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The Role of Vitamin D Levels in Geriatric Patients with Hip Fractures

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ABSTRACT

Background: Vitamin D deficiency is common amongst the geriatric population. Severe vitamin D deficiency causes rickets or osteomalacia. Less severe vitamin D deficiency causes an increase of serum Parathormone (PTH) leading to bone resorption, osteoporosis and fractures.

Objectives: In this study our aim was to determine, whether levels of vitamin D in geriatric patients are associated with postoperative rehabilitation in terms of mobility and functional status, as well as with specific(haematoma, seroma, wound dehiscence, secondary dislocation of osteosynthesis/luxation of prothesis, wound infection) and nonspecific (infection of the urinary tract, pneumonia, bronchopulmonal infect, influenza, sepsis, infect without focus, enteritis/diarrhoea/clostridium difficile infection, gastrointestinal bleeding/reflux oesophagitis/gastric ulcers, thrombosis, pulmonal embolism, exacerbation of COPD, respiratory insufficiency, NSTEMI myocardial infarction, cardialdecompensation, brady – or tachycardia, kidney failure, cerebral infarction, delirium, coma and death) postoperative complications.

Methods: We prospectively studied 170 geriatric patients (>75years) with hip fractures, that were admitted to our traumatology department over the course of a 7 month period (January-July). Upon admission we noted their sex, fracture type (per/subtrochanteric, femoral neck)and took their history of existing premedication (vitamin D, calcium, specific osteoporosis treatment).The duration of taking premedication was not further determined and specified. Also, we measured the level of 25-hydroxyvitamin D, which was determined by our laboratory, using the electrochemiluminescent immunoassay method (ECLIA). We defined vitamin D deficiency using Holick classification.Post surgery, we collected data on the occurrence of specific and nonspecific complications, the success of remobilisation and their overall functional status. For this a mobility index, as well as Barthelindex, were used.

Results: Vitamin D levels in male patients were lower than those measured in female patients ($p < 0.01$). Using Holick classification, only 13.4% of all our patients showed a normal value of vitamin D levels (≥30ng/L). There is a strong statistic correlation between taking premedication and the level of vitamin D ($p < 0.001$). There was no statistically significant correlation between vitamin D levels and postoperative specific or nonspecific complications. However, patients with higher vitamin D levels performed better in terms of functional status and remobilisation with improvement of Barthel index ($p = 0.03$) and a better mobility index ($p = 0.018$).

Conclusions: Efforts to screen the geriatric population for vitamin D deficiency should be made. Regular administration of vitamin D and calcium seems to play an important role in terms of reintegration of the geriatric patient into daily life activities following a hip fracture.

INTRODUCTION

Hypovitaminosis D has become a pandemic, being observed in all ethnicities and age groups worldwide.Severe vitamin D deficiency causes rickets or osteomalacia. Less severe vitamin D deficiency causes an increase of serum PTH leading to bone resorption, osteoporosis and fractures [1]. Elderly people are at greater risk of vitamin D deficiency because of risk factors such as suboptimal sunlight exposure and lower cutaneous synthesis (vitamin D3 is synthesized in the skin during summer under the influence of ultraviolet light of the sun), reduced dietary intake of D2 (ergocalciferol) and D3 (cholecalciferol), impaired intestinal absorption, and impaired hydroxylation in the liver and kidneys (hydroxylation in the liver into 25-hydroxyvitamin D (25(OH)D) and kidney into 1,25-dihydroxyvitamin D (1,25(OH)2D)) [1,2].

The percentage of older people in the population keep increasing steadily and with it does the number of hip fractures [3-5]. Outcomes for geriatric people surviving hip fractures are poor, with the majority of patients not recovering their previous level of function. It has been established that 50% of people surviving a hip fracture require long-term help with routine activities and cannot walk unaided and 25% require full-time nursing-home care [6]. Improving functional parameters following a hip fracture has the potential to be of great benefit to older people by reducing disability and enhancing quality of life. Mobility is the key activity underlying functioning and quality of life [7].

Recent studies about the impact of oral administration of Vitamin D in geriatric patients on the risk of falls, fractures and frailty vary greatly. Future large scale trials with longer follow up are needed to confirm/refute findings so far [8-13].

Our aim was to determine, whether serum levels of vitamin D in geriatric patients are associated with post operative rehabilitation in terms of mobility and functional status, as well as with specific and nonspecific postoperative complications.

METHODS

We prospectively studied 170 geriatric patients (>75years) with hip fractures that were admitted to our traumatology department over the course of a 7 month period (January-July). Upon admission we noted their sex, fracture type (per/subtrochanteric, femoral neck) and took their history of existing premedication (vitamin D, calcium, specific osteoporosis treatment). The duration of taking premedication was not further determined and specified. Also, we measured the level of 25-hydroxy vitamin D, which was determined by our laboratory, using the electrochemiluminescent immunoassay method (ECLIA).

We defined vitamin D deficiency using Holick classification [14] where vitamin D deficiency is considered where there is a vitamin D level <20ng/mL, vitamin insufficiency is defined as vitamin D level 21 to 29ng/mL, and normal vitamin D levels are defined as ≥30ng/mL.

Post-surgery, we collected data on the occurrence of specific and nonspecific complications, the success of remobilisation and their overall functional status.

As for specific complications we collected data on the occurrence of postoperative haematoma, seroma, wound dehiscence, secondary dislocation of osteosynthesis/luxation of prothesis and wound infection.

Regarding nonspecific complications, infection of the urinary tract, pneumonia, bronchopulmonal infect, influenza, sepsis, infect without focus, enteritis/diarrhoea/clostridium difficile infection, gastrointestinal bleeding/reflux oesophagitis/gastric ulcers, thrombosis, pulmonal embolism, exacerbation of COPD, respiratory insufficiency, NSTEMI myocardialinfarction, cardialdecompensation, brady – or tachycardia, kidney failure, cerebral infarction, delirium, coma and death, were all noted.

Specific and nonspecific complications were all determined during the time of in-hospital stay by our medical staff.

In accordance with our findings on postoperative success of remobilisation we designed a mobility index, dividing the patients into six groups (attachment 1).

The postoperative functional status was determined using the Barthel index (attachment 2).

STATISTICAL ANALYSIS

Statistical evaluations were performed in R (Version 2. 7. 0, 2008, The R Foundation for Statistical Computing, ISBN 3 – 900051 – 07 - 0, http:// cran.r-project.org) resp. (elementary statistics and figures) in HP-RPL (Ver. 2.08, 2006; Hewlett-Packard Company, San Diego, CA 92123).

We used the Kolmogoroff-Smirnov-Test to test normality of distributions, the Wilcoxon-Mann-Whitney (U) – test resp. Kruskall-Wallis-test to compare two or several data sets, and the Spearman rank correlation to investigate the correlation of data sets.

RESULTS

The results of this study are based on collected data of 170 geriatric (>75years) patients that were admitted to our traumatology department following a hip fracture.The mean age was 85.17 years and our patients were predominantly female (n=117) (Attachment 3).The level of vitamin D in male patients was significantly lower than in female patients ($p < 0.01$; Wilcoxon-Mann-Whitney (U)-test) (Attachment 4).The distribution of fracture type showed 51.8%pertrochanteric fractures and 47.6% fractures of femoral neck.Only 0.6% of patients presented with subtrochanteric fractures. There is no statistically relevant difference of vitamin D levels between both fracture types ($p = 0.201$; Wilcoxon-Mann-Whitney (U)-test) (Attachments 5, 6).22.9% of our patients were taking premedication in form of calcium, vitamin D, calcium + vitamin D, vitamin D + specific osteoporosis medication or vitamin D + calcium + specific osteoporosis medication. Only 13.4% of all our patients had a normal level of vitamin D of 30ng/L or higher (Holick classification). There is a strong statistic correlation between taking premedication and the level of vitamin D ($p < 0.001$; Spearmann rank correlation) (Attachment 7, 8). Significant statistical association was shown between the level of vitamin D and our mobilityindex ($p = 0.018$; Spearmann rank correlation). Higher levels of vitamin D correlate with a lower (»better«) mobility index (Attachment 9). Furthermore our study showed that higher vitamin D levels correlate with a greater improvement of Barthel index ($p = 0.031$; Spearmann rank correlation), whereas the age of patients did not play a role in improvement of Barthel index ($p = 0.107$; Spearmann rank correlation). Patients with specific as well as with unspecific complications did not have a statistically significant lower level of vitamin D than those without complications.

DISCUSSION

The impact of vitamin D on fall prevention, fractures, frailty and mortality has been studied extensively. Though there are numerous studies, results vary greatly. Clearly, further large scale trials with longer follow up are needed to confirm/refute findings so far [8-13]. There is, however, very few data on the role of vitamin D levels in geriatric patients with hip fractures on postoperative complications, remobilisation and overall functional status.

The predominance of female patients with hip fracture in our study (68.8%) mirrors that seen in other studies [2,15]. Our study showed, that patients who presented with a higher level of vitamin D at the time of hip fracture, performed much better in terms of postoperative remobilisation as well as reintegration into everyday life than patients with lower serum vitamin D levels. All our patients received intensive and daily physiotherapy care during hospitalisation. Patients with higher vitamin D levels scored better in our mobility index and tended to regain faster independent mobility, with or without walking aids. Whereas patients with lower vitamin D levels showed a tendency toward difficulty in remobilisation, needing an additional person for help, being able to master only short distances independently or being remobilised only into a wheelchair.Patients with higher vitamin D levels also showed a significant improvement of Barthel index (measured shortly after surgery and again upon discharge), showing a greater independence in everyday activities such as washing themselves, eating a meal, walking stairs or dressing up. This seems an interesting finding which surely merits further study.

As expected, patients that were already taking any form of supplement medication (vitamin D, calcium, specific treatment for osteoporosis) showed a higher vitamin D level upon admission. The percentage of this group up to this day, however, remains low (22.9% in our study). In a similar study, carried out in Switzerland, only 10% of patients had vitamin D supplementation [16]. This is surely a consequence of incoherent study findings involving the benefits of vitamin D supplementing and the non-existence of clear guidelines on the topic. It has been established that only about 4-8% of geriatric patients with hip fractures have sufficient levels of vitamin D [2,16-18]. This is comparable to our findings, where 13.4% of patients presented themselves with normal levels of vitamin D. Normal levels in this study are defined following Holick's classification (see above).Considering our results, there is a clear benefit on higher vitamin D levels regarding postoperative mobility and functional status. Consequently, supplementing vitamin D in the geriatric population should be readily considered, as mobility is key to a better quality of life.

One limitation of this study was, that data on mobility was collected only once, at the time of discharge, so there was no comparison as to mobility shortly after surgery and mobility upon discharge. Also, no widely used, accepted mobility Index was used. Surely it would be beneficial to determine, for example, the de Morton mobility index (DEMMI) or the cumulated ambulation score (CAS). For this, tighter cooperation between traumatology and geriatric departments should be encouraged. However, there is evidence, that during the time of acute hospitalisation in patients with hip fracture, the value of the de Morton index seems limited in comparison to the Barthel index. Cumulated ambulation score also seems superior to the deMortonMobilityindex for the early assessment of outcome in patients with hipfracture admitted to an acute geriatric ward [19].

CONCLUSION

In summary, this study shows, that higher levels of serum vitamin D following a hip fracture in the elderly, are beneficial in terms of mobility and functional status. These findings should be investigated further. Optimally Barthel index as well as cumulated ambulation score (CAS) should be used. Efforts for substitution of vitamin D in geriatric patients should be made.

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Attachment 1: Mobility Index:	
1	mobile without aid/assistive devices
2	mobile with rollator or crutches
3	mobile with rollator or crutches over short distances
4	mobile with rollator or crutches over short distances with one assisting person
5	was mobilised into standing position
6	was mobilised only into wheelchair

Attachment 2: Barthel Index:

The Barthel Index

Patient name Rater name Date

ACTIVITY	SCORE
Feeding 0 = unable 5 = needs cutting, spreading butter, etc, or requires modified diet 10 = independent	________
Bathing 0 = dependent 5 = independent (or in shower)	________
Grooming 0 = needs help with personal care 5 = independent face/hair/teeth/shaving (implements provided)	________
Dressing 0 = dependent 5 = needs help but can do about half unaided 10 = independent (including buttons, zips, laces, etc)	________
Bowels 0 = incontinent (or needs to be given enemas) 5 = occasional accident 10 = continent	________
Bladder 0 = incontinent, or catheterised and unable to manage alone 5 = occasional accident 10 = continent	________
Toilet use 0 = dependent 5 = needs some help, but can do something alone 10 = independent (on and off, dressing, wiping)	________
Transfers (bed to chair and back) 0 = unable, no sitting balance 5 = major help (one or two people, physical), can sit 10 = minor help (verbal or physical) 15 = independent	________
Mobility (on level surfaces) 0 = immobile or <50 yards 5 = wheelchair independent, including corners, >50 yards 10 = walks with help of one person (verbal or physical) >50 yards 15 = independent (but may use any aid, eg. stick) >50 yards	________
Stairs 0 = unable 5 = needs help (verbal, physical, carrying aid) 10 = independent	________
Total (0–100)	

Attachment 3: Male to Female Ratio.

Male	Female	Total
53	117	170
31.2%	68.8%	100.0%

Attachment 4: Vitamin D Levels in Male and Female

	Level of Vitamin D			
Gender	Min	Max	Mean	Total
Male	2	47	13.36	53
Female	2	54	17.92	117

Attachment 5: Types of Fractures.

Pertrochanteric fractures	88
Fractures of femoral neck	81
Subtrochanteric fractures	1
Total	170

Attachment 6: Vitamin D Levels in Different Types of Fractures.

	Level of Vitamin D			
Fracture Type	Min	Max	Mean	Total
Pertrochanteric fractures	2	54	16.92	88
Fractures of femoral neck	2	45	15.91	81
Subtrochanteric fractures	27	27	27	1

Attachment 7: Types of Premedication.

Premedication	n	%
None	131	77.1
Vitamin D	13	7.6
Vitamin D + Calcium	19	11.2
Vitamin D + Specific Osteoporosis Treatment	2	1.2
Vitamin D + Calcium + Specific Osteoporosis Treatment	5	2.9
Total	170	100.0

Attachment 8: Vitamin D Levels in Patients Taking Specific Type of Premedication.

	Level of Vitamin D			
Premedication	Min	Max	Mean	Total
None	2	42	13.50	131
Vitamin D	8	47	26.23	13
Vitamin D + Calcium	7	54	26.68	19
Vitamin D + Specific Osteoporosis Treatment	23	38	30.50	2
Vitamin D + Calcium + Specific Osteoporosis Treatment	10	40	25.40	5

Attachment 9: Vitamin D Levels in Different Groups of Our Mobility Index.				
	Level of Vitamin D			
Mobility index	**Min**	**Max**	**Mean**	**Total**
mobile without aid/assistive devices	3	38	15	9
mobile with rollator or crutches	3	45	18.37	82
mobile with rollator or crutches over short distances	3	40	13.38	29
mobile with rollator or crutches over short distances with one assisting person	5	24	13	6
was mobilised into standing position	2	21	9.29	7
was mobilised only into wheelchair	2	32	15.19	16