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AN OBSERVATIONAL STUDY OF CHANGES IN BONE HOMEOSTASIS IN PATIENTS UNDERGOING LONG-TERM DIALYSIS IN A TERTIARY CARE HOSPITAL IN KOLKATA

Orthopedics

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ABSTRACT

Background: Chronic kidney disease–mineral bone disorder (CKD-MBD) significantly alters bone homeostasis in patients on long-term dialysis. This study aimed to evaluate changes in bone mineral density (BMD) and biochemical bone markers over time.**Methods:** A longitudinal observational study was conducted on 100 adult patients undergoing maintenance hemodialysis for more than three months. Baseline and 6-month assessments included serum calcium, phosphate, alkaline phosphatase (ALP), intact parathyroid hormone (iPTH), vitamin D, albumin, and femoral neck BMD using DEXA.**Results:** Seventeen percent had osteoporosis (Z score ≤ -2.5), and 49% had osteopenia. Age and female sex were significantly associated with low BMD (p<0.001). iPTH, ALP, and vitamin D levels showed significant correlation with Z scores.**Conclusion**: Long-term dialysis patients demonstrate significant alterations in bone homeostasis, particularly involving PTH and vitamin D, necessitating regular monitoring.

KEYWORDS

INTRODUCTION

Chronic kidney disease (CKD) affects nearly 10% of the global population and is frequently complicated by CKD–mineral bone disorder (CKD-MBD). Impaired renal function disrupts calcium–phosphate balance, reduces vitamin D activation, and stimulates secondary hyperparathyroidism. These disturbances result in renal osteodystrophy, characterized by altered bone turnover, reduced bone mineral density (BMD), and increased fracture risk.Patients undergoing long-term hemodialysis represent a particularly vulnerable group. Persistent hyperphosphatemia, hypocalcemia, elevated iPTH levels, inflammation, and nutritional deficiencies collectively impair bone homeostasis. Although dialysis sustains life in end-stage renal disease (ESRD), it cannot fully correct metabolic derangements affecting bone integrity.

Despite therapeutic advances, CKD-MBD remains inadequately studied in long-term dialysis populations in Eastern India. This study evaluates dynamic changes in bone biomarkers and BMD in such patients.

Method Study Design

Longitudinal observational study conducted over 12 months. Study Population 100 adult CKD patients (18–80 years) on maintenance hemodialysis for >3 months. Inclusion Criteria Adult CKD patients on long-term hemodialysis Exclusion Criteria Dialysis <3 months Renal transplant recipients Age <18 or >80 years Patients who expired or discontinued within 1 year Data Collection Baseline and 6-month assessments included: Serum calcium Serum phosphate ALP iPTH

Vitamin D Albumin Creatinine
BMD (DEXA scan at femoral neck) Statistical Analysis
Data analyzed using SPSS v25.
Chi-square/Fisher's exact test for categorical variables
Mann–Whitney U/Kruskal–Wallis test for continuous variables
Spearman correlation for associations
$p < 0.05$ considered significant

Results Demographics

72% patients were >50 years
59% males, 41% females Bone Mineral Density Osteoporosis (Z ≤ -2.5): 17%
Osteopenia (-2.5 to -1): 49%
Normal (> -1): 34%Age (p=0.001) and female sex (p<0.001) were significantly associated with lower BMD.
Biochemical Markers iPTH:
Significantly higher in osteoporotic patients (p<0.001).

Mean increase over 6 months noted but change not statistically significant between groups. Vitamin D:

Significantly lower in severe osteoporosis (p<0.001). Baseline and 6-month differences significant across groups. ALP:

Higher baseline ALP in severe osteoporosis (p=0.011). Calcium & Phosphate:

No significant intergroup differences. Albumin:
Higher levels observed in patients receiving nutritional supplementation (p<0.001). Comorbidities

Hypertension (44%) was most common. Multiple comorbidities were more frequent in lower BMD groups.

DISCUSSION

This study demonstrates a high prevalence of osteopenia and osteoporosis among long-term dialysis patients. Age showed a significant inverse correlation with Z score, confirming aging as a major determinant of bone loss.

Elevated iPTH levels were strongly associated with lower BMD, indicating high-turnover bone disease as a key mechanism. Increased ALP further supported enhanced bone turnover in osteoporotic patients.

Vitamin D deficiency was significantly linked to poor bone density, highlighting its central role in mineral homeostasis. Interestingly, short-term fluctuations in calcium and phosphate did not significantly correlate with BMD, suggesting chronic hormonal dysregulation plays a greater role than transient biochemical changes.

Nutritional supplementation improved albumin and vitamin D levels, reinforcing the importance of nutritional optimization in CKD-MBD management.

Overall, bone homeostasis disruption in dialysis patients appears multifactorial, involving hormonal imbalance, nutritional deficiency, and metabolic dysregulation.

CONCLUSION

Long-term hemodialysis patients exhibit significant alterations in bone homeostasis, with high prevalence of osteopenia and osteoporosis.

Age, female sex, elevated iPTH, high ALP, and low vitamin D levels are strongly associated with reduced bone mineral density.

Routine monitoring of bone biomarkers and early nutritional intervention are essential to prevent fractures and improve quality of life in CKD-MBD patients.

Further long-term multicentric studies are recommended to refine management protocols.

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