Relationship of vitamin D with bone mineral density, fracture type and social deprivation in neck of femur fractures

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1. Introduction

Hip fractures occur in over 70,000 people each year in the United Kingdom (UK), a figure predicted to rise to over 100,000 by 2020.¹ Hip fractures are increasingly becoming an important public health issue, as they incur a large cost. Approximately £2 billion each year is spent on both medical and social care for those with hip fractures.² Some of this cost can be attributed to the fact that hip fractures are often ‘fragility fractures’, occurring in those who need more support in their recovery. The frailty of the patients that get these type of fractures is reflected in a 30-day mortality, of approximately 8%.³ Identifying predictive factors for neck of femur fractures may, therefore, help to reduce their incidence.

Fragility fractures are defined as “fracture caused by forces equivalent to a fall from standing height or less”.⁴ The ageing of the population in the UK is causing an increase in the incidence of these fractures. There are now over 300,000 admissions to hospitals in the UK because of fragility fractures each year, and about a quarter of these are hip fractures.¹ The major risk factor for suffering a fragility fracture is reduced bone mineral density (BMD).⁵ Other risk factors include oral or systemic glucocorticoid use, increasing age, female sex, previous fractures and having a family history of osteoporosis.

Osteoporosis is a disease where low bone mass and a deterioration of the structure of the bone itself leads to an increase in fragility of bone and therefore a further increase in susceptibility to fracture. Diagnosis of osteoporosis is made on the basis of bone mineral density in comparison to the mean BMD of young adults at their peak bone mass.⁶ Low vitamin D levels are increasingly being recognised as a risk factor in developing osteoporosis.⁷ This is because of their link with low BMD

and increased bone turnover.⁸ Because of the links between hip fractures and reduced BMD, UK national guidelines recommend that before discharge from hospital, all patients who have suffered a hip fracture undergo a bone health assessment.⁹ This is meant to ensure that all patients are offered adequate pharmacological treatment before discharge. It has been found that giving vitamin D supplementation to those with osteoporosis can increase their BMD.¹⁰ It is well known that vitamin D levels are associated with sunlight exposure and a varied diet.¹¹ Some authors have suggested that reduced vitamin D levels may be associated with higher levels of deprivation.¹²

Hip fractures are classified into being either extracapsular or intracapsular, depending on whether the fracture occurs within or distal to the hip capsule. Intracapsular and extracapsular hip fractures have also been associated with different levels of bone mineral density.¹³ One study found that trochanteric bone mineral density was lower for patients with extracapsular fractures, compared to those with intracapsular fractures.¹⁴ If vitamin D is directly related to bone mass density, it could be feasible that vitamin D could indirectly affect the type of fracture sustained.

The role of vitamin D in neck of femur fractures was therefore investigated, and how this was related to levels of deprivation, bone mineral density and fracture type, in order to identify potential predictive factors.

2. Methods

All patients who had been admitted with a neck of femur fracture, at a level 1 trauma centre, over the course of one year were retrospectively reviewed. Vitamin D levels from admission blood tests were recorded

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and patients were assigned as being either of adequate, insufficient or deficient vitamin D status.⁷

Patients who underwent dual energy absorptiometry (DEXA) scans were assigned a BMD status of normal, osteopenia, osteoporosis based on their T scores.⁶ The T-score was then equated to a diagnosis of normal, osteopenia, or osteoporosis. Admission hip radiographs were also reviewed and the fracture type was recorded as intracapsular or extracapsular, based on whether the fracture line was located within or outside the parameters of the hip capsule.⁴ Extracapsular fractures were also classified based on the degree of fracture comminution and involvement of lesser and greater trochanters (two, three or four-part fractures). To improve accuracy of measurements, all images were reviewed separately by two authors (KE and TT).

Using the postcodes from the recorded address of patients, their lower layer super output area (LSOA) code was generated.¹⁵ Using the LSOA code, a score for health deprivation and disability and a rank for that score could be identified, using national census data. Higher scores and ranks indicate greater levels of deprivation. The patients who were involved in the study were then split by deprivation score. A positive score was termed 'deprived', a negative score termed 'affluent', and a score of exactly zero 'intermediate'.

Statistical analysis was performed using Pearson's correlation coefficient to assess continuous variables and Chi-Square for categorical variables.¹⁶

3. Results

In total 360 patients were admitted over the study period with a neck of femur fracture. Of these patients, 305 had vitamin D levels recorded during their admission, and of these 298 patients had radiographs available to review. In total 76 patients had DEXA scans performed following their fracture. Of these patients 65 had scans performed of the hip but only 60 of these patients had vitamin D levels recorded.

Of the 305 patients with recorded vitamin D levels, 206 (67.5%) had decreased vitamin D levels with 80 (26.2%) being classed as vitamin D insufficient and 126 (41.3%) being vitamin D deficient. Of these patients 298 had recorded postcodes to determine deprivation levels. There were 112 patients classed as 'affluent', 7 'intermediate', and 179 'deprived'. When the vitamin D levels were compared to levels of deprivation, a significant correlation was found between low vitamin D levels and decreasing levels of social deprivation ($R = 0.1181$, $p = 0.04$).

Of the affluent patients, 27 (24.1%) were reported as never going outside, or being bed- or wheelchair-bound. In the 'intermediate' group, only 1 patient was reported as never going outdoors (14.3%). In the 'deprived' group, 46 patients (25.7%), were in this reduced mobility group. There was no significant association found between deprivation and mobility status. The mean age of patients in the study was 83.5 years. Age compared to vitamin D score and age compared to deprivation score were both calculated. There was no significant correlation found between age and vitamin D status or age and deprivation level.

Of the 60 patients who had DEXA and vitamin D levels analysed, 57 patients (95%) had reduced BMD on DEXA scans with 31 patients (51.7%) being classed as osteopenic and 26 (43.3%) being osteoporotic. Statistical analysis, however, showed no significant difference in vitamin D status with patients with low bone mineral density or normal BMD. Similarly, there was no significant correlation score found between DEXA scores and vitamin D levels (Appendix 1).

Type of fracture (extracapsular or intracapsular) and vitamin D status were also compared. In total there were 120 patients with extracapsular fractures and 177 patients with intracapsular fractures. There was no significant association found between fracture type and vitamin D status (Appendix 2). Of the extracapsular fractures 41 patients had two-part fractures (34.2%), 57 had three-part fractures (47.5%) and 22 had four-part fractures (18.5%). Fracture comminution

and vitamin D level also demonstrated no significant relationship.

4. Discussion

Hip fractures are an increasing burden in modern health care.² As fragility fractures cause a large proportion of hip fractures, identifying potentially modifiable factors is important to try and reduce this burden.^{1,4}

In this study, deprivation and vitamin D status was found to have a significant relationship, with patients from a more affluent area more likely to be vitamin D deficient. This was surprising, as studies by Knox et al., Hayden, Sandle and Berry; and Grimes all showed the opposite, with more deprived patients having lower vitamin D levels.^{17–19} The populations that these authors investigated, however, were younger and without hip fractures, which may account for the differences in our results. Kuchuk et al. also found a link between being more deprived and lower vitamin D levels, as well as a positive correlation between BMD and vitamin D status, which we could not conclusively demonstrate.¹²

Possible confounding factors, which we accounted for in our study included patient age, as this is recognised as a risk factor for fragility fracture. There was, however, no significant relationship between age and vitamin D status or age and deprivation score. Age may have contributed to fragility fractures through patients being unsteady and confused but did not appear to have a direct effect on vitamin D levels.

Another possible confounding factor is mobility levels. It is known that exercise strengthens bones, and that being bed-bound or wheelchair bound causes bone to weaken and become more likely to fracture.⁷ Having mobility limitation can also limit the ability to go outside in the sunshine, so reducing vitamin D synthesis, and thus a suggestion as to why the original results were unexpected was that those who are more affluent are more likely to be housebound. Our results did not however, show any association between deprivation and mobility levels.

In this study we were unable to identify a significant correlation between BMD and vitamin D levels. Napoli et al. and Heckman et al. have however demonstrated a link between these two factors.^{8,10} This discrepancy may have resulted due to the small sample size in our study, due to the lack of patients who received a DEXA scan. Some authors have also demonstrated a difference in the mechanism of injury and hip fracture type.¹⁴ In our study, however, we found no relationship between fracture type and vitamin D levels, suggesting that vitamin D deficiency does not directly influence the comminution of fractures.

There are also other potential confounding factors that could have contributed to the results of this study. Ethnicity and smoking status are known to have effects on vitamin D levels and BMD but were not accounted for in our data.^{11,20} Future research should aim to address these other confounding factors, as well as dietary and sunlight exposure, to enable the direct effects of vitamin D on fragility fractures to be further investigated.

5. Conclusion

This study demonstrated a significant correlation between decreased vitamin D levels and decreased levels of social deprivation. No relationship was, however, identified between fracture pattern or bone mineral density and vitamin D levels.

The effect of vitamin D on fragility fractures is complex, with multiple confounding factors, potentially resulting in bias of results. Further research is required to examine this relationship, in order to establish which cohort of patients may benefit most from prophylactic vitamin D treatment.

Conflicts of interest

Emma Formoy, Ekemini Ekpo, Timothy Thomas, Cezary Kocialkowski and Anand Pillai confirm that they have no conflict of interest.

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Appendix 1. Categorisation of study patients by bone mineral density and vitamin D levels

	Normal	Osteopenia	Osteoporosis	Total
Sufficient		14	6	20
Inadequate	1	4	9	14
Deficient	2	13	11	26
Total	3	31	26	60

Appendix 2. Categorisation of study patients by hip fracture type and vitamin D levels

	Extracapsular	Intracapsular	Total
Sufficient	38	47	85
Inadequate	24	39	63
Deficient	58	91	149
Total	120	177	297

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