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Growth in childhood thyrotoxicosis

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Abstract Childhood thyrotoxicosis is an uncommon condition. To investigate the effect of thyrotoxicosis on the growth of children and to detect possible influence of the disease on their final height, 105 Chinese children (90 girls; 15 boys) with thyrotoxicosis were studied longitudinally from diagnosis. At presentation their mean age was 11.57 years. Their height and weight measurements were converted to standard deviation scores (SDS) using normal height and weight-for-height reference standards for Chinese children established in Hong Kong. Their mean height SDS at diagnosis was +0.73. Bone age assessment at diagnosis was done in 48 girls and 8 boys and their mean ± S.D. bone development quotient was 1.16 ± 0.11. A total of 53 girls have reached adult height and their mean height was 161.3 cm, corresponding to a SDS of +0.63. Their final heights significantly exceeded their target heights.

Conclusion This study demonstrates that children with thyrotoxicosis were tall for age and their bone ages were advanced at presentation. They continued to be tall for age after starting treatment and they achieved final heights exceeding their target height.

Key words Childhood · Thyrotoxicosis · Growth

Abbreviation SDS standard deviation score

Introduction Thyrotoxicosis is an uncommon condition affecting children and adolescents. The presence of excess circulating thyroid hormone during the neonatal and early childhood periods has been documented to cause premature craniosynostosis [4, 7]. Accelerated bone maturation and growth velocity in children with thyrotoxicosis have also been reported [8]. There are, however, only a few reports of the effect of thyrotoxicosis on final height [1, 2, 9]. Only one report attempted to compare the final heights of affected children with their target heights [2]. All these reports are limited by their small number of subjects because childhood thyrotoxicosis is relatively rare precluding definite conclusions of the effect of childhood thyrotoxicosis on final height.

In order to investigate the effect of thyrotoxicosis on the growth of children at presentation as well as the possible influence of the disease on their final height, 105 Chinese children with thyrotoxicosis were studied. They were followed and assessed longitudinally since diagnosis. For those who had reached adult height, we compared their final heights with their target heights as estimated by their mid-parental heights.
Patients and methods

Subjects

We reviewed all cases of childhood thyrotoxicosis presenting to our centre since 1986. A total of 105 children and adolescents with thyrotoxicosis were studied. All patients were Chinese and they were under 15 years of age at diagnosis. The diagnosis of thyrotoxicosis was based on clinical features, diffuse enlargement of the thyroid gland, raised free thyroxine or tri-iodothyronine levels, along with suppressed thyroid-stimulating hormone levels and the presence of thyroid auto-antibodies. Subjects with transient neonatal hyperthyroidism were excluded. There were 90 girls and 15 boys. All patients were treated initially with propylthiouracil or carbimazole for 18 to 24 months before attempting withdrawal or weaning off the antithyroid medication. Of these, 26 patients (22 girls and 4 boys) were in remission and they had been off treatment for at least 12 months. Two girls underwent thyroidectomy after 4 and 5 years of medical treatment because they could not be weaned off the antithyroid drug and their thyroid glands were quite large. The mean period of follow up was 5.04 years (range 0.74–13.8 years).

Measurements

All patients were measured and weighed at diagnosis and every 3–4 months during the follow up period. Standing heights were measured by a wall-mounted stadiometer using the Tanner method [5, 6]. Weights were measured by Seca digital physician’s scale. The data were then converted to standard deviation scores (SDS) using the normal height and weight-for-height reference standards for Chinese children established in Hong Kong [5, 6]. The parents of the patients were also measured with the stadiometer. Target heights were calculated based on the formula: (father’s height + mother’s height ± 12)/2 in centimeters. Bone age was estimated according to Tanner et al. [10]. This method has been validated to be applicable to skeletal maturation assessment in Chinese children [3, 11]. Bone development quotient was calculated by dividing the bone age by the chronological age as a measure of advancement or retardation of bone maturation. Subjects were considered to have reached their final heights if their annual growth velocity dropped below 2 cm. The corrected target height for female subjects equals the target heights plus 2.7 cm because there has been a secular height increase of 2.7 cm in women over the past 30 years [6].

The study was approved by the Ethics Committee of the Chinese University of Hong Kong. Informed parental consent was obtained from all participating subjects.

Results

At diagnosis, the mean age of the subjects was 11.57 years (range 2.71–14.93 years). Twenty-seven girls and 5 boys were prepubertal at presentation. The mean height and weight-for-height SDS at presentation are shown in Table 1. At presentation, the mean height SDS (S.D.) was +0.73 (1.02) and +0.73 (0.98) for girls and boys, respectively, indicating that they were tall for their age. Bone age was assessed in 48 girls and 8 boys at presentation. Their mean age, mean bone age and bone development quotient are summarized in Table 2. The mean ± S.D. bone development quotient was 1.16 ± 0.11 with a mean bone age advancement of 1.84 years. Their bone ages were statistically significantly greater than their chronological ages (paired t-test, $P < 0.001$).

Figure 1 shows the changes of height SDS of girls during the first 3 years of treatment since diagnosis. Their height SDS remained positive throughout the treatment period. Figure 2 shows the weight-for-height SDS of girls during the same follow up period. Those girls who were prepubertal at diagnosis had significantly lower weight-for-height SDS at presentation (unpaired t-test, $P = 0.0003$) and at 1 year after treatment ($P = 0.014$) than girls who were pubertal. Similar analyses of boys were not performed due to the small number of patients.

Adult height was achieved in 53 girls who were postmenarchal for at least 2 years. Only 11 girls (21%) were in remission and off medication for at least 12 months. The mean (S.D.) final height was 161.3 (5.7) cm, which corresponds to a SDS of +0.63 for adult Chinese women. Their mean target height was 155.6 cm (SDS = −0.51) and their mean corrected target height (= target height + 2.7) was 158.3 cm (SDS = 0). Their final heights exceeded significantly their corrected target heights (paired t-test, $P < 0.0001$). Out of 53 girls, 46 (87%) had final heights in excess of their corrected target heights. As they reached adult height, their mean (S.D.) weight-for-height SDS was +0.53 (0.75).

Discussion

Thyrotoxicosis is an uncommon condition in childhood and adolescents; therefore, there have been very few studies investigating the long-term effect of childhood

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Table 1 Age and auxological data of subjects at presentation

<table>
<thead>
<tr>
<th>Age</th>
<th>$n$</th>
<th>Mean (S.D.) Height SDS</th>
<th>Weight-for-height SDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>90</td>
<td>11.51 (2.51) 0.73</td>
<td>−0.65</td>
</tr>
<tr>
<td>Males</td>
<td>15</td>
<td>11.66 (2.14) 0.73</td>
<td>−0.74</td>
</tr>
<tr>
<td>Total</td>
<td>105</td>
<td>11.57 (2.63) 0.73</td>
<td>−0.66</td>
</tr>
</tbody>
</table>

Table 2 Bone ages of patients at presentation

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>$n$</th>
<th>Mean age ± S.D.</th>
<th>Mean bone age ± S.D.</th>
<th>Bone development quotient ± S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>48</td>
<td>11.73 ± 2.21</td>
<td>13.59 ± 2.66</td>
<td>1.16 ± 0.12</td>
</tr>
<tr>
<td>Males</td>
<td>8</td>
<td>12.50 ± 1.77</td>
<td>14.26 ± 2.21</td>
<td>1.15 ± 0.10</td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
<td>11.84 ± 2.17</td>
<td>13.68 ± 2.53</td>
<td>1.16 ± 0.11</td>
</tr>
</tbody>
</table>