SINGLE PHOTON BONE DENSITOMETRY IN HEMODIALYSIS PATIENTS

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Renal osteodystrophy is a common finding in patients with renal insufficiency. The maximum of its intensity is found in hemodialysis patients. Bone densitometry is so far the best method for non-invasive assessment of the extent of the illness. Some densitometric studies in hemodialysis patients have already been published but their results differ in prevalence and intensity of renal osteodystrophy. They also demonstrated a slight relationship between intensity of renal osteodystrophy and duration of the dialysis treatment. Opinions vary on the relationship between bone mineral density and markers of bone turnover. This cross-sectional study found high prevalence of renal osteodystrophy (Z-score below –1 in 57% of patients) as well as high a number of severely damaged patients (T-score below –2.5 in 40% of patients). It also showed some correlation between bone demineralisation and the duration of dialysis. None from evaluated markers of bone turnover correlated with bone mineral density.

INTRODUCTION

Kidney function impairment leads to disturbance in metabolism of many substances. The after-effects are found in all tissues and organs of the body. One of the most affected tissues is bone. There are several pathophysiologic mechanisms, which lead to different types of renal osteodystrophy.[1,2] The common characteristic for all of them is worsening of the quality of bone followed by loss of bone tissue with a decrease of its biomechanical stability. Definitive diagnosis of renal osteodystrophy is made by a bone biopsy sample examination. Because of its invasiveness this method is not suitable for routine clinical practice and is often replaced by non-invasive procedures. They assess biomechanical stability according to bone mineral density, and bone turnover according to markers of osteoblast and osteoclast activity.[3,4] Renal osteodystrophy reaches its maximum in patients dependent on kidney function replacement. All of its forms cause predominant damage of cortical bone.[5,6,7,8] Bone mineral density was shown to be the most accurate predictor of the risk of bone fracture.[8] So far, quite a few densitometric studies have been done. They found high prevalence of bone demineralisation, which slightly varies among dialysis centres and has some relationship to dialysis duration.[6,8,9,10,] The physiological bone turnover is necessary for a steady, good biomechanical stability of bone – high as well as a low one leads to a decrease of the bone mineral density. The most reliable markers of bone turnover are intact parathormone, bone alkaline phosphatase, and in patients without liver disease also total alkaline phosphatase.[11,12] There are various patterns of the types of bone turnover in different centres. The relationship between markers of bone turnover and bone mineral density is discrepant.[6,10,13,14]

To assess the renal osteodystrophy in patients at our dialysis centre we carried out a cross-sectional study in which we measured the bone mineral density of the distal third of the non-dominant forearm and the most reliable markers of bone turnover. We then evaluated the relationship between bone mineral density and either bone turnover and dialysis duration by statistical analysis.

PATIENTS AND METHODS

Thirty five patients in hemodialysis participated in the study of which there were 13 females and 22 males. The median age was 55 years, and length of dialysis treatment was in the range of 2–142 months with a median of 23 months. The original illness leading to renal failure was chronic interstitial nephritis and pyelonephritis in 20 patients, polycystic kidney disease in 4 patients, chronic glomerulonephritis in 7 patients, diabetic nephropathy in 3 patients and systemic lupus erythematosus in 1 patient. All of them were administered Rocaltrol 0,25 μg qd. The serum level of intact parathormone (PTH) was measured by RIA method, kit Byk-Sangtec ®, normal range 10–65 pg/ml. Total akaline phosphatase (ALP) was measured by automatic analyser Encore. Bone alkaline phosphatase was anylsed by method of Forsman and O'Brien.[21] Normal range of serum activity was up to 2,3 μkat/l for ALP and up to 1,2 μkat/l for BALP. Bone mineral density of the non-

dominant forearm was evaluated by osteodensitometer Osteometr – 100A/S DTX 100. The computer program Statgraphics was used for statistic calculation.

RESULTS

Obtained Z-scores of bone mineral density were sorted into groups according to their values. Tab. 1.

Table 1. Z-score in the group of 35 hemodialysis patients.

Z- score	No	%
Z ≥ 0	12	34
0 < Z ≥ -1	3	9
-1 < Z ≥ -2	7	20
-2 < Z ≥ -3	7	20
-3 < Z ≥ -4	6	17
n	35	100

T-score of the bone mineral density was used for evaluation of the whole risk of fracture. See tab. 2.

Table 2. T-score of bone mineral density in group of 35 hemodialysis patients.

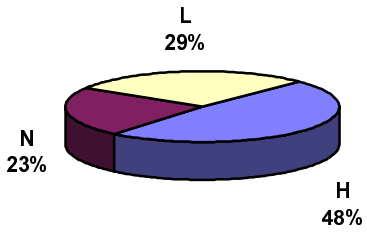
T-score	No	%
T ≥ -1	9	26
-1 > T ≥ -2.5	12	34
T < -2.5	14	40
n	35	100

The bone turnover was assessed according to the serum level of intact parathormone (PTH), total alkaline phosphatase (ALP) and bone alkaline phosphatase (BALP). Average values of these markers of bone turnover are in tab. 3.

Table 3. The average values of serum levels of bone turnover markers in the group of 35 hemodialysis patients.

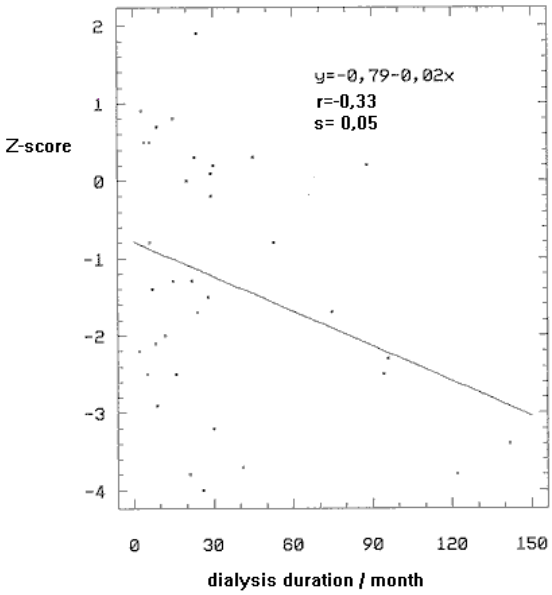
PTH	225.8 ± 198.0 pg/ml
ALP	3.3 ± 1.2 μkat/l
BALP	1.0 ± 0.8 μkat/l

The serum level of intact parathormone was then used for the assessment of bone turnover. According to Sherrard et al. the serum level of intact PTH in hemodialysis patients within a range 100–200 pg/ml is required for the normal bone turnover.[15] In this study the value above 200 pg/ml was considered as a high bone turnover renal osteodystrophy, with the value below 50 pg/ml as a low turnover. Values in-between this range were considered as noncharacteristic. The amount of patients in each group is depicted in graph 1.



Graph 1. The amount of patients with high (H), low (L) and noncharacteristic bone turnover (N) in the group of 35 hemodialysis patients.

For evaluation of any relationship between bone mineral density and the duration of dialysis we correlated Z-score with months of dialysis, see graph 2.



Graph 2. Correlation between Z-score and the duration of dialysis in the group of 35 hemodialysis patients.

Then we correlated markers of bone turnover to Z-score and dialysis duration to see if a relationship existed among them. Tab. 3.

Table 3. Correlation coefficients of the Z-score, the markers of bone turnover and dialysis duration in the form of r/p, where r is Pearson's correlation coefficient and p is level of statistical significance.

parameter	PTH	ALP	BALP	dialysis duration
Z-score	-0.15/0.39	-0.12/0.48	-0.30/0.08	-0.33/0.05
PTH		0.08/0.65	0.43/0.01	0.25/0.15
ALP			0.73/0.00	0.10/0.56
BALP				0.36/0.03

DISCUSSION

The severity of renal osteodystrophy is assessed non-invasively according to two parameters. One of them is the bone mineral density. Because all forms of renal osteodystrophy affect mainly cortical bone we chose the distal third of the non-dominant forearm for examination. Similarly as Huraib, deVita and Asaka, we found a high prevalence of serious bone demineralisation: Z-score was below –1 in 57% of patients and T-score, which is the most accurate predictor of the risk of bone fracture, was below the critical point of the bone fracture –2.5 in 40% of patients.

When we evaluated the bone turnover we could see that the most common was high one (48%), followed by the low one (29%). A similar pattern of bone turnover was also reported by other authors (deVita, Hutchison), but it is changing over the years. The high bone turnover is going down and on the other hand the low one is rising.

To assess the relationship between Z-score of bone mineral density and markers of bone turnover we calculated Parson's correlation coefficient. Similarly as Hutchison and on contrary to Ha, we could not demonstrate any significant correlation.

The renal osteodystrophy is considered to get worse during hemodialysis treatment. As Chan, Gabay and others reported, there is some correlation between hemodialysis duration and bone mineral density. We also found their dependence, but very weak, correlation coefficient r was only –0.33. The explanation of this finding could be in the different individual bone mass before beginning of dialysis treatment as well as in the different types of renal osteodystrophy with various bone turnover, which can lead to bone demineralisation with different rapidity. Bone mineral density is optimal only under physiological bone turnover. A high or low turnover lead to bone density impairment.

Having correlated markers of bone turnover among themselves, we found statistically significant correlation between PTH and BALP. The correlation coefficient was 0.43, with even better correlation between BALP and ALP. This fact implies increased osteoblast activity under the influence of PTH. Tight correlation between total alkaline phosphatase and it's bone fraction enables us to use just the total one as a marker of bone turnover in patients without gut and liver impairment.

CONCLUSION

This cross-sectional study showed that a marked decrease of bone mineral density affects a high number of dialysis patients. The majority of patients suffer from high turnover renal osteodystrophy. Because of the different types of renal osteodystrophy only a weak correlation was found between bone demineralisation and duration of dialysis treatment. Single photon bone densitometry of the non-dominant forearm seems to be simple and in comparison to others, also a cost effective investigatory method. Its use for evaluation of bone demineralisation is based on the fact that all forms of renal osteodystrophy affect predominantly cortical bone.

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