Roentgenographic Bone Changes in Chronic Iron Deficiency Anemia

A Study in Twelve Patients

By MUZAFFER AKSOY, NECDET ÇAMLI AND SAKIR ERDEM

Bone changes similar to those occurring in Cooley's anemia and observed in chronic iron deficiency anemia were first described by Reimann in 1956. He noted striking alterations, particularly in the skull and also in short and long bones, due to erythroid hyperplasia of the bone marrow. According to Reimann, these changes were never so pronounced as in Cooley's anemia.

In 1958 Eng described bone changes in the skull of a 12-year-old Indonesian girl with chronic iron deficiency anemia. The skull changes very much resembled those found in Cooley's anemia or related congenital hemolytic anemias. Following Eng's communication, several reports appeared describing bone changes confined to the skull, similar to those found in Cooley's anemia. For instance, in 1960 Shahidi and Diamond reported skull changes in three infants with iron deficiency anemia, and Britton et al. described skull changes in five children. In addition to these, in 1961 Moseley reported skull changes in a 3-year-old Puerto Rican boy, and Burko and his associates described seven Negro children with similar skull alterations. Prasad et al. described a syndrome of iron deficiency anemia, hepatosplenomegaly, hypogonadism, dwarfism and geophagia in 11 males from Iran. Some of these patients also showed skull alterations similar to those described above.

Contrary to the findings of Reimann, no long and short bone changes were radiographically demonstrated in the cases of iron deficiency anemia reported by the investigators mentioned above.

Taking into consideration the presence or absence of long and short bone changes in chronic iron deficiency anemia, we decided to perform an x-ray study among the patients with chronic iron deficiency anemia.

Material

Our series of chronic iron deficiency anemia consisted of 11 males and one female from 8 to 41 years of age. The clinical and laboratory data of significance are tabulated in Table 1. The serum iron levels were below the normal range, varying between 10 and 63 gamma percent in all patients. In order to rule out the possibility of thalassemic syndromes, a careful hemoglobin analysis was performed, including determinations of...
Table 1.—Some Clinical and Hematologic Findings in Twelve Patients with Chronic Iron Deficiency Anemia

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (years)</th>
<th>Duration (years)</th>
<th>Etiologic Factor</th>
<th>RBC (10^9 cu. mm.)</th>
<th>Hb (Gm. %)</th>
<th>Hct. (%)</th>
<th>MCV (μm)</th>
<th>MCHb (γγ)</th>
<th>Serum Iron (γ γ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24</td>
<td>Ch.</td>
<td>N.</td>
<td>3.10</td>
<td>6.4</td>
<td>23</td>
<td>74</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>41</td>
<td>12</td>
<td>Bleeding</td>
<td>3.00</td>
<td>5.7</td>
<td>23</td>
<td>77</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>13</td>
<td>Ch.</td>
<td>N.</td>
<td>4.00</td>
<td>5.6</td>
<td>30</td>
<td>75</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>Ch.</td>
<td>N.</td>
<td>3.20</td>
<td>4.3</td>
<td>25</td>
<td>77</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>25</td>
<td>12</td>
<td>N.</td>
<td>2.40</td>
<td>4</td>
<td>18</td>
<td>75</td>
<td>16.5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>8</td>
<td>Ch.</td>
<td>N.</td>
<td>1.80</td>
<td>3</td>
<td>12</td>
<td>60</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>12</td>
<td>Ch.</td>
<td>N.</td>
<td>2.60</td>
<td>4.8</td>
<td>21</td>
<td>80</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>16</td>
<td>?</td>
<td>Hypermenorrhoe</td>
<td>3.80</td>
<td>5.1</td>
<td>30</td>
<td>78</td>
<td>13.3</td>
<td></td>
</tr>
</tbody>
</table>

Ch.: Since early childhood.
Hct.: Hematocrit.
N.: Nutritional.
Abs.: Absorption.

Table 2.—Roentgenographic Bone Changes in Twelve Patients with Chronic Iron Deficiency Anemia

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Skull</th>
<th>Elbow</th>
<th>Knee</th>
<th>Hands</th>
<th>Pelvic Bones</th>
<th>Vertebra</th>
<th>Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>++</td>
<td>X</td>
<td>+</td>
<td>-</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>++++</td>
<td>-</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>4</td>
<td>++</td>
<td>++++</td>
<td>-</td>
<td>++++</td>
<td>-</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>+</td>
<td>++++</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>7</td>
<td>++</td>
<td>++</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>-</td>
<td>++</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>9</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Oc.:

<table>
<thead>
<tr>
<th>Case No.</th>
<th>X: Not performed.</th>
<th>Oc: Occipital.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>±</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Results and Comments

The results of radiologic bone study in twelve patients with chronic iron deficiency anemia are summarized in Table 2. The bone changes which were
Radiologically demonstrated in 12 patients with chronic iron deficiency anemia are similar to those found in Cooley’s anemia (thalassemic syndromes) or related congenital hemolytic anemias. Before comparing the bone changes in chronic iron deficiency anemia with those of Cooley’s anemia, we will summarize the results of x-ray study in our 12 patients.

Skull

The widening of the diploic space, marked trabecular striation of mild to moderate degree, and generalized granular osteoporosis were found in five out of 12 patients (Fig. 1). In two patients the widening of the diploic space was observed in the frontal, parietal, and occipital regions; in the remaining three patients the bone changes were confined to the occipital region. In two of these five patients marked trabecular striation was noticed. None of these five patients have shown “hair standing on end” appearance and swelling of the facial bones with retardation of the pneumatization of the maxillary sinuses as occur in severe Cooley’s anemia. Furthermore, in one of our patients (case 10) who showed the most pronounced and generalized bone changes in the skeletal system, no evident abnormalities concerning the skull were demonstrated (Fig. 2).
Fig. 2.—This is the skull of a patient with chronic iron deficiency anemia (case 10) who showed the most pronounced and generalized bone changes in the skeletal system. No evident bone changes were found in the skull. There was only a mild thickening of the occipital bone.

Bones of the Elbow

In 11 out of 12 patients with chronic iron deficiency anemia, osseous changes such as osteoporosis and coarse trabecular striation of varying degrees were noticed (Fig. 3). In some of these patients osteoporosis was very marked, giving the impression of honeycomb pattern. According to the results obtained in the present study, the osseous changes in the bones of the elbow are the most frequently encountered roentgenographic finding in chronic iron deficiency anemia.

Bones of the Knee

Roentgenograms of the knee were taken in 10 out of 12 patients. Only five of them showed osteoporosis with coarsened trabeculae (Fig. 4).

Bones of the Hands

In nine of 11 patients studied, demonstrable osseous alterations of varying degree were found in the bones of the hands. The coarsened trabeculae were observed in the metacarpals and phalanges, giving in some cases the impression of the mosaic pattern (Fig. 5).
Pelvic Bones

The roentgenographic examinations of the pelvic bones were performed in 11 patients. Eight patients had normal roentgenograms. In two of the remaining three a mild degree of osteoporosis was noticed. One patient with chronic iron deficiency anemia showed a very severe degree of osteoporosis of all pelvic bones (Fig. 6).

Vertebral Bodies

Only in three out of 10 patients studied have osseous alterations of varying degrees in the lumbar vertebral bodies been found. In addition to that in one patient (case 10) who showed a generalized and severe osteoporosis of the skeletal system, the 5th lumbar vertebral body appeared to be slightly flattened (Fig. 7).

Bones of the Foot

There was a generalized osteoporosis with coarsened trabeculae in the bones of the foot in three out of seven patients studied (Fig. 8). In addition to these, the roentgenographic findings of infantilism and hypogonadism have been found in three patients; two of them were reported elsewhere.9

The bone changes which were radiographically demonstrated in the present series of 12 patients with chronic iron deficiency anemia were similar to those in thalassemic syndromes or in congenital hemolytic anemias. On the other
hand, there were significant differences between the roentgenographic findings of our patients with chronic iron deficiency anemia and those of the cases published by other investigators.2-8 As mentioned above, these investigators reported several cases of iron deficiency anemia with skull changes without involvement of the long and short bones. This fact was particularly emphasized by some investigators dealing with this problem.2,6 As Moseley stated: "On the basis of our experience and the descriptions of all cases published to date the absence of facial bone involvement and more particularly, the absence of long bone changes differentiate the roentgen bone changes of iron deficiency anemia from other conditions."

Fig. 4.—Film of the knee of a patient with chronic iron deficiency anemia (case 10), showing marked osteoporosis with coarsened trabeculae.
Fig. 5.—The roentgenogram of the hands of a patient with chronic iron deficiency anemia (case 10), showing marked osteoporosis with coarsened trabeculae in the metacarpals and phalanges.

Fig. 6.—Film of the pelvis of a patient with chronic iron deficiency anemia (case 10), showing marked osteoporosis with coarsened trabeculae.
Fig. 7.—The roentgenogram of the lateral spine of a patient with chronic iron deficiency anemia (case 10), showing marked osteoporosis.

anemia from those of severe Cooley’s anemia in infants and young children.”

Contrary to these findings, in this study of chronic iron deficiency anemia the roentgenographic changes were found not only in the skull but particularly in the long and short bones. According to the findings obtained in the present study we may conclude that the areas which show the most changes in iron deficiency anemia are the short and long bones. As can be seen from Table 2, although five patients of the present study showed some radiologic skull changes, all patients presented certain roentgenographic alterations in the long
or short bones. This finding is clearly evident in case 10. Although the patient showed the most severe and generalized radiologic bone alterations of the skeleton, the skull changes were insignificant (Fig. 2). From this standpoint, there is a remarkable difference between the roentgen findings of the present study and those of the cases published by other investigators. On the other hand, Reimann has noticed that the radiologic alterations in iron deficiency anemia have been found in the skull as well as in the long and short bones. From this standpoint our roentgen findings are in accordance with those of Reimann.

As Moseley pointed out, there is a marked variation in the roentgen findings...
in the skulls as well as in the long and short bones of the patients with chronic iron deficiency anemia. We have encountered several cases of chronic iron deficiency anemia of very severe degree without bone changes as mentioned above. On the other hand, we were not able to compare the roentgen findings obtained in the present study with those of post-iron treatment. In one patient only (case 10), approximately one year after iron treatment no significant changes were found in the roentgen findings of the skeleton.

As in congenital hemolytic anemias, the abnormalities in the skull and long and short bones of the patients with chronic iron deficiency anemia are thought to be the result of bone marrow hyperplasia which has its onset in early childhood. We think that dietary deficiency of amino acids and minerals necessary for bone formation also plays a role as a contributory factor in the development of osseous changes seen in our cases of chronic iron deficiency anemia.

SUMMARY
Radiologic bone changes of the skull and long and short bones similar to those of thalassemia are described in 12 patients with chronic iron deficiency anemia. Certain differences between the roentgen findings of the present study and those of the cases reported by other investigators are discussed.

SUMMARY IN INTERLINGUA
Radiologic alterationes ossee del cranio e del longe e breve ossos simile a illos de thalassemia esseva observate in 12 patientes con chronic anemia a carentia de ferro. Certe differentias inter le constatationes roentgenographic in le presente studio e illos del casos reportate per altere investigatores es commentate.

REFERENCES
Roentgenographic Bone Changes in Chronic Iron Deficiency Anemia: A Study in Twelve Patients

MUZAFFER AKSOY, NECDET ÇAMLI and SAKIR ERDEM