Metaphyseal growth arrest lines in psychosocial short stature

V V Khadilkar, F L Frazer, D H Skuse, R Stanhope

Abstract
Metaphyseal growth arrest lines are seen in children who experience significant physical stress such as infection or malnutrition over a sufficient period of time. These lines have not been reported previously in children with psychosocial short stature (PSS). Two boys and a girl with PSS with metaphyseal growth arrest lines on skeletal radiographs at the time of maximal stress in their homes are described. All three had reversible growth hormone insufficiency during admission, which is pathognomonic for PSS. Multiple growth arrest lines in the distal end of the radius or vertebrae should alert clinicians to an alternative diagnosis in a child with growth hormone insufficiency. This may provide a clue to the diagnosis of occult PSS.

Keywords: psychosocial short stature; linear growth; growth arrest lines

Opaque transverse lines in the metaphyses of growing long bones (Harris's lines) are found in children with a variety of clinical disorders.1 Marginal lines of increased density in the round and flat bones, such as the vertebrae, develop under the same circumstances. Such lines have even been observed in Egyptian mummies.2 They have been reported in a variety of childhood conditions such as malnutrition,3 infections,4 hypothyroidism,5 hypoparathyroidism,6 Cushing's syndrome,7 juvenile chronic arthritis,8 and during chemotherapy for malignancies in childhood.9–10 They have also been reported with immobilisation of extremities during orthopaedic procedures.1 PSS is a condition where growth failure occurs, particularly in children who are involved with child protection services because of suspected physical abuse and neglect. At initial assessment he was noted to have developmental delay, moderate hearing loss, and behavioural difficulties including encopresis. He had a history of hyperphagia and stealing food from the refrigerator at home, and was described as "always hungry".

Table 1

<table>
<thead>
<tr>
<th>Case</th>
<th>Age (years)</th>
<th>Height SDS</th>
<th>Height velocity SDS</th>
<th>BMI SDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.3</td>
<td>−3.3</td>
<td>−5.3</td>
<td>+2.5</td>
</tr>
<tr>
<td>2</td>
<td>5.4</td>
<td>−4.2</td>
<td>−1.3</td>
<td>+0.5</td>
</tr>
<tr>
<td>3</td>
<td>7.7</td>
<td>−2.9</td>
<td>−0.3</td>
<td>+0.8</td>
</tr>
</tbody>
</table>

SDS, standard deviation score.

Table 2
Peak growth hormone concentrations achieved following glucagon stimulation tests in three children with psychosocial short stature

<table>
<thead>
<tr>
<th>Case</th>
<th>Initial</th>
<th>At the end of 3 week admission</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.5</td>
<td>107.0</td>
</tr>
<tr>
<td>2</td>
<td>8.6</td>
<td>30.6</td>
</tr>
<tr>
<td>3</td>
<td>10.8</td>
<td>23.0</td>
</tr>
</tbody>
</table>

Growth hormone insufficiency or panhypopituitarism has been reversed in children with hyperphagic PSS when they are removed from their stressful home environment.12 We report three cases of PSS with bilateral metaphyseal growth arrest lines at multiple sites on skeletal surveys at the time of maximal stress in their homes. Skeletal surveys were performed at the time of admission to the endocrinology ward at Great Ormond Street Hospital, London, UK to exclude non-accidental injury. No radiological evidence was found for non-accidental injury. None of the children had a history of malnutrition, supported by body mass index data (table 1). All other biochemical and endocrine investigations were normal. We showed reversible growth hormone insufficiency in all three children during their three week admission, pathognomonic of the condition (table 2).
Case 1

This girl was born at 41 weeks' gestation with a birthweight of 3936 g. Her younger sibling had died of suspected sudden infant death syndrome. Our patient had a history of physical abuse, developmental delay, and suspected PSS with hyperphagia. She stole food and was described as constantly hungry. We found reversible growth hormone insufficiency during admission. A skeletal survey showed five growth arrest lines at the end of all the long bones (Fig 2) as well as the characteristic "bone within bone" appearance within vertebrae. At 5.5 years old she was placed in foster care with improvement in growth velocity. At 6.2 years old she was returned to her biological parents and her growth velocity decreased. At 6.8 years old she was returned to foster care with contemporaneous catch up growth and resolution of hyperphagia; at 9 years old she was adopted.

Figure 1 Growth data from case 1. The horizontal bar represents the time in foster care; the squares represent bone age. Maternal (M) and paternal (F) heights are shown.

Discussion

The diagnosis of PSS is based on reversible growth failure and pituitary dysfunction before and after the removal of a child from an adverse environment. All three children had such an environment, growth failure, reversible growth hormone insufficiency, and multiple metaphyseal growth arrest lines.

Our observation of metaphyseal growth arrest lines in PSS has not previously been reported. Metaphyseal growth arrest lines are seen in children with a variety of diseases but the exact mechanism remains uncertain. They appear to form whenever there is sufficient stress over a long enough time period, such as starvation or severe, chronic illness. It is assumed that acute injury and illness are a threat to survival similar to malnutrition, and that mechanisms concerned with production and modification of growth stimulating factors at the growth plate of bones are inhibited. The mechanism in PSS is also related to varying intensities of abuse and stress spread over time, so that periods of stress and recovery are likely to alternate.

The clinical assessment of children with growth failure usually involves a wrist x-ray to

Case 2

This patient was the first born child of parents with severe mental illness. He was delivered full term with birth weight 3360 g. He was adopted at 1 year. In his adoptive family he was the youngest child with two older sisters. He suffered emotional abuse and possible physical abuse. At 8 years old he was referred because of short stature. Tests showed growth hormone insufficiency and he was started on growth hormone treatment. He had a suboptimal response with failure to increase height velocity to expected levels. His adoptive parents and school teachers gave a history of disruptive and aggressive behaviour. He had a normal eating pattern. There was no history of enuresis or abnormal sleep behaviour. At 11.7 years old he was admitted to hospital for endocrine reassessment. Skeletal survey showed multiple metaphyseal growth arrest lines at the ends of each radius. Growth hormone treatment was continued at a dosage of 20 U/m²/week. Growth velocity improved at 13 years of age after his home environment improved following separation of his adoptive parents and intervention of social services.

Figure 2 Radiograph of the distal tibia and fibula from case 2 with psychosocial short stature. Multiple growth arrest lines are seen in the metaphyses.
estimate epiphyseal maturation; such children may also have a skeletal survey to exclude skeletal dysplasia or non-accidental injury. Multiple growth arrest lines in the distal end of the radius or vertebrae should alert the clinician to an alternative diagnosis in a child with growth hormone insufficiency. This may provide a clue to the diagnosis of occult PSS.15

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