Allied Health Sciences

Vitamin D Deficiency in the Morbidly Obese

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Although vitamin D deficiency has been well-documented following gastric bypass surgery, there are few studies of vitamin D status in the non-operative morbidly obese patient. We examined 25-hydroxyvitamin D (25-OHD) levels in 60 morbidly obese pre-operative females; 62% of them had 25-OHD levels below normal range (16–74 ng/ml) which were not associated with reductions in serum calcium or phosphorus, liver or kidney dysfunction, and were not significantly correlated to patients' age. However, 25-OHD levels were significantly ($p < 0.0001$) and negatively correlated to body mass ($r = -0.49$). These data suggest that low vitamin D may be associated with obesity per se. Hypovitaminosis D, when it is found in post-bariatric surgery patients, may not be caused by the surgery since it may have been present to some degree pre-operatively.

Key words: Obesity, pre-operative, 25-hydroxyvitamin D.

Introduction

Vitamin D deficiency has been reported in patients following malabsorptive types of bariatric surgery such as jejunoileal bypass. However, the vitamin D status of the non-operated morbidly obese individual remains unclear. We have hypothesized that a high percentage of pre-operative morbidly obese patients are vitamin D deficient and have tested this hypothesis by examining 25-hydroxyvitamin D (25-OHD) levels pre-operatively in a series of patients.

Subjects and Methods

Sixty morbidly obese females, ages 16–61, 87–184 kg total body weight, had blood samples drawn and anthropometrics determined on the day of their initial office history and physical examination. Blood samples were collected for measurement of 25-hydroxyvitamin D (25-OHD), calcium, phosphorus, alkaline phosphatase, serum glutamic oxaloacetic transaminase (SGOT), and gamma-glutamyl transferase (GGT). All measurements were obtained between the months of October to March. At the time of the study, none of the subjects were under supervised dietary regimens nor, to our knowledge, receiving any vitamin supplements.

Patients were considered to have vitamin D deficiency if their levels of serum 25-OHD were below the range of normal values established by our laboratories, i.e. 16–74 ng/ml. All indices examined in the vitamin D deficient and non-deficient groups were expressed as the mean ± SEM, with statistical calculations based on the unpaired Student’s t-test. Linear regression analysis was used to study the relationships between 25-OHD and certain possible influences, i.e. age, liver function, body mass.

Results

Of 60 morbidly obese patients studied (Figure 1), 23 women, 38% of the total, had 25-OHD levels within the normal range. However, 37 patients, 62% of the total, had 25-OHD levels below normal values, confirming our hypothesis that, in the morbidly obese, there is a high incidence of vitamin D deficiency. When patients were grouped according to their vitamin D status (Figure 2), the mean value of 25-OHD of the deficient group was found to be $60\%$ below that of patients with normal values, i.e. $10.2 \pm 0.55$ vs $22.3 \pm 1.2$ ng/ml for the deficient and non-deficient groups, respectively. It is of further interest that the mean 25-OHD of 22 ng/ml in the non-deficient group was in the lower quartile of the range of normal controls (16–74 ng/ml). These findings would suggest...
that low vitamin D may be associated with morbid obesity per se.

Table 1 reports the mean ± SEM of the various indices measured in the vitamin D deficient and non-deficient patients. Both groups of subjects were similar with regard to age and there were no significant differences between them for serum calcium and phosphorus, alkaline phosphatase, SGOT, or GGT. These values were within the respective normal range in both deficient and non-deficient patients. The only significant difference observed between the two groups of study subjects, aside from their 25-OHD levels, was body mass. The mean BMI of morbidly obese patients with vitamin D deficiency was approximately 20% above that of the patients whose 25-OHD fell within the normal range.

In an attempt to identify factors associated with low vitamin D in morbidly obese patients, we examined, by regression analysis, the interrelationship between 25-OHD and the various indices reported in Table 2. As can be seen, 25-OHD levels of our study population were not significantly correlated with age nor those various enzyme levels which might suggest liver dysfunction, i.e. GGT, SGOT, or alkaline phosphatase. However, as reported, 25-OHD levels in all study subjects were significantly (p < 0.01) and negatively (r = 0.49) correlated with body mass index, suggesting that individuals with exceptionally large body mass may be more prone to develop a low 25-OHD.

**Discussion**

In the present study, we found that a large percentage of pre-operative morbidly obese women are vitamin D deficient. In general, vitamin D deficiency may occur secondary to insufficient dietary intake, intestinal malabsorption,\(^1\-\(^1\) reduced exposure to sunshine,\(^1\)\(^2\) or to a reduction in hepatic hydroxylation.\(^1\)\(^6\)\^-\(^1\)\(^7\) With the

![Diagram](image_url)

**Figure 1.** Incidence of vitamin D deficiency in morbidly obese females (n = 60). Solid = deficient; diagonal = non-deficient.

![Graph](image_url)

**Figure 2.** 25-hydroxyvitamin D (25-OHD) levels of vitamin D deficient and non-deficient patients.

* p < 0.01

**Table 1.** Vitamin D deficient vs non-deficient*

<table>
<thead>
<tr>
<th>Indices</th>
<th>Deficient (n = 37)</th>
<th>Non-deficient (n = 23)</th>
<th>Normal range</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (kg/m(^2))</td>
<td>50.8 ± 1.8(\dagger)</td>
<td>42.3 ± 1.1</td>
<td>N/A</td>
</tr>
<tr>
<td>Age (years)</td>
<td>36.5 ± 1.8</td>
<td>34.9 ± 2.2</td>
<td>N/A</td>
</tr>
<tr>
<td>Calcium (mg/dl)</td>
<td>9.4 ± 0.09</td>
<td>9.5 ± 0.1</td>
<td>8.6-10.6</td>
</tr>
<tr>
<td>Phosphorus (mg/dl)</td>
<td>3.4 ± 0.09</td>
<td>3.5 ± 0.1</td>
<td>2.5-4.5</td>
</tr>
<tr>
<td>Alkaline phosphatase (U/L)</td>
<td>68.5 ± 3.8</td>
<td>61.1 ± 3.3</td>
<td>30-115</td>
</tr>
<tr>
<td>SGOT (U/L)</td>
<td>19.9 ± 1.4</td>
<td>20.9 ± 1.9</td>
<td>0-40</td>
</tr>
<tr>
<td>GGT (U/L)</td>
<td>25.9 ± 3.1</td>
<td>23.5 ± 4.5</td>
<td>0-30</td>
</tr>
</tbody>
</table>

* Values = mean ± SEM
\(\dagger\) p < 0.01