of falling with alterations in strength, gait and balance, vitamin D presents an emerging and effective approach to improve musculoskeletal strength, function and navigational abilities.

Economic analysis of fall prevention strategies has demonstrated that vitamin D replacement, in addition to medication reviews, were the most cost effective intervention to reduce falls.^{10,11}

What does vitamin D do to the musculoskeletal system?

Vitamin D has both direct genomic and non-genomic effects on skeletal muscle tissue. The receptor for vitamin D (VDR) is found in skeletal muscle (among various other tissues) which upon activation promotes *de novo* protein synthesis in muscle.¹² The proteins synthesized are responsible for events such as calcium influx and muscle fiber differentiation and proliferation.² Type II muscle fibers play a key role in falls because they are the first to be recruited when the body reacts to prevent a fall. Vitamin D deficiency can lead to muscle fiber atrophy, slow peak muscle contraction, prolonged time to relaxation and increased risk of chronic musculoskeletal pain.¹³⁻²¹ Deficient states have also been linked to generalized musculoskeletal pain, significant myopathy, muscle weakness, hypotonia and resultant gait abnormalities.^{21,22} Vitamin D supplementation can do the following: reverse the atrophy seen in Type II fibers decreasing fall risk by 20% in both institutionalized and non-institutionalized individuals, improve proximal muscle weakness and body sway associated with gait impairments, increase muscle strength/function and balance, reduce and reverse myalgias, and decrease muscle protein degradation.^{21,23-32} There is a dose-response relationship between serum 25(OH)D concentration and lower extremity function; higher 25(OH)D levels improve function.^{33,34} Studies have shown that in order to receive a fall protection benefit

Figure 1: Fall prevention with Vitamin D is concentration dependent with the most benefit obtained by correction of vitamin D deficiency defined as 25(OH)D < 30 ng/ml.



from supplementation, 25(OH)D levels need to be maintained above 24 ng/mL.^{23,24} These specific relationships and findings provide supportive evidence that vitamin D has a key role in muscle health and fall prevention.

In addition to the well-established effects of vitamin D on muscles it is also important to note the benefits of increased levels of vitamin D on the skeletal system, notably fracture reduction. A meta-analysis that will be discussed at length below showed that hip fractures can be reduced by 26% with vitamin D supplementation of 700-800 IU/day.³¹

Did supplementation increase 25(OH)D?

One critical concept is that any report on the efficacy of vitamin D supplementation as a fall prevention strategy should take into account the effect on the circulating form of vitamin D, 25-hydroxyvitamin D or 25(OH)D. 25(OH)D level is determined in ng/ml (or mmol/l) following a simple blood test with vitamin D deficiency defined as less than 30 ng/ml. Supplementation with vitamin D3 (cholecalciferol) instead of vitamin D2 (ergocalciferol) has shown to have a more significant effect on elevating 25(OH)D levels.³⁵ It is important to note that the cutaneous synthesis of vitamin D is less efficient as we age, so pharmacological protocols become very important in the senior demographic.³⁶

Meta-Analysis and Randomized Controlled Trials (RCT)

There are several key factors for reducing fall risk with vitamin D: (1) dosing protocol, (2) supplemental calcium and (3) baseline vitamin D status of participants.

Dosing matters

Dosing of vitamin D is a critical determinant in fall risk reduction and fracture prevention. Daily doses appear to be better than annual dosing strategies with daily doses of 700-1000 IU vitamin D per day reducing the number of falls by 19-26% in meta-analysis studies of randomized controlled trials.²⁵ However, no reduction in fall risk was shown when the vitamin D dose was 200-600 IU demonstrating a threshold effect for benefit. A serum 25(OH)D concentration of ≥ 24 ng/ml produced a 23% fall reduction with no reduction in falls noted for levels below 24 ng/ml (Figure 1). A subgroup analysis found that vitamin D3 was superior with a pooled relative risk reduction of 26% when compared to vitamin D2 (12% risk reduction). In a more recent meta-analysis of 11 double-blind, placebo controlled RCT with vitamin D with or without calcium in 31,022 patients >65 years of age, vitamin D supplementation of ≥ 800 IU daily produced a 30% reduction in the risk of hip fracture and a 14% reduction in the risk of nonvertebral fractures.³⁷ The American and British Geriatric

Societies have therefore produced guidelines that recommend 800 IU of daily vitamin D for all older adults at risk of falling.⁵ Annual dosing protocols of 500,000 IU vitamin D3 in a placebo-controlled trial of 2256 women >70 years of age actually increase the risk of falls by 15% with 26% more fractures than the placebo group.³⁸ Vitamin D deficiency is appropriately corrected with rapid supplementation protocols -- 50,000 IU vitamin D3 (Bio-Tech Pharmacal, Inc. Fayetteville, AR [12 capsules per bottle #36212A]) per week for 8 weeks in conjunction with daily dosing with repeat 25(OH)D testing in 3 months.³⁶ Of note, supplementation protocols can also use vitamin D2 for rapid supplementation with conversion to vitamin D3 for long term management.

Supplemental calcium and vitamin D status is important

A recent meta-analysis of 45,782 participants indicated that vitamin D use produced a statistically significant reduction in the risk of falls (Odds ratio for one fall 0.86) with a more prominent effect in patients with vitamin D deficiency and with calcium co-administration.³⁹ The optimal dose of vitamin D and calcium has not been established for maximal fall risk reduction but several promising RCT are in progress.^{40,41} One double-blind RCT worth highlighting studied 122 elderly women receiving either 1200 mg calcium + 800 IU Vit D or 1200 mg calcium per day for 12 weeks.²³ In this study 90% of patients were vitamin D deficient (< 31ng/ml) with the protocol increasing the 25(OH)D levels by 71% with a 49% reduction in falls in the calcium + vitamin D group when compared to calcium alone. Recurrent fallers benefitted most from this protocol. Of note, recent data indicates that vitamin D and calcium supplementation at levels used in this RCT do not promote kidney stone formation.^{42,43}

Conclusions

Falls are the number one cause of injury-related morbidity and mortality in West Virginia senior citizens. An excellent and cost effective strategy to improve muscle strength and reduce fall risk is supplementation with vitamin D and calcium. Data presented indicates that the most benefit in fall reduction is obtained in patients where vitamin D deficiency states are corrected (< 30ng/ml 25(OH)D) and with protocols that use at least 800 IU vitamin D3 per day with supplemental calcium. By implementation of these protocols, it is projected that a reduction of over 27,000 falls per annum can be realized in our senior population thus improving the quality of life, reducing the economic impact, and improving overall health of West Virginia seniors.

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