Calcium Phosphate Product in Hemodialysis Patients in Marjan Teaching Hospital

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Abstract

Background: Chronic renal failure is a growing field in medicine with multisystem complications. Calcium and phosphate are among the major metabolic disturbances that affect all systems and mainly the vascular body components and mainly the coronary circulation.

Objectives: The aim of the study is to identify the weight of control and distribution of the calcium phosphate product among our unit hemodialysis patients.

Patients and method: This is a cross section study enrolling 47 hemodialysis end stage renal disease in Merjan hemodialysis unit. investigations implicated in the study are those who were routinely done for the follow up the units patients.

Biotek kits were used in the biochemistry measures.

Results: There were significant mean differences of Ca2+ Po4+ Product grades by age, serum creatinine and Po4+. Patients with severe Ca2+ Po4+ Product aged 32 years. Meanwhile, patients with severe Ca2+ Po4+ Product had serum creatinine more than 11mg/dl. Furthermore, patients with severe Ca2+ Po4+ Product had Po4+ more than 10 mg/dl.

Conclusions: Calcium x phosphate product is high in many of our patient on hemodialysis and thus many of them are in the elevated rank of increased cardiovascular mortality

Recommendations
1. More diet control
2. More frequent hemodialysis sessions are required and longer duration of hemodialysis
3. parathyroid hormone level must be checked frequently.

Keywords: Calcium Phosphate Product

الخلاصة

يعتبر العجز الكلوي المزمن من الموضوعات المتسلقة في الطب الباطني مع عقابية واسعة وهمها ما يؤثر على جهاز القلب والدوران. ومن بين العوامل المؤثرة منتج الكالسيوم والفسفات والذي يؤثر سلبا على شرايين القلب.

الأهداف:

مقدار السيطرة على منتج الكالسيوم والفسفات في مرضى الدائرة الدموية في مدينة مرجان الطبية.

طريقة الدراسة ونوع المرضى:

تمت الدراسة على 47 مريض عجز كلي مزمن من ضبطين في برنامج الدائرة الدموية المتوفى واستخدمت التحاليل الروتينية للمتابعة وباستخدام تكنولوجيا البلايكوت.

النتائج:

وجدت الدراسة 47 مريض عجز كلي مزمن ضبطين في برنامج الدائرة الدموية المتوفى. ووضعت العلاقة بشكل جدي في مرضى الثلاثينيات من العمر ومن لهم معدل كرياتينين 11 ملغم لكل ديسيلتر من مصل الدم.

الاستنتاجات:

كثير من مرضى الدائرة الدموية في مدينة مرجان الطبية معرضون للاصابة بالصمادات القلبية نتيجة ارتفاع منتج الكالسيوم والفسفات.
Introduction

Hyperphosphatemia is a common problem among patients with end stage renal disease. It is a highly prevalent condition, as almost 37-40% of the United States hemodialysis population has a serum inorganic phosphate greater than 6.5 mg/dl (Block et al., 1998a).

Block et al. from the United States Renal Data System (USRDS) identified in multivariate analysis hyperphosphatemia as an independent predictor of mortality (Block et al. 1998).

Elevated Calcium phosphate product greater than 72 mg²/dl² was also associated with increased mortality risk (Santhi et al. 2001).

Hyperphosphatemia may aggravate coronary atherosclerosis through increased vascular calcification and smooth muscle proliferation (Schwarz, et al. 2000).

Calcium and phosphorus deposition may have direct cardiovascular consequences, independent of PTH levels (Slinin et al. 2005).

Management of hyperphosphatemia and secondary HPT in patients with ESRD is critical, because cardiovascular disease is the leading cause of death in this patient population (Foley et al. 1998).

Annual cardiovascular mortality rates are several-fold higher in patients with ESRD than in the general population, even when adjusted for age, gender, race and the presence of diabetes (Glenn et al. 2004).

Ongoing basic sciences and animal studies have linked abnormal mineral metabolism to vascular calcification. Nonetheless, conflicting results in clinical studies have led to confusion. (Stevens et al. 2004).

Higher serum calcium concentrations were also associated with an increased risk of death, even when examined within narrow ranges of serum phosphorus (Jofre’ et al. 2006).

Vascular calcification

Vascular calcification is more frequent and more severe in HD patients than in the general population. This is because of altered mineral metabolism and a decrease in calcification inhibitors, such as fetuin-A and matrix Gla protein. (Block et al. 2004).

Bone disease

Four reports indicate that alterations in calcium and phosphorus metabolism contribute to vascular calcification, and the risk of death (Wang et al. 2013).

Among hemodialysis patients, bone and mineral metabolism dysregulation is a serious and pervasive problem. Markers of mineral and bone disorders including hyperphosphatemia, secondary hyperparathyroidism and hypercalcemia, have been
associated with increased risk of hospitalization and mortality (Slinin et al., 2005; Foley et al., 1998; Glenn et al., 2004; Stevens et al., 2004; Jofre’ et al., 2006; Block et al., 2004; Wang et al., 2013). The National Kidney Foundation Kidney Disease Outcomes Quality Initiative (KDOQI) specifies that serum phosphorus levels should be maintained between 3.5 and 5.5 mg/dL, primarily through dietary restrictions and phosphate binders (PBs), yet only 41–64% of dialysis patients are able to maintain phosphorus within the target range (Belém et al., 2014; Browne et al., 2014). Similarly, the Kidney Disease: Improving Global Outcomes (KDIGO) clinical practice guidelines for bone and mineral disorders suggest lowering elevated phosphorus levels toward the normal range, although no specific target range is prescribed (Belém et al., 2014).

**Hypercalcemia**

It can lead to pulmonary, cardiac, and vascular calcifications that will disappear by kidney transplant or parathyroidectomy (Browne et al., 2014).

**Aim of the study**

The aim of the study is to identify the weight of control and distribution of the calcium phosphate product among our unit hemodialysis patients.

**Patients and method**

A cross sectional study was done in dialysis unit, Merjan Teaching Hospital from 26/4/2013- 22/4/2014. Patients enrolled are those who were on hemodialysis for at least one year.

**Exclusion criteria:**- Those who are not on regular calcium carbonate as a phosphate binders or are not on regular hemodialysis schedules were excluded from the study.

**Investigations:**- Serum calcium, phosphate, creatinine, urea and glomerular filtration were recruited from the patients record and these were requested routinely every two weeks.

*eGFR was estimated by Cockroft Gault equation.*

**Statistical analysis**

Statistical analysis has been done using SPSS version (20). Continuous variables have been presented by mean and standard deviation. Categorical variables have been presented by frequency. One Way Analysis of Variance (ANOVA) has been used to find mean differences among more than two continuous variables. A p value of ≤ 0.05 will be significant.

**Results**

This study has been carried out on 47 patients with chronic renal failure and on hemodialysis. The overall mean age of the patients was (49.64± 15.51) years old and majority (53.2%) of the patients were aged between 45-65 years (Figure 1) of them 13 are males , 9 are females. Majority (61.7%) of the patients were males (Figure 2).

Seventy percent of our patient were hyperphosphatemic and 50% of them had more than 6.5mg/dl serum phos[phate.
Figure 1: Distribution of patients by age groups

Figure 2: Distribution of patients by sex

Table 1 shows the mean differences of Ca$^{2+}$ Po$^{4+}$ Product grades (Mild, Moderate and Severe) by study variables. There were significant mean differences of Ca$^{2+}$ Po$^{4+}$ Product grades by age, serum creatinine and Po$^{4+}$. Patients with severe Ca$^{2+}$ Po$^{4+}$ Product aged 32 years. Meanwhile, patients with severe Ca$^{2+}$ Po$^{4+}$ Product had serum creatinine more than 11mg/dl. Furthermore, patients with severe Ca$^{2+}$ Po$^{4+}$ Product had Po$^{4+}$ more than 10 mg/dl.
Table 1: Mean differences of Ca\(^{2+}\) Po\(^{4+}\) Product grades (Mild, Moderate and Severe) by study variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ca(^{2+}) Po(^{4+}) Product</th>
<th>N</th>
<th>Mean± SD</th>
<th>F</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>&lt; 45 Mild</td>
<td>19</td>
<td>56.21± 15.87</td>
<td>6.776</td>
<td>0.003*</td>
</tr>
<tr>
<td></td>
<td>45-65 Moderate</td>
<td>22</td>
<td>48.64± 11.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 65 High</td>
<td>6</td>
<td>32.50± 13.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body Wight (kg)</td>
<td>&lt; 45 Mild</td>
<td>19</td>
<td>67.79± 14.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>45-65 Moderate</td>
<td>22</td>
<td>68.70± 16.74</td>
<td>0.494</td>
<td>0.614</td>
</tr>
<tr>
<td></td>
<td>&gt; 65 High</td>
<td>6</td>
<td>61.67± 13.11</td>
<td></td>
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<tr>
<td>Serum Creatinine (mg/dl)</td>
<td>&lt; 45 Mild</td>
<td>19</td>
<td>8.22± 2.56</td>
<td>4.940</td>
<td>0.012*</td>
</tr>
<tr>
<td></td>
<td>45-65 Moderate</td>
<td>22</td>
<td>9.42± 2.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 65 High</td>
<td>6</td>
<td>11.83± 2.05</td>
<td></td>
<td></td>
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<tr>
<td>Blood Urea (mg/dl)</td>
<td>&lt; 45 Mild</td>
<td>19</td>
<td>134.75± 37.86</td>
<td></td>
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<tr>
<td></td>
<td>45-65 Moderate</td>
<td>22</td>
<td>152.34± 25.97</td>
<td>2416</td>
<td>0.101</td>
</tr>
<tr>
<td></td>
<td>&gt; 65 High</td>
<td>6</td>
<td>161.00± 21.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GFR (ml/min/1.73m(^{2}))</td>
<td>&lt; 45 Mild</td>
<td>19</td>
<td>10.01± 4.87</td>
<td>1.110</td>
<td>0.339</td>
</tr>
<tr>
<td></td>
<td>45-65 Moderate</td>
<td>22</td>
<td>8.35± 4.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 65 High</td>
<td>6</td>
<td>7.62± 1.98</td>
<td></td>
<td></td>
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<tr>
<td>Ca(^{2+}) (mg/dl)</td>
<td>&lt; 45 Mild</td>
<td>19</td>
<td>7.47± 1.44</td>
<td>2.348</td>
<td>0.107</td>
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<td></td>
<td>45-65 Moderate</td>
<td>22</td>
<td>8.18± 1.14</td>
<td></td>
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<tr>
<td></td>
<td>&gt; 65 High</td>
<td>6</td>
<td>8.53± 1.09</td>
<td></td>
<td></td>
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<tr>
<td>Po(^{4+}) (mg/dl)</td>
<td>&lt; 45 Mild</td>
<td>19</td>
<td>4.87± 1.21</td>
<td>21.326</td>
<td>&lt;0.001*</td>
</tr>
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<td>45-65 Moderate</td>
<td>22</td>
<td>6.41± 1.16</td>
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<tr>
<td></td>
<td>&gt; 65 High</td>
<td>6</td>
<td>10.20± 3.98</td>
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<td>Ca2+ Dose</td>
<td>&lt; 45 Mild</td>
<td>19</td>
<td>1.74± 0.65</td>
<td>0.930</td>
<td>0.402</td>
</tr>
<tr>
<td></td>
<td>45-65 Moderate</td>
<td>22</td>
<td>2.18± 1.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt; 65 High</td>
<td>6</td>
<td>2.17± 0.41</td>
<td></td>
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</tr>
</tbody>
</table>

*p value ≤ 0.05 is significant
Figure 3: Mean Differences of Ca$^{+2}$ Po$^{+4}$ Product by age

\[ F = 6.776, \ p = 0.003^* \]

Figure 4: Mean Differences of Ca$^{+2}$ Po$^{+4}$ Product by serum creatitine

\[ F = 4.940, \ p = 0.012^* \]
Figure 5: Mean Differences of Ca+2  Po+4 Product by serum phosphate

Discussion

The majority of patients in the hemodialysis program were 45 to 65 years of age and most of them were males and of the whole patients 61.7% were males also. This might be due to the more prevalence of chronic diseases like hypertension or diabetes in males and it has been found that chronic kidney diseases due to glomerular pathology are more to progress rapidly to end stage renal failure in males than females (Cubbon et al., 2015).

From table 1 and figure 3 there was a significantly higher calcium phosphate product in younger people on hemodialysis program. This could be explained by the good absorption maintained by the younger and probably the more intake of meat which has higher phosphate level as in our study and in a study published on 2013 December in United States showed that higher phosphate level is associated with more calcium phosphate product (Rostami et al., 2014).

The product was higher with higher creatinine level which can be attributed to reduced excretory capacity of the kidney and the consequent secondary hyperparathyroidism (Rostami et al. 2014).

There was a significant association between the product and hyperphosphatemia and the higher the phosphate level the higher the product and so the higher the vascular calcification risk because the the phosphate level is the primary stimulus for vascular calcifications (Achinger and Ayus 2006).

Seventy percent of our hemodialysis patients are hyperphosphatemic and about 50% of them are more than 6.5 mg/dl concentration. This figure is much higher than what has been documented in United States (Block et al., 1998a) which was 37-
40% is the range of hyperphosphatemia more than 6.5 mg/dl. This can be attributed to inadequate hemodialysis, inadequate use of phosphate binders due to costs or side effects or non-palatability of the calcium carbonate tablets.

Recent study in the United States showed that hemodialysis will reduce phosphate significantly within the first 120 minutes then there will be a significant rebound of hyperphosphatemia but daily hemodialysis removed significant amount of phosphate (Quinibi et al., 2004) and this can be the new way to remove phosphate level and consequently reducing the product.

Hyperphosphatemia alone is associated with increased cardiovascular mortality and has been found that the calcium - phosphate product has the same trend of association with mortality (Block et al., 1998b).

**Conclusion**

Calcium x phosphate product is high in many of our patients on hemodialysis and thus many of them are in the elevated rank of increased cardiovascular mortality, especially in younger patients and those with higher calcium phosphate product.

**Recommendations**

4. More diet control.
5. More frequent hemodialysis sessions are required and longer duration of hemodialysis.
6. Parathyroid hormone level must be checked frequently.

**References**


