ASSOCIATION OF URINARY CALCIUM AND PHOSPHATE WITH BONE
MINERAL DENSITY AMONG POSTMENOPAUSAL WOMEN

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ABSTRACT

Introduction: Development of peak bone mass and premenopausal bone loss is determined by the
menstrual status of a women. Objective of this study was to determine the association of urinary
calcium and phosphate with bone loss in post-menopausal women. This study is cross sectional. It
was carried out in the Department of Biochemistry, Basic Medical Sciences Institute, Jinnah Post-
graduate Medical Centre, Karachi.

Method: Females (n = 90) were assessed with measurements of Body Mass Index, 24 hour urinary
excretion of calcium creatinine ratio, Phosphate creatinine ratio. Bone mineral density of women
was evaluated by Dual Energy X-ray Absorptiometery (DEXA) and its association was analyzed
with urinary calcium creatinine ratio and urinary phosphate creatinine ratio.

Results: Twenty two (44%) postmenopausal women were found to be osteoporotic while 24 (48%)
were osteopenic on the basis of BMD measurements. The mean urinary calcium creatinine ratio
and phosphate creatinine ratio was increased in postmenopausal women compared to pre-meno-
pausal women (p < 0.001). A significant negative correlation was found between BMD (hip) and
urinary calcium and phosphate (r = – 0.65, p < 0.05) (r = - 0.58, p < 0.01) respectively in post-me-
nopausal osteoporotic women.

Conclusion: Urinary calcium and phosphate creatinine ratio appears to be a valuable markers for
assessing bone loss in postmenopausal women.

Key Words: Postmenopausal women, Osteoporosis, Urinary Calcium Phosphate Creatinine ratio,
Bone Mineral Density, Body Mass Index.

INTRODUCTION

Development of peak bone mass and premenopau-
sal bone loss is determined by the menstrual status
of a women.1 Decline in bone mass with age beco-
mes accelerated during menopause. Menopausal
bone loss refers to the accelerated bone loss that
occurs during the perimenopausal age and after the
final menses.2 Bone as a dynamic tissue constantly
undergoes formation and resorption and the pro-
cess is balanced in healthy adults, however the ex-
ceptions are growing children and menopause.3

Bone is a connective tissue that provides mech-
anical support to the body vital organs and act as re-
servoir of calcium and phosphate as 99% of calcium
and 85% of phosphate are present in skeleton.4 Peak
bone mass is achieved during the third decade of life
which gradually declines leading to osteopenia (low
bone mass) which predisposes to osteoporosis.5 Va-
rious risk factors are involved for the decline in Bo-
ne Mineral Density (BMD) including dietary defici-
cy of calcium, phosphorus and vitamin D.6 Stu-
dies have shown the association of increased bone
mineral density with higher calcium intake compa-
red to those with low bone mass density due to lo-
wer calcium intake.7 Similarly dietary intake of ade-
quate phosphorus is required for bone growth and its
deficiency results in decreased bone formation
and mineralization.8 Decline in bone mineral densi-
ty is manifested by structural deterioration and low
bone mass which ultimately leads to bone fragility
and fractures, specially in elderly postmenopausal
women where spine and hip fracture results in high
morbidity and mortality.9,10

Bone formation and resorption is analyzed by
measuring the concentration of bone turnover mar-
kers in blood or urine (or both). However bone reso-
ption markers are considered as strong predictors
of bone loss as compared to bone formation mar-
kers.11,12 Bone mass can be determined by bone min-
eral density measurements for assessing fracture
risk and diagnosing osteoporosis.13 Many technolo-
gies are available for measuring bone mineral den-
sity but Dual Energy X-ray Absorptiometry (DEXA)
has been reported by many investigators as gold
standard for measurement of bone mass density.14

The aim of this study was to investigate the sig-
nificance of urinary calcium and phosphate excretion in assessing bone loss in postmenopausal women and to find out their association with bone mineral density.

PATIENTS AND METHODS
This cross sectional study was conducted in the Department of Biochemistry, Basic Medical Sciences Institute (BMSI), Jinnah Postgraduate Medical Centre Karachi, from Jan 2007 – July 2007 in collaboration with Karachi Institute of Radiotherapy and Nuclear Medicine (KIRAN). A group of 90 healthy females (40 premenopausal and 50 postmenopausal) were selected from general population belonging to different socioeconomic status and ethnicity. Age group of premenopausal women was between 20 – 35 years whereas postmenopausal women were in 46 – 75 years of age. All women had normal liver and renal function and were not taking any drug like bisphosphonates, calcium vit D supplements, Calcitonin, hormone replacement known to affect bone metabolism.

Twenty four hour urinary calcium was estimated by the spectrophotometric method using Kit Catalogue no. CA590 by Randox. Urinary phosphate was estimated by spectrophotometric method using Kit Catalogue no. 11508 by Biosystem SA. For 24 hour urinary calcium and phosphate analysis, urine samples were collected in clean plastic containers. The pH of urine was adjusted to > 2 by adding 2ml HCl and mixed thoroughly. Total volume measured and aliquotes were stored at -20°C until analysis.

Bone Mineral Density of subjects was analysed by Dual Energy X-ray Absorptiometry (DEXA) at two sites, lumber spines (L₁ – L₄) and hip bone. Hip bone measurements included at total hip, femoral neck, trochanter, intertrochanter and Ward’s triangle.

Statistical Analysis
The data feeding and analysis was done on computer package SPSS version 11. Statistical comparison was performed using student t test. Pearson coefficient of correlation was calculated between BMD (postmenopausal females) and 24 hour urinary calcium and phosphate. In all statistical analysis p value < 0.05 was considered significant.

RESULTS
Table 1 shows the comparison of BMD and urinary calcium and phosphate in pre and postmenopausal women. There is significantly increased excretion of urinary calcium and phosphate in postmenopausal women (p < 0.001) compared to premenopausal women. BMD values were significantly lower in postmenopausal women compared to premenopausal women (p < 0.001).

Mean age of osteopenia cases was (54.38±1.69). The mean age of osteoporosis cases year was (59.18 ± 1.64).

Table 1: Comparison of Age, BMD, urinary Calcium and Phosphate in pre and postmenopausal women.

<table>
<thead>
<tr>
<th></th>
<th>Premenopausal women n = 40 Mean (± SEM)</th>
<th>Postmenopausal women n = 50 Mean (± SEM)</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>28.45 ± 0.806</td>
<td>56.06 ± 1.1.171*</td>
<td>2.027</td>
<td>.050</td>
</tr>
<tr>
<td>Biochemical parameters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urinary Calcium (mg/gm creatinine)</td>
<td>126.12 ± 4.975</td>
<td>216.80 ± 11.24*</td>
<td>7.680</td>
<td>.00</td>
</tr>
<tr>
<td>Urinary Phosphate (mg/gm creatinine)</td>
<td>463.08 ± 11.493</td>
<td>527.20 ± 18.02*</td>
<td>3.452</td>
<td>.001</td>
</tr>
<tr>
<td>Bone mineral density at Hip bone (gm/cm²)</td>
<td>1.088 ± 0.026</td>
<td>0.774 ± 0.017*</td>
<td>-9.44</td>
<td>.00</td>
</tr>
<tr>
<td>Bone mineral density at Lumbar spine (gm/cm²)</td>
<td>0.939 ± 0.016</td>
<td>0.794 ± 0.017*</td>
<td>-6.81</td>
<td>.00</td>
</tr>
</tbody>
</table>
that biochemical parameters can be used to monitor
in relation to creatinine is due to relatively cons-
tional to the muscle mass of an individual and thus

The expression of urinary calcium and phospha-
tes the urinary excretion of calcium and phosphate

** DISCUSSION **

Results of this study show no significant difference
in body mass index in pre and postmenopausal wo-
men except age which was significantly higher am-
ong postmenopausal group. Higher mean values of
urinary calcium: creatinine ratio and phosphate :
creatinine ratio were found in the postmenopausal
group compared to the premenopausal group as

Significant negative correlation is observed be-
 tween BMD at hip bone and urinary calcium, phos-
phate excretion in postmenopausal osteoporotic wo-
men. This correlation is shown in table II. No signi-
ficant correlation was found between BMD at lum-
bar spine and hip bone with urinary calcium and
phosphate excretion in postmenopausal osteopenic
women.

** Table 2: Correlation coefficient of biochemical pa-
 rameters with BMD in postmenopausal osteoporotic women. **

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Biochemical Parameters</th>
<th>r Value at hip bone</th>
<th>r value at lumbar spine</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Urinary Calcium (mg/gm creatinine)</td>
<td>-0.65**</td>
<td>-0.13</td>
</tr>
<tr>
<td>2.</td>
<td>Urinary Phosphate (mg/gm creatinine)</td>
<td>-0.58*</td>
<td>-0.07</td>
</tr>
</tbody>
</table>

*P < 0.05,  ** P < 0.01

Fig 1 shows distribution of postmenopausal wo-
men into normal, osteopenic and osteoporotic acco-
rding to the finding of bone mineral density measu-
red at hip and lumbar spine.

Significant negative correlation is observed be-
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phate excretion in postmenopausal osteoporotic wo-
men. This correlation is shown in table II. No signi-
ficant correlation was found between BMD at lum-
bar spine and hip bone with urinary calcium and
phosphate excretion in postmenopausal osteopenic
women.

In this study bone mineral density observed at
hip and lumbar spine in pre and postmenopausal
women shows a significant reduction among post-
menopausal women compared to premenopausal
women. Similar results are given by a previous stu-
dy. Another study has reported variation in BMD
values in women of different menstrual status and
low BMD values which leads to the diagnosis of os-
teopenia and osteoporosis.

There was a significant negative correlation of
calcium and phosphate with bone mineral density at
hip bone in postmenopausal women as compared to
premenopausal women. Similar results has also be-
en highlighted by Deutschmann et al who has fou-
nd association of hypercalcuria with severe osteo-
porosis. The significant correlation of urinary calci-
um, phosphate suggest that the factors that incre-
ases the urinary excretion of calcium and phosphate
would affect the quality of bones both in males and
females. This significant inverse correlation of uri-
nary calcium and phosphate with BMD at hip bone
as seen in osteoporotic females in our study reveals,
that in senile osteoporosis proportionate loss of bo-
th cortical and trabecular bone and increased risk of
hip and vertebral fractures, compared to the osteo-
porosis occurring within 10 years after menopause
in which there is more trabecular bone loss leading
to vertebral crush fractures. The irreversible natu-
re of osteoporosis demands that it should be pre-
vented by optimizing peak bone mass and minimiz-
ing bone loss specially in elderly individuals.

It is thus, concluded that urinary calcium and
phosphate can be used as valuable markers of bone
loss in postmenopausal women and further studies
are necessary to highlight their role in the diagnosis
and prognosis of postmenopausal osteoporosis. Th-
ese biochemical bone markers are inexpensive and
valuable predictors of bone loss at all ages especially
in the postmenopausal women. Evaluation of bone
loss by these biochemical markers also decreases
the risk of osteoporotic fractures which may be due
to estrogen deficiency or nutritional deficiencies.

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