The Relationship between Calcium Content and Aluminum and Silicon Content in Uraemic Rats

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The relationship between calcium (Ca) content and aluminum (Al) and silicon (Si) content in uraemic rats was examined. Significant correlations with serum [Ca] x [Pi] products and serum Al levels and serum Si values were found \( r = 0.73, p < 0.01 \). There were significant \( r = -0.26, p < 0.05 \); \( r = -0.46, p < 0.05 \) relationships between corpuscular [Ca] x [Pi] products and corpuscular Al levels and corpuscular Si values. We found that renal tissue [Ca] x [Pi] products tend to increase with the increase of renal tissue Al content and renal tissue Si content.

Serum and corpuscular Al content and Si content can be used as one of the indicators of renal osteodystrophy.

Introduction

Renal osteodystrophy is one of the complications in uraemic patients. It is well known that calcium (Ca) metabolism, phosphate (Pi) metabolism, parathyroid hormone (PTH) metabolism and activities of vitamin D play important role in bone diseases in uraemia.

Recently, it has been becoming clear that trace element metabolic abnormalities such as high aluminum (Al) accumulation caused bone disease in uraemic patients [1]. Silicon (Si) is an essential trace element for human growth and bone formation in chicken [2] and rats [3].

We [4, 5] and others [6, 7, 8] previously described that Al and Si caused various sorts of complications in uraemic patients.

The purpose of this study is to examine the relationship between Ca content and Al levels and Si concentrations in normal and uraemic rats.

Material and methods

Wistar series of rats (body weight 200–240 g, male rats) were used. The following sham operation was done on normal control rats: (1) after opening the left retroperitoneal cavity, the fascia and skin were sutured with silk. (2) Seven
days after sham operation the same operation was carried out in the left retroperitoneal cavity. The chronic uraemic rats were subjected to 5/6 nephrectomy. Nephrectomy of the right kidney was done 7 days after the 2/3 nephrectomy of the left kidney. Blood collection from the aorta was done three months after sham operation or 5/6 nephrectomy.

All samples were taken in polystyrene tubes protecting them from contamination with silicon and aluminum.

Calcium, phosphate, blood urea nitrogen (BUN) and serum creatinine were measured by standard laboratory methods. Aluminum (Al) and silicon (Si) were measured with flameless atomic absorption spectrophotometer. The methods of these measurements were previously described [9, 10].

Student's t-test was used, with p < 0.05 considered as significant.

Results

Serum Ca levels were 9.7 ± 0.3 mg/dl in normal rats and 9.0 ± 2.1 mg/dl in uraemic rats. Phosphate (Pi) levels of serum in normal and uraemic rats were 5.4 ± 0.3 mg/dl and 15.0 ± 3.0 mg/dl, respectively. Serum Al levels were 0.5 ± 0.2 µg/dl in normal rats and 8 ± 3 µg/dl in uraemic rats. Serum Si levels of normal and uraemic rats were 24.6 ± 9.0 µg/dl and 178 ± 56 µg/dl, respectively. The data are shown in Table 1. Calcium phosphate product levels in corpuscles were 750 ± 119 in normal rats and 1144 ± 251 in uraemic rats. Calcium phosphate product levels in renal tissue of normal and uraemic rats were 0.1 ± 0.04 and 0.2 ± 0.2, respectively (Table 2).

Table 1

Concentrations of calcium (Ca), phosphate (Pi), aluminum (Al) and silicon (Si) in serum of normal and uraemic rats

<table>
<thead>
<tr>
<th></th>
<th>Ca (mg/dl)</th>
<th>Pi (mg/dl)</th>
<th>Al (µg/dl)</th>
<th>Si (µg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal rats</td>
<td>10.1</td>
<td>5.3</td>
<td>0.5</td>
<td>13.6</td>
</tr>
<tr>
<td></td>
<td>9.7</td>
<td>5.2</td>
<td>0.7</td>
<td>24.6</td>
</tr>
<tr>
<td>Mean ± S.D.</td>
<td>9.7 ± 0.3</td>
<td>5.4 ± 0.3</td>
<td>0.5 ± 0.2</td>
<td>24.6 ± 9.0</td>
</tr>
<tr>
<td>Uraemic rats</td>
<td>12.9</td>
<td>18.6</td>
<td>8</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>9.0</td>
<td>12.2</td>
<td>8</td>
<td>149</td>
</tr>
<tr>
<td>Mean ± S.D.</td>
<td>9.0 ± 2.1</td>
<td>15.0 ± 3.0</td>
<td>8 ± 3</td>
<td>178 ± 56</td>
</tr>
</tbody>
</table>

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