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Investigation of renal osteodystrophy among hemodialysis patients referring to Towhid Hospital, Sanandaj, Iran

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Original Article

Abstract

BACKGROUND: Renal osteodystrophy is a major complication among dialysis patients that can lead to muscle weakness, and bone pain and fractures by minor trauma. In the present study, the frequency of these symptoms and status of blood markers among dialysis patients are discussed.

METHODS: In a crass-sectional study, blood sample was obtained from 82 hemodialysis patients for calcium (Ca), phosphorus (P), alkaline phosphatase (ALP), and parathyroid hormone (PTH) level measurement. Radiography of the right hand was performed for 57 patients. Data analysis was performed via SPSS by using chi-square test, Fisher's exact test, and Pearson correlation coefficient.

RESULTS: The prevalence of osteodystrophy among dialysis patients was 72% (59 patients), including 29 patients with high bone turnover and 30 patients with adynamic bone disease. Moreover, 24 patients (29.3%) were hypocalcaemic and 25 patients (30.5%) were hypercalcemic. In addition, 25 (30.5%) patients had hyperphosphatemia. In the present study, 82 patients, 40 male (48.8%) and 42 female (51.2%), were recruited. Patients' mean age ± standard deviation was 55.77 ± 14.99. There was a relation between increase in age and adynamic bone disease (P = 0.004). Calcium level had a significant association with radiologic manifestation of renal osteodystrophy (P = 0.007). PTH levels had moderate correlation with ALP level (r = 0.55).

CONCLUSION: In the present study, there was a relation between age and adynamic bone disease; meaning that by increasing of age, the prevalence of adynamic bone disease also increased. There was a strong positive correlation between PTH and ALP.

KEYWORDS: Renal Osteodystrophy, Hemodialysis, High Bone Turnover, Adynamic Bone Disease

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Introduction

Renal osteodystrophy is a chronic kidney disease-mineral and bone disorder (CKD-MBD) which occurs due to renal failure. This disorder is a direct result of electrolyte abnormalities and endocrine disorders that accompany elevated serum phosphate levels, low or normal serum calcium, and parathyroid function stimulation.[1] The disruption is divided into two groups based on metabolic bone status; high exchange bone disease [high parathyroid hormone (PTH)] and low exchange bone disease (low PTH), or

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adynamic bone disease.[2] A sample of high exchange bone disease is osteitis fibrosa which is developed due to high levels of PTH and manifests as pain and fragile bones. Other examples of disease with low bone turnover are adynamic bone disease (ABD) and osteomalacia. The cause of adynamic bone disease is not fully known; however, it is known that, diabetes, medications, and dialysis solutions with high concentrations play a role in its creation. In adynamic disease, the number of osteoblasts and osteoclasts are also reduced. The risk of bone fractures in adynamic patients is high.[3]

Osteodystrophy is most common in dialysis patients. These patients suffer from bone pains, increased incidence of bone fracture and deformity, myopathy, muscular pain, and tendon rupture.[4] This disease is associated with disability and reduced quality of life.[5,6] In developing countries, the prevalence of this disease varies from 33.3% in Egypt to 81% in Brazil.[7]

Most researchers use PTH, total alkalin phosphatase (ALP), calcium, and phosphorus as replacement for bone biopsy which is a gold standard diagnosis.[8] PTH measurement is a suitable screening instrument for differential diagnosis of high bone exchange (osteitis fibrosa) and adynamic bone disease.[5] Measuring PTH and ALP increases the accuracy of disease diagnosis.[9] Renal osteodystrophy manifestations in plain radiography include subchondral resorption of bone, soft tissue calcification osteopeny, amyloid repletion, and fracture.[10]

The present study is designed and conducted for investigating renal osteodystrophy in hemodialysis patients.

Materials and Methods

In a crass-sectional study, blood sample was obtained from 82 hemodialysis patients for Ca, P, ALP, and PTH levels measurement. The patient's blood samples were sent to the laboratory of Tovhid Hospital. In this study, PTH levels above 300 pg/ml show high exchange bone disease and PTH levels below pg/ml represent adynamic bone disease. The normal amount of calcium was considered to be 8.4-9.5 mg/dl, of phosphorus 3.5-5.5 mg/dl, and of PTH was 100-300 pg/ml.

Radiography of the right hand, including wrist, hand, was performed for 57 patients and results were interpreted by one radiologist. Radiological manifestation is positive in case of presence of at least 1 of these findings: disseminated demineralization of bones; osteolytic lesions; osteosclerosis; bone resorption; soft tissue calcification; osteopenia; amyloid deposition; and fracture predisposition.

A checklist including demographic data, duration of disease, frequency of dialysis per week, and radiography reports was completed. Data analysis was performed via SPSS for Windows (version 16; SPSS Inc., Chicago, IL, USA) by using chi-square test, Fisher's exact test, and Pearson correlation coefficient.

Results

The prevalence of osteodystrophy among dialysis patients was 72% (59 patients), including 29 patients with high exchange bone disease, and 30 patients with adynamic bone disease. In addition, 23 patients (28%) had normal PTH.

In the present study, 82 patients, 40 male (48.8%) and 42 female (51.2%), were recruited. Patients' mean age ± standard deviation was 55.77 ± 14.99 (range: 16-91 years). The largest and smallest age groups were 61-70 years (26.8%) and below 40 years (14.6%), respectively. During the study, 25 patients died. The frequency of dialysis for most of the patients (50 patients; 61%) was three times per week, 9.8% of patients had dialysis once a week. Moreover, 29 patients (35.4%) had PTH levels above 300 pg/ml that indicate high bone exchange disease.

Normal PTH range was observed in 23 patients (28%). In addition, 30 patients (36.6%) had a PTH level of below 100 pg/ml that indicates adynamic bone disease. There was a relation between increase in age and adynamic bone disease (P = 0.004) (Table 1).

In terms of Ca levels, 24 patients (29.3%) were hypocalcaemic, 33 patients (40.2%) were normal, and 25 patients (30.5%) were hypercalcemic. In

terms of P levels, 25 patients (30.5%) had hyperphosphatemia, 57 patients (69.5%) were normal, and none of the patients had low phosphorus.

Radiography of the wrist was performed for 57 patients. The mean levels of calcium, alkaline phosphatase, and parathyroid hormone were not significantly different between the two groups of positive and negative radiological manifestations. However, the mean level of phosphorus was significantly different between the two groups ($P < 0.05$) (Table 2). However, Ca and P had no association with positive radiologic manifestation based on Fisher's exact test ($P > 0.05$) (Table 3). PTH levels had moderate correlation with ALP level ($r = 0.55$).

Discussion

The prevalence of renal osteodystrophy based on PTH level was 72%, which consisted of 35.4% high bone exchange disease and 36.6% adynamic bone disease. In a study, the prevalence of renal osteodystrophy, high bone exchange disease,

Table 1. Association between bone diseases and variables among hemodialysis patients

Variables \ Bone disease	High exchange No (%)	Normal No (%)	Adynamic No (%)	P
Sex				
Man	15 (37.5)	14 (35.0)	11 (27.5)	0.201
Woman	14 (33.3)	9 (21.4)	19 (45.2)	
Age				
< 40 y	9 (75.0)	2 (16.7)	1 (8.3)	0.004
41-60	15 (41.7)	9 (25.0)	12 (33.3)	
> 60 y	5 (14.7)	12 (35.3)	17 (50.0)	
Dialysis frequency				
Once per week	1 (12.5)	1 (12.5)	6 (75.0)	0.483
Twice per week	6 (25.0)	9 937.5)	9 (37.5)	
Three times per week	22 (44.0)	13 (26.0)	15 (30.0)	
Radiologic manifestation				
Positive	6 (31.6)	6 (31.6)	7 (36.8)	0.902
Negative	14 (31.8)	12 (31.6)	12 (31.6)	

Table 2. Association between Ca and P, and radiological manifestation among hemodialysis patients

Variables \ Radiologic manifestations	Normal No (%)	Abnormal No (%)	P
Calcium			
Positive	8 (42.1)	11 (57.9)	0.70
Negative	14 (36.8)	24 (63.2)	
Phosphorus			
Positive	8 (42.1)	11 (57.9)	0.22
Negative	10 (26.3)	28 (73.7)	

Table 3. Mean of blood indicators among hemodialysis patients based on radiologic manifestations

Indicators	Radiologic manifestations	No	Mean	t	P
PTH	Positive	19	320.95	0.672	0.18
	Negative	38	389.24		
ALP	Positive	19	345.74	0.101	0.72
	Negative	38	339.42		
Ca	Positive	19	8.88	0.090	0.90
	Negative	38	8.90		
P	Positive	19	5.55	1.635	0.02
	Negative	38	5.13		

PTH: Parathyroid hormone; ALP: Alkalin phosphatase

and adynamic bone disease were 55.3%, 28.1%, and 27.1%, respectively; these results are in accordance with the present study.[11] In another study, total prevalence, and the prevalence of high bone exchange disease and adynamic bone disease were 87%, 45%, and 42%, respectively; this is higher than our study findings considering the proportion of the two diseases.[12]

In the present study, we did not find any relation between sex and renal osteodystrophy. However, in the study by Gupta, female gender had association with renal osteodystrophy.[13] This difference in findings might be because of the small sample size of our study. Regarding age, adynamic bone disease increased along with increase in patients' age (P = 0.004). This finding was in agreement with the study by Hernandez et al.[14]

Considering calcium level, 29.4% of patients were hypocalcemic and 30.4% were hypercalcemic, which is in accordance with the study by Lye and Lee in which the prevalence of renal osteodystrophy was 24.4%.[15] In the present study, 30.5% of patients were hyperphosphatemic, but there were no hypophosphatemic patients, which is reasonable considering the nature of chronic renal failure. However, in the study of Lye and Lee, the prevalence of renal osteodystrophy was higher (75.4%). This can explain the relative efficiency of chelation therapy in our patients and effect of phosphorus chelator treatment in our patients. In an Indonesian study, 61% of the patients were hypocalcemic and 10% were hypercalcemic.[16] In another study, hypocalcaemia was associated with dialysis frequency and efficiency of dialysis.[17] In the present study, phosphorus level had no association with PTH level; this is in agreement with the results of the study conducted in Gorgan.[18]

Among the 57 candidates on whom hand radiography was performed, 23.2% had radiologic manifestations. This rate was 26% in the study by Gupta[13], 94% in the study by Lacativa et al.[19], and 3.35% in the study by Odenigbo et al.[20] This difference might be because of ethnic variations and imaging techniques.

A limitation of our study that reduced the prevalence of renal osteodystrophy was lack of access to digital radiography with higher quality and clearer radiographs. Radiologic findings in our study are consistent with the study by Odenigbo et al.[20], but are not in accordance with the study by Lacativa et al.[19] There was no significant relation between dialysis frequency and renal osteodystrophy which is not in agreement with the study by Lugon et al., this may be related to sample size.[17] In our study, the mean blood level of ALP, PTH, and Ca were 320 Iu/I, 372 pg/ml, and 8.95 mg/dl, respectively; this is in accordance with the studies by Nouri Majelan and Sanadgol, and Buargub et al.[1,11]

There was a strong positive correlation between ALP and PTH that is similar to the results of studies by Nouri Majelan and Sanadgol, and Couttenye et al.[1,21] This is a valuable finding in that it makes it possible to use ALP instead of PTH in medical centers which do not have access to PTH measurement for renal osteodystrophy patients.

In our study, PTH level for high bone exchange disease was higher than 300 pg/ml. Based on this range, the prevalence of renal osteodystrophy was 35.4%. In the study by Atsumi et al., the prevalence of renal osteodystrophy was also 35%.[22]

We had one limitation in this study; we were not able to perform drug assessment accurately because of irregular drug taking by patients.

In the present study, there was a high prevalence of renal osteodystrophy (approximately two-thirds of patients). With increase in age, the prevalence of adynamic type of osteodystrophy (PTH levels below 100 pg/ml) increased and high exchange bone disease decreased. This finding shows that more attention should be paid to adynamic osteodystrophy in the elderly and high exchange bone disease and its treatment in younger patients.

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Conflict of Interests

Authors have no conflict of interests.

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