ACID AND ALKALINE PHOSPHATASE ACTIVITY IN BONE-CYST FLUID

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The acid and alkaline phosphatase activity in fluid aspirated from solitary bone cysts in six patients was measured, and large increases in the concentration of acid phosphatase were found. In some cases this increase was reflected in venous blood concentrations. The significance of these findings for the pathogenesis and the management of solitary bone cyst is discussed.

Acid and alkaline phosphatase are enzymes of the hydrolase group. They have very similar catalytic functions and structures, but act within different ranges of pH.

Acid phosphatase is active from pH 4.5 to 6.1. Current theory in relation to bone metabolism is that the enzyme is synthesised in osteoclasts and is an indicator of bone degradation. It is found in growth zones and in fractures, and also in osteocytes and osteoblasts after stimulation by parathormone (Gossner and Schwabe 1971). Using histochemical and quantitative tests, Jeffre (1972) found intense acid phosphatase activity in the mononuclear cells of osteoclastomas and suggested a relationship between the enzyme activity and the onset of the tumour.

Alkaline phosphatase is active from pH 8.4 to 10.5, and is an indicator and an important factor in osteogenesis. It appears to act by catalysing the breakdown of phosphate compounds to produce high local concentrations of phosphate ions, leading to the precipitation of phosphates on collagen to mineralise new bone matrix (Kuhlman and Downs 1963; Berkeš and Tomašević-Berkeš 1975).

The importance of these enzymes in the morphogenesis of bone tissue is clear, but their role in bone destruction is not fully understood.

The pathogenesis of a solitary bone cyst is uncertain; the electrolyte and protein levels in the fluid have been reported (Cohen 1960), but we have been unable to find reports of the levels of enzymes. We have investigated these in six patients with solitary cysts, and report the results from a lesion which amounts to an accessible area of bone destruction starting within a growth zone.

PATIENTS AND METHODS

We selected six patients from those who, between 1981 and 1986, were having primary treatment by injection of methylprednisolone acetate (Depo-Medrol, Upjohn). From each patient a specimen of fluid was taken from the cyst by transcunaneous puncture before treatment, and also a specimen of peripheral venous blood.

The level of activity of both enzymes was determined in both specimens, at pH 4.8 for acid phosphatase and pH 10.5 for alkaline phosphatase. We used the 30-minute Bessey–Lowry–Brock method at 37°C with sodium para-nitrophenylphosphate (Boehringer) as a substrate. Results were expressed in nanocatalys for acid (1 iu = 16.67 nanocatalys), and microcatalys for alkaline phosphatase.

RESULTS

In all cases there was a high level of acid phosphatase in the cyst fluid (Table I) and levels at or just above the upper limit of normal in the venous blood specimen. The higher activity of acid phosphatase in cystic fluid compared with that in venous blood is shown in Figure 1. The patients are listed according to age; the first was six years old and the last was twelve and a half years old. Values were lower in the oldest patient, but the mean values were significantly greater than those for venous blood (Student’s t-test).

Alkaline phosphatase levels are shown in Table II and Figure 2. There was a much lower elevation of concentration in cyst fluid, being significantly above the normal serum value only in one case. Levels were normal in the oldest patient of the series.
DISCUSSION

We found a ten-fold increase in acid phosphatase levels in cyst fluid over the normal value for venous blood. The level in venous blood exceeded normal values in only three cases, but that did seem to be related to a high level within the cyst. There was much less increase in values for alkaline phosphatase, but this too seemed to be reflected in blood values.

Table I. The activity of acid phosphatase in cystic fluid and venous blood measured in nanocatal

<table>
<thead>
<tr>
<th>Patient</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Mean ± s.e.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cystic fluid</td>
<td>1202</td>
<td>2924</td>
<td>2190</td>
<td>2405</td>
<td>2614</td>
<td>396</td>
<td>1955 ± 392.7</td>
</tr>
<tr>
<td>Venous blood</td>
<td>80</td>
<td>275</td>
<td>197</td>
<td>244</td>
<td>190</td>
<td>90</td>
<td>179.3 ± 32.46</td>
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</tbody>
</table>

Table II. The activity of alkaline phosphatase measured in microcatal

<table>
<thead>
<tr>
<th>Patient</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Mean ± s.e.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cystic fluid</td>
<td>2.34</td>
<td>7.2</td>
<td>20.6</td>
<td>3.9</td>
<td>4.42</td>
<td>1.09</td>
<td>6.59 ± 2.45</td>
</tr>
<tr>
<td>Venous blood</td>
<td>1.50</td>
<td>2.41</td>
<td>3.88</td>
<td>1.6</td>
<td>1.9</td>
<td>1.015</td>
<td>2.03 ± 0.86</td>
</tr>
</tbody>
</table>

The increased concentration of acid phosphatase may be related to bone destruction by osteoclastic activity in the walls of the cyst, but the mechanism is uncertain, particularly whether osteoclastic activity initiates bone destruction, or only attacks previously damaged bone structure. Since acid and alkaline phosphatase differ only in the pH in which they act, their relative relationship to bone destruction and osteogenesis will depend on the acidity of the local tissues. The cause for the marked acidosis which is required for acid phosphatase activity remains uncertain, and the fluid within the cyst does not show such a marked acidosis. The role of the lysosomal enzymes which are also found in osteoclasts may be important, but difficult to separate from that of acid phosphatase.

Our results indicate that it may be possible to estimate the activity of solitary bone cysts and thereby to choose the most appropriate management. They also contribute to the understanding of the pathogenesis of this and similar condition.

REFERENCES


